Wednesday, December 04, 2013

10:30-12:00 PM • SSK01 • Arie Crown Theater • Breast Imaging (Digital Breast Tomosynthesis Screening Outcomes)
10:30-12:00 PM • SSK02 • Room: E450A • Breast Imaging: Interventional Techniques and Pathology/Pathology Correlation
10:30-12:00 PM • SSK03 • Room: S504AB • Cardiac (Coronary CT/MR IV)
10:30-12:00 PM • SSK04 • Room: S404CD • Chest (Diffuse Lung Disease)
10:30-12:00 PM • SSK05 • Room: E350 • Gastrointestinal (CT Colonography)
10:30-12:00 PM • SSK06 • Room: E350 • Gastrointestinal (Focal Liver Lesions and Metastases)
10:30-12:00 PM • SSK07 • Room: E353B • Gastrointestinal (Pancreas Benign Disease)
10:30-12:00 PM • SSK08 • Room: E353C • Gastrointestinal (Prostate Cancer: Multimodality Diagnosis and Staging of Disease)
10:30-12:00 PM • SSK09 • Room: E451B • Gastrointestinal (Invasive Imaging in Staging and Follow-up of Gynecologic Cancers)
10:30-12:00 PM • SSK10 • Room: S102D • ISP: Health Service, Policy and Research (Evidence, Guidelines and Outcomes)
10:30-12:00 PM • SSK11 • Room: S02A • ISP: Informatics (Business Analytics)
10:30-12:00 PM • SSK12 • Room: S02B • Molecular Imaging (Neurosciences)
10:30-12:00 PM • SSK13 • Room: E451A • Musculoskeletal (Shoulder II)
10:30-12:00 PM • SSK14 • Room: E228 • Musculoskeletal (Epidysplasia)
10:30-12:00 PM • SSK15 • Room: N229 • Neuroradiology/Head and Neck (Head and Neck Tumors)
10:30-12:00 PM • SSK16 • Room: N230 • Neuroradiology (Advanced Neuroimaging of Alzheimer’s Disease)
10:30-12:00 PM • SSK17 • Room: S404AB • Nuclear Medicine (PET/MRI for Oncology)
10:30-12:00 PM • SSK18 • Room: S102A • Pediatrics (Imaging)
10:30-12:00 PM • SSK19 • Room: S403A • Physics (CT-Imaging Phantoms)
10:30-12:00 PM • SSK20 • Room: S403B • Physics (Quantitative Imaging II)
10:30-12:00 PM • SSK21 • Room: S404B • Physics (Molecular Imaging)
10:30-12:00 PM • SSK22 • Room: S104A • Radiation Oncology and Radiobiology (Gastrointestinal)
10:30-12:00 PM • SSK23 • Room: E353A • Vascular/Interventional (Venous Access/Women’s Intervention)
10:30-12:00 PM • SSK24 • Room: N226 • Vascular/Interventional (GI Interventions/Topics of Interest)
10:30-12:00 PM • SSM01 • Room: S504AB • Breast Imaging (MRI Lesion Characterization)
10:30-12:00 PM • SSM02 • Room: E451A • Breast Imaging (Multiparametric Breast Imaging)
10:30-12:00 PM • SSM03 • Room: S502AB • Cardiac (Experimental and Animal)
10:30-12:00 PM • SSM04 • Room: S504B • Cardiac (Clinical Trials and Population Studies)
10:30-12:00 PM • SSM05 • Room: E350A • Chest (Thoracic Malignancy)
10:30-12:00 PM • SSM06 • Room: E353A • Gastrointestinal (CT Technique: Intravenous Contrast)
10:30-12:00 PM • SSM07 • Room: E353B • Gastrointestinal (Esophagus)
10:30-12:00 PM • SSM08 • Room: E353C • Gastrointestinal (Liver Imaging)
10:30-12:00 PM • SSM09 • Room: N226 • Gastrointestinal (Evaluation of Hematoma)
10:30-12:00 PM • SSM10 • Room: S102D • ISP: Health Service, Policy and Research (Medicolegal and Ethics)
10:30-12:00 PM • SSM11 • Room: S403A • Informatics (Image Sharing)
10:30-12:00 PM • SSM12 • Room: S404CD • Molecular Imaging (Imaging Probes)
10:30-12:00 PM • SSM13 • Room: E450A • Musculoskeletal (Ankle/Foot)
10:30-12:00 PM • SSM14 • Room: S226 • Neuroradiology (Hydrocephalus and Intracranial Hypotension)
10:30-12:00 PM • SSM15 • Room: S227 • Neuroradiology (Neuro-Oncology)
10:30-12:00 PM • SSM16 • Room: S228 • Neuroradiology (Resting State Functional Brain Imaging)
10:30-12:00 PM • SSM17 • Room: S205A • Nuclear Medicine (Comparative Technologies and Modalities)
10:30-12:00 PM • SSM18 • Room: S102AB • Pediatrics (Chest)
10:30-12:00 PM • SSM19 • Room: S228 • Physics (Quantitative Imaging III)
10:30-12:00 PM • SSM20 • Room: E450B • Physics (X-ray Imaging Techniques)
10:30-12:00 PM • SSM21 • Room: S104A • Radiation Oncology and Radiobiology (Breast)
10:30-12:00 PM • SSM22 • Room: S352 • Vascular/Interventional (Radiation Safety and Ergonomics)
10:30-12:00 PM • SSM23 • Room: E450B • Vascular/Interventional (Vascular Ultrasound)

Thursday, December 05, 2013

10:30-12:00 PM • SQQ01 • Arie Crown Theater • Breast Imaging (Ultrasound Screening)
10:30-12:00 PM • SQQ02 • Room: E450A • Breast Imaging (CAD/Quantitative Imaging)
10:30-12:00 PM • SQQ03 • Room: S504AB • Cardiac (Myocardial Ischemia and Viability)
10:30-12:00 PM • SQQ04 • Room: E350A • Chest (Radiation Dose Reduction)
10:30-12:00 PM • SQQ05 • Room: N226 • Emergency Radiology (Imaging Abdominal Emergencies)
10:30-12:00 PM • SQQ06 • Room: S350 • Gastrointestinal (Crohn's Disease)
10:30-12:00 PM • SQQ07 • Room: E350 • Gastrointestinal (Ablation and Abdominal Interventions)
10:30-12:00 PM • SQQ08 • Room: E353A • Gastrointestinal (Endoscopy and Biliary Imaging)
10:30-12:00 PM • SQQ09 • Room: E353B • ISP: Gastrointestinal (Contrast and Safety Issues Involving the GI Tract)
10:30-12:00 PM • SQQ10 • Room: S352 • ISP: Gastrointestinal (Non-Invasive Assessment of Native and Transplanted Kidneys)
10:30-12:00 PM • SQQ11 • Room: S403A • ISP: Informatics (Results and Reporting)
10:30-12:00 PM • SQQ12 • Room: S504CD • Molecular Imaging (Oncology and Subspecialties)
10:30-12:00 PM • SQQ13 • Room: E451A • Musculoskeletal (Spine)
10:30-12:00 PM • SQQ14 • Room: S228 • Neuroradiology (Advances in Brain CT Imaging)
10:30-12:00 PM • SQQ15 • Room: S228 • Neuroradiology (Cerebrovascular Imaging)
Saturday, 10:45 AM - 12:15 PM  •  Arie Crown Theater

SSQ01  •  AMRA PRA Category 1 Credit ™:1.5  •  ARRT Category A+ Credit:1.5
Moderator
Wendie A Berg, MD, PhD *
Moderator
Jung Min Chang, MD
Moderator
Regina J Hooley, MD *

SSA01-01  •  Utility of Targeted Ultrasound in the Evaluation of Breast MRI-detected Non-mass Enhancement (NME)

Adrienne R Newburg MD (Presenter) ; Chloie M Chhor MD ; Jiyon Lee MD ; Samantha L Heller MD, PhD ; Hildegard B Toth MD ; Linda Moy MD

PURPOSE
Prior studies showed the likelihood of identifying an ultrasound (US) correlate for an MRI-detected abnormality depends on lesion type. NME was less likely to be seen on US compared to a mass or focus. Targeted second-look US may result in prolonged work-up time, added expense, and false reassurance in the setting of a negative US. Our study was performed to determine the utility of targeted US and to determine how often a MRI-US discordant lesion was found.

METHOD AND MATERIALS
An IRB-approved retrospective review was performed for breast MRI examinations performed from 2005-2008. Data regarding patient demographics, MRI findings and subsequent sonographic and pathologic results were recorded. Of 2,222 breast MRI exams, 70 (3.2%) NME lesions were identified for which targeted US was recommended. An additional 85 NME lesions went directly to an MRI biopsy because the interpreting radiologist felt it unlikely that an US correlate would be seen. The rate of subsequent malignancy was analyzed.

RESULTS
Targeted US was performed in 59 of 70 (84%) women. In the remaining 11 (16%) cases, targeted US was not performed because 5 women underwent mastectomy or had metastatic disease. MRI-guided biopsy was pursued directly in 2 women and 4 women did not undergo further imaging at our institution. Mean age was 46.7 years, range was 25 to 99 years. In 14 (24%) of 59 sonograms, an US correlate was seen. An US-guided biopsy was performed in 7 (50%) of 14 cases. None yielded cancer. One of 7 (14%) yielded papillomas which were subsequently excised. One of 7 (14%) yielded atypia. Three benign biopsies were discordant with the MRI findings. At subsequent MRI biopsy, one lesion was an invasive ductal carcinoma (IDC). Forty-five of 59 (76.3%) cases had no US correlate; 15 proceeded to MRI-guided biopsy. Two (13%) yielded cancer, 1 IDC and 1 DCIS. An additional 2 (13.3%) cases demonstrated atypia/ADH. In the 11 remaining cases, pathology was benign. The cancer yield for the 85 NME lesions that went directly to MRI biopsy was 12% (12/85); 2 were IDC and 10 were DCIS.

CONCLUSION
The yield for detecting an US correlate for an MRI-detected NME is low (24%) with no detection of malignancy.

CLINICAL RELEVANCE/APPLICATION
Confident MRI-US correlation for an MRI-detected abnormality can be challenging. It may be advisable to forego targeted US and proceed directly to MRI-guided core biopsy.

SSA01-02  •  3D Breast Ultrasound: Diagnostic Yield Compared to MR Imaging and Histopathology

Mathijn D De Jong MD (Presenter) ; Gerrit J Jager MD, PhD ; Ivo Dubelaar MD ; Thomas A Fassaert MD ; Matthieu Rutten MD

PURPOSE
To prospectively assess the performance characteristics of 3D ultrasound (3DUS) for the detection and classification of breast tumors compared to breast magnetic resonance imaging (MRI) and histopathology.

METHOD AND MATERIALS
Two hundred twenty patients with an indication to undergo breast MRI provided informed consent were enrolled in an institutional review board-approved 3DUS study protocol. Patients underwent 1.5T MRI and 3DUS within 10 days. 3DUS was performed with a 5-14 MHz broadband transducer featuring harmonic imaging and compound scanning. The 3D US findings were reviewed by 2 observers independently, who were blinded for histopathological diagnoses and prior imaging findings such as mammography, hand-held 2D US and MRI. Histopathological findings or MRI with 12 months clinical follow-up were used as reference standard. Diagnostic yield, sensitivity, specificity, positive (PPV) and negative (NPV) predictive values were determined.

RESULTS
3DUS scanning was technically successful in 220 patients. One patient was excluded due to erroneous data transfer. Each breast was evaluated with 3 to 5 scans. The overall examination time was 15-20 (mean 14) minutes per patient. Mean patient age was 48 years (range 17-82). 194 and 191 benign and 43 and 46 malignant breast tumors were detected with 3D-US and MRI, respectively. In 61 patients 67 histopathological findings were available as reference standard. The sens, spec, PPV and NPV of 3D US was compared to MRI 85, 97, 91, 96, respectively, and compared to the histopathological findings 93, 96, 91, 98, respectively.
CONCLUSION
3D US is a reliable imaging technique for the detection and classification of benign and malignant breast tumors.

CLINICAL RELEVANCE/APPLICATION
3DUS can reliably be used in a clinical setting and can probably be feasible for dense breasts in a screening program.

SSA01-03 • Breast Cancer Detection with CD276-targeted Ultrasound Imaging

Sunita Bachawal PhD (Presenter); Ferdinand Kniebling; Amelie M Lutz MD; Lu Tian; Juergen K Willmann MD *

PURPOSE
CD276 has been shown to be differentially expressed in various cancers including human breast cancer. Our goal was to compare the potential of ultrasound (US) molecular imaging using microbubbles (MB) targeted to CD276 with vascular endothelial growth factor receptor type2 (VEGFR2)-targeted MB for assessment of breast tissue progression to early breast cancer in transgenic mice (FVB/N Tg (MMTV/PyMT634Mul)).

METHOD AND MATERIALS
A transgenic mouse model of breast cancer (FVB/N-Tg(MMTV-PyMT634Mul)) was used in this study. The progression of breast tissue from normal to invasive cancer was examined using US molecular imaging (Vevo2100, Visualsonics) with VEGFR2- and CD276- targeted MB in 160 mammary glands. Ex vivo expression levels of VEGFR2 and CD276 were examined using immunofluorescence staining followed by confocal microscopy.

RESULTS
There was a significant (p<0.05) difference in VEGFR2 expression between normal and invasive cancer. Combined VEGFR2- and CD276- targeted molecular imaging information can further improve accuracy of US for in vivo assessment of breast tissue progression from normal to breast cancer in this transgenic mouse model

CLINICAL RELEVANCE/APPLICATION
US molecular imaging of tumor angiogenesis using tumor specific endothelial markers in breast cancer may help improve accuracy of US in breast cancer detection in future clinical trials.

SSA01-04 • Sonographic Findings in 691 Pure Ductal Carcinoma in Situ Lesions with Histopathologic and Biologic Correlation

Marion E Scoggins MD (Presenter); Gaiane M Rauch MD, PhD; Patricia S Fox MS; Ana Paula Benveniste MD; Henry M Kuerer MD; Wei T Yang MD; Young Mi Park MD, PhD; Sara Lari; Savitri Krishnamurthy MD

PURPOSE
Sonographic (US) findings in 691 pure ductal carcinoma in situ (DCIS) lesions were retrospectively analyzed by estrogen receptor (ER) status, nuclear grade, and comedonecrosis to evaluate the prognostic value of US as an adjunct to mammography (M). A review board approved retrospective single institution database search performed for patients with pure DCIS evaluated from January 1996 to July 2009 who underwent pre-operative M and whole-breast US. Images were reviewed per ACR BI-RADS lexicon.

METHOD AND MATERIALS
Pathologic features recorded were ER status, nuclear grade, and comedonecrosis. ER+ was defined as nuclear staining in at least 1% of cells. Statistical comparisons were made using t-test, Chi-square, Fisher’s exact test, Kruskal-Wallis or Wilcoxon rank-sum test.

RESULTS
There were 1911 pure DCIS patients identified; those with incomplete data (n=5), lacking pre-operative US (n=1214) or M (n=1) were excluded leaving 691 patients for analysis. Of 691 lesions, 304 (44%) were visible on M and US, 315 (46%) visible on M only, 58 (8%) visible on US only, and 14 (2%) visible on neither M nor US. There were 425 (62%) ER+, 104 (15%) ER-, and 162 (23%) lesions with unknown ER. Comedonecrosis was present in 296 (43%) lesions, absent in 395 (57%). There were 334 (48%) non-high grade (nuclear grade I/II) lesions, 353 (51%) high-grade (III), and 4 (1%) of unknown grade. ER- lesions were more frequently visible on US than ER+ lesions (62% vs. 48%, p<0.001)

CONCLUSION
ER- DCIS is more likely visible on US than ER+ DCIS. A shadowing US mass is more frequently high grade or ER-. While a mass is the most common US finding of DCIS regardless of histopathologic features, nonmass lesions are more likely to be associated with high-grade tumors and comedonecrosis.

CLINICAL RELEVANCE/APPLICATION
A shadowing mass on US should raise suspicion for ER- DCIS which provides imaging-based prognostic and biologic information during cancer diagnosis and work-up.

SSA01-05 • Detectability and Diagnostic Performance of ABVS in Suspicious Calcifications in Comparison with Hand-held US

Eunjeong Kim (Presenter); Sung-Hun Kim MD; Chang Suk Park

PURPOSE
To prospectively evaluate the detectability and performance of automated breast US scanner and compare it with hand held breast US in suspicious calcifications on mammography.

METHOD AND MATERIALS
Forty-two patients with 43 breast lesions, scheduled for US guided or stereotactic biopsy for suspicious calcifications on mammography, underwent automated breast US and hand-held US examination. Two radiologists reviewed the automated breast US data in consensus. A radiologist who had not performed the hand-held US examination reviewed hand-held US data.

RESULTS
Among 43 lesions, 25 (58.1%) were malignant and 18 (41.9%) were benign. Detection on ABVS was more frequent than mammography; malignant vs. benign (96.0% [24/25] vs. 44.4% [8/18], p<0.002), of maximal extent more than 10mm (86.7% [26/30]) vs. 46.2% [6/13], p=0.009, or lesions with fine pleomorphic or fine linear shape vs. round or amorphous or coarse heterogeneous shape (94.7% [18/19] vs. 58.3% [14/24], p=0.021) at mammography. No significant difference was found in AUC between automated breast US (0.758, 0.603-0.875) and hand-held US (0.786, 0.634-0.896) (p=0.571).

CONCLUSION
Automated breast US detected 96.0% (24/25) of malignant calcifications on mammography. Detection was found to be related to the pathology, to calcification extent, and shape at mammography.

CLINICAL RELEVANCE/APPLICATION
This study is the first study to compare the detectability and diagnostic performance for suspicious microcalcifications between ABVS and HHUS. ABVS showed similar diagnostic performance to HHUS.

SSA01-06 • Clinical Application of Shear Wave Elastography (SWE) in the Differential Diagnosis of Small (≤2cm) Breast Lesions

Kyung Hee Ko (Presenter); Hae Kyong Jung MD; Jung Hyun Yoon MD; Hye Rin Kim
To evaluate the usefulness of SWE for the differential Diagnosis of small (=2cm) breast lesions

METHOD AND MATERIALS
From June 2012 to December 2012, of 215 women who had been performed conventional US and SWE, 165 masses of 155 women (mean age: 44.97±9.54 years, range 22-87 years) who had 2cm and smaller lesions were included in this study. All patients underwent US guided core biopsy or surgical excision. US BI-RADS final assessment and quantitative SWE parameters were recorded. Final assessments of the 165 breast lesions were categorized as follows: category 3 in 23, category 4a in 119, category 4b in 11, category 4c in 8, and category 5 in 4. Histopathologic diagnosis was used as reference standard. Optimal cutoff value for each quantitative SWE parameter was calculated by ROC curve. Calculated cutoff value was used to upgrade BI-RADS 3 lesions to category 4a and downgrade BI-RADS 4a lesions to category 3.

RESULTS
Of the 165 small breast masses, 20 masses (12%) were malignant and 145 masses (88%) were benign. Mean Emax of malignant masses (141.97±98.03kPA) was significantly higher than that of benign (49.14±39.89kPA). Emax with a cutoff value of 87.5kPA had the highest Az value (0.796, sensitivity 75.0%, specificity 85.5%, PPV 41.7%, NPV 96.1%). However, for small masses equal or smaller than 1cm, Az values of all quantitative SWE parameters were lower than 0.6. After adding SWE to conventional US, there was no improvement of diagnostic performance (sensitivity 80%, specificity 95.2%, PPV 69.6%, NPV 97.2%). When applying Emax

CONCLUSION
Small malignant masses=2cm were significantly stiffer than small benign lesions. However adding SWE parameters to conventional US showed no improvement of diagnostic performance. SWE could give US BI-RADS some help for reducing benign biopsy rate.

CLINICAL RELEVANCE/APPLICATION
SWE could give conventional US BI-RADS some help on differential diagnosis of small breast masses 2cm or smaller with reducing benign biopsy rate.

SSA01-07 • Indications for Biopsy of Imaging-detected Intramammary and Axillary Lymph Nodes in the Absence of Concurrent Breast Cancer
Christine Westra BS; Vandana M Dialani MD; Shambhavi Venkataraman MD; Valerie J Fein-Zachary MD; Alexander Brook PhD *; Tejas S Mehta MD, MPH (Presenter)

PURPOSE
To evaluate prevalence and identify features predictive of malignancy in imaging-detected lymph nodes (LNs) in women without concurrent cancer.

METHOD AND MATERIALS
Retrospective review of all image-guided LN fine needle aspirations (FNA) and core needle biopsies (CNB) from 1/1/08-12/31/10. LNs in patients without concurrent cancer comprised our study group (SG; n=80) and with concurrent breast cancer our control group (CG; n=66). FNAs were sent for flow cytometry in addition to cytology at discretion of breast imager. Blinded to cytology/histology, imaging features of LNs including size, loss of fatty hilum, and/or focal/diffuse cortical thickness were recorded. BI-RADS category was assigned by reviewer based on LN appearance.

RESULTS
In 80 SG cases, 63 (78%) had FNA and 17 (22%) had CNB; all in CG had FNA. Of the 80 SG cases, 69 (86%) were negative, 2 (3%) positive, 6 (7%) atypical and 3 (4%) non-diagnostic (ND). Of 8 atypical/positive LNs, 3 had breast cancer, 2 had lymphoma, and 3 negative on excision. Of 66 CG cases, 30 (45%) were negative, 30 (45%) positive, 5 (8%) atypical and 1 (2%) ND. There were 6 false negative FNAs in CG; all atypical/positive LNs in CG were positive for breast cancer on excision. ND LNs were negative on follow up/excision in both groups. Prevalence of malignancy in LNs in SG was 6% (5/80) and in CG 62% (41/66); p = 3mm and/or eccentric/focal cortical thickening were negative and not predictive of malignancy. If BI-RADS 4C/S were used as threshold to biopsy, the sensitivity, specificity, PPV, and NPV for cancer in SG would have been 100%, 99%, 83% and 100% respectively, higher than CG results of 73%, 92%, 93% and 68% respectively.

CONCLUSION
In the absence of concurrent breast cancer, using loss of fatty hilum as criterion to biopsy image-detected LNs keeps sensitivity of 100% but lowers false positives. FNAs should also be sent for flow cytometry to diagnose lymphoma.

CLINICAL RELEVANCE/APPLICATION
Without concurrent breast cancer, loss of fatty hilum as criterion to biopsy LNs has 100% sensitivity with low false positives. Flow cytometry is also needed in these patients to exclude lymphoma.

SSA01-08 • Are Shear Wave Ultrasound Findings an Independent Predictor of Lymph Node Involvement in Women with Invasive Breast Cancer?
Andrew Evans MRCP, FRCSR (Presenter); Patsy Whelehan MSc *; Petra Rauchhaus; Colin Puride; Lee Jordan; Kim Thomson; Sarah J Vinnicombe MRCP, FRCSR

PURPOSE
Shear wave elastography shows promise as an adjunct to greyscale ultrasound in assessing breast masses. In breast cancer, higher lesion stiffness values have been shown to be associated with poor prognostic features. The purpose of this study was to assess whether higher lesion stiffness at shear wave elastography is an independent predictor of lymph node involvement

METHOD AND MATERIALS
Patients with invasive breast cancer treated by primary surgery, who had undergone shear wave elastography examination at the time of diagnosis, were eligible. Data were retrospectively analysed from 396 consecutive patients meeting these criteria. The mean stiffness values were obtained using the Aixplorer<sup>®</sup> ultrasound machine from SuperSonic Imagine Ltd. Measurements were taken from a region of interest positioned over the area identified via the colour map as the stiffest part of the abnormality. The average of the mean values were obtained using the Aixplorer<sup>®</sup> ultrasound machine from SuperSonic Imagine Ltd. Measurements were taken from a region of interest positioned over the area identified via the colour map as the stiffest part of the abnormality. The average of the mean values obtained in each of four projections was used for analysis. Associations between lymph node involvement and mean lesion stiffness in kilopascals, invasive cancer size, histological grade, tumour type, ER and HER-2 receptor status and vascular invasion were assessed using univariate and multivariate logistic regression.

RESULTS
Median age was 62 years, median invasive tumour size was 19 mm and 28% of patients had lymph node involvement. At univariate analysis, invasive size, histological grade, HER-2 status, vascular invasion, tumour type and mean stiffness were significantly associated with nodal involvement. At multivariate analysis, invasive size, tumour type, vascular invasion and mean stiffness maintained independent significance.

CONCLUSION
Mean stiffness at shear wave elastography is an independent predictor of lymph node metastasis in women with invasive breast cancer.

CLINICAL RELEVANCE/APPLICATION
High tumor stiffness at shear wave elastography increases the risk of lymph node metastasis in women with invasive breast cancer.

SSA01-09 • Diagnostic Usefulness of Breast Ultrasonography in the Evaluation of the Patients with Pathologic Nipple Discharge: Comparison with Galactography
The lesions were depicted at galactography in 98 cases (83.8%), at US in 96 cases (82.1%) and both examinations in 85 cases (72.6%). Eight cases (6.8%) showed poor visualization of lesions at both examinations. The lesions were depicted at galactography only in 13 cases (11.1%) and US only in 11 cases (9.4%), of which galactograms were negative (n=1), only ductal dilatations (n=5), or failure of procedure (n=7). In 85 cases which abnormalities were visualized at both examinations, the evaluation of lesion extent was superior at US in 19 cases and superior at galactogram in 12 cases. Of 117 cases, US was superior or equal to galactography in 88 cases (75.2%) with respect to detection of lesion and extent evaluation. Galactography was superior or equal to US in 57 cases (48.7%).

**CONCLUSION**

Breast US is useful to detect the causes of pathologic nipple discharge and to evaluate the lesion extent exactly. Therefore, in the evaluation of patients with pathologic nipple discharge, we suggest that galactography may be skipped if the lesion is well detected at US.

**CLINICAL RELEVANCE/APPLICATION**

Galactography may be skipped in the evaluation of patients with pathologic nipple discharge if the lesion is well detected at ultrasonography.

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**S502AB**

**Cardiac (Coronary CT/MR I)**

**Sunday, 10:45 AM - 12:15 PM • S502AB**

**SSA02 • AMA PRA Category 1 Credit™:1.5 • ARRT Category A+ Credit:1.5**

**Moderator**

Vincent B Ho, MD, MBA *
Lisa Diethelm, MD *

**METHOD AND MATERIALS**

117 cases in 105 patients (all women; mean, 43.2 years; range, 20 - 76 years) with pathologic nipple discharge were enrolled in this study, who had undergone US and galactography between 2004 and 2012. Eighty three cases were pathologically proved by surgical excision (n=66), or US-guided core needle biopsy (n=17), and the remaining cases were followed up for mean 24 months by US and mammography. Two radiologists retrospectively reviewed and compared US and galactography images with regard to detectability of lesion and evaluation of disease extent.

**RESULTS**

The lesions were depicted at galactography in 98 cases (83.8%), at US in 96 cases (82.1%) and both examinations in 85 cases (72.6%). Eight cases (6.8%) showed poor visualization of lesions at both examinations. The lesions were depicted at galactography only in 13 cases (11.1%) and US only in 11 cases (9.4%), of which galactograms were negative (n=1), only ductal dilatations (n=5), or failure of procedure (n=7). In 85 cases which abnormalities were visualized at both examinations, the evaluation of lesion extent was superior at US in 19 cases and superior at galactogram in 12 cases. Of 117 cases, US was superior or equal to galactography in 88 cases (75.2%) with respect to detection of lesion and extent evaluation. Galactography was superior or equal to US in 57 cases (48.7%).

**CONCLUSION**

Breast US is useful to detect the causes of pathologic nipple discharge and to evaluate the lesion extent exactly. Therefore, in the evaluation of patients with pathologic nipple discharge, we suggest that galactography may be skipped if the lesion is well detected at US.

**CLINICAL RELEVANCE/APPLICATION**

Galactography may be skipped in the evaluation of patients with pathologic nipple discharge if the lesion is well detected at ultrasonography.

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**SSA02-01 • Diagnostic Accuracy of 320-detector Computed Tomography Angiography in Evaluating In-stent Restenosis of Coronary Artery**

Yung-Liang Wan MD; Sophie Chan MD (Presenter); Zhonghua Sun PhD; Yu-Hsien Juan MD; I-Chang Hsieh; Ming-Shien Wen

**PURPOSE**

To study the sensitivity (SN), specificity (SP), accuracy, positive predictive value (PPV) and negative predictive value (NPV) of 320-detector CT angiography (CTA) in diagnosing in-stent restenosis (ISR) on the bases of invasive coronary angiography (ICA) as a golden standard.

**METHOD AND MATERIALS**

**RESULTS**

ISR was found in 18 (9.5%) of 189 patients and in 25 (7.9%) of 318 stents. On stent level, the SN, SP, accuracy, PPV, and NPV of CTA in detecting ISR were 92%, 96%, 96%, 66% and 99%, respectively. On patient level, the corresponding figures were 94%, 96%, 96%, 66% and 99%, respectively. The number of implanted stents in patients with ISR was significantly higher than that in those without ISR (2.56 ± 1.38 vs. 1.59 ± 0.92, p = 0.009). ISR was significantly more frequently found in 12.7% (14/96) of RCA stents, 10% (5/45) of LAD stents and in 3.8% (6/149) of LCX stents, and in 3.8% (6/149) of LAD stents (p = 0.027).

**CONCLUSION**

On both stent and patient levels, the SN, SP, and accuracy of 320-detector CTA in diagnosing ISR is high, ranging from 92% to 96%. However, the PPV is is 66% on stent level, and 77% on patient level.

**CLINICAL RELEVANCE/APPLICATION**

The advanced technique 320-detector CTA plays a potential and promising role in assessing ISR of coronary arteries, it is especially useful in excluding ISR with a high NPV of 99%.

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**SSA02-02 • Value of Super-resolution Technique in Detection of Coronary Artery Stenoses on Whole-heart Coronary MRA**

Mio Uno MD (Presenter); Ryohei Nakayama PhD; Masaki Ishida MD, PhD; Tatsuro Ito MD; Yoshitaka Goto MD; Motonori Nagata MD, PhD; Kakuya Kitagawa MD, PhD; Hajime Sakuma MD *

**PURPOSE**

Coronary MRA provides noninvasive detection of coronary artery disease without exposing the patient to radiation. However, the image resolution of coronary MRA is limited. In the conventional coronary MR images, resolution enhancement is usually performed with bicubic interpolation. Recently, Super-Resolution (SR) technique has been proposed to increase resolution of brain MRI. The purpose of this study was to demonstrate the value of SR technique for the detection of coronary artery stenoses on whole-heart coronary MRA as compared with conventional bicubic interpolation.

**METHOD AND MATERIALS**

Whole-heart coronary MRA was acquired with 32-channel cardiac coils in 36 patients at 1.5 T (n=16) and 3.0T (n=19). We have newly developed a SR technique optimized for whole-heart coronary MRA by modifying the existing SR method. Receiver operating characteristic (ROC) analysis was performed to evaluate the diagnostic performance of SR technique and conventional bicubic interpolation to detect coronary stenoses of >50% on coronary angiography. In the observation study, the cases were displayed in a random order with a custom-made viewer, and three observers independently rated the likelihood of the presence of coronary artery stenoses using a continuous scale from 0 to 1. Two reading sessions were conducted with 3-day interval.

**RESULTS**

For all observers, the areas under the ROC curves (AUCs) were improved by using SR technique. The mean AUC was 0.861 for SR technique, being significantly higher than that for conventional bicubic interpolation (0.797, P = .024). Interobserver variability was
High-resolution whole-heart coronary MRA using a Super-Resolution technique permits noninvasive detection of coronary artery stenoses with significantly improved image quality as compared to conventional bicubic interpolation method.

**CONCLUSION**

High-resolution coronary MRA generated by Super-Resolution technique allows for more accurate detection of coronary stenoses with higher confidence level as compared to conventional bicubic methods.

**Semi-automated assessment** was performed in 39% of all cases and improved the plaque burden correlation with IVUS, independent of the reconstruction algorithm (p < 0.05). Manual corrections in the semi-automated assessment were performed in 39% of all cases and improved the plaque burden correlation with IVUS, independent of the reconstruction algorithm (p < 0.05).

**CLINICAL RELEVANCE/APPLICATION**

High-resolution coronary MRA generated by Super-Resolution technique allows for more accurate detection of coronary stenoses with higher confidence level as compared to conventional bicubic methods.

**Semiauto**
CONCLUSION
Using MBIR algorithm in CCTA with a semi-automated assessment enables more accurate measurement of plaque burden as compared to ASIR and FBPR using IVUS as the reference standard.

CLINICAL RELEVANCE/APPLICATION
Model-based reconstruction algorithm could further enhance the role of coronary CT angiography as a non-invasive risk stratification tool for patients with coronary artery disease

SSA02-06 • Diagnostic Accuracy of Computed Tomography Coronary Angiography for Evaluation of Coronary Artery Disease: A Comparison between High Definition versus Standard Definition Scanner

Gianluca Pontone MD (Presenter) ; Daniele Andreini MD ; Erika Bertella ; Saima Mushtaq ; Paola Gripari ; Sarah Cortinovis ; Monica Loguercio ; Andrea Baggiano ; Edoardo Conte ; Andrea Daniele Annoni MD ; Alberto Formenti ; Mauro Pepi

PURPOSE
A high-definition computed tomography coronary angiography (HDCTCA) scanner, with improved in-plane spatial resolution of 230 μm, has recently been developed. The aim of this study is to compare the diagnostic accuracy by HDCTCA with standard definition 64-slice scanner (SDCTCA) by using ICA as the reference method.

METHOD AND MATERIALS
One-hundred-forty consecutive patients (mean age 65±8 years, male 105) scheduled for ICA were randomized to SDCTCA (n= 70, group 1) or HDCTCA-scan protocol (n= 70, group 2) (Discovery CT 750 HD scanner, GE Healthcare, Milwaukee, WI) before ICA. The scanning parameters were: slice acquisition 64x0.625 mm, gantry rotation time 330 msec and prospective ECG-triggering. We evaluated the Likert image quality (score 1: non-diagnostic to score 4: excellent), overall feasibility (Fe), the sensitivity (Se), specificity (Sp), negative predictive value (NPV), positive predictive value (PPV) and accuracy (Ac) versus ICA in a segment-based model and comparing the diagnostic performance between group 1 and group 2.

RESULTS
The 2 groups were homogeneous in terms of baseline characteristics. Group 2 showed a higher mean image quality score (3.8 vs 3.1, p<0.001) without any premedication to lower the heart rate.

CONCLUSION
HDCTCA offers a possible and alternative solution to the problem of heavily calcified coronary arteries reducing the overestimation of calcium volume by nearly half.

SSA02-07 • Efficacy of 256 Slice Dual Source CT Angiography in Evaluation of Patients with High Heart Rates and Its Comparison with Catheter Angiography: Do We Still Require Beta Blockers?

Neeraj Jain DMRD (Presenter) ; Sunil Kumar Puri MD ; Vasanthakumar Venugopal MD

PURPOSE
Comparative analysis of 256-slice dual source CT angiography (DSCTA) and catheter coronary angiography (CCA) in evaluation of coronary arteries (CA) in patients with clinical suspicion of coronary artery disease (CAD) and to study its effectiveness at higher heart rates (HR) without using beta blockers.

METHOD AND MATERIALS
This prospective study was conducted on patients (n=40) with suspected CAD using ECG triggered 256 slice DSCT (Somatom Definition Flash, Siemens). Patients were sub grouped according to HR (Group I: 85-100) and (Group 2: 101-115 bpm). 22 patients had HR of 85-100 bpm while 18 patients had HR 101-115 bpm. All patients were scanned with retrospective spiral scan protocol. Coronary artery segments were analyzed for image quality (IQ) on a 4 point scale (1 is worst while 4 is best) by two independent readers who were blinded to patients details. Accuracy to detect significant luminal stenosis was correlated with CCA (gold standard). Statistical significance of study was determined by chi-square test.

RESULTS
A total of 545 coronary artery segments were analyzed. The mean IQ score and standard deviation in group 1 and 2 were 3.45 ± 0.26 and 3.03 ± 0.36 respectively. Inter-observer agreement analysis was performed using Kappa analysis to determine consistency between DSCTA readers. The Kappa values for group 1 and 2 were 0.838 and 0.808 respectively. The sensitivity, specificity, PPV, NPV and accuracy for detecting significant stenosis in group 1 and group 2 were 97.3%, 98.6%, 100%, 98.7%, 98.9% and 91.3%, 96.9%, 95.4%, 95.6%, 96.9% respectively.

CONCLUSION
256 slice DSCTA is a reliable technique with high sensitivity, specificity, PPV and NPV for assessment of coronary arteries even at higher HR without using beta blocker to reduce the HR.

CLINICAL RELEVANCE/APPLICATION
256 slice dual source CT can be used effectively for patients with suspected coronary artery disease irrespective of their heart rate and without any premedication to lower the heart rate.

SSA02-08 • Iterative Reconstruction Algorithms in Coronary CT Angiography for the Characterization of Coronary Atherosclerotic Plaque—A Comparison with Histology

Stefan Puchner MD (Presenter) ; Maros Ferencik MD ; Pal Maurovich-Horvat MD ; Masataka Nakano ; Fumiyuki Otsuka ; Hans-Ulrich Kauczor MD * ; Renu Virmani ; Udo Hoffmann MD ; Christopher L Schlett MD, MPH

PURPOSE
To evaluate whether iterative reconstruction algorithms improve the accuracy of coronary CT angiography (CCTA) for coronary plaque characterization as compared to histology.

METHOD AND MATERIALS
CCTA and histological data were acquired from coronary arteries of 3 ex-vivo hearts. CT images were reconstructed using filtered-back projection (FBPR), adaptive-statistical iterative (ASIR) and model-based iterative (MBIR) reconstruction algorithms. First, cross-sectional CCTA images were co-registered between all three reconstruction algorithms and second CCTA triplets were co-registered with histology. Plaque area, 2007m and circumference >60°, as well as a cap thickness.

RESULTS
In total, 173 FBPR/ASIR/MBIR triplets by CCTA were co-registered with histological cross-sections, where lipid-core plaque (LCP) was presence in 26 locations based on histology. Plaque area

CONCLUSION
Plaque area

CLINICAL RELEVANCE/APPLICATION
Model-based reconstruction algorithm further enhances the accuracy of coronary CT angiography as a non-invasive tool for the detection and characterization of vulnerable plaque

SSA02-09 • CT Coronary Artery Opacification Gradients Using Different Iodinated Contrast Injection Protocols

Dimitris Mitsouras PhD (Presenter) ; Kanako K Kumamaru MD, PhD ; Chi Wai S Cheung MBBS ; Amir Imanzadeh MD ; Michael
**PURPOSE**
To evaluate differences in coronary contrast opacification gradients, also known as TAG or Transluminal Attenuation Gradients, between biphasic and triphasic coronary CTA injection protocols.

**METHOD AND MATERIALS**
Contrast opacification gradients from 320 x 0.5 mm detector row CT were computed for two populations: 32 patients with normal coronary arteries plus 12 patients with left anterior descending (LAD) coronary artery stenosis (>50%) scanned with biphasic injection protocol, and 11 normal patients scanned at a separate institution with a triphasic injection protocol. Linear regression determined correlation between mean Hounsfield Unit and distance from the coronary ostium, lumen cross-sectional area, and lumen short axis diameter. For each gradient (regression slope), multivariate regression model adjusting for BMI analyzed differences found between the two patient cohorts.

**RESULTS**
While gradients showed strong to excellent linear-fit (Pearson r values = 0.64 - 0.91) for each injection protocol, the different protocols introduced variability in normal coronary artery gradients. However, the gradients computed from biphasic injection protocol in LAD arteries with >50% stenosis were significantly (p-values: from CONCLUSION
Coronary contrast opacification gradients vary with respect to a biphasic versus triphasic injection protocols, with both showing differences between normal and abnormal coronary arteries.

**CLINICAL RELEVANCE/APPLICATION**
To date, gradients have been validated using only biphasic protocols; these data suggest that both biphasic and triphasic injections can be used to differentiate normal and abnormal coronary arteries.
CONCLUSION
The new TRO-CTA protocol could feasibly reduce the total dose of radiation and the contrast dose and yielded adequate vascular enhancement compared with the conventional protocol.

CLINICAL RELEVANCE/APPLICATION
Triple-rule-out-CTA protocol with serial non-ECG-gated low kVp scan of the whole chest could feasibly reduce the total dose of radiation and the contrast dose compared with the conventional protocol.

SSA03-03 • Assessment of Image Quality and Radiation Dose of Prospectively Triggered Adaptive Coronary CT Angiography: In Comparison with Retrospectively Gated Mode and High Pitch Mode
Yunling Wang (Presenter) ; Hong Wang

PURPOSE
The purpose of this study was to evaluate the image quality and radiation dose of dual-source computed tomography (DSCT) application in coronary computed tomography angiography (CTA), using three different modes: prospectively electrocardiogram (ECG)-triggered sequential scan mode, retrospectively ECG gated spiral scan mode and Flash spiral scan mode.

METHOD AND MATERIALS
Ninety eligible patients (47 males and 43 females, mean age 54.3 years), with heart rate within 60 to 80 beat per minute (bpm) and relative sinus rhythm (fluctuation =10bpm), were included in this study: They are randomly distributed into three groups: 30 patients in Group A using prospectively ECG-triggered sequential mode, 30 in Group B using retrospectively ECG-gated spiral mode and 30 in Group C using Flash spiral mode. The X-ray tube voltages were selected according to body mass index (BMI). Both the radiation dose and image quality were evaluated and compared, which were based on statistics analysis of image score, HU value standard deviation (SD), Signal-Noise Ratio (SNR, mean/SD), Contrast-Noise Ratio (CNR).

RESULTS
The mean image score in Group A is 3.36±0.39, with effective radiation dose of 5.12±0.77 mSv, SD of 17.8±0.51, SNR of 23.64±0.49, and CNR of 20.77±0.43. The mean image score in Group B is 3.58±0.51, with effective radiation dose of 6.79±0.41 mSv, SD of 18.8±0.46, SNR of 22.12±0.55, and CNR of 27.87±0.38. The mean image score in Group C is 1.47±0.62, with effective radiation dose of 0.89±0.81 mSv, SD of 15.1±0.44, SNR of 34.9±0.67, and CNR of 47.77±0.56. There were significant differences in the radiation dose and image quality among these three groups (p<0.05).

CONCLUSION
The prospectively triggered mode has a better image quality and lower radiation dose, compared with retrospectively gated mode and Flash mode, which may be the first choice in CTA imaging.

CLINICAL RELEVANCE/APPLICATION
The prospectively triggered mode has a better image quality and lower radiation dose, compared with retrospectively gated mode and Flash mode, which may be the first choice in CTA imaging.

SSA03-04 • Impact of Model Based Iterative Reconstruction on Noise Reduction of Ultra Low-dose Coronary CT Angiography
Tobias A Fuchs MD (Presenter) ; Julia Stehle MD ; Sacha Bull MD, PhD ; Svetlana Dougoud MD ; Martin W Huebner MD ; Andreas Brauchlin MD ; Ronny R Buechel ; Oliver Gaemperli MD ; Philipp A Kaufmann MD

PURPOSE
Reduction of tube voltage and current for lowering radiation exposure from coronary CT angiography (CTA) is associated with an increase in noise which may render images uninterpretable. We evaluated the impact of model based iterative reconstruction (MBIR) on noise reduction in ultra-low submillisievert dose CTA.

METHOD AND MATERIALS
Twenty-five patients underwent standard low-dose CTA (100 -120 kV; 450 - 700 mA) and an additional same-day ultra-low dose (ULD) CTA (80 - 100 kV; 150 - 210 mA) using MBIR. After assessing attenuation in the left main (LMA) and right coronary artery (RCA) as well as noise in the aortic root the signal-to-noise-ratio (SNR) was calculated for LMA and RCA.

RESULTS
The mean body mass index of the study population was 25.4 ± 4.4 kg/m2 (range 18.4 ± 40.2 kg/m2), and the mean weight 75.1 ± 15.3 kg (range 46.5 ± 112.0 kg). The mean effective radiation dose was 1.3 ± 0.4 mSv in standard and 0.2 ± 0.1 mSv in ULD CTA (p < 0.001). Nevertheless mean image noise decreased significantly from 32 ± 7 HU in standard CTA to 21 ± 4 HU in ULD MBIR CTA (p < 0.001). Interestingly, this was paralleled by an increase in mean attenuation in LMA from 466 ± 85HU to 563 ± 119 HU, and in RCA from 446 ± 63HU to 503 ± 83 HU (p < 0.001).

CONCLUSION
MBIR efficiently compensates for increased noise in ULD CTA. In combination with the shift towards higher beam attenuation by iodine in low tube voltage scanning this results in a SNR substantially higher than standard CTA.

CLINICAL RELEVANCE/APPLICATION
New reconstruction algorithms such as MBIR achieve efficient noise reduction allowing substantial radiation dose reduction in cardiac CT scanning.

SSA03-05 • Dual Source Cardiac Computed Tomography Angiography (CTA) in the Follow Up of Cardiac Transplant: Comparison of Image Quality and Radiation Dose Using Three Different Scan Protocols
Florian Wolf MD (Presenter) ; Dietrich Beitzke MD ; Vanessa Berger-Kulemann ; Richard Nolz ; Gudrun Feuchtner MD * ; Christian Loewe MD *

PURPOSE
Cardiac allograft vasculopathy represents a major cause of mortality in the later course of cardiac transplant. CCTA represents a valuable non-invasive imaging tool in the diagnosis of cardiac allograft vasculopathy with the disadvantage of radiation burden. Radiation dose reduction in CCTA of cardiac transplant is challenging as patients often present with elevated heart rates. The aim of this prospective randomized study was to evaluate image quality, diagnostic confidence, and radiation dose using 3 different CT scan protocols for dual-source CCTA in heart transplant recipients.

METHOD AND MATERIALS
Dual source CCTA was performed in 150 consecutive patients after heart transplantation using either the conventional prospective-triggered spiral technique (120 kV/320 mA, tube current modulation) in group 1, the prospective ECG-gated sequence technique (120 kV/320 mA, main padding window 40-70%) in group 2, or the prospective ECG-gated sequence technique in the systolic phase with automated tube voltage selection (Automated kV, main padding window 35-45%) in group 3. Subjective image quality was rated using a 16 segment coronary artery model and a four-point scale (1=excellent, 2= good, 3= fair, 4 = non-diagnostic) for each segment. Effective dose (ED) was used to compare the differences in radiation dose.

RESULTS
No difference was observed in subjective image quality between the study groups regarding segments with excellent or good image quality (Group 1: 90.5%; group 2: 89.3%; group 3: 86.8%). The number of segments with non-diagnostic image quality was lowest in group 3 (Group 1: 1.8%, group 2: 2.1%; group 3: 1.1%) and did not differ between group 1 and 2. Mean ED did not differ significantly between group 1 and group 2 (9.9±2.7 mSv vs. 9.1±2.3 mSv; p=0.13), but was significantly lower in group 3 (4.6±1.9 mSv; p<0.001).

CONCLUSION
Radiation dose of dual source CCTA in heart transplant recipients can be significantly reduced by using the ECG-gated sequence.
METHOD AND MATERIALS
This study evaluated a novel algorithm for optimizing both radiation and contrast dose at cardiovascular CT.

PURPOSE
Halliburton Yajuan Wang in invasive coronary angiography. CCTA scanning with an ultra-low radiation dose may pave the way for the broad clinical implementation of CCTA as an alternative for the combination with MBIR reconstruction.

CLINICAL RELEVANCE/APPLICATION
Our results document the feasibility of CCTA acquisition with diagnostic image quality at an ultra-low radiation dose of 0.2 ± 0.1 mSv in agreement of image quality of ρ = 0.8. The mean image quality score per segment was 3.3 ± 0.5 in standard CCTA vs. 3.4 ± 0.6 in ULD MBIR (p < 0.05). Diagnostic image quality (score 2 – 4) was found in 319 coronary segments (97%) of standard CCTA, and 317 (96%) segments of ULD MBIR (p = ns).

RESULTS
A total of 100 vessels and 330 coronary artery segments with a diameter of = 1.5 mm were evaluated and revealed an inter-observer ρ ≥ 0.5 (excellent). Independent-sample t-test was performed on dose and Mann-Whitney test on image quality scores.

CONCLUSION
Prospective ECG-triggered CCTA with low tube voltage significantly reduces radiation exposure while maintaining acceptable image quality. For the patient population with BMI ≥ 25 mg). The mean heart rate for standard and ULD CCTA was 57.5 ± 5.6 and 57.0 ± 5.9 bpm (p = ns). Intravenous beta-blockers were administrated for heart rate control prior to CCTA in 20 patients (80%) (10.8 ± 9.5mg, range 3 – 25mg). The mean heart rate as 80kV in second generation dual-source CT equipped with novel high sensitive detector is feasible in patients with normal BMI. This scan mode can obviously reduce the radiation dose while with no influence on image quality.

CLINICAL RELEVANCE/APPLICATION
The use of prospective ECG-triggering and 100kV tube voltage in CCTA can reduce radiation to patients, and achieve sub-mSv dose for patient population with BMI ≥ 25 mg).

SSA03-07 • Low Tube Voltage and High Sensitive Detector Reduce the Radiation Dose of Coronary CTA
Jian Cao (Presenter) ; Yining Wang MD ; Lingyan Kong ; Lin Lu MD ; Huadan Xue MD ; Zhiwei Wang MD ; Zhengyu Jin MD

METHOD AND MATERIALS
To investigate the application of low tube voltage (80kV) for coronary artery computed tomography angiography (CCTA) in patients with normal body mass index (BMI) with second generation dual-source CT equipment with novel high sensitive detector.

RESULTS
Tube voltage as 80kV in second generation dual-source CT equipped with novel high sensitive detector is feasible in patients with normal BMI. This scan mode can obviously reduce the radiation dose while with no influence on image quality.

CLINICAL RELEVANCE/APPLICATION
Tube voltage as 80kV in second generation dual-source CT equipped with novel high sensitive detector is feasible in patients with normal BMI.

SSA03-08 • Feasibility and Image Quality of Ultra-low Dose Submillisievert Radiation Exposure in Coronary CT Angiography Using Model Based Iterative Reconstruction: First Clinical Experience
Julia Stehli MD (Presenter) ; Tobias A Fuchs MD ; Sacha Bull MD, PhD ; Svetlana Dougoud MD ; Martin W Huelnner MD ; Andreas Brauchin MD ; Ronny R Buechel ; Oliver Gaemperli MD ; Philipp A Kaufmann MD

METHOD AND MATERIALS
In 25 patients undergoing standard low-dose contrast enhanced CCTA (100 ± 120 kV; 450 - 700 mA) an additional same-day ultra-low dose (ULD) CCTA was acquired (80 ± 100 kV; 150 - 210 mA) and reconstructed with MBIR. Two independent readers semi-quantitatively assessed image quality on a four-point Likert scale in each coronary segment (1: non-diagnostic, 2: good, 3: adequate, 4: excellent). Independent-sample t-test was performed on dose and Mann-Whitney test on image quality scores.

RESULTS
Over a wide range of weight (47 - 112 kg) and body mass index (18.4 - 40.2 kg/m²), the mean DLP from standard and ULD CCTA was 89.5 ± 29.4 mGycm (range 69.8 - 188.3 mGycm) and 15.9 ± 6.2 mGy cm (range 10.2 - 35.6 mGy cm) resulting in an estimated mean radiation dose exposure of 1.3 ± 0.4 mSv (range 1.0 - 2.6 mSv) for standard and 0.2 ± 0.1 mSv (range 0.1 - 0.5 mSv) for ULD CCTA (p < 0.001). Intravenous beta-blockers were administrated for heart rate control prior to CCTA in 20 patients (80%) (10.8 ± 9.5mg, range 3 - 25 mg). The mean heart rate as standard and ULD CCTA was 57.5 ± 5.6 and 57.0 ± 5.9 bpm (p = ns). A total of 100 vessels and 330 coronary artery segments with a diameter of = 1.5 mm were evaluated and revealed an inter-observer agreement of image quality of ρ = 0.8. The mean image quality score per segment was 3.3 ± 0.5 in standard CCTA vs. 3.4 ± 0.6 in ULD MBIR (p < 0.05). Diagnostic image quality (score 2 – 4) was found in 319 coronary segments (97%) of standard CCTA, and 317 (96%) segments of ULD MBIR (p = ns).

CONCLUSION
Our results document the feasibility of CCTA acquisition with diagnostic image quality at an ultra-low radiation dose of 0.2 ± 0.1 mSv in combination with MBIR reconstruction.

CLINICAL RELEVANCE/APPLICATION
CCTA scanning with an ultra-low radiation dose may pave the way for the broad clinical implementation of CCTA as an alternative for the invasive coronary angiography.

SSA03-09 • Optimization of Radiation and Contrast Dose for Cardiovascular Computed Tomography
Yajuan Wang PhD (Presenter) * ; Kassem Soufan ; Anjali Kottha ; Corey Kemper PhD * ; John F Kalafut PhD * ; Sandra S Halliburton PhD *

METHOD AND MATERIALS
Lowering x-ray tube potential is an effective way to reduce both radiation exposure and contrast load from computed tomography (CT). This study evaluated a novel algorithm for optimizing both radiation and contrast dose at cardiovascular CT.
RESULTS
100 kV [n=40] and 120 kV [27] cohorts had similar age (62±15 vs 59±13 yrs) and height (1.74±0.10 vs 1.78±0.07 m). The cohort imaged at 100kV had significantly lower body mass index (25.7±2.8 vs. 32.0±3.2 kg/m²) and percentage of males (67.5% vs. 92.6%). Patients scanned at 120 kV had a longer scan delay (33±6 vs. 26±4 s) but similar scan time (12±1 vs. 12±1 s) compared to 100 kV patients. Image quality metrics were equivalent between groups (aortic attenuation: 287±83 vs 281±48 HU; noise: 27±4 vs 26±3 HU; SNR: 11±3 vs 11±2) despite lower contrast dose (50 vs 90 mL) and effective radiation dose (1.8±0.3 vs 3.6±0.4 mSv) at 100 kV.

CONCLUSION
Simultaneous optimization of x-ray parameters and contrast protocols yielded equivalent image noise and blood enhancement across a range of patient sizes for cardiovascular CT. Smaller patients required 49% less radiation and 44% less contrast.

CLINICAL RELEVANCE/APPLICATION
Cardiovascular CT can be performed in smaller patients using lower radiation and contrast doses compared to those used for larger patients without compromising image quality.
CONCLUSION
Using a helical acquisition technique, CTPA images with good diagnostic quality can be obtained using a very low dose of iodinated contrast and low radiation dose. There is also potential for further reduction in the contrast and radiation doses and cost savings.

CLINICAL RELEVANCE/APPLICATION
Diagnostic CTPA can be performed with ultra-low contrast dose techniques while reducing potential toxicities associated with the administration of iodinated contrast.

SSA04-03 • Diagnostic Accuracy of Low-dose CT Pulmonary Angiography: Results of a Prospective Randomized Trial (REDOPED)

Zsolt Szucs-Farkas MD, PhD (Presenter); Andreas Christe; Boglarka Megyeri MD; Martin Rohacek; Peter Vock MD; Endre V Nagy; Johannes T Heverhagen MD, PhD *; Sebastian T Schindera MD *

PURPOSE
To compare diagnostic accuracy of low-dose computed tomography pulmonary angiography (CTPA), with both reduced radiation and reduced contrast material (CM) dose with a normal-dose protocol in detecting acute pulmonary embolism (PE).

METHOD AND MATERIALS
The Reduced Dose in Pulmonary Embolism Detection (REDOPED) trial was a single-centre, single-blinded, HIPAA-compliant, prospective randomized study. Five hundred and one patients with body weights of RESULTS
The reference diagnosis was equivocal in 20 of 501 patients. CTPA diagnosis was correct in 240 patients and incorrect in 5 in the normal-dose group. CTPA was correct in 230 cases and incorrect in 6 in the low-dose group (odds ratio 1.25, 95% confidence interval, 0.38 to 4.16, P=0.77). Sensitivity was 96.5% and 100% and specificity was 98.1% and 97.1% in the normal-dose and low-dose groups, respectively. All PE or PE-related death occurred during 90-day follow-up. The mean estimated effective dose was 3.28 mSv in the normal-dose group and 2.25 mSv in the low-dose group, corresponding to a reduction by 31% (P

CONCLUSION
The accuracy of low-dose CTPA with reduced radiation and reduced CM dose is not significantly different from that of normal-dose CTPA in detecting or excluding acute PE in patients weighing

CLINICAL RELEVANCE/APPLICATION
CTPA with 80 kVp tube voltage provides high accuracy at reduced radiation and reduced CM dose and can be recommended for routine PE diagnosis in patients weighing

SSA04-04 • Sub-mSv CT Imaging of Pulmonary Arteries Using an Iterative Model Reconstruction Algorithm

Daniela Muenzel MD (Presenter); Thomas Koehler PhD *; Bernhard Brendel *; Kevin M Brown MS *; Stanislav Zabic PhD *; Alexander A Fingerle MD; Ernst J Rummey MD; Martin Dobritz MD; Peter B Noel PhD

PURPOSE
To investigate the improvement in diagnostic quality of iterative model reconstruction (IMR) algorithm for sub-mSv computed tomography angiography of the pulmonary arteries (CTA).

METHOD AND MATERIALS
Eighteen patients (single-center, IRB approved) were imaged on a Philips Brilliance ICT (Philips, Cleveland, OH) for visualization of the pulmonary arteries. 8 with and 10 without pulmonary artery embolism. All scans were performed at 120 kVp (average effective doses 4.34±1.99mSv). Acquisitions with reduced radiation exposure were simulated from the original CT data to 15% of the tube current, resulting in a sub-mSv average dose of 0.65±0.30mSv. Filtered backprojection (FBP) was used to reconstruct the original data (protocol A); sub-mSv data were reconstructed using FBP (protocol B) and IMR (protocol C). The performance of IMR was assessed with respect to the images' image noise and contrast-to-noise ratio (CNR) and with respect to effective dose of each protocol. Two blinded readers determined subjective image quality and assessed the detectability of pulmonary artery embolism, where ground truth was obtained from protocol A.

RESULTS
With IMR noise could be subjectively removed, while the image texture (look and feel) of these images differed from FBP reconstructions. Specifically, with IMR, the noise is significantly reduced by a factor up to 20 (B vs. C). This is reflected by an improvement in the contrast-to-noise ratio and improved image quality with a median image quality score of 3 (IMR, B) vs. 1 (FBP, C), p < 0.05. With respect to diagnosis, the angiographic datasets protocol A and C were identical, while B was worse: To detect pulmonary artery embolism in IMR and FBP low dose images, the sensitivity was 100% for IMR and 62.5% for FBP while specificity was 100% for both protocols.

CONCLUSION
This simulation study indicates that by using IMR for reconstruction, pulmonary artery embolism can be detected accurately in scans with sub-mSv dose levels.

CLINICAL RELEVANCE/APPLICATION
IMR has the potential to reduce patient dose and improve image quality in clinical day-to-day routine.

SSA04-05 • Impact of Perfusion Imaging on the Assessment of Peripheral Chronic Pulmonary Thromboembolism: Clinical Experience in 62 Patients

Francesco Molinari MD (Presenter); Julien Le Faiivre MD; Francois Pontana MD; Kanna Yasunaga MD; Jacques Remy MD *

PURPOSE
To evaluate the impact of perfusion imaging on the detection of peripheral chronic pulmonary thromboembolism (CPTE).

METHOD AND MATERIALS
62 patients (30 males; 32 females; mean age: 60 yr) with chronic thromboembolic disease underwent a dual-source, dual-energy chest CT angiographic examination with (a) reconstruction of diagnostic (i.e., averaged images from both tubes) and pulmonary blood volume (PBV) images; (b) enabling separate depiction of peripheral CPTE on diagnostic images (i.e., cross-sectional images viewed on lung and mediastinal window settings for analysis of segmental arteries, completed by maximum intensity projections for the subsegmental level) and perfusion defects by using PBV images. On diagnostic scans, the CT features of CPTE included stenosed arterial branches and/or endoluminal filling defects within segmental and subsegmental arteries. On PBV images, embolic type defects consisted of triangular, pleural-based and sharply marginated hypoattenuated areas which recorded at a segmental level (20 segments/patient; total: 1240 segments). The readings of diagnostic and perfusion images were independently performed by two readers.

RESULTS
On diagnostic images: (a) the analysis of segmental arteries depicted CT features of CPTE within 476 segments; (b) the analysis of both segmental and subsegmental arteries depicted CT features of CPTE within 872 segments. PBV imaging depicted: (a) 313 segments with perfusion defects at the level of which segmental arteries had not been diagnosed with CPTE, increasing the number of segments affected by CPTE by 66% (313/476); (b) 66 segments with perfusion defects at the level of which subsegmental arteries had not been diagnosed with CPTE, increasing the number of segments affected by CPTE by 7.5% (66/872).

CONCLUSION
The reading of PBV images enables depiction of a greater number of segments involved in peripheral CPTE.

CLINICAL RELEVANCE/APPLICATION
Depiction of CT features of CPTE at the level of the segmental and subsegmental pulmonary arterial bed is improved by the reading of
SSA04-06 • Detection of Pulmonary Hypertension in Patients with Cystic Fibrosis (CF) Using Magnetic Resonance (MR) Flow Measurements

Nino Kiria MD (Presenter); Jutta Hammermann; Bernhard Schulte-Hubbert; Michael Laniado MD; Nasreddin Abolmaali MD

PURPOSE
Pulmonary arterial hypertension (PAH) is a severe complication of a cystic fibrosis lung disease. The aim of this study was to evaluate MR based flow measurements in the pulmonary trunk to detect evolving signs of PAH in patients suffering from CF.

METHOD AND MATERIALS
23 patients (median age: 25 years, age range: 11-39 years, 10 female, 13 male) suffering from CF of different severity were examined using MRI based flow measurements. The examinations were performed at 1.5 Tesla scanner using body matrix coils and were the part of an annual follow-up. In addition to the standard CF-lung protocol an ECG-triggered phase-contrast flow measurement was acquired over the entire cardiac cycle with a temporal resolution of 12 ms. The assessed data, especially the acceleration times (AT,[ms]) and the average diameter of the pulmonary trunk were evaluated and the blood flow graphs in the pulmonary trunk during the heart cycle were analysed.

RESULTS
The comparison of means revealed significant differences for AT and average diameter of pulmonary trunk as well as the double peak increase of pulmonary flow during the heart cycle. It was possible to identify 5 patients demonstrating definite signs of PH, such as shortened AT and enlarged diameter of pulmonary trunk and its restricted distensibility during systole/diastole as well as slow/double peak increase of the blood flow in pulmonary trunk. In patients with clinically no signs of pulmonary hypertension mean AT was 149 ± 25 ms and the mean diameter of the pulmonary trunk was 4.1 ± 1 cm. The CF-patients with suspected PH showed a mean AT of 131 ± 25,9 ms and a mean diameter of the pulmonary trunk of 5.1±1.2 cm.

CONCLUSION
Signs for the development of a PAH (i.e. reduction of AT) are detectable using MRI based flow measurements. This technique could be a valuable screening tool for CF patients to identify the development of a PAH. Correlation to the echocardiographic results of the respective five patients will be presented.

CLINICAL RELEVANCE/APPLICATION
As PAH is a crucial complication of CF, MRI based flow measurements in pulmonary trunk can be helpful for detection, follow-up and control of therapy of PAH in CF patients.

SSA04-07 • Evaluation of Pulmonary Hypertension (PH) by Pulmonary Artery (PA) Tortuosity Measurements: Correlations with Mean Pulmonary Artery Pressure (mPAP) and Pulmonary Vascular Resistance (PVR)

Seyed Ameli-Renani MBBS,FRCR (Presenter); Jenny L Bacon MRCP *; Sarah L Sheard MBBS, FRCR; Anand Devaraj MBBS; Brendan P Madden MB BCH, MD; Ioannis Vlahos MRCR, FRCR *

PURPOSE
To evaluate whether PA automated curved multiplanar reformat (cMPR) measurements correlate with mPAP or PVR and whether these can discriminate patients with PH.

METHOD AND MATERIALS
57 patients (22 male), suspected of PH, who underwent CT pulmonary angiography (CTPA) with contemporaneous (2 or PVR>3 WU patient subsets was evaluated (Mann-Whitney U).

RESULTS
cMPRs were successful in 100/114 (88%) of vessels. Moderate correlations were demonstrated between right, left and mean cPA with mPAP (r=0.41, 0.46, 0.47, all p

CONCLUSION
PA tortuosity, quantified by limited automated artery measurements, is feasible, correlates with mPAP, and may identify patients with PH.

CLINICAL RELEVANCE/APPLICATION
Automated pulmonary arterial tortuosity measurement may be an indicator of pulmonary artery pressure and PH, however, relationships to PVR are more complex, requiring correction for lung expansion.

SSA04-08 • Incidence of Repeat CT Pulmonary Angiography for Suspected Pulmonary Embolism and Clinical Factors Associated with Repeat Testing

Daniel M Adams MD (Presenter); Scott Woller MD; Scott Stevens MD *; Scott Evans PhD; Greg Snow PhD; Joseph Bledsoe MD; Jim Lloyd BS; Todd D Lovelace MD; Valerie Aston RT; C. Gregory Elliott MD

PURPOSE
CT pulmonary angiography (CTPA) for suspected pulmonary embolism (PE) is a frequently performed exam that bears inherent risks. We measured the proportion of exams performed for patients who undergo repeat CTPA and identified differences in characteristics for those patients.

METHOD AND MATERIALS
This retrospective study was performed at Intermountain Medical Center and LDS Hospital in the Salt Lake City, Utah area. Consecutive CTPA exams for suspected PE ordered from the emergency department from May 22, 2009 to June 30, 2010 were identified. Data for patient characteristics were extracted from the medical record electronically and by manual review. Pretest probability was calculated with the Revised Geneva Score (RGS), d-dimer values were collected, and the final interpretation of each CTPA was recorded. Guideline concordant use was defined as CTPA being ordered for ‘PE Likely’ (RGS >10) patients or following a d-dimer that was positive among PE unlikely (RGS = 10) patients. All patients who underwent multiple examinations were identified, and comparisons of patient characteristics from CTPA encounters were made based on whether a single exam or multiple exams were performed during the study period.

RESULTS
3500 CTPA exams for suspected PE were performed during the study period for 3279 individual patients. 3090 patients had 1 exam, 164 patients had 2 exams, 19 patients had 3 exams, 5 patients had 4 exams, and 1 patient had 5 exams. Repeat examinations were associated with younger mean age (50 vs. 53 years); a higher incidence of prior venous thromboembolism (48.0% vs. 15.7%), trauma (6.6% vs. 2.9%), and signs and symptoms of deep vein thrombosis (unilateral leg pain 10.5% vs. 6.7%, signs of DVT 9.5% vs. 6.2%); and a higher mean pretest probability for PE (RGS 6.3 vs. 5.0). Repeat exams also had a higher yield of positive interpretations (14.4% vs. 9.1%); and were less frequently performed in concordance with evidence-based guidelines (39.5% vs. 46.3%).

CONCLUSION
Repeat CTPA exams are commonly performed. Patients receiving multiple exams have a higher clinical pretest probability and incidence of PE than patients receiving single CTPA exams. Repeat CTPA exams are less likely to be performed in concordance with evidence-based guidelines.

CLINICAL RELEVANCE/APPLICATION
SSA04-09 • 70 kV CT Pulmonary Angiography - Advantages of a Dual-source Protocol with Reduced Iodine Load

Ralf W Bauer MD (Presenter) *; Claudia Frellesen; Firas Al-Butmeh; Boris Bodelle MD; Julian L Wichmann MD; Josef Matthias Kerl MD *; Martin Beeres MD; Boris Schulz MD; Thomas Lehpert MD; Thomas J Vogl MD, PhD

PURPOSE
Lower kV settings go along with higher iodine attenuation, but also with increased noise, if mA are not adapted accordingly. Low kV scanning opens the door for the application of low iodine content contrast agents with potential benefits for patients with reduced kidney function. We investigated the potential of a novel 70 kV dual-source CTPA protocol (DS70) with low iodine load in comparison to a single-source 70 kV (SS70) and 100 kV (SS100) protocol with standard iodine load in terms of image quality and radiation exposure.

METHOD AND MATERIALS
Each 20 consecutive patients with suspected pulmonary embolism underwent CTPA either with a standard single-source 100 kV (120 mAs; group 1), a single-source 70 kV (208 mAs; group 2) or a novel dual-source 70 kV protocol (416 mAs; group 3). A dual-source protocol can overcome tube output restrictions that occur at 70 kV by using both X-ray tubes of the scanner simultaneously. Contrast enhancement was achieved with 70 ml of a contrast agent with 400 mgI/ml in group 1 and 2, whereas in group 3 the same volume was injected but with a lower iodine concentration of 300 mgI/ml. Injection rate was constant at 4 ml/s and bolus tracking was used for automated scan start. CTDIvol, DLP, noise, signal intensity in the pulmonary trunk and segmental arteries and corresponding SNR values were compared.

RESULTS
Chest diameter was not statistically significantly (p>0.05) different between the groups. CTDIvol (median: 5.86 vs. 2.49 vs. 5.79 mGy) and DLP (167 vs. 68 vs. 156 mGycm) were statistically significantly lower in group 2 with no such difference between group 1 and 3. Vascular attenuation was significantly higher (segmental arteries, 332 HU vs. 647 HU vs. 521 HU) with both 70 kV protocols. Image noise was significantly reduced with the DS70 protocol compared to the SS70 protocol and was at the level of the SS100 protocol. This resulted in a significantly higher SNR in group 3 compared to group 1 (56.0 vs. 60.1 vs. 64.3).

CONCLUSION
70 kV DS CTPA can achieve better SNR at similar dose values than a standard single-source 100 kV protocol, but with 25% less iodine load. The 70 kV single-source protocol showed lowest dose values, but has a demand for a high iodine contrast material in order to achieve equivalent image quality.

CLINICAL RELEVANCE/APPLICATION
The introduced 70 kV DS CTPA protocol holds potential for reducing iodine load in patients at risk for developing contrast-induced nephropathy.

Emergency Radiology (Imaging Chest Emergencies)

Sunday, 10:45 AM - 12:15 PM • N228

SSA05-01 Detection of Intramural Hematoma: Is a Non-contrast Phase Really Necessary?

Christopher A Potter MD (Presenter); Daniel S Hipp MS *; Elan D Bomsztyk MD; Guy E Johnson MD; Bruce E Lehner MD; Lorenzo Mannelli MD, PhD; Claire K Sandstrom MD; Martin L Gunn MBChB *

PURPOSE
CT angiography is sensitive and specific for diagnosis of intramural hematoma (IMH), aortic dissection (AD) and penetrating atherosclerotic ulcer (PAU). Most acute aortic syndrome (AAS) protocols use a pre-contrast phase to detect IMH, as contrast-enhanced phase alone is believed insufficiently sensitive for IMH, but there is little supporting data.

METHOD AND MATERIALS
We retrospectively reviewed images of patients who presented to our Emergency Department with suspected AAS and received pre- and post-contrast CTA from 2/1/2005 to 2/1/2010 for isolated acute IMH, defined as IMH without visible intimal flap. 423 studies were reviewed. 11 cases of IMH were identified. 22 normal controls and 12 abnormal controls (AD or PAU) were age and sex matched and included. The 45 studies were randomized. Only contrast-enhanced images were evaluated by three blinded, independent fellowship-trained radiologists. Reviewers rated their confidence for IMH using a 5-point modified Likert scale, also indicating if they recommended a non-contrast study to exclude IMH. Inverse probability weighting was used to extrapolate ordering rates from the matched case-control sample to the original sample.

RESULTS
423 patients underwent CTA for AAS; 11 patients were diagnosed with IMH (incidence of 2.6%). On independent case review, overall reader sensitivity for IMH on contrast-enhanced images alone was 94% (CI 74-99%) and specificity 97% (CI 88-99%). For all false negative cases, confidence rating for exclusion was low and delayed non-contrast examination was recommended. If delayed CT were ordered due to suspicious findings on contrast-enhanced images, 7.1% of patients (CI 3.3-14%) would undergo a delayed CT to exclude IMH. More conservatively, if delayed CT were ordered when confidence rating of 1 or 5 (definitely not present or definitely present) cannot be assigned, only 14% (CI 7.5-25%) of patients would undergo additional delayed CT. While the present sample was not large enough to be definitive, no IMH cases would be missed using this approach.

CONCLUSION
Acute IMH is a very uncommon diagnosis in patients with suspected AAS. A pre-contrast examination is unnecessary for diagnosis of acute IMH. Dose and time savings may be achieved by eliminating the pre-contrast phase.

CLINICAL RELEVANCE/APPLICATION
Exclusion of non-contrast phase on CTA for acute aortic syndrome, used in most ED protocols, may result in overall patient time and radiation dose savings.

SSA05-02 Is the Precontrast CT Series Necessary for Ruling Out Acute Aortic Intramural Hematoma?

Elie Portnoy MD (Presenter); Maria C Shiau MD; James S Babb PhD; Rose Weiner BS; Francis G Girvin MBChB; Jane P Ko MD; Derek M Mason MD; Maj L Wickstrom MD

PURPOSE
To assess the need for pre-contrast imaging when evaluating for Acute Aortic Intramural Hematoma (IMH). The current gold standard for the detection of Aortic Dissection (AD) is CT angiography. However, along the disease spectrum of AD, lie several related pathologies with
near identical clinical presentations. IMH, one such disease, lacks an intraluminal flap or discernible communication between the luminal blood and the intramural hematoma. It has long been posited that concern for this pathology alone necessitated pre-contrast images (in addition to post contrast images) to conclusively rule out IMH (in addition to AD.) This study seeks to demonstrate non-inferiority to post-contrast imaging alone in comparison to pre- and post-contrast studies.

METHOD AND MATERIALS
Study group of 23 patients (10M;13F;age 57-93;mean:78.5y) who underwent Pre- and Post-Contrast CT series and were diagnosed with IMH via official radiology report at a tertiary care hospital between 2007-2011. 23 gender and age controlled subjects were selected with no remarkable findings on CT. Five independently operating thoracic radiologists (dedicated experience in specialty 5-14 years) were presented with randomized, anonymized post-contrast imaging alone of the 46 above patients, aware of suspected acute aortic injury, and asked to comment on the absence or presence of IMH, AD, and/or penetrating ulceration. They were then presented with both the Pre- and Post-Contrast series for these patients and asked for their diagnoses yet again.

RESULTS
Within the post-contrast group, the readers were diagnostically accurate for IMH 72.8% of the time, as opposed to the combined pre- and post-contrast group, where they were accurate 76.8%. (p-value .340). (95% CI -2.278.8.) Since the difference between the 2 groups was statistically insignificant and it can be asserted with 95% confidence that no greater than 8.8% of cases of IMH would be missed with post-contrast imaging alone, post-contrast imaging alone was statistically non-inferior to combined pre- and post-contrast imaging.

CONCLUSION
IMH is radiographically evident on post contrast imaging alone and it is statistically non-inferior to combined pre- and post-contrast sequences.

CLINICAL RELEVANCE/APPLICATION
In clinical practice, when evaluating for possible aortic syndromes (Dissection, IMH, etc.) we contend that post-contrast angiography alone may suffice. Broader/confirmatory study may be warranted.

SSA05-03 Reduced Z Axis CTPA in Pregnant Women for Pulmonary Embolism - Do We Really Miss Any Important Diagnoses? How Much Is the Resultant Dose Reduction?

Kaushik S Shahir MD (Presenter); Luis A Sosa MD; Jonathan M McCrea MD; Lawrence R Goodman MD

PURPOSE
To evaluate the feasibility for applying reduced z axis coverage in CTPA in pregnant women. Were important diagnoses missed? What dose reduction resulted?

METHOD AND MATERIALS
In this IRB-approved retrospective study, 84 pregnant patients underwent CTPA for pulmonary embolism during 2004-2012. New axial, sagittal and coronal series were created with a reduced anatomic coverage extending from aortic arch to the base of the heart. These were read individually by 2 experienced blinded readers on the PACS workstation. The scans were evaluated for PE, incidental and pertinent findings. The readers had access to most recent chest radiograph. These results were compared with original report by the 3rd reader. In case of missed abnormality, 3rd reader checked whether the finding was a known abnormality or whether it influenced the clinical outcome. Additionally, we estimated dose length product (along z axis) for 40 patients as a quality control project.

RESULTS
Two out of 84 patients had PE and were successfully identified by both readers. 32 patients had normal exams. Rest of the patients had 57 pertinent and 20 incidental findings. 4 incidental findings including 3 benign thyroid nodules and one benign splenic calcification were missed. One pertinent but a benign lung nodule was missed, but this was a known abnormality based on prior CT. None of these missed findings affected further clinical outcome or management. Radiation dose was reduced by a mean of 69%.

CONCLUSION
No PE or any important diagnosis are missed using the reduced anatomic coverage CTPA for PE in pregnant women. The radiation dose is reduced by approximately 69%. Hence we highly recommend this technique in pregnant women.

CLINICAL RELEVANCE/APPLICATION
The study helps solve any doubts as regards to using a reduced z-axis CTPA technique for PE in pregnant women.

SSA05-04 Feasibility Study of Low Dose Chest CT for Initial Evaluation of Blunt Chest Trauma Patients

Jae Yong Cho MD (Presenter); Joo Sung Sun MD; Sung Jung Kim; Kyu-Sung Kwack MD, PhD; Sung Hoon Park MD; Kyung Joo Park MD; Young Gi Min MD

PURPOSE
To evaluate the feasibility of low dose chest CT (LDCT) for initial evaluation of blunt chest trauma.

METHOD AND MATERIALS
A total of 71 patients who met criteria indicative of major trauma (76% male; age range, 16-85) were included. All patients underwent LDCT without IV contrast and standard CT with IV contrast using parameters as followings: LDCT, 40mAs with ATCM and 100kVp or 120kVp (based on BMI); standard post-contrast CT, 180mAs with ATCM and 120kVp. Transverse, coronal, sagittal images were reconstructed with 3-mm slice thickness without gap. Reference standard images were reconstructed using standard CT data (1-mm slice thickness without gap). Reference standard was established by 2 radiologist by consensus. Four readers independently evaluated chest injury (fractures of bony thoracic cage, aortic injury, tracheobronchial injury, esophageal injury, hemotherax, pneumothorax, pulmonary contusion). Four investigators recorded results with 4 confidence scale (0-3 point). Comparison of radiation dose was done.

RESULTS
Radiation dose (CTDIvol) of LDCT (average 2.67mGy) was significantly lower than those of standard CT (average 13.4mGy) 78% dose reduction). ROC analysis and intraclass correlation coefficient ICC measurement demonstrated that LDCT was comparable to standard dose CT for evaluation of chest injury. ROC comparison analysis revealed no significant difference of diagnostic performance between LDCT and standard dose CT for the diagnosis of bony thoracic cage fracture, pulmonary contusion, hemotherax, pneumothorax, chest wall injury (>0.05). ICC was measured for inter-observer consistency and revealed that there was good inter-observer consistency in each examination of LDCT and standard dose CT for evaluation of aortic injury (0.83–0.94). Aortic injury could not be appropriately compared due to LDCT underwent without using contrast materials and this was limitation of this study.

CONCLUSION
Our conclusion is that there is a great potential benefit to use LDCT for initial evaluation of blunt chest trauma because LDCT could maintain diagnostic image quality as standard dose MDCT and provide significant radiation dose reduction. Further study of LDCT with IV contrast for evaluation of aortic injury is needed.

CLINICAL RELEVANCE/APPLICATION
This preliminary study suggest LDCT could be adequate initial imaging modality for blunt chest trauma patients with maintaining diagnostic image quality and reducing radiation dose.

SSA05-05 Usefulness of Ultra Low-dose (sub mSv) Chest CT Using iDose4 Iterative Reconstruction for Initial Evaluation of Sharp Fish-bone Esophageal Foreign Body
To evaluate the usefulness of ultra low dose chest CT (uLDCT) as initial imaging study for sharp fish-bone esophageal foreign body (EFB).

METHOD AND MATERIALS
A total of 38 subjects who visited emergency room with an obvious history and symptoms of sharp fish-bone EFB were included in this study. uLDCT were acquired at 20mAs with ATCM and 100kVp or 120kVp on a 64 MDCT scanner (Based on BMI). All uLDCT data were reconstructed twice, once with FBP and once with iDose4 IR, then 2 sets of CT data were randomly arranged and reviewed by 3 readers who were blinded to the result. Readers independently reviewed 3-mm thickness transverse and coronal images. Readers also scored subjective image quality (4 point scale). One reader measured objective image noise (SD of circular ROI, 10 pixels in diameter at the following level: right common carotid artery of the thoracic inlet; pulmonary trunk; D-aorta of lug base). Positive findings were defined as identification of high-density foreign body, secondary findings (soft tissue swelling, pneumomediastinum). ROC analysis was used to evaluate diagnostic performance of uLDCT. Intraclass correlation coefficient (ICC) was measured for analysis of inter-observer consistency.

RESULTS
Thirty-three fish bone EFBs were identified and removed by 31 esophagogastroscopy, and 2 operations. Among 5 cases of true negative, false positive lesions were frequently recorded as the cervical EFB when reviewing CT data using FBP than CT data using iDose4 IR. uLDCT provided radiation dose reduction by average 0.82 mGy of CTDIvol and 32.7 mGy*cm of DLP (0.46mSv). Significant noise reduction (objective and subjective) of mediastinum was achieved using iDose4 IR technique (p

CONCLUSION
Very low dose CT using iDose4 provided satisfactory diagnostic image quality for identifying fish-bone EFB with reduced radiation dose, therefore, uLDCT would be adequate as first imaging modality for sharp fish-bone EFB. iDose4 IR would be useful to reduce image noise of mediastinum mimicking EFB.

CLINICAL RELEVANCE/APPLICATION
Very low dose chest CT using iDose4 IR would be first imaging modality for initial evaluation of sharp fish bone esophageal foreign body before flexible endoscopic removal.

SSA05-06 • Increased Referral-rate for Investigation, and Increased Incidence of Symptomatic Radiologically-diagnosed Pulmonary Embolus in a Large Teaching Hospital, over a 10 Year Period

Kenneth Muir (Presenter) ; Nicholas C Morley MA, FRCR ; Edwin J Van Beek MD, PhD * ; John Murchison MBCHB

PURPOSE
To measure the rate of referral for radiological investigation of suspected acute Pulmonary Embolism (PE) and the incidence of PE detected in these scans, in a large teaching hospital. To observe changes in these measurements over the recent decade.

METHOD AND MATERIALS
Retrospective review of radiology records for Computed Tomography Pulmonary Angiograms (CTPA) and Perfusion Scans (Q-scans) for suspected acute PE, between 1st April 2002 and 1st April 2012. Graphical and statistical analyses were performed with Microsoft Excel and Graphpad Prism. Some of the data for the earlier years in this study was published previously (O'Neill et al., 2004). Our local research ethics service approved this project.

RESULTS
111% increase in total VTE investigations over 10 years, from 996 to 2111. Substantial increase in referral for CTPA, incremantly from 706 to 2020 scans per year. We also saw a decline in Q-scans from 290 to 91 per year. Increase in total number of PEs diagnosed, with annual incidence rising from 147 (15% positive-scan rate) to 426 (20% positive-scan rate), an increase of 190%. We observed an older population of PE patients, with mean age at diagnosis of PE going up from 62.2 to 65.4 (p= 0.03) and a 6-fold increase in PEs diagnosed in the 85-94 age group, from 9 to 57 per year.

CONCLUSION
There has been a major increase in the total number of investigations for suspected acute PE, accounted for by an increased use of CTPA with a corresponding decrease in the use of Q scans. In spite of what is generally assumed, the positive diagnosis rate increased, which may be a reflection of changed patient demographics combined with greater sensitivity of CTPA with newer CT scanners.

CLINICAL RELEVANCE/APPLICATION
The current rate of investigation for suspected acute PE is justified by a high rate of relevant diagnoses. Analysis of PE severity in these cohorts is warranted and is ongoing.

SSA05-07 • Cost and Risk Analysis of CT Pulmonary Angiography to Rule Out Pulmonary Embolism in Low and Very Low Risk Emergency Department Patients

Scott A Atkins MD (Presenter) ; Steven Munson MD ; J. Paul Jacobson MD * ; Thomas J Kelly MD

PURPOSE
A recent study has shown that approximately one third of CT pulmonary angiograms (CTPAs) performed to rule out pulmonary embolism (PE) in the emergency department (ED) are in low risk or very low risk patients based on Wells criteria and D-dimer, resulting in potentially avoidable cost to our healthcare system and risk to patients. The purpose of this study is to evaluate the cost effectiveness of CTPA in diagnosing PE in low risk patients and to quantify potentially avoidable cost and patient risk with the current medical practice pattern. Other studies have been done showing that CTPA is a cost effective method to diagnose PE when used in conjunction with Wells criteria and D-dimer. However, no studies have quantified the additional cost and patient risk when this standard of care is not followed and potentially avoidable imaging is performed.

METHOD AND MATERIALS
A literature search was performed and data on the current use of CTPA in the diagnosis of PE was reviewed. A decision model was constructed for evaluating low and very low risk patients for PE with and without the use of CTPA. The costs and patient utilities for each outcome were plotted to determine the dominant strategy. Strategies are dominant if they have lower costs and better outcomes constructed for evaluating low and very low risk patients for PE with and without the use of CTPA. The costs and patient utilities for each

RESULTS
The strategy of ED observation, not performing CTPA, dominated the strategy of performing CTPA to rule out PE in low and very low risk ED patients. ED observation dominated over a wide range of clinically relevant values, showing cost savings to the medical system and better patient outcomes when compared to performing CTPA in this population.

CONCLUSION
Ruling out pulmonary embolism in ED patients should begin with an assessment of risk based on clinical factors (Wells criteria) and a D-dimer to ensure that CTPA is not performed on patients who are low or very low risk. The potentially avoidable CTPAs performed on low risk patients add significant cost to the medical system without improving patient care. In fact, potentially avoidable imaging poses significant risk to these patients.

CLINICAL RELEVANCE/APPLICATION
Performing CTPA to rule out PE in low and very low risk ED patients increases medical costs and increases patient risk, worsening patient outcomes.
SSA06-08 • Variation in Utilization and Positivity Rates of CTPA among Emergency Physicians at an Academic Tertiary Emergency Department

Yingming Amy Chen MD (Presenter) ; Bruce G Gray MD ; Glen Bandiera MD ; David Mackinnon ; Djeven P Deva MBBCh

PURPOSE
This project examines the utilization and diagnostic yield patterns for CT pulmonary angiography (CTPA) ordered by individual Emergency Physicians (EPs) at an academic tertiary care center. The study is part of the institution’s quality improvement initiative aimed at establishing quantitative parameters for assessing individual EP’s image utilization.

METHOD AND MATERIALS
A cross-sectional retrospective study was conducted on 850 consecutive ED patients with suspected pulmonary embolism (PE) who underwent CTPA. Radiology report data was extracted from our institution’s RIS PACS software (syngo Imaging, Siemens) based on a targeted search of all CTPA reports from January 2010 to December 2012. Positivity rate for PE as well as nonthrombotic clinically significant findings were calculated. Utilization rates and positivity rates for individual physicians were calculated and correlated with both years of experience and certification.

RESULTS
Acute PE was diagnosed in 142 of the 850 patients evaluated by CTPA (16.7%). A further 25.2% of scans were negative for PE but had other clinically significant findings: 11.2% infection, 2.7% pulmonary edema, 2.9% effusion, 3.1% tumour, and 4.9% other. EPs ordered an average of 0.5 CTPA scans per 100 patients seen, with a significant variation across EPs in utilization (0.2 to 1 scans per 100 patients). Considerable variation also existed in the positivity rate for PE, ranging between 6.5% and 38.9%. There was no significant correlation between EP years of experience and utilization rate (linear regression r = -0.27; ANOVA p = 0.36 for 20 years) or positivity rate (r = -0.32; ANOVA p = 0.39). Furthermore, utilization and positivity rates were not significantly different between EPs with emergency medicine certification by the Royal College (FRCP) vs by the College of Family Physicians of Canada (CCFP-EM) (student t-test p = 0.34 for utilization rate, p = 0.56 for positivity rate).

CONCLUSION
While average utilization and positivity rates of CTPA for ED patients with suspected PE at our institution are comparable to those in the literature, considerable interphysician variability exists for both metrics. Utilization and positivity rates for CTPA did not correlate with either the physicians’ years of experience or specialty certification.

CLINICAL RELEVANCE/APPLICATION
Results of the study suggest an opportunity for a more standardized approach to the use of CTPA among EPs.

SSA05-09 • Comparison between CT Angiography of the Bronchial and Non-bronchial Systemic Arteries vs. Conventional Angiography in Patients Undergoing Endovascular Treatment of Hemoptysis

Hosny M Hamza MD, FRCR (Presenter) ; Yasser Ragab MBBCh, MSc ; Magdy Abdelsalam MD

PURPOSE
To compare bronchial and nonbronchial systemic CT angiography at 320 multi-detector row computed tomography with conventional angiography in patients undergoing endovascular treatment of hemoptysis.

METHOD AND MATERIALS
A retrospective study including 50 patients (37 men, 13 women) with hemoptysis of bronchial and nonbronchial systemic artery origins underwent 320 multi-detector CT angiography of the thorax prior to embolization. Findings on CT angiograms, including CT scans, maximum intensity projections, and three-dimensional volume-rendered images, were used to evaluate the depiction of bronchial and nonbronchial systemic arteries. Retrospective analysis of the ostium and the course of bronchial and/or nonbronchial systemic arteries on CT angiograms enabled evaluation of the accuracy of this technique in identification of the relevant vasculature.

RESULTS
Among the 50 patients initially treated with bronchial artery embolization, 56 bronchial arteries were identified at CT angiography. In 94% of cases, concordant findings were observed with both modalities. In five 6% cases, CT could not be used to identify the ostia of bronchial arteries. In 5% cases, CT depicted bronchial arteries that could not be selectively catheterized. Three-dimensional images were found to be superior to 2D CT angiographic in depicting the ectopic origin of the bronchial arteries, which enabled the interventional radiologists to perform successful embolization after direct catheterization of the ectopic vessel in every case. In 10% of patients, the nonbronchial systemic origin of bronchial bleeding was identified on CT angiograms.

CONCLUSION
CT angiography using 320 Multi-detector systems provides more accurate depiction of bronchial and nonbronchial systemic arteries than does conventional angiography.

CLINICAL RELEVANCE/APPLICATION
The routine use of 320 CT scan in patients with hemoptysis can help identifying the origin of the bleeding vessels and can improve the efficiency of the treatment by identifying unexpected vessels.

RESULTS
SSDE for routine abdominal CT examinations were highest for age group 61-70 years (11 mGy) and lowest for 10-20 years (9.4 mGy). EED (ICRP 103) were 6.9-8.7 mSv and 11.4-9.1 mSv for these age groups (p<0.001).

CONCLUSION
SSDE and estimated effective doses are suboptimal for cancer risk estimation and organ doses should be used for solid cancer radiation induced risk estimation, regardless of patient’s age.

CLINICAL RELEVANCE/APPLICATION
Contrary to the prior belief, dose concerns are not only important for the younger age groups (0-20) but also for older patients (30-60 years), especially for risk estimations of lung, breast cancers.

SSA06-02 Multi-reader Detectability of Simulated Low-contrast, Low-attenuation (LCLA) Liver Lesions on MDCT: Effect of Dose and Reconstruction Method

Ajit H Goenka MD (Presenter) ; Brian R Herts MD * ; Nancy A Obuchowski PhD ; Andrew Primak PhD * ; Frank Dong PhD * ; Wadhia Karim RT ; Mark E Baker MD *

PURPOSE
To assess the effect of reduced radiation exposure and reconstruction method on detection of lesions that are low-contrast, low-attenuation (LCLA) relative to the background liver.

METHOD AND MATERIALS
Semi-anthropomorphic phantom containing custom inserts with 36 spherical liver lesions of 3 sizes and attenuations (10 and 15-mm at 6, 12, and 18HU, and 5-mm at 12, 18 and 24HU below 90HU simulated liver) was scanned at 120kVp, 0.6-mm collimation, 200 (CTDIvol 13.49), 150, 100 and 50mAs on a 128-slice MDCT scanner (Definition Flash, Siemens). Lesions were distributed non-uniformly to reduce memory bias. Images were reconstructed at 3-mm thickness using filtered back projection (FBP) and sinogram-confirmed iterative reconstruction (SAFIRE, S3). A randomized dataset containing 256-images was generated for each reader (12 images with one lesion, 12 with two lesions and 8 without lesions, for each dose and reconstruction method). Eighteen Radiologists blinded to phantom and study design independently reported region-level lesion presence or absence on a 5-point diagnostic confidence scale. Statistical evaluation included multi-reader, multi-case (MRMC) ROC analysis using nonparametric methods with the area under the ROC curve (AUC) considered accuracy.

RESULTS
Pooled AUC decreased with each 25% reduction from 100% dose: 0.848, 0.842, 0.792 and 0.743 for SAFIRE. At a given dose, improvement in AUC with SAFIRE was, however, not statistically significant. For both FBP and SAFIRE, accuracy at 75% dose was statistically equivalent to 100% dose FBP (p =0.002 and CONCLUSION
In this LCLA liver lesion model, a 25% dose reduction did not reduce detection of the lesions studied. However, detection was inferior with each subsequent dose reduction regardless of reconstruction method. For lesions with attenuation differences larger than or equal to 12HU, lesion detection was not reduced even at 50% dose with FBP.

CLINICAL RELEVANCE/APPLICATION
Estimates of loss of accuracy at reduced doses and limits of iterative reconstruction should be known especially for low contrast, low attenuation liver lesions to enable dose optimization in practice.

SSA06-03 Effect of the Learning Curve on Radiologist's Diagnostic Performance for Hypervascular Liver Lesion Detection and Image Quality Perception Using an Adaptive Statistical Iterative Reconstruction Algorithm

Daniele Marin MD (Presenter) ; Achille Mileo MD ; Lisa M Ho MD ; Brian C Allen MD ; Rajan T Gupta MD * ; Ehsan Samei PhD * ; Rendon C Nelson MD *

PURPOSE
To prospectively evaluate the effect of experience with an adaptive statistical iterative reconstruction (ASIR) algorithm on diagnostic accuracy and confidence for the diagnosis of hypervascular liver tumors, as well as reader’s perception of image quality, using dual energy CT (DECT).

METHOD AND MATERIALS
Patient consent was obtained for this IRB-approved, HIPAA-compliant, prospective study. The final study cohort comprised 40 patients (29 M; mean age, 60±8.4 years; mean BMI, 28±5.6 kg/m2) with 65 hypervascular liver tumors who underwent DECT during the hepatic arterial phase. The low energy (80 kVp) image set was reconstructed with standard filtered backprojection (FBP) and ASIR at 20%, 40%, 60%, and 80% levels of blending. Two readers (one attending and one fellow in abdominal imaging) inexperienced with the imaging appearance of ASIR reconstructions randomly assessed all image sets for confidence in detecting and characterizing liver lesions, as well as evaluation of image quality (1st session). The same cases were re-examined by the same readers after three years of readers’ experience with ASIR in their daily practice (2nd session).

RESULTS
For both reading session, there was no significant difference in diagnostic accuracy and sensitivity for lesion detection using different reconstruction algorithms, among different readers. Diagnostic accuracy did not change significantly between the 1st and 2nd session for both FBP (0.91 vs. 0.85) and any levels of ASIR reconstruction (0.90 vs 0.89). However, while ASIR yielded a significant decrease in specificity for lesion detection compared to FBP during the 1st session (0.81 vs. 0.62, P<0.001), no significant difference in specificity was observed between ASIR and FBP in the 2nd session. Readers’ perception of image quality improved significantly for any levels of ASIR reconstruction between the 1st and 2nd session (P<0.001).

CONCLUSION
Readers’ experience with ASIR does not significantly change diagnostic accuracy for hypervascular liver lesion detection, but may decrease the number of false positive findings as well as improve reader’s perception of image quality.

CLINICAL RELEVANCE/APPLICATION
Reader’s experience with ASIR improves subjective perception of image quality and may significantly decrease false-positive findings.

SSA06-04 Potential of Radiation Dose Savings in Abdominal and Chest CT Using Automated Tube Voltage Selection in Combination with Automated Tube Current Modulation

Mathias Meyer (Presenter) ; Caroline Mayer ; Christian Fink MD ; Bernhard Schmidt PhD * ; Martin U Sedlmair MS * ; Paul Apfaltrer MD ; Thomas G Flohr PhD * ; Stefan O Schoenberg MD, PhD * ; Thomas Henzler MD

PURPOSE
To evaluate the simultaneous use of automatic tube current modulation (ATCM) and automatic tube voltage selection (ATVS) for abdominal and thorax contrast-enhanced CT examinations regarding radiation dose reduction and image quality.

METHOD AND MATERIALS
In total 617 consecutive patients were enrolled in this retrospective single center study who all either underwent a portal-venous abdomen CT examination or a contrast-enhanced arterial phase chest CT examination and were divided into two groups. In group A, 317 patients were enrolled using ATCM with a fixed body-mass-index adjusted tube voltage of either 120 kV or 100 kV. In group B, consisting of 300 patients, ATCM as well as ATVS was used. Image attenuation and noise was measured in different abdominal and thoracic regions for each patient. To compare the CT density and image noise, signal-to-noise ratio, contrast-to-noise ratio and radiation parameters...
between both groups a 1-way analysis-of-variance was preformed.

RESULTS
The mean contrast-to-noise ratio and the signal-to-noise ratio of abdomen and chest CT scans was higher in group B if compared to group A (p.<0.05).

CONCLUSION
The simultaneous use of ATVS and ATCM allows for significant radiation dose reduction in abdominal and thoracic contrast enhanced CT examinations when compared to the use of ATCM alone while maintaining adequate image quality and diagnostic confidence without user interaction. The ATVS tool reduced tube voltage effective in the majority of patients (49%) resulting in a dose reduction of 18%, demonstrating the potential of this new dose modulation tool.

CLINICAL RELEVANCE/APPLICATION
Simultaneous use of ATCM and automatic tube voltage selection allows for significant radiation dose reduction in abdominal/thoracic CT examinations of up to 18% when compared to ATCM alone.

SSA06-05 • Model Based Iterative Reconstruction Algorithm for Abdominal CT at Variable Radiation Doses: Assessment of Image Quality, Lesion Conspicuity and Radiation Dose in Anthropomorphic Liver Phantoms

Jeong Hee Yoon MD (Presenter) ; Jeong-Min Lee MD * ; Mi Hye Yu MD ; Joon Koo Han MD ; Byung Ihn Choi MD, PhD *

PURPOSE
To assess the image quality, lesion conspicuity and radiation dose of model-based iterative reconstruction algorithm (IMR) compared with filtered back projection (FBP) and hybrid iterative reconstruction algorithm (iDose) for the liver computed tomography (CT) at radiation dose.

METHOD AND MATERIALS
Small and large anthropomorphic phantoms with 4 simulated hypervasular tumors and 4 hypovascular tumors were scanned using a 256-channel CT scanner using 120 and 100kVp with 20, 40, 60, 80, 100, 130, 150, 180 and 200mAs. CT images of both phantoms at the two kVp were classified by radiation dose: standard dose (200mAs); mild dose reduction (DR) (130-180mAs), severe DR groups (20-40mAs). All scans were reconstructed using FBP, iDose level 4 and IMR. Signal-to-noise ratio (SNR) and contrast-to-noise ratio (CNR) were calculated in the organs and compared among the different reconstruction modes. In addition, two radiologists assessed the image quality and lesion conspicuity of 8 focal liver lesions (FLLs).

RESULTS
SNR and CNR of IMR images were significantly higher than those of others, at the same radiation dose in both phantoms by reducing noise effectively (p.<0.05).

CONCLUSION
IMR significantly reduces noise and improved SNR and CNR compared with FBP and iDose, and provide the similar image quality with mild to moderate dose reduction in variable body habitus. However, IMR can improve FLL conspicuity only with mild to moderate dose reduction.

CLINICAL RELEVANCE/APPLICATION
IMR can reduce noise and improve image quality and allows use of lower radiation dose for abdominal CT. Lesion conspicuity can be improved with IMR at mild to moderate dose reduction, severe dose reduction.

SSA06-06 • Assessment of Hybrid and Pure Iterative Reconstruction with Filtered Back Projection Technique for Low Dose Abdominal CT

Atul Padole MD (Presenter) ; Sarabjeet Singh MD ; Michael A Blake MBBS * ; Garry Choy MD, MS ; Sanjay Saini MD ; Mannudeep K Kalra MD * ; Synho Do PhD * ; Ranish D Khawaja MBBS, MD ; Sarvenaz Pourjabar MD ; Diego A Lira MD

PURPOSE
To evaluate standard and low dose abdominal CT images reconstructed with filtered back projection (FBP), hybrid (hIRT) and pure (pIRT) iterative reconstruction techniques.

METHOD AND MATERIALS
In an IRB approved, prospective clinical study, 20 patients (mean age 59 ± 14 years, mean weight 181±41 lbs, M:F 13:7, undergoing routine abdomen CT on a 64 channel MDCT (Discovery CT750 HD) gave written informed consent for acquisition of an additional sub-milli-Sievert (submSv) abdomen CT series. The latter series were acquired with reduced tube current but identical scan length and pitch. All scans were reconstructed using FBP, iDose level 4 and IMR. Mean CTDIvol were 9.3±3.5 and 1.3±0.2 mGy for standard and submSv CT, respectively. Lesion conspicuity was improved from poorly visualized margins in FBP and hIRT images to well defined margins on submSv pIRT. All 3 radiologists found suboptimal noise in submSv images, whereas noise was acceptable with pIRT. Except for minor pixelated appearance of pIRT images, no significant artifacts were seen. Noise power spectrum analyses showed hIRT retains the noise spectral signature as FBP, in spite of lowering the noise, whereas pIRT had lower noise as well as more regularized noise spectral pattern.

CONCLUSION
SubmSv abdominal CT examinations when reconstructed with pIRT improves the visualization of lesion margins and normal abdominal structures and are associated with lower image noise as compared to hIRT and FBP, without any significant image artifacts affecting diagnostic interpretation.

CLINICAL RELEVANCE/APPLICATION
Pure iterative reconstruction technique can allow use of submSv radiation dose for routine abdominal CT with retained diagnostic confidence.

SSA06-07 • Comparison of Dose from Single Energy and Dual Energy Multi-detector Computed Tomography Examinations in the Same Patient Screened for Hepatocellular Carcinoma

Andrei S Purysko MD (Presenter) ; Mark E Baker MD * ; Andrew Primak PhD * ; Erick M Remer MD ; Nancy A Obuchowski PhD ; Binh John MD, MPH ; Federico Aucejo ; Brian R Herts MD *

PURPOSE
To compare the dose and noise level between single energy (SE) and dual energy (DE) multi-detector computed tomography (MDCT) examinations in patients undergoing screening for Hepatocellular Carcinoma (HCC).

METHOD AND MATERIALS
IRB-approved, HIPPA-compliant prospective study of 59 adult subjects (mean age 59.5yrs) undergoing HCC screening with 3-phase CT (unenhanced, arterial and portal-venous phases), who were each examined on both SE (Sensation 64, Siemens Healthcare) and DE CT scanners (Flash, Siemens Healthcare) on different dates. SE scans were performed using 120kVp and weight-based mAs (mAs=patient’s weight), and DE scans at 100kVp and 140kVp, with mAs adjusted to match the estimated CTDIvol of a weight-based mAs SE scan. The CTDIvol and DLP of each phase were recorded. Maximum anteroposterior and transverse dimensions measured from CT radiographs were
used to calculate the effective diameter (ED) and size-specific dose estimate (SSDE). Regions of interest (ROI) were drawn in liver, retroperitoneal (RP) fat, IVC, and aorta and Hounsfield unit values with Standard Deviation (SD) recorded. Paired t-tests were used to compare BMI, weight, and ED at the time of the two imaging studies. Distributions of outcome variables (dose and noise) were examined using Q-Q plots and Shapiro tests.

RESULTS
BMI and weight of the subjects were highly correlated with the ED (r=0.75 and 0.87) and did not differ significantly between the two scans. CTDIvol and SSDE were significantly lower for all the phases on DE scans compared to SE scans (p-values)

CONCLUSION
Dose with the MDCT DE scanning protocol was significantly lower when compared to SE examinations, with either similar or lower noise levels.

CLINICAL RELEVANCE/APPLICATION
DE scanning protocols can be an alternative to decrease dose in patients undergoing HCC screening who require repetitive imaging.

SSA06-08 • Ultra Low-Dose CT for Patients with Clinically Suspected Acute Appendicitis: Optimal Strength of Sinogram Affirmed Iterative Reconstruction for Image Quality and Diagnostic Performance

Seung Ho Kim MD (Presenter) ; Janghee Lee MD ; Kyeong Hwa Ryu MD ; Een Young Cho MD ; Jung Hee Yoon MD ; Yun-Jung Lim ; Choong K Eun MD

PURPOSE
To evaluate the optimal strength of Sinogram Affirmed Iterative Reconstruction (SAFIRE) to obtain the best image quality on ultralow-dose CT (ULDCT) and to compare its diagnostic performance with that of the half-dose CT (HDCT) for the diagnosis of acute appendicitis.

METHOD AND MATERIALS
This prospective study was IRB approved, and informed consent was obtained from all patients. A total of 102 consecutive patients (47 men, 55 women; mean age, 41.2 years; range, 15-82 years) with right lower quadrant pain underwent low dose CT, which consisted of enteric phase HDCT (120 kVp, 100 mAs, effective dose=3.6 mSv) and portal phase ULDCT (120 kVp, 30 mAs, 1.5 mSv). ULDCT images were reconstructed separately with five levels strength levels (S1-S5). Two blinded radiologists recorded scores for the subjective image quality of the ULDCT data set (S1-S5 and S0 (filtered back projection)) according to the European guidelines on quality criteria for CT, as well as confidence scores for the diagnosis of acute appendicitis on each set and HDCT. Histopathological findings served as a reference standard for diagnostic performance. For the quantitative analysis, CT image noise was measured for each set. Subjective image quality data were analyzed by Wilcoxon rank test, measured noise data by repeated measures ANOVA, and diagnostic performance by pair-wise comparison of ROC curves.

RESULTS
The study population consisted of 58 positives and 44 negatives. There was no significant difference in diagnostic performance between HDCT and ULDCT with any strength for both readers (AUC for reader 1, S0-S5=0.965, HDCT=0.933, p>0.05; for reader 2, S0=0.963, S1-S5=0.964, HDCT=0.966, p>0.05). The measured noise decreased as the strength increased from S0 to S5 (mean, 19.1>17.3>15.1>13.0>10.9>8.8, p>5S, p)

CONCLUSION
Although measured noise declined as SAFIRE strength increased, S3 seems optimal for the best subjective image quality on ULDCT. The diagnostic performance of ULDCT with any strength is comparable to that of HDCT for the diagnosis of acute appendicitis.

CLINICAL RELEVANCE/APPLICATION
For reducing radiation dose and maintaining diagnostic performance in patients with clinically suspected acute appendicitis, ULDCT with S3 reconstruction can be recommended.

SSA06-09 • Imaging of Acute Appendicitis: Role of Low-Dose CT

Gopesh Mehrotra MBBS, MD (Presenter) ; Anupama Tandon MD, MBBS ; Sanjay Gupta MD ; Agarwal A Durgadas MD ; Ajai K Srivastava

PURPOSE
The clinical diagnosis of acute appendicitis is not always accurate and twin objectives of imaging are to avoid negative appendectomies and to diagnose alternate pathologies. There is controversy about optimal imaging techniques and accuracy of imaging modalities. This study compared the diagnostic accuracy of ultrasonography (USG), low dose CT and standard dose CT in diagnosis of acute appendicitis.

METHOD AND MATERIALS
Subjects were hundred patients of all age group and either sex with clinical suspicion of acute appendicitis. Informed consent and clearance from institutional ethical committee was taken. USG was conducted by two reviewers and Low dose CT images obtained at predefined protocols were presented to the two reviewers, who were blinded to clinical findings. Standard dose CT was done thereafter only if required (in 36 cases). Patients who refused consent, had contrast allergy, fulminant peritonitis or pregnancy were excluded from the study. A control group was 75 patients who had USG / CT done for non-GI complaints. The sensitivity, specificity, PPV, NPV of each modality and scoring was calculated in comparison to operative findings.

RESULTS
The overall sensitivity, specificity, PPV, NPV and accuracy of USG was 98.6%, 96.2%, 98.6%, 96.2% and 97.4 respectively. Standard dose CT had highest sensitivity and specificity of 100%. Overall detection rate of appendix was 88% on USG, 100% on standard dose CT and 85.6% to 87.6% on low dose CT. On USG statistically significant association was found between acute appendicitis and thickened wall of appendix (>2mm), fluid in lumen and peri-appendicial fluid and on low dose CT between acute appendicitis and hyperdense wall, periappendicial fluid and stranding. Mean radiation dose was 0.664mSv on low dose CT (eff mAs 20) and 4.286mSv on standard dose (eff mAs 120).

CONCLUSION
Overall diagnostic performance of USG and low dose CT was good and was almost similar. There were no false positives or negatives on imaging, using USG and low dose CT together and a diagnosis was possible in most cases. Alternative diagnoses were seen in 17% cases and could be detected in all cases.

CLINICAL RELEVANCE/APPLICATION
Low dose CT in association with sonography has the potential to be used as a less radiating alternative for standard dose CT for diagnosing acute appendicitis or alternative diagnosis.
Impact on Survival, Local Recurrence and Metachronous Peritoneal Carcinomatosis

SSA07-03 • Texture Analysis of MR Dixon Images in Primary Colorectal Cancer: Initial Experience Using PET-MRI

Balaji Ganeshan PhD (Presenter) *; Asim Afq FRCR; Shonit Punwani MBBS; Alec Engledow; Daren Francis; Nicholas Rhys-Jones; Tan Arulampalam; Sanjay Dindyal; Omer Jalil; Anna Barnes; Celia O'Meara; Manuel Rodriguez-Justo; Peter J Ell MD *; Kenneth Miles *; Ashley M Groves MBBS *

PURPOSE
To describe the technique and initial results obtained from texture analysis of MR Dixon images derived from PET-MRI in primary colorectal cancer.

METHOD AND MATERIALS
10 consecutive prospectively recruited primary colorectal cancer patients (6 male and 4 female; Mean age 61.3±10.02) underwent PET-MRI including acquisition of Dixon images for attenuation correction, measurement of tumor fluorodeoxyglucose uptake (SUVmean) and MRI apparent diffusion coefficient (ADCmean). A parametric image of fractional water content was produced from the Dixon images from the ratio of the water-weighted image and the summed water- and fat-weighted images. Fractional water images underwent texture analysis using a filtration-histogram method. Filtration highlighted image features ranging between approximately 2mm and 7mm diameter. Histograms of filtered images quantified as standard-deviation (SD) and proportion of positive pixels (PPP) were correlated against SUVmean and ADCmean using Spearman Rank Correlation.

RESULTS
The mean tumor fractional water content was 0.88 (range: 0.74 ± 0.95). Fractional water content did not correlate significantly with ADCmean (r = 0.358, p = 0.310) and SUVmean (r = -0.303, p = 0.934). Fractional water texture expressed as SD correlated negatively with ADCmean (r = -0.75, p = 0.013) with PPP values correlated positively with SUVmean (r = 0.75, p = 0.013).

CONCLUSION
Texture analysis of Dixon images can potentially assess tumor water distribution. Tumor ADCmean and SUVmean measurements may be related to tumor water distribution in colorectal cancer.

CLINICAL RELEVANCE/APPLICATION
Texture analysis of Dixon images in colorectal cancer may potentially provide information about tumor biology with possible applications in personalized medicine.

SSA07-02 • CT Manifestations of the Mesorectal Fascia Invasion of Rectal Carcinoma

Chen Nan MD (Presenter); Kuncheng Li MD

PURPOSE
The total mesorectal excision (TME), which the surgical removal of rectal tumor and the surrounding mesorectum along the mesorectal fascia (that is circumferential resection margin, CRM), has become the standard surgical method of rectal cancer which originated from the section below the pelvic peritoneum reflection. Therefore, to preoperatively comprehensive evaluate the state of mesorectal fascia is very important an impact on the decision of potential for TME surgical removal as well as whether neoadjuvant therapy should be administered. So, our Purpose is to evaluate the CT manifestations of the mesorectal fascia invasion of rectal carcinoma.

METHOD AND MATERIALS
Seventy-eight patients with rectal carcinoma which originated from the section below the pelvic peritoneum reflection underwent preoperative CT examinations and the operations were performed with TME method in 72 resectable tumor. Compared the CT characteristics of mesorectal fascia invasion of rectal carcinoma with the pathologic findings.

RESULTS
In 78 cases, 51 cases rectal carcinoma had penetrated through the rectal wall present patching-like, lining or mass shadows distributed within the perirectal fat tissue on CT. Among them, none of rectal fascia was thicken on CT in 27 cases. In these cases, no tumor cells infiltrating was found in the CRM proved by pathology. The thickening of the rectal fascia present even or irregularly thickened was found in 28 cases on CT and the CRM involvement proved by pathology was 11 cases and 13 cases, respectively. The e values was 0.818 and the p = 0.013.

CONCLUSION
CT is valuable in identifying tumor invasion mesorectal fascia. The state of mesorectal fascia on CT is excellent agreement with the pathologic findings of CRM.

CLINICAL RELEVANCE/APPLICATION
It’s very important for preoperative determination of resectability, surgical approach and prognosis of rectal carcinoma.

SSA07-03 • The Correlation of Radiologic Serosal Involvement in Rectal Cancer to Pathologic Assessment, and Comparison of Impact on Survival, Local Recurrence and Metachronous Peritoneal Carcinomatosis

Michael R Torkzad MD, PhD (Presenter) *; Faoz Dranichnikov; Hakan Ahlstrom; Peter Nygren; Lars Pahlman; Haile Mahteme MD, PhD

PURPOSE
To investigate the correlation between radiologic and pathologic assessment of serosa involvement in patient with rectal cancer, and also compare the impact of serosa involvement on survival, local recurrence and metachronous peritoneal carcinomatosis (MPC).

METHOD AND MATERIALS
100 consecutive patients diagnosed with T3 and T4 primarily rectal cancer between 2007 and 2008 made the basis of this study. Detailed radiologic analysis of magnetic resonance imaging (MRI) of rectum at the time of diagnosis of rectal cancer was performed by an experienced radiologist blinded to the clinical data. T4s was defined as tumor growing locally into the serosal layer; rT4s was when the radiologist made such an assessment and pT4s when the pathologist made such assessment. The clinical data at the time of diagnosis and surgery, and 4-5 years postoperative, follow-up regarding survival and adverse outcomes (cancer-related mortality and recurrence) and development of MPC were recorded.

RESULTS
94 patients had complete clinical data of which 63 had MRI prior to treatment. 11 patients showed radiologic signs of local peritoneal involvement (rT4s), while 6 patients showed this at pathology (pT4s). Only two of these were assessed as T4s by both the radiologist and the pathologist. Cancer-related mortality and local recurrence rate were higher among rT4s patients than pT4s (55% vs. 33% and 58% vs. 17%, respectively with odds ratio of 1.67 and 3.49). The only two cases of MPC were seen among rT4s patients. Step-wise multivariate regression showed higher impact by rT4s than pT4s classification on survival, recurrence rate and MPC with adjusted correlation coefficients (R2) of 0.04, 0.15 and 0.14. rT4s staging was the only factor with adjusted R2 > 0.03 for development of MPC.

CONCLUSION
There seems to be a large discrepancy between rT4s and pT4s though the latter was usually after neoadjuvant therapy. rT4s showed higher impact on development of MPC, local recurrence and even cancer-related survival.

CLINICAL RELEVANCE/APPLICATION
Involvement of serosal layer in rectal cancer denotes a higher risk for metachronous development of peritoneal carcinomatosis, local
SSA07-04 • Diffusion Weighted Imaging for Evaluating Lymph Node Eradication after Neoadjuvant Chemoradiation Therapy in Locally Advanced Rectal Cancer

Kyeong Hwa Ryu MD (Presenter); Seungho Kim MD; Jung Hee Yoon MD; Yedaun Lee MD; Yun-Jung Lim; Choong K Eun MD

PURPOSE
To evaluate the added value of the diffusion-weighted imaging (DWI) for evaluating lymph node (LN) eradication after neoadjuvant chemoradiation therapy (CRT) in patients with locally advanced rectal cancer (LARC).

METHOD AND MATERIALS
Institutional review board approved this retrospective study and waived informed consent. Ninety-five consecutive patients (64 men, 31 women; mean age: 59 years, range: 32-82 years) with LARC (=T3 or LN metastasis) who underwent CRT and subsequent surgery, were enrolled in this study. All patients underwent pre-and post-CRT 1.5-T rectal MRI with DWI (b=0, 1000). To evaluate the added value of the DWI for evaluating LN eradication after CRT, two blinded radiologists independently read the pre- and post-CRT T2-weighted images (T2WI) first and then the combined image set of the T2WIs and pre- and post-CRT DWI with a four-week interval and recorded their confidence score for LN eradication with a 5-point scale on a per-patient basis. The diagnostic performances were compared between the two reading sessions for each reader by using pair-wise comparison of receiver operating characteristic histograms. Histopathology reports served as the reference standard for LN eradication.

RESULTS
Study population consisted of LN-eradicated group (n=65) and non-eradicated group (n=30). The diagnostic performances did not significantly differ between the two reading sessions for both readers (AUC, for reader 1, 0.770, 0.774, p=0.8155; for reader 2, 0.794, 0.798, p=0.8588). The sensitivity, specificity and accuracy for LN eradication were stationary after adding DWI for both readers (for reader 1, from 88%, 63% and 80% to 88%, 73% and 83%, respectively; for reader 2, from 77%, 77% and 77% to 77%, 80% and 78%, respectively).

CONCLUSION
Adding DWI to T2WI provides no additional diagnostic benefit for evaluating LN eradication after CRT in patients with LARC.

CLINICAL RELEVANCE/APPLICATION
Adding DWI to T2WI provides no additional diagnostic benefit for evaluating LN eradication after CRT in patients with LARC.

SSA07-05 • Magnetic Resonance Imaging of Tumor Initiation and Progression, and Response to Vitamin D in a Mouse Model of Colitis and Colitis-associated Colon Cancer

Devkumar Mustafi PhD (Presenter); Urszula Dougherty MS; Erica Markiewicz BA; Xiaobing Fan PhD; Marc Bissonnette MD; Gregory S Karczmar PhD *

PURPOSE
Colitis cancer is a leading cause of cancer-deaths in the US. Ulcerative colitis is causally linked to colitis-associated neoplastic progression but is difficult to detect and monitor non-invasively. Goals of this study were to determine MRI characteristics of early colitis-associated colon cancer and to assess vitamin D chemopreventive efficacy.

METHOD AND MATERIALS
This study included CF1 female control mice (n=12), and mice treated with azoxymethane i.p. and dextran sulfate sodium in the drinking water (n=25) to induce colitis and colon cancer. Mice were fed a Western diet or Western diet supplemented with vitamin D (500 µg/kg chow). Western diets are relatively deficient in vitamin D and calcium. Mice were studied serially using anatomic and dynamic contrast enhanced MRI (DCEMRI) with a Gd-based contrast agent in vivo MR and ex vivo histological images were co-registered using an agar based color-coded phantom in a flexible tube (2 mm o. d.) that was inserted via the rectum to the cecum. The phantom provided visual and MRI-detectable reference markers to co-register in vivo and ex vivo images.

RESULTS
We demonstrated that: 1) a visible reference marker could be used to successfully co-register MRI abnormalities with histological features identified in HandE stained sections; 2) T2 values distinguished normal colon from colitis, and from focal neoplastic lesions (trans values assessed by DCEMRI (a measure of perfusion/capillary permeability) reliably distinguished normal colon from tumor (0.12±0.01 min-1 vs. 0.61±0.05 min-1, respectively, p3-fold larger adjacent to early colonic tumors compared to vessels in control mice, suggesting that MRI might be used to detect dilated blood vessels as biomarkers of early colorectal cancer; 5) Vitamin D reduced the number of colonic tumors and degree of inflammation detected by MRI (p

CONCLUSION
A novel technique was successfully developed to co-register MR and histological images. Several reliable image-based markers for colitis and colon cancer were identified. These MRI methods could monitor the chemopreventive efficacy of vitamin D in this model in real time and without sacrifice.

CLINICAL RELEVANCE/APPLICATION
Non-invasive MRI/DCEMRI studies of colitis and colon cancer in mice will improve understanding of these diseases, produce new MRI markers to improve diagnosis, and guide development of new therapies.

SSA07-06 • Neoadjuvant Radiochemotherapy Response Evaluation with Magnetic Resonance and FDG-PET/CT in Rectal Cancer Patients: Predictive Value of Combined Quantitative Parameters of ADC and SUV Compared with TRG at Histology

Davide Ippolito MD (Presenter); Pietro A Bonaffini MD; Davide Fior MD; Cristina Capraro MD; Chiara Trattenero MD; Sandro Sironi MD

PURPOSE
To determine the clinical value of functional imaging by analyzing quantitative parameters of ADC and SUV max values before and after chemo-radiation therapy in prediction of tumor response of patients with rectal cancer, correlated with the histologic examination expressed as tumor regression grade.

METHOD AND MATERIALS
A total of 45 patients with biopsy proven diagnosis of rectal carcinoma were enrolled in our study. All patients underwent a whole body 18 FDG PET/CT scan and a pelvic MR examination before(PET 1, MR 1) and after the neoadjuvant chemoradiation therapy(PET 2, MR 2). Subsequently all patients underwent total mesorectal excision and the histologic results were compared with imaging findings. MR scanning, performed on 1,5 T magnet(Philips,Achieva), comprised T2-weighted multiplanar imaging and in addition DW images with b-value of 0 and 1000 mm²/sec. On PET/CT the SUVmax of the rectal lesion were calculated in PET1 and PET2. The percentage decrease of SUVmax(%) and ADC(TACD) values from baseline to presurgical scan were assessed and correlated with pathologic response classified as tumor regression grade (Mandard’s criteria;TRG 1 = complete regression,TRG 5 = no regression).

RESULTS
At histological examination, according to Mandard’s criteria, 29 tumors(68%) showed complete or subtotal regression(TRG 1-2) and were classified as responders;16 tumors(32%) were classified as non-responders(TRG 3-5). Considering all patients the mean values of SUVmax in PET 1 was higher than mean value of SUVmax in PET 2 (p =3mm²/s) with high sensitivity and specificity. Combining in a single analysis median quantitative value, the PPV in predicting the different group category response, related to TRG system, presented an AUC of 96%, higher than DWI (88.2%) or SUVmax (93.3%).

Page 23 of 258
CONCLUSION
Combination of PET-CT and MR imaging, evaluating changes in glucose metabolism and ADC, allows the identification of spatially distinct regional responses to therapy within tumor tissues, with higher sensitivity than either method alone.

CLINICAL RELEVANCE/APPLICATION
In era of PET/MRI scanner, the combination of DWI and PET/CT represents the most feasible method to evaluate LARC patients, with accuracy values higher than those reported for other imaging technique.

SSA07-07 • Most Accurate Selection of Complete Responders After Chemoradiation for Rectal Cancer with a Combination of T2-weighted MRI, Diffusion-weighted MRI and Endoscopy
Monique Maas MD (Presenter) ; Doenja M Lambregts MD, PhD ; Luc Heijnen ; Milou Martens ; Jeroen Leijtens ; Meindert Sosef ; Karel Hulsee ; Geerard L Beets MD, PhD ; Regina G Beets-Tan MD, PhD

PURPOSE
Chemoradiation (CRT) for rectal cancer leads to complete tumour response (CR) in 15-25% of the cases. Accurate identification of a CR is necessary to allow for less invasive treatments (e.g. local excision or waitandsee). Standard imaging cannot accurately identify a CR due to incorrect overestimation of fibrosis as residual tumour. Aim was to evaluate what is the best strategy to identify patients with a CR by use of T2W MRI, DWI and endoscopy.

METHOD AND MATERIALS
49 patients underwent CRT and restaging consisting of T2W-MRI, DWI and endoscopy 8 weeks after completion of CRT. One reader scored the T2W images followed by immediate evaluation of the DWI images with the T2W images at his disposal. A second reader scored the endoscopy images. Readers were blinded for histology and each other’s results. Scoring was performed with a confidence level score (0=definitely residual tumour, 4=definitely CR).

RESULTS
Of the 49 patients, 18 had residual tumour and 31 had a CR. The AUCs for T2W-MRI, T2+DWI and endoscopy were 0.71, 0.78 and 0.88, respectively. Corresponding sensitivities and specificities were 39% and 87% for T2W, 39% and 93% for T2+DWI and 67% and 97% for endoscopy. When a combination of MRI (T2W and DWI) with endoscopy was used the highest accuracy was reached: 0.91.

CONCLUSION
The combination of endoscopy, T2W-MRI and DWI leads to a very high accuracy for the identification of patients with a CR after CRT for rectal cancer. Endoscopy corrects for overestimation of fibrosis as residual tumour with MRI. MRI provides a low risk for missing residual tumour and thus guarantees a safe selection process. It is therefore highly recommendable to use this combination of endoscopy and T2W-MRI with DWI to select patients with a CR after CRT, particularly now less invasive treatment is increasingly being considered as an alternative for standard TME.

CLINICAL RELEVANCE/APPLICATION
Use of endoscopy with T2W-MRI+DWI for the selection of a CR for CRT for rectal cancer leads to a high accuracy and is recommended for restaging when considering less invasive treatment instead of TME.

SSA07-08 • Diffusion-weighted MR Imaging for the Follow-up of Patients after Primary Surgical and Non-surgical Treatment for Rectal Cancer
Doenja M Lambregts MD, PhD (Presenter) ; Max Lahaye MD, PhD ; Luc Heijnen ; Monique Maas MD ; Milou Martens ; Regina G Beets-Tan MD, PhD ; Geerard L Beets MD, PhD

PURPOSE
Detection of local recurrences after primary treatment of rectal cancer is crucial in order to allow for timely surgical intervention. Standard imaging is known to experience difficulties in differentiating between post-treatment effects (inflammation/fibrosis) and recurrent tumor. Diffusion-weighted MRI (DWI) has in various studies shown to be a powerful technique for the detection of tumors. Hence, DWI may also be a promising tool for follow-up (FU) after treatment. Aim of this study was to evaluate the diagnostic value of DWI for the FU of patients after primary surgical or non-surgical treatment for rectal cancer.

METHOD AND MATERIALS
The study group consisted of 117 patients who had previously undergone rectal cancer treatment, consisting of either standard surgical resection +/- neoadjuvant (chemo-)radiotherapy (n=36), a local transanal excision (n=40, of which 15 after chemoradiotherapy), or a non-operative ‘wait-and-see’ policy (n=41). During clinical FU all patients underwent one or more FU-MRIs (1.5T) including DWI (highest b-value b1000), as part of routine FU or because of a suspected local recurrence (e.g. clinical complaints or rising CEA levels) after surgery. Two readers in consensus evaluated each MRI and scored the b1000 DWI-images as ‘no high signal’, ‘high signal suspected of recurrence’ or ‘not adequately assessable due to artefacts’. Scoring was performed with a confidence level score (0=definitely residual tumour, 4=definitely CR).

RESULTS
Patients underwent a mean number of 3 FU-scans (range 1-11) with a mean FU-time of 44 months (4-144). 27/117 patients developed a suspected of recurrence or not adequately assessable due to artefacts. 14 DWI scans were false positive (mainly at the first FU-scan after surgery), of which 50%, however, again remained true negative on DWI. 57 DWI-scans (19%) could not adequately be assessed due to artefacts. When a combination of MRI (T2W and DWI) with endoscopy was used the highest accuracy was reached: 0.91.

CONCLUSION
1. DWI can be a useful tool for the FU of patients after primary rectal cancer treatment. 2. False positive DWI findings may occur shortly after surgery, but the DWI signal generally normalises during further follow-up. This should be taken into account when using DWI for the clinical FU of rectal cancer patients.

CLINICAL RELEVANCE/APPLICATION
Diffusion-weighted MRI can be a useful tool for the follow-up of rectal cancer patients after primary surgical or non-surgical treatment and can help detect locally recurrent disease.

SSA07-09 • MRI with DWI Compared with FDG-PET/CT in the Evaluation of Suspected Local Recurrence in Rectal Cancer
Matteo Cappucci MD (Presenter) ; Marco Di Girolamo MD ; Vincenzo David MD ; Daniela Prosperi ; Stefania Durante ; Elsa Iannicelli MD

PURPOSE
In case of suspicion of locally recurrent rectal cancer, the use of MRI with diffusion-weighted MRI or [18F]-fluorodeoxyglucose (FDG) PET/CT still remains debated. Our purpose was to compare the two imaging modalities in the discrimination between local recurrence and post-treatment scar tissue.

METHOD AND MATERIALS
Since September 2010, all patients treated with neo-adjuvant chemio-radiation therapy and surgical resection for rectal cancer were referred, in case of high suspicion of local recurrence during follow-up, for MRI and PET/CT. 25 patients were enrolled (17M, 8F; mean age: 64±11) and the mean time of the diagnostic evaluation after surgical resection was 14 months. MRI was performed with 1.5T superconductivc magnet with TSE T2-w. scan on sagittal, axial and coronal planes, DWI axial scans (b-values: 50,400,800) and post-contrast fat saturated Flash 2D T1-w. axial scans. All exams were reported by two radiologists in consensus. Total-body PET/CT scans of the same patients were performed at the same time as the MRI and DWI exams.
images were acquired 60 minutes after i.v. injection of 185 MBq FDG and reported by two physicians who were unaware of MRI findings. In case of concordantly negative findings, the patients followed a routine follow-up. Patients with concordantly positive findings or discordance were subjected to a CT-guided biopsy or surgical excision for histological evaluation.

RESULTS
MRE+DWI and PET/CT were concordantly negative in 15 pts and concordantly suggestive of recurrence in 7 pts. The patients with concordantly findings of fibrosis remained disease-free after 10 months follow-up. In 6 pts the concordantly imaging suggestion of recurrence was confirmed by biopsy while in one patient histology disconfirmed the suspected diagnosis. A discordance with negative MRE+DWI and positive PET-CT was found in 3 cases: in 2 pts the histological specimen was negative (2 PET/CT false positive) while in 1 patient a recurrence was found at biopsy (MRI+DWI false negative). The sensitivity, specificity and diagnostic accuracy of MRI+DWI was respectively 86%, 94% and 92% while for PET/CT was 100%, 83% and 88%

CONCLUSION
MRE+DWI shows higher specificity than PET/CT, especially in case of active inflammatory tissue while PET/CT has a higher sensitivity than MRE+DWI and can detect distant metastasis. MRI is also essential in the local recurrence surgical planning.

CLINICAL RELEVANCE/APPLICATION
MRI with DWI shows higher specificity than PET/TC in the evaluation of suspected local recurrence rectal cancer and it is recommended.

Gastrointestinal (Hepatic Fibrosis Imaging)

Sunday, 10:45 AM - 12:15 PM • E450B

SSA08 • AMA PRA Category 1 Credit ™:1.5 • ARRT Category A+ Credit:1.5
Moderator
Nirvikar Dahiya, MD
Moderator
Hero K Hussain, MD *
Moderator
Wui K Chong, MD *

SSA08-01 • The Effect of Echo Times on the Accuracy of Susceptibility Weighted Magnetic Resonance Imaging in Staging Liver Fibrosis

Csilla Balassy MD (Presenter); Diana S Feier MD; Friedrich Wrba; Stephan Witoszynskyj; Gert Reiter *; Ahmed Ba-Ssalamah MD

PURPOSE
To assess the effect of echo-sampling on the accuracy of magnetic resonance (MR) susceptibility-weighted imaging (SWI) to detect and stage liver fibrosis in patients with chronic liver diseases (CLD), using histology as reference standard.

METHOD AND MATERIALS
This prospective study was approved by the local ethics committee. All subjects gave written informed consent. Sixty-eight consecutive patients (mean age 55.86 years; 60% males) with CLD and histologically proven liver fibrosis were included. Liver fibrosis was evaluated according to the Metavir scoring system. SWI MRI sequences were performed on a 3 Tesla unit and data were collected at two different echo times (TE), 2.5 ms and 10ms. Signal intensity (SI) of the liver and spinal muscle was defined using region-of-interest measurements and liver-to-muscle signal intensity ratios (2.5TE LMR and 10TE LMR) were calculated. The diagnostic performance of both LMR in staging liver fibrosis was assessed using sensitivity (Se%), specificity (Sp%) and area under receiver operating characteristics (AUROC) analysis.

RESULTS
Histology resulted F0 (n=13, 19.4%), F1 (n=6, 9%), F2 (n=8, 11.9%), F3 (n=12, 17.9%), F4 (n=28, 41.8%). Both 2.5TE LMR and 10TE LMR correlated strongly with liver fibrosis (r=-0.74, p < 0.001).

CONCLUSION
SWI is a promising non-invasive tool to detect and stage liver fibrosis in CLD patients, having increased accuracy with higher TE values.

CLINICAL RELEVANCE/APPLICATION
Implementation of imaging parameters as assessed in our study will enable improved and accurate assessment of liver fibrosis in patients with CLD using SWI.

SSA08-02 • Intravoxel Incoherent Motion Magnetic Resonance Imaging of the Liver: Diagnostic Accuracy in Classifying the Severity of Liver Fibrosis

Sae Rom Chung MD (Presenter); Seung Soo Lee MD; Namkug Kim PhD; Eunki Kim; Seong Ho Park MD *; So Yeon Kim MD; Jae Ho Byun MD; Moon-Gyu Lee MD

PURPOSE
To investigate the relationship of liver ADC and intravoxel incoherent motion (IVIM) parameters with liver fibrosis and to evaluate the diagnostic performance of these parameters in classifying the severity of liver fibrosis.

METHOD AND MATERIALS
RESULTS
CONCLUSION
CLINICAL RELEVANCE/APPLICATION
IVIM magnetic resonance imaging of the liver can be used as a diagnostic test to assess the severity of liver fibrosis.

SSA08-03 • Correlation of Magnetic Resonance Elastography (MRE) with Hepatic Fractional Extracellular Space (fECS) - Preliminary Findings

Sudhakar K Venkatesh MD, FRCR (Presenter); Bogdan Dzyubak BS; Benjamin M Yeh MD *; Joel G Fletcher MD *; Jeff L Fidler MD *; Naoki Takahashi MD *; David M Hough MD; Jayant A Talwalkar MD *; Richard L Ehman MD *; Adam J Weisbord MD

PURPOSE
The purpose of the study was to evaluate the correlation of two promising MRI techniques of measuring diffuse liver disease: magnetic resonance elastography (MRE) and hepatic fractional extracellular space (fECS) measured with gadolinium (Gd-DTPA) enhanced MRI.

METHOD AND MATERIALS
Thirty-two consecutive clinical patients underwent routine liver MRI examinations. The MRI protocol included MRE as well as Gd-DTPA enhanced equilibrium phase (10-15 minute delay) sequences. MRE was performed with a standard GRE-based sequence to calculate liver
Liver stiffness. Hepatic fECS (%) was calculated from equilibrium phase liver and aortic enhancement normalized to the pre-enhancement signal and hematocrit. Pearson’s correlation coefficient between MRE and fECS was calculated. Comparison of mean fECS values of normal and elevated liver stiffness group was also performed using the current clinical cut-off value of 2.93 kPa for detection of liver fibrosis.

RESULTS
The liver stiffness and fECS of the study population ranged from 1.68 kPa to 8.6 kPa and 17.5% to 40.1% respectively. There was good correlation between MRE measures of liver stiffness and equilibrium phase measures of fECS (Pearson’s correlation coefficient r = 0.86, 95% CI, 0.73-0.93, p < 0.001).

CONCLUSION
Liver stiffness with MRE correlates strongly with fECS. Future study of these methods is warranted improve the multiparametric evaluation of diffuse liver disease.

CLINICAL RELEVANCE/APPLICATION
MRE correlates strongly with hepatic fECS suggesting a complementary role in the evaluation of diffuse liver disease.

SSA08-04 • Liver Fibrosis Staging: Magnetic Resonance Elastography Is Better than Liver Biopsy

Hiroyuki Morisaka MD (Presenter) ; Utaroh Motosugi MD ; Shintaro Ichikawa MD ; Katsumi Sano MD ; Satoshi Ikenaga ; Tadao Nakazawa MD, PhD ; Tetsuo Kondo MD, PhD ; Tomoaki Ichikawa MD, PhD * ; Ryoheki Kato MD, PhD

PURPOSE
Liver biopsy for the staging of liver fibrosis is an invasive procedure and presents some clinical concerns; sampling errors, variability and reproducibility. In this study, we aimed to compare magnetic resonance elastography (MRE) of the liver with liver biopsy specimens for liver fibrosis staging by using surgically resected samples as a reference.

METHOD AND MATERIALS
In this retrospective study, we included 55 patients with chronic liver disease who underwent preoperative MRE on a 1.5 or 3-Tesla clinical MR scanner and subsequent surgical liver resection. Liver biopsy specimens were obtained from 55 surgically resected liver tissues by using an 18-gauge biopsy needle; the sample size was more than 15 mm, and the specimens were stained with Masson trichrome. Whole sections were used as a reference for liver fibrosis. Liver stiffness (kPa) was measured using MRE, and the results were divided into 5 stages corresponding to the METAVIR scoring system: F0-4. Liver fibrosis was graded on biopsy specimens and whole sections by using the METAVIR system. The concordance rate (kappa value) with reference fibrosis grades in the two methods was calculated. The proportion of correct diagnosis was compared between the two methods.

RESULTS
The kappa coefficient value between MRE staging and the reference fibrosis staging was 0.49 (moderate agreement) and that between the biopsy staging and the reference fibrosis staging was 0.18 (slight agreement). The proportion of correct diagnosis of MRE was significantly higher than that of biopsy specimens (33/55 vs. 18/55, respectively; p = 0.004).

CONCLUSION
A substantial sampling error of biopsy specimens was observed. MRE is an accurate and promising method of noninvasive liver fibrosis staging as compared with biopsy specimens.

CLINICAL RELEVANCE/APPLICATION
Liver MR elastography is more accurate than liver biopsy specimens in liver fibrosis staging and can be serve as biopsy in clinical practice.

SSA08-05 • Automated Technique for Hepatic MR Elastography Analysis: Comparison to Skilled Human Interpretation

Bogdan Dzyubak BS (Presenter) ; Armando Manduca PhD * ; Joel P Felmlee PhD ; Kevin J Glaser * ; Sudhakar K Venkatesh MD, FRCR ; Richard L Ehman MD *

PURPOSE
To test the performance of an automated technique for the analysis of clinical MR Elastography (MRE) images.

METHOD AND MATERIALS
In a retrospective analysis of 64 MRE cases performed for fibrosis screening, the performance of an automated algorithm (A) was compared to that of clinical readers (R), with gold standard (G) measurements provided by a radiologist highly experienced with MRE. The algorithm presented here has been developed to fully automate MRE ROI selection and yield a standardized stiffness measurement. First, a crude outline of the liver was found by using the known relative positions and intensities of the dominant tissue types in the abdominal images (abdominal fat, lung, liver, and other). A Random Walker segmentation was subsequently run on the MRI magnitude images to capture liver tissue and exclude vessels, and then again on the reconstructed stiffness images to remove partial-volume effects. The average stiffness from the ROIs was then calculated. The proportion of correct diagnosis was compared between the two methods.

RESULTS
Of the 64 cases, 28 were classified by G as having fibrosis. The accuracy of A for diagnosing fibrosis was 92% and was superior to R’s 84%. It was shown to be statistically non-inferior within 10% accuracy with a p < 0.05.

CONCLUSION
The fully automated algorithm presented here has been shown to yield results as accurate as the manual methods currently used in the clinic. If implemented as a standard, it can remove biases due to inter-reader variability as well as facilitate future MRE developments by creating a consistent framework for ROI selection and artifact exclusion.

CLINICAL RELEVANCE/APPLICATION
The automated algorithm presented here can provide a standard for the practice of clinical hepatic MRE that reduces the measurement variability and improves diagnostic accuracy.

SSA08-06 • Ultrasound Elastography with Concomitant Liver Biopsy: Comparison of Acoustic Radiation Force Impulse (ARFI) Measurement with Histopathological Grading

Minal C Jagtiani MBBS, MD (Presenter) ; Philip J Shorvon FRCR, FRCP ; Paul Bassett ; Kesavan Kandiah ; Paul Tadrous ; David J Sherman

PURPOSE
To correlate ultrasound elastography stiffness measurements in chronic liver disease patients with concomitant liver biopsy histopathological scores of fibrosis.

METHOD AND MATERIALS
Patients from January 2010 through January 2013 (n = 161; 84 males) who underwent ultrasound guided liver biopsy for chronic liver disease, performed by an Attending Radiologist with a specialist interest in liver imaging, were assessed prospectively. All patients also underwent ultrasound elastography for liver stiffness immediately prior to the biopsy by the same Attending Radiologist. Elastography measurements (ARFI method shear velocity m/ sec; mean of 10 measurements) were obtained in the same anatomical region of the liver as the biopsy. All histopathology reports were scored by a specialist attending Pathologist. ISHAK and Metavir fibrosis scores were then compared.
RESULTS
Data for 159 patients (mean age 49 ± 14 years) were available. The mean elastography measurement was 1.7 ± 0.7 m/sec. The results demonstrated statistically significant associations between higher histological grading and increasing ARFI measurements in all analyses. Significant correlation was obtained between the ARFI measurement and both the ISHAK (r value= 0.58; p value < 0.001) and Metavir scores (r value= 0.58; p value < 0.001) in all comers. For the subgroup of patients with viral hepatitis (n= 85), the correlation coefficient for ISHAK and METAVIR scores were 0.51 and 0.53 respectively with p values < 0.001 in both groups.

CONCLUSION
To the best of our knowledge, this is the first study with a large cohort to assess ARFI elastography measurements and liver biopsy taken concomitantly and validating its accuracy in 'all-comers'. It has demonstrated a highly significant statistical correlation between elastography measurements by the ARFI method and the histological grading of fibrosis.

CLINICAL RELEVANCE/APPLICATION
This study demonstrates that ARFI elastography can be performed as part of a routine ultrasound study of the liver to aid in the assessment of liver fibrosis thus optimising patient pathway.

SSA08-07● Accuracy of Shear-wave Elastography to Determine the Degree of Liver Fibrosis in Patients with Hepatitis C Virus Infection
Anand Rattansingh (Presenter) ; Hosein Aminoshahi MSc ; Sandra Fischer MD ; Morris Sherman * ; Richard Kirsch MD, PhD ; Mostafa Atri MD
PURPOSE
The purpose of this study was to determine the accuracy of shear-wave elastography in grading fibrosis in patients with Hepatitis C virus (HCV) infection.

METHOD AND MATERIALS
105 patients (85 Men and 20 women), mean age 56 (range23-74) with HCV infection underwent US guided random core biopsy and shear-wave elastography on the same day. Elastography was performed on a Supersonics machine using a 3.5 MHz probe. Five samples were obtained from the right lobe of liver of each patient and averaged to determine stiffness measured as kilo-Pascal (kPa). The same pathologist reported all pathology specimens using METAVIR fibrosis scoring 0 to 4. Student’s t-test was used for comparison of continuous variable, and ROC curve to calculate Area Under Curve (AUC).

RESULTS
There were 82 patients with no to moderate fibrosis (METAVIR 0 to 2) and 23 with severe fibrosis or cirrhosis (METAVIR 3and4) with the prevalence of severe fibrosis or cirrhosis being 22% (23/105). Stiffness ranged from 3.2 to 26.4 (mean 9.6) kPa. Stiffness of livers with no or moderate fibrosis on pathology ranged from 3.2 to 26.4 (mean 9.1) kPa and for severe fibrosis and cirrhosis 6.2 to 24.3 (mean 12.2) kPa (p=0.01). ROC curve showed an AUC of 0.78 (CI: 0.68-0.89) (p < 0.0001).

CONCLUSION
Shear-wave elastography has the potential to discriminate between moderate liver fibrosis and severe liver fibrosis or cirrhosis in patients with HCV infection.

CLINICAL RELEVANCE/APPLICATION
Ultrasound shear-wave elastography has the potential to assess parenchymal stiffness of the liver with good correlation to degree of fibrosis.

SSA08-08● Comparison of Liver Stiffness Measurement by Acoustic Radiation Force Imaging (ARFI) and Fibroscan for the Non-invasive Diagnosis of Liver Fibrosis
Victoire Cartier MD (Presenter) ; Derek Bardou ; Jerome Boursier ; Jerome Lebigot MD ; Sophie Michalak ; Isabelle Fouchard-Hubert ; Christophe Aube MD, PhD *
PURPOSE
To compare ARFI and Fibroscan in an intention-to-diagnose (ITD) basis for the non-invasive diagnosis of liver fibrosis in chronic liver disease.

METHOD AND MATERIALS
219 patients with chronic liver disease and liver biopsy were prospectively included. Liver stiffness measurements (m/s) were performed by ARFI (right lobe: ARFI-D, left lobe: ARFI-G) and Fibroscan (right lobe). ARFI-DG corresponded to the median value of all valid measurements obtained in both lobes. Reference for fibrosis was Metavir F staging. Diagnostic accuracy was evaluated using AUROC and Obuchowski index (adjusted AUROC). For ITD analysis, failures of elastographic measurement were replaced by the median value measured in the opposite group of the biopsy diagnosis.

RESULTS
Fibrosis stage prevalence was F=2: 50%, F=3: 26% and F4: 9%. Rate of measurement failure was ARFI-D or ARFI-G: 0.5% versus Fibroscan: 5.9% (p=0.002). In per-protocol analysis, AUROCs of Fibroscan were significantly higher than those of ARFI-D for each diagnostic target (p

CONCLUSION
ARFI and Fibroscan have close and high accuracy for liver fibrosis diagnosis. Due to a higher failure rate, accuracy of Fibroscan decreases in the ITD analysis but remains not significantly different from ARFI accuracy.

CLINICAL RELEVANCE/APPLICATION
The high feasibility and reliability of ARFI could be useful to detect undiagnosed significant fibrosis during any abdominal ultrasound examination, with a high diagnostic accuracy.

SSA08-09● Simply Combine the Results of Multiple Elastographies and Serum Fibrosis Markers Using Bayesian Prediction for Noninvasive Liver Fibrosis Staging
Utaroh Motosugi MD (Presenter) ; Katsuhiro Sano MD ; Hiroyuki Morisaka MD ; Shintaro Ichikawa MD ; Tomoaki Ichikawa MD, PhD *
PURPOSE
Elastography, using ultrasound or MRI, has been applied to liver fibrosis staging, while serum fibrosis marker has commonly been used to predict the fibrosis stage. The combined use of elastographies and fibrosis marker may be a superior method to their individual use. This study was aimed to evaluate the usefulness of Bayesian prediction method to combine the results of elastographies and serum fibrosis marker for noninvasive liver fibrosis staging.

METHOD AND MATERIALS
This study included 20 cases of chronic liver disease. The pathological fibrosis staging were performed with the specimen of partial hepatectomy by using METAVIR staging system in all cases. The use of Bayesian prediction to stage liver fibrosis can provide the possibility of the fibrosis stages on the basis of the results of elastographies or serum fibrosis markers. We used aspartate transferase-to-platelet ratio index (APRI) as a serum fibrosis marker and ultrasound transient elastography (UTE) and MR elastography (MRE) as imaging-based elastographies for liver fibrosis stage estimation. We compared the accuracy of fibrosis staging and the
**RESULTS**
The most probable stage by Bayesian prediction were accurate in 6 (30%), 8 (40%), and 15 (75%) of 20 cases for APRI only, APRI+UTE, and APRI+UTE+MRE, respectively. The confidence of Bayesian prediction significantly increased by adding UTE and MRE to APRI (mean [SD] confidence of prediction [SD]; APRI only, 42.6 [6.7%]; APRI+UTE, 67.1 [23.0%]; APRI+UTE+MRE, 77.7 [18.0%]).

**CONCLUSION**
Bayesian prediction is simple and useful method to combine variable methods for noninvasive liver fibrosis staging.

**CLINICAL RELEVANCE/APPLICATION**
Probability of each liver fibrosis stage for the patient can be estimated with Bayesian prediction which can simply combine the results of multiple elastographies and serum fibrosis markers.

### ISP: Genitourinary (New Methods of Detection and Characterization of Urolithiasis)

**Sunday, 10:45 AM - 12:15 PM • E351**

**SSA09 • AMA PRA Category 1 Credit ™:1.5 • ARRT Category A+ Credit:1.5**

**Moderator**
Douglas S Katz, MD

**Moderator**
Naoki Takahashi, MD *

**SSA09-01 • Genitourinary Keynote Speaker**
Parvati Ramchandani MD (Presenter) *

**SSA09-02 • Detectability of Urinary Stones on Virtual Nonenhanced Images Generated at Nephrographic and Excretory Phase Dual-source Dual-energy CT**

_Hao Sun MD (Presenter) ; Huadan Xue MD ; Xuan Wang MD ; Yu Chen MD ; Yonglian He MD ; Zhengyu Jin MD_

**PURPOSE**
To evaluate the detectability of urinary stones on virtual nonenhanced (VNE) images generated at nephrographic and pyelographic phase dual-source dual-energy computed tomography (DsDeCT).

**METHOD AND MATERIALS**
This prospective study was approved by our institutional review board, and written informed consent was obtained from each patient. A total of 100 patients were examined with single-energy nonenhanced CT and DsDeCT in the nephrographic and excretory phase (100kVp/230mAs and Sn140kVp/178mAs). Commercial software was used to create VNE images by suppressing the contrast medium in the urinary system from the nephrographic and excretory phase DsDeCT, respectively. Two radiologists evaluated the VNE images for the presence of stones in consensus. The true nonenhanced (TNE) scan was considered the reference standard. The sensitivity regarding the detection of calculi on two sets of VNE images compared with TNE images was determined. By using logistic regression, the influences of stone size and attenuation of the contrast medium on the stone detection rate were assessed.

**RESULTS**
185 stones were detected on TNE images. All (sensitivity, 100%) and 158 (sensitivity, 85.4%) calculi were identified on VNE images generated on nephrographic and excretory phase images, respectively. Size (long-axis diameter [P = .017], short-axis diameter [P = .027]) and attenuation of the contrast medium (P = .0012) were significantly associated with the detection rate on VNE images generated on excretory phase images. As threshold values, size larger than 3mm, maximum attenuation of the contrast medium than 640HU were found.

**CONCLUSION**
VNE images generated at nephrographic and excretory phase DsDeCT enabled the detection of urinary stones with good and moderate accuracy, respectively. Small size of stones (≤40HU) might affect the diagnostic capability of VNE images generated at excretory phase DsDeCT.

**CLINICAL RELEVANCE/APPLICATION**
The VNE images generated at nephrographic phase DsDeCT is superior to that generated at excretory phase in detection of urinary stones.

**SSA09-03 • Incidental Findings on CT for Suspected Renal Colic: Prevalence and Clinical Importance in 5383 Consecutive Examinations**

_Mohammad M Samim MD, MRCS (Presenter) ; Sarah Goss MD ; Seth Luty MS ; Jeffrey C Weinreb MD * ; Christopher Moore MD_

**PURPOSE**
To determine the prevalence and clinical consequences of incidental findings (IFs) found on non-contrast enhanced flank pain protocol CT scans (FPP CT) obtained for suspected renal colic in adults presenting to two emergency departments (EDs) over more than 5 year period based on the American College of Radiology’s (ACR) Incidental Findings Committee White paper and other published guidelines.

**METHOD AND MATERIALS**
Reports of all FPP CTs performed in two EDs between April 2005 and November 2010 were reviewed retrospectively for IFs. Using established guidelines, IFs were classified into two groups: not important (follow-up not required) and important (further radiologic characterization or additional surgical or medical evaluation recommended). The prevalence for each group was determined and correlated with various demographic features. Inter-rater reliability was determined by blinded re-review of randomly selected subsets of the CT reports.

**RESULTS**
5383 FPP CT reports for 4845 unique patients, revealed 875 important IFs in 681 scans for an overall prevalence of 12.65% (95% CI: 11.79%-13.56%). Prevalence of important IFs was significantly associated with age (p < 0.001). FPP CT reports for patients aged 80 years had important IFs compared to 6.9% (95% CI: 5.5%-8.6%) of patients aged 18-30 years. Females had higher prevalence of important IFs compared to males: 13.4% (95% CI: 12.2%-14.7%) vs. 11.9% (95% CI: 10.7%-13.2%). Inter-rater reliability for the presence of IFs was excellent (kappa 0.93), with substantial agreement (kappa 0.69) regarding presence of important IFs.

**CONCLUSION**
This is the largest study of its type and the first to use the ACR guideline to strictly define important IFs. The prevalence of important IFs in FPP CT is high and increases with age.

**CLINICAL RELEVANCE/APPLICATION**
In addition to concerns about ionizing radiation, the potential burden of IFs should be considered when FPP CT is contemplated in ED setting.
SSA09-04 • Comparison of Three Commercially Available Iterative Reconstruction Algorithms (ASIR, Idose Safire) on Image Quality and Radiation Dose in Kidney Stone CT Exams

Yasir Andrabi MD, MPH (Presenter) ; Oleg S Pianykh ; Aditya Yadavalli BS ; Mukta D Agrawal MBBS, MD * ; Jorge M Fuentes MD ; Dushyant V Sahani MD

PURPOSE
To evaluate the impact of three commercially available iterative reconstruction (IR) algorithms ASIR, IDOSE and SAFIRE on the image quality and radiation dose in kidney stone abdominal CT exams in a busy academic practice.

METHOD AND MATERIALS
We reviewed 380 consecutive adults kidney stone CT exams performed on 16 scanners (GE=12, Siemens=2, Philips=2) between Dec 12 to Mar 13. A total of 138/380 exams were reconstructed using FBP while 242/380 exams were processed using IR (ASIR=163, IDOSE=41 and SAFIRE=36). The standard dose (SD) scanning parameters for various FBP scanners including weight based kV (100,120), mA (150-450), slice thickness 5 mm in the IR scanner the dose was modified (DM). Two radiologists blinded to image reconstruction and scanning technique independently reviewed the CT exams for image quality (IQ) and diagnostic acceptability. Size specific dose estimate (SSDE) within patient cohorts was compared using ANOVA.

RESULTS
All 350 CT exams were rated of diagnostic quality with higher IQ for the DM-IR group compared with SD-FBP group (p<0.001).

CONCLUSION
CT exams for kidney stones performed with IR preserves the diagnostic acceptability of images with significant reduction (25%) in radiation dose irrespective to the type of commercial IR algorithm.

CLINICAL RELEVANCE/APPLICATION
Introduction of commercially available IR techniques are beneficial to CT practice for lowering substantial radiation dose in a busy practice while yielding diagnostic quality images irrespective of th

SSA09-05 • Differentiation of Uric Acid and Non-uric-Acid Urinary Stones Using a Single-source CT Scanner: Initial Clinical Experience

Song-Tao Ai ; Shuai Leng PhD (Presenter) ; Mingliang Qu MD ; Maria Shiang ; Cynthia H McCollough PhD *

PURPOSE
To prospectively assess the accuracy of a single-source CT technique that uses two consecutive scans for differentiating uric acid (UA) and non-uric-acid (NUA) urinary stones.

METHOD AND MATERIALS
33 patients (15 males and 18 females) undergoing clinically-indicated dual-source (DS), dual-energy CT to differentiate UA and NUA urinary stones were enrolled in this IRB-approved study. Immediately following the DS scan, each patient was scanned on a single-source (SS) CT scanner with two consecutive scans (80 and 140 kV) over a scan range limited to where stones had been identified using DSCT. UA and NUA stones were differentiated using commercial dual-energy software that included 3D deformable registration (Syngo DE, Siemens). The ranges of the smoothing filter were set to 3 for both DS and SS exams. The accuracy of stone classification for stones >2 mm in diameter was calculated using the results from the DS scanner as the reference standard.

RESULTS
A total of 469 stones were identified in DS exams (26 UA and 443 NUA). Average stone diameter was 4.4 ± 2.5 mm (range 2 to 18.9 mm). Among these stones, SS exams detected 63 UA and 406 NUA stones. Overall sensitivity and specificity for identifying UA stones were 74% and 91%. For stones =3 mm (28 UA and 323 NUA on SS exams, 20 UA and 341 NUA on DS exams), sensitivity and specificity were 95% and 97%. Image quality of the SS exam was similar to or slightly better than that of the DS exam.

CONCLUSION
Differentiation of UA and NUA urinary stones is feasible by using two consecutive scans. UA stones could be identified using a SS CT scanner with an accuracy of 97% for stone sizes >3 mm.

CLINICAL RELEVANCE/APPLICATION
Accurate identification of UA stones using SS scanners may increase availability for this technique, which is clinically useful in identifying patients with medically treatable stones.

SSA09-06 • Material Decomposition Generated from Excretory-phase Spectral CT: Determinants of Detection of Urinary Calculi in the Renal Collecting System

Yan Chen (Presenter) ; Peijie Lv MMed ; Jianbo Gao MD

PURPOSE
To determine which features of urinary calculi are associated with their detection on material decomposition images generated from spectral computed tomographic (CT) urography.

METHOD AND MATERIALS
This retrospective study was approved by the institutional ethics committee with waiver of informed consent. 34 patients were examined with true nonenhanced (TNE) CT and spectral CT urography in the excretory phase. The contrast medium was virtually removed from excretory-phase images by using water-based (WB) and calcium-based (CaB) material decomposition (MD) analysis. The sensitivity regarding the detection of calculi on MD images using true nonenhanced (TNE) images as the reference standard was determined. By using logistic regression, the influences of image noise, attenuation, and stone size, as well as attenuation of the contrast medium, on the stone detection rate were assessed on CaB and WB images. The signal-noise-ratio (SNR) and contrast-noise-ratio (CNR) were calculated to evaluate the detectability of MD images.

RESULTS
129 stones were detected on the TNE images; 110 stones were identified on CaB images (sensitivity 85.9%) and 106 stones on WB images (sensitivity 82.5%). Size (long-axis diameter and short-axis diameter), attenuation of the calculi and image noise were significantly associated with the detection rate on CaB and WB images (both p<0.005).

CONCLUSION
After virtual elimination of contrast medium with material decomposition, large and high-attenuation calculi can be detected with high reliability.

CLINICAL RELEVANCE/APPLICATION
Material decomposition images generated at excretory-phase spectral CT can depict calculi larger than 2.9 mm in the presence of contrast medium.

SSA09-07 • Low-dose CT for Renal Colic with Automatic Tube Current Modulation, Adaptive Statistical Iterative Reconstruction and Low kV: Impact of Body Mass Index

Alban Gervaise MD, MSc ; Pierre Naulet ; Florence Beuret (Presenter) ; Christelle Henry ; Matthieu Pernin ; Yann Portron ; Marie Lapierre-Combès

PURPOSE
This retrospective study was approved by the institutional ethics committee with waiver of informed consent. 34 patients were examined with true nonenhanced (TNE) CT and spectral CT urography in the excretory phase. The contrast medium was virtually removed from excretory-phase images by using water-based (WB) and calcium-based (CaB) material decomposition (MD) analysis. The sensitivity regarding the detection of calculi on MD images using true nonenhanced (TNE) images as the reference standard was determined. By using logistic regression, the influences of image noise, attenuation, and stone size, as well as attenuation of the contrast medium, on the stone detection rate were assessed on CaB and WB images. The signal-noise-ratio (SNR) and contrast-noise-ratio (CNR) were calculated to evaluate the detectability of MD images.
METHOD AND MATERIALS
This retrospective study included all patients who underwent low-dose CT for renal colic in our imaging department during 2012. Only CTs performed with automatic tube current modulation, ASIR and low kV were evaluated. The study was approved by the institutional ethics committee. Three radiologists independently reviewed all the images and evaluated diagnostic confidence (scale 1-3), image quality (scale 1-5), and the presence of renal colic. These results, along with the radiation doses, were compared between patients with different categories of BMI and between patients with a BMI < 25 kg/m² and ≥ 25 kg/m².

RESULTS
A total of 86 patients were included in the study, with 39 (45%) having a BMI < 25 kg/m², and 47 (55%) a BMI = 25 kg/m². No statistically significant difference was found between the accuracy rates for the diagnosis of renal colic, when the rates reviewed by the three readers were averaged across both patient groups (respectively 95.7% vs. 96.4%, p = 0.83). Image quality and diagnostic confidence were significantly better for patients with a BMI = 25 kg/m², compared to patients with a BMI < 25 kg/m² (respectively 3.7 vs. 3.4, p

CONCLUSION
The diagnostic performance of our low-dose CT for renal colic was excellent for all patients, with a significantly better image quality and diagnostic confidence for patients with a BMI = 25 kg/m². However, it also required exposure to a greater dose of radiation for overweight and obese patients.

CLINICAL RELEVANCE/APPLICATION
Our low dose CT for renal colic shows better image quality and diagnostic confidence for patients with a BMI=25 kg/m2. However, it requires exposure to a greater dose for overweight and obese patients.

SSA09-08 • Detection of Urolithiasis: Comparison of FBP and ½ Dose FBP with Iterative Reconstruction in 99 Patients

Erick M Remer MD (Presenter); Mark E Baker MD *; Andrew Primak PhD *; Andrei S Purytsky MD; Myra K Feldman MD; Daniel M Roesel DO; Alison C Greiwe MD; Shubha De MD; Shetal Shah MD; Wadih Karim RT; Nancy A Obuchowski PhD; Manoj Monga MD *; Brian R Herts MD *

PURPOSE
To assess the effect of CT dose reduction on the detection of urolithiasis.

METHOD AND MATERIALS
99 patients with 192 kidneys (6 solitary) were imaged to follow urolithiasis on a dual energy scanner [Definition Flash (Siemens Healthcare)] in dual-source mode using 120 kVp, 128x0.6 collimation and pitch 0.9. Dose modulation used with weight-based reference mAs. Data from both tubes was reconstructed with standard filtered back projection (100% FBP). Data from primary tube (50% total dose) was reconstructed using sonogram-affirmed iterative reconstruction (1:3:50% IR). Two readers (2 senior and 2 junior staff, 2 imaging fellows, 1 urology fellow) evaluated 100% FBP and 50% IR images in a randomized fashion for presence or absence of calculi in 9 regions (pyelocalyceal, proximal, mid, distal ureter, and bladder). Largest axial stone size on magnified bone windows per region was measured and categorized as =1, 2-3, 4-5, 6-7, =8 mm. Confidence scored on 5 point scale. Presence or absence of ancillary findings (hydronephrosis, stranding) or alternative diagnosis to explain flank pain was noted. Findings unrelated to history were scored using the CT colonography extracolonic reporting system. Truth was determined by 2 senior uroradiologists in consensus with access to medical record and other imaging. Nonparametric methods for clustered data were used to estimate the ROC curves and their areas for each reader. A 95% CI was constructed for the difference in the mean ROC areas.

RESULTS
113 locations had stones and 752 did not (86 pyelocalyceal, 7 proximal, 4 mid, 15 distal ureter). Mean ROC area for FBP was 0.879 (range 0.967-0.97) and 50% IR was 0.883 (0.646-0.971). For one reader, ROC area with 50% IR was significantly better. The p-value for the hypothesis of non-inferiority was 0.001, indicating that 50% dose IR was not inferior. The 95% CI for the difference in ROC areas between 100% FBP vs. 50% IR is [-0.025, +0.031]. There was hydronephrosis or stranding in 23, an alternate diagnosis to explain pain was noted. Findings unrelated to history were scored using the CT colonography extracolonic reporting system. Truth was determined by 2 senior uroradiologists in consensus with access to medical record and other imaging. Nonparametric methods for clustered data were used to estimate the ROC curves and their areas for each reader. A 95% CI was constructed for the difference in the mean ROC areas.

CONCLUSION
50% CT dose reconstructed with IR was equivalent to standard dose reconstructed with conventional FBP to detect urolithiasis.

CLINICAL RELEVANCE/APPLICATION
50% dose reduction does not alter urolithiasis identification efficacy.

SSA09-09 • A Novel Technique to Assess Delineation of the Whole Ureter Using the Non-contrast Curved Sagittal Oblique Reformatted CT Images

Haisam A Atta MD (Presenter); Enas A Abd El Gawad MBBCh, MD; Ahmad S. El-Azab MD; Medhat A Saleh MD; Hisham M Imam MBBCh, MD

PURPOSE
Our aim was to develop a standardized technique to assess delineation of the whole ureter for the evaluation of symptomatizing urologic patients.

METHOD AND MATERIALS
Two thousand and five hundred patients were subjected to this technique during the period between 2007 to 2012 using 64-row multidetector scanner. Examinations were performed with oral hydration alone (each patient ingested 500-750 ml of water over a 15-30 min. period before scanning began) Group I (n=834), Group II received 20 mg of IV furosemide alone (n=347 ), or Group III with nothing at all (n=393 ). Curved planar reformatted (CPR) images were obtained manually by drawing a line over the entire course of the ureter. The ureter was traced in the sagittal oblique image to obtain the entire ureter in a single coronal oblique image. The ureter was divided into 3 anatomic segments (proximal, middle, and distal) for estimating the degree of its delineation, at least two radiologists assessed the degree of delineation where if the segment is assessed along it whole length is graded as satisfactory delineation, and if the ureters cannot be assessed along its whole length is graded as non-proper delineation. The delineation degree for each ureteral segment with patient group were compared.

RESULTS
Degree of satisfactory delineation obtained with group II (86.18%) were statistically much higher than those obtained with group I (62.47%) or group III (59.70%) with p value =0.000 , regarding the degree of ureteric delineation, there was a statistical significant result (p=0.000) where the upper ureteric segment showed satisfactory delineation with all 3 techniques with percentage 100%, the middle ureteric segment showed satisfactory delineation in 86% of cases with group II, 62.5% in group 1 and 60% in group III while the lower third segment showed satisfactory degree of delineation in 86.2% in group II, 61% with group I and 54.6% with group III. The sex of patients also showed a significant statistical result (p=0.000) where there was non proper delineation is higher in females with percentage 44.4% among groups II and III.

CONCLUSION
Unenhanced curved sagittal oblique reformatted image with IV furosemide allows better delineation and tracing of the whole course of the ureter.

CLINICAL RELEVANCE/APPLICATION
Genitourinary (Adrenal Masses: New Methods for Specific Diagnosis)

Sunday, 10:45 AM - 12:15 PM • E353B

SSA10 • AMA PRA Category 1 Credit ™:1.5 • ARRT Category A+ Credit:1.5

Moderator
Seung Hyup Kim, MD
Moderator
Zhen J Wang, MD

SSA10-01 • MDCT of the Indeterminate Adrenal Mass: Identification of a Venous Enhancement Level to Distinguish Pheochromocytoma from Adenoma

Benjamin G Northcutt MD; Erin N Zingarelli BS; Michael A Trakhtenbroit MD; Siva P Raman MD; Elliot K Fishman MD *

Pamela T Johnson MD (Presenter) *

PURPOSE
Adrenal protocol CT identifies adenomas due to rapid washout. Hypervascular lesions, including pheochromocytoma and metastatic renal cell carcinoma, can also exhibit rapid washout due to high levels of enhancement. The purpose of this study was to compare the absolute venous phase enhancement level of adenoma and pheochromocytoma, the two most commonly identified incidental adrenal masses. Delineation of a venous phase enhancement level predictive of pheochromocytoma could prevent misdiagnosis of vascular pheochromocytomas as adenoma with washout CT.

METHOD AND MATERIALS
Retrospective review of medical records was performed between 2002-2012 to identify adrenal masses measuring < 4 cm. Inclusion criteria for adenomas were venous phase IV contrast enhanced CT (single phase, dual phase, or adrenal protocol CT), confirmatory adrenal CT (precontrast +/- washout) and absence of clinical indicators of pheochromocytoma. All pathologically proven pheochromocytomas with venous phase CT imaging were evaluated. CT examinations were reviewed by a body CT attending, who recorded size and venous attenuation (± precontrast and delayed attenuation when available). T-test analysis was used to compare venous enhancement levels.

RESULTS
79 subjects with 88 adenomas were compared to 22 subjects with 26 pheochromocytomas. Mean±SD venous enhancement level for all adenomas (61±24 HU) and lipid poor adenomas (90±18) was lower than that of pheochromocytomas (111±38 HU) (p < 0.05), compared to 50% (13/26) of the pheochromocytomas. A threshold of 110 HU to identify pheochromocytoma was 50% sensitive and 98% specific for pheochromocytoma, whereas a threshold of 130 HU was 38% sensitive and 100% specific. Of the 21 pheochromocytomas with washout imaging, rapid washout was identified in 12/12 (100%) that enhanced >110 HU on the venous phase, compared to 11% (1/9) that enhanced 79 subjects with 88 adenomas were compared to 22 subjects with 26 pheochromocytomas. Mean±SD venous enhancement level for all adenomas (61±24 HU) and lipid poor adenomas (90±18) was lower than that of pheochromocytomas (111±38 HU) (p < 0.05), compared to 50% (13/26) of the pheochromocytomas. A threshold of 110 HU to identify pheochromocytoma was 50% sensitive and 98% specific for pheochromocytoma, whereas a threshold of 130 HU was 38% sensitive and 100% specific. Of the 21 pheochromocytomas with washout imaging, rapid washout was identified in 12/12 (100%) that enhanced >110 HU on the venous phase, compared to 11% (1/9) that enhanced 79 subjects with 88 adenomas were compared to 22 subjects with 26 pheochromocytomas. Mean±SD venous enhancement level for all adenomas (61±24 HU) and lipid poor adenomas (90±18) was lower than that of pheochromocytomas (111±38 HU) (p < 0.05), compared to 50% (13/26) of the pheochromocytomas. A threshold of 110 HU to identify pheochromocytoma was 50% sensitive and 98% specific for pheochromocytoma, whereas a threshold of 130 HU was 38% sensitive and 100% specific. Of the 21 pheochromocytomas with washout imaging, rapid washout was identified in 12/12 (100%) that enhanced >110 HU on the venous phase, compared to 11% (1/9) that enhanced 79 subjects with 88 adenomas were compared to 22 subjects with 26 pheochromocytomas. Mean±SD venous enhancement level for all adenomas (61±24 HU) and lipid poor adenomas (90±18) was lower than that of pheochromocytomas (111±38 HU) (p < 0.05), compared to 50% (13/26) of the pheochromocytomas. A threshold of 110 HU to identify pheochromocytoma was 50% sensitive and 98% specific for pheochromocytoma, whereas a threshold of 130 HU was 38% sensitive and 100% specific. Of the 21 pheochromocytomas with washout imaging, rapid washout was identified in 12/12 (100%) that enhanced >110 HU on the venous phase, compared to 11% (1/9) that enhanced.

CONCLUSION
For indeterminate adrenal masses in patients without a history of malignancy, venous phase enhancement >110 HU should prompt consideration of pheochromocytoma; a mass with venous enhancement >130 HU should be considered pheochromocytoma until proven otherwise.

CLINICAL RELEVANCE/APPLICATION
High levels of venous phase enhancement (>110-130 HU) are specific for pheochromocytoma and should be used in conjunction with wash-out characteristics to distinguish this lesion from adrenal adenoma.

SSA10-02 • Intra-individual Comparison of Chemical Shift MRI and Washout CT for Characterizing a Hyperattenuating Adenoma (>10 HU) on Unenhanced CT

Moon Young Kim MD (Presenter); Byung Kwan Park MD; Sung Yoon Park; Chan Kyo Kim MD, PhD

PURPOSE
To retrospectively compare the accuracy of MRI and CT in characterizing hyperattenuating adrenal adenomas with respect to lesion attenuation values measured on unenhanced CT.

METHOD AND MATERIALS
Fifty-two hyperattenuating adrenal masses measuring >10HU on unenhanced CT were identified in 52 patients who underwent both chemical shift MRI and washout CT. Accuracies using adrenal-to-spleen ratio (16.5%) for MRI and using absolute (40%) or relative (40%) percentage washout for CT were calculated to determine which modality was more accurate for hyperattenuating adenoma characterization. Sensitivities of MRI and CT were also compared according to the lesion attenuation values measured on unenhanced CT. Either follow-up imaging or histologic diagnosis was used as the standard reference. McNemar’s test was used to compare the accuracies of CT and MRI.

RESULTS
Hyperattenuating adrenal masses consisted of 37 adenomas and 15 non-adenomas. The sensitivities and specificities for adenoma on MRI versus CT were 75.7% (28/37) versus 100% (37/37), and 60.0% (9/15) versus 80.0% (12/15), respectively. CT achieved a higher accuracy than did MRI (p=0.008). The sensitivities for adenomas measuring >20HU on unenhanced CT were 100% (12/12) in both MRI and CT, while those measuring >20HU were 64.0% (16/25) and 100% (25/25) in MRI and CT, respectively.

CONCLUSION
MRI is equivalent to CT for characterizing adenomas measuring >20HU on unenhanced CT. However, MRI is inferior to CT for adenomas measuring >20HU due to decreased MR sensitivity.

CLINICAL RELEVANCE/APPLICATION
MRI may be used the first-line examination for patients with an incidental adrenal mass measuring >20 HU unenhanced CT if contrast-enhanced CT scans are contraindicated.

SSA10-03 • Differentiate Adrenal Metastases from Adrenocortical Adenoma with Single-source Dual-energy Computed Tomography, a Preliminary Study

Lifeng Wang (Presenter); Xuejun Chen; Liang H Li; Jinrong Qu; Jianbo Gao MD; Weili Xia; Cuicui Liu

PURPOSE
To evaluate the ability of spectral CT imaging in distinguishing adrenal metastases from adenoma on enhanced CT.

METHOD AND MATERIALS
35 patients with 40 lesions(24 adenomas and 16 metastases) underwent conventional plain CT and spectral CT to generate conventional plain CT images and monochromatic images of the arterial phase (AP) and the portal venous phase (PVP). Adenoma was divided into lipid-rich group(14 lesions) and lipid-poor group(10 lesions) by 10HU on unenhanced CT. Iodine(water, fat)-contribution value on enhanced CT were obtained to analyse. ROC analyses were performed to evaluate the diagnostic value of spectral CT, and to calculate...
RESULTS
Iodine-contribution value of adrenal adenoma, lipid-rich adenoma, the lipid-poor adenoma was statistically significant higher than that of metastases during the AP (13.65, 12.67,15.83 vs. 2.28 100ug/cm², P =0.00,0.00,0.00) and PVP(20.96, 19.99, 22.92 vs. 2.16 100ug/cm² P3, P3, P3, P).

CONCLUSION
Spectral CT can differentiate adrenal metastases from adenoma on enhanced CT, especially in differentiating metastases from lipid-poor adenoma.

CLINICAL RELEVANCE/APPLICATION
Spectral CT can differentiate adrenal metastases from lipid-poor adenoma.

SSA10-06 • Differentiation of Large Adrenal Adenomas (≥ 3cm) and Cortical Carcinomas Using Washout CT

Moon Young Kim MD (Presenter); Byung Kwan Park MD; Sung Yoon Park; Chan Kyo Kim MD, PhD

PURPOSE
To retrospectively differentiate large adrenal adenomas (= 3cm) and cortical carcinomas in patients with no history of extra-adrenal malignancy using washout CT.

METHOD AND MATERIALS
Between January 2004 and November 2012, 141 adenomas (mean size, 2.5 ± 1.2 cm, range 1.0 ~ 7.3 cm) and 16 cortical carcinomas (mean size, 7.9 ± 4.5 cm, range 2.4 ~ 17.8 cm) were histologically diagnosed in 141 and 16 patients, respectively. Of these adenomas, 34 adenomas and 13 cortical carcinomas were 3 cm or larger in size. All of these patients underwent unenhanced CT, 1 minute post-contrast CT, and 15 minute post-contrast CT. The attenuation values were measured at three different areas within a mass using a region-of-interest (ROI); (a) the highest attenuated area at 1 minute post-contrast image (highest ROI), (b) lowest attenuated area at 1 minute-postcontrast image (lowest ROI), and (c) ROI covering more than half of a mass (largest ROI). On unenhanced and 15 minute-postcontrast images, attenuation values were also measured at the corresponding areas, and percentage washouts were calculated. The CT diagnoses of adenoma were made if a mass had > 60% absolute percentage washout or = 40% relative percentage washout. The CT diagnosis of carcinoma was made if a mass had < 60% absolute washout and

RESULTS
The sensitivities for small (< 3 cm) adenoma were 99.1% (106/107), 95.3% (102/107), and 99.1% (106/107) while those for large adenomas (≥ 3 cm) were 100% (34/34), 52.9% (18/34), and 64.7% (22/34) at highest, lowest, and largest ROIs, respectively. As an adenoma increased in size, heterogeneous enhancement of the lesion increased (p<0.001) and subsequently the sensitivity for adenoma decreased significantly (p<0.001). The sensitivities for carcinoma (≥ 3 cm) were 46.2% (6/13), 100% (13/13), and 100% (13/13) at highest, lowest, and largest ROIs, respectively.

CONCLUSION
The diagnosis of small adenomas can be confidently made using washout CT wherever an ROI is placed. However, the differentiation of large adenomas and carcinomas is not easy because CT sensitivity widely varies according to an ROI placement in the heterogeneous lesion.

CLINICAL RELEVANCE/APPLICATION
The preoperative diagnosis of an large adenoma is not easy because it is much similar to cortical carcinoma in terms of CT densitometry or percentage washout.

SSA10-07 • CT Findings in Adrenal Adenoma: A New Sign, the Vessel Sign

Carlos L Vergara Diaz (Presenter); Juan Carlos Pernas; Diana Hernandez; Magdalena Menso; Carmen Perez Martinez MD

PURPOSE
To describe a new helpful CT sign for diagnosis of adrenal adenoma with certainty.

METHOD AND MATERIALS
We designed a descriptive study based on the review of the clinical history and follow-up of 50 patients who undergone diagnosis of adrenal adenoma by means of contrast enhanced computed tomography and who presented with The Vessel Sign. Patients were followed up either by computed tomography, positron emission tomography, magnetic resonance imaging or surgery.

RESULTS
We found a high degree of correlation between The Vessel Sign and the diagnosis of adrenal adenoma, close to a 100%. The Vessel Sign
Researchers

CONCLUSION
When present, The Vessel Sign is a helpful and reliable sign for the diagnosis of adrenal adenoma.

CLINICAL RELEVANCE/APPLICATION
The Vessel Sign is a helpful and reliable sign for the diagnosis of adrenal adenoma, mostly when other diagnostic imaging modalities are not possible or available

**SSA10-08 • The Value of Spectral CT Imaging in Differentiating Metastases from Adenoma in Adrenal Glands**

**Ye Ju (Presenter) ; Ailian Liu MD ; Meiyu Sun ; Yijun Liu ; Renwang Pu MBBCh, FRCPC ; Shifeng Tian**

**PURPOSE**
To determine if implementation of a CDS software tool which auto-generates best practice recommendations for a given set of imaging and clinical findings would be successful in improving report consistency by abdominal and emergency radiologists in adrenal lesion characterization detected at CT.

**METHOD AND MATERIALS**
A point-of-care CDS tool was created into which radiologists input key imaging and clinical patient data real-time. CDS output language was automatically inserted into the report body, impression and recommendation fields within a standardized template (radiologists could make free-text modifications). We evaluated performance from 10/24/12-12/31/12 in 7499 consecutive abdominal CT examinations. Those.

**RESULTS**
A total of 177 total nodules ranging from 8mm-10.5cm in 172 patients were evaluated with a final diagnosis of 77 adenomas, 14 myelolipomas/cysts/hemorrhage, 10 metastases and 76 indeterminate lesions. The CDS tool was used in 44/177 lesions and not used in133/177 lesions. Recommendation concordance rates of the subgroups were as follows (by chi-square, p All Non-CDS Lesions: 64% level I, 19% level II, 35% clinical.

**CONCLUSION**
After implementation of CDS, there was significantly improved correlation between the departmental guidelines and the recommendations made in the radiologists report.

**CLINICAL RELEVANCE/APPLICATION**
An automated CDS tool increases consistency in recommendations for adrenal lesion characterization with implications for adherence to best practice guidelines and referring physician expectations.

**SSA10-09 • Variation of Radiologist Recommendations for Adrenal Lesions Detected at CT: Comparison of Departmental Standards with and without a Point-of-Care Clinical Decision Support (CDS) tool**

**David A Rosman MD (Presenter) * ; Tarik K Alkasab MD, PhD ; Anand M Prabhakar MD ; Daniel I Rosenthal MD ; Keith J Dreyer DO, PhD * ; Debra A Gervais MD * ; Giles W Boland MD**

**PURPOSE**
To make free-text modifications). We evaluated performance from 10/24/12-12/31/12 in 7499 consecutive abdominal CT examinations. Those.

**RESULTS**
A total of 177 total nodules ranging from 8mm-10.5cm in 172 patients were evaluated with a final diagnosis of 77 adenomas, 14 myelolipomas/cysts/hemorrhage, 10 metastases and 76 indeterminate lesions. The CDS tool was used in 44/177 lesions and not used in133/177 lesions. Recommendation concordance rates of the subgroups were as follows (by chi-square, p All Non-CDS Lesions: 64% level I, 19% level II, 35% clinical.

**CONCLUSION**
After implementation of CDS, there was significantly improved correlation between the departmental guidelines and the recommendations made in the radiologists report.

**CLINICAL RELEVANCE/APPLICATION**
An automated CDS tool increases consistency in recommendations for adrenal lesion characterization with implications for adherence to best practice guidelines and referring physician expectations.
The user is required to identify the location and size of all lesions in a dataset by delineating the long axis of the lesion. Both manual and

The workstation allows a user to conduct lesion detection and characterization, and image quality assessment in a time-efficient manner.

METHOD AND MATERIALS

Purposes

We have developed an open source computer workstation to efficiently conduct observer studies of low dose CT protocols to determine the

The presented search engine is extremely useful to assist radiologists, medical researchers and students to mine meaningful information for

Clinical Relevance/Application

The presented search engine is extremely useful to assist radiologists, medical researchers and students to mine meaningful information from PACS and RIS for their decision support, research and care-

Implementation and Clinical Evaluation of Content-based Searching Engine in RIS-integrated PACS

Jianguo Zhang PhD (Presenter); Tonghui Ling MS; Jianyong Sun; Suo Li; Yuanyuan Yang MS; Kai Zhang BS

Purpose

We had designed a searching engine combining semantic space searching and CBIR techniques to search lung CT images with solitary pulmonary nodules (SPN) in PACS environment, and presented this prototype system in scientific presentation in 2009 RSNA Conference. In this paper, we present new approach to extend this searching engine to cover more organs and lesions, gave an implementation of this searching engine in RIS-integrated PACS, and discussed its clinical evaluation.

Method and Materials

The studies of cardiology CT images with coronary heart disease, brain CT and MR images with stroke, and abdomen CT with colorectal cancer as well as lung CT images with SPN, were included in our research. The diagnostic reports of the studies with findings of lesions are first analyzed by a NLP engine and then indexed in an inverted index. The contents of images related to the reports are identified by their low level features extracted from the ROIs of images containing the lesions and indexed in a specified high-dimensional database. The first step in using this search engine uses the inverted index to search for relevant radiology report matching the symptoms or diagnoses specified by users as query criteria. The second step searches and retrieves the features of images from the high dimensional database associated with each report returned in the first step and computes the feature similarities between user query image and the retrieved images. The final search results are then sorted by similarities computed on the second step.

Results

The developed searching engine was integrated a clinical RIS-integrated PACS, and operated for two years in Huadong hospital in Shanghai. There were about more than 30 cases averagely being searched and retrieved by using this searching engine daily. But the usages of this search engine for the purposes of decision support, research, and education were quite different.

Conclusion

The developed content-based searching engine can be easily integrated with a clinical RIS-integrated PACS and has been operating for two years in a hospital. The evaluation results showed that searching engine can be used for the purposes of decision support, research, and education.

Clinical Relevance/Application

The presented search engine is extremely useful to assist radiologists, medical researchers and students to mine meaningful information from PACS and RIS for their decision support, research and care-

Development of a Dedicated Workstation to Facilitate Rapid Performance of Observer Studies in Low-dose CT

David R Holmes PhD (Presenter); Rickey Carter PhD; Kurt E Augustine MS; Yu Liu MD; Maria Shiang; Lifeng Yu PhD; Phillip Edwards; Cynthia H McCollough PhD *; Joel G Fletcher MD *

Purpose

While numerous CT noise reduction methods have been developed, it is difficult to directly measure the clinical impact of each approach. We have developed an open source computer workstation to efficiently conduct observer studies of low dose CT protocols to determine the superiority or non-inferiority of new reconstruction methods.

Method and Materials

The workstation allows a user to conduct lesion detection and characterization, and image quality assessment in a time-efficient manner.

The user is required to identify the location and size of all lesions in a dataset by delineating the long axis of the lesion. Both manual and automatic software tools have been developed to match corresponding lesions between an observer and routine dose FBP reference.
In response to the need to improve the learning of radiology in medical schools using PBL, we have created MEDGAME. We discuss the clinical relevance/application dedicated workstations for observer performance in low dose CT minimize radiologist effort with streamlined workflow and provide automated and visual tools for reference standard matching.

**SSA11-06 • Compression of Radiology Reports Using a Semi-static Dictionary and Directed Pseudoforest**

**Naveen Garg** MD (Presenter) *; **Peter Kamel**; **Sarfaraz Sadruddin** MD; **Jorge Herskovic** MD, PhD; **David J Vining** MD *; **Kevin W McEnery** MD *

**PURPOSE**
A radiologist will generally dictate a normal chest the same way every day, and usually describe the same pathology in a consistent style. Speech recognition systems rely on these recurring patterns of reporting style to develop statistical language models for improving. Because of this, we hypothesized that radiology reports would be highly compressible using static dictionaries. The more commonly used compression algorithms such as gzip obtain approximately 4x compression, but lose random access of the compressed data. In this work, we report on the compression ratios achieved on a large corpus of radiology reports using static dictionaries. We also present a novel method of compressing the static dictionary itself using a directed pseudoforest.

**METHOD AND MATERIALS**
We constructed dictionaries from a variable number of radiology reports. Dictionaries were constructed using a variation of a generalized suffix tree pruning by a threshold frequency of the suffixes. The dictionary was then itself compressed using a directed pseudoforest, taking advantage of the shared structure between phrases in the dictionary. Source documents were then compressed using the integer indices into the dictionary, coded with a prefix-free entropy code. The algorithm was coded in c++11 with no platform specific dependencies.

**RESULTS**
Compression ratios improved with increasing number of reports. A million reports compressed to 18.7% of original size including the compressed reports, and dictionary. These randomly accessible compressed reports were further compressible by gzip, bringing compressed size to 13.7 %. Pruning the dictionary of less frequently used n-grams substantially decreased the size of the dictionary with only a minor increase in the size of the compressed reports. On a million reports, limiting the dictionary to n-grams that occur at least 30 times in the corpus results in overall better compression than allowing n-grams that occur 10 or more times.

**CONCLUSION**
Static dictionaries with directed pseudoforests can compress radiology reports with a very high efficiency while retaining random access capability.

**CLINICAL RELEVANCE/APPLICATION**
Better compression of radiology reports and other medical records can be used to enable data mining applications to retain more data in memory allowing faster analytics.

**SSA11-07 • Detailed Comparison of Average Journal Impact Factors of Oral and Poster Abstracts Presented at Scientific Session that Achieved Publication at 2009 Radiological Society of North America Scientific Assembly and Annual Meeting**

**Hiroyuki Takaoka** MD, PhD (Presenter) ; **Nobusada Funabashi** MD, PhD ; **Naoko Mizuno** ; **Koya Ozawa** MD ; **Yoshio Kobayashi** MD *

**PURPOSE**
To determine the average journal impact factors of oral and poster abstracts presented at the scientific sessions of the 2009 Radiological Society of North America (RSNA) 95th scientific assembly and annual meeting that achieved publication for each category using Pubmed.

**METHOD AND MATERIALS**
From the 2009 RSNA meeting program (total of 1509 oral abstracts, and 684 poster abstracts), authors' names and abstract titles were entered into PubMed. Publication consistent with abstract content was confirmed by PubMed in March 2013.

**RESULTS**
Percentages of all oral and poster abstracts in the scientific sessions achieving publication were 18.4 and 11.4% and that of oral abstracts was significantly higher than that of poster abstracts. The percentage of oral abstracts achieving publication was significantly higher than the poster abstracts in Breast (26.3 vs 10.0%, P < 0.05), Nuclear Medicine (20.6 vs 3.2%, P < 0.05), Musculoskeletal (29.0 vs 14.0%, P < 0.05), and Radiation Oncology categories (12.7 vs 0.1%, P < 0.05). Even though impact factors were significantly higher for the oral abstracts that achieved publication (3.3 ± 1.8) than for the poster abstracts that achieved publication (2.6 ± 1.3) in all categories (P < 0.04), but there were no significant differences in average Impact factors achieving publication between oral and poster abstracts in each category.

**CONCLUSION**
Although the percentages of oral abstracts to achieve publication were significantly higher than poster abstracts in all, Breast, Nuclear Medicine, Musculoskeletal, and Radiation Oncology categories, both oral and poster abstracts at the 2009 RSNA 95th scientific assembly and annual meeting were similar in achieving publication in terms of average journal impact factor in each category.

**CLINICAL RELEVANCE/APPLICATION**
Both oral and poster abstracts presented at the scientific sessions of the 2009 RSNA annual meeting were similar in achieving publication in terms of average journal impact factor in each category.

**SSA11-08 • Developing a Computer Game for Problem Based-learning (PBL) of Radiology for Undergraduate Medical Education (MEDGAME)**

**Salvador Pedraza** MD, PhD (Presenter) *; **Joan C Vilanova** MD, PhD ; **Elda Balliu** MD ; **Carles Munoz** ; **Enric Marti** ; **Jordi Arnal** ; **Pere Nolla** ; **Joan Domenech** ; **Albert Ramon** ; **Luis Branda**

**CONCLUSION**
In response to the need to improve the learning of radiology in medical schools using PBL, we have created MEDGAME. We discuss the
Background
Problem-based learning (PBL) is a recognized and implemented educational strategy in the learning of radiology. In this project we developed and validated a learning tool radiological computer game (MEDGAME) of image interpretation in order to improve the effectiveness of PBL applied to radiology and its associated disciplines.

Evaluation
The study population was composed of 150 second-year medical students at the Medical School of the University of Girona during the 2012-2013 academic year. MEDGAME has been developed under Mac Platform with the Unity3D Engine which allows deployment for Mac and Windows standalone application. 3D Studio MAX program was used to create 3D characters and environments models. Images of five scenarios of typical radiology departments were obtained: a reporting room, a plain-film X-ray room, a sonography room, a computed tomography room, and a magnetic resonance imaging room. It was decided to include only three roles: a) The player requests a radiological examination and then must answer the questions asked by the senior radiologist; b) senior radiologist, who asks the player; c) patient, whose avatar is different in each challenge. Summarizing picture is shown in Figure 1. On the other hand, four challenges have been developed into the game: Cervical trauma, appendicitis, pulmonary embolism, and acute stroke. Each challenge contains several questions about the patient’s radiological diagnoses.

RESULTS
Three search modes are available:
- A search mode by gamuts, which allows the user to make a diagnosis in just a few clicks, through the use of more than 500 gamuts;
- A search mode by anatomy, which lists all diagnoses present in database according to a simple but comprehensive anatomic classification;
- A keyword search, which works like a conventional search engine, for which the user enters the name of diagnosis, allowing access to many images of the same diagnosis Diagnostig is present on social networks, and presents the ‘case of the day’ commented by radiologists worldwide.

CONCLUSION
www.diagnologic.com is a simple, rapid, and complete website, to solve diagnoses problems, even the most complex one

CLINICAL RELEVANCE/APPLICATION
Diagnostig is a free radiologic website to help and educate radiologists.

ISP: Molecular Imaging (Oncology I)

Sunday, 10:45 AM - 12:15 PM • S504CD

SSA11-09 • A Diagnostic Problem? Think www.diagnologic.com!

Raphael E Khayat MD (Presenter)

PURPOSE
Diagnostig.com is a free innovating medical database allowing an unique computer assisted diagnosis in radiology. The website has several goals:
- To provide a quick and reliable computer assisted diagnosis in radiology using more than 500 gamuts.
- To educate radiologists by showing more than 150 000 images, Diagnostig.com publishes cases of radiology everyday on fabecook with the account Diagnostig Radiology

METHOD AND MATERIALS
After 4 years of collaboration between radiologists, and experts in database, a Diagnostic Decision Support System has been developed. The website has more than
- 100 000 images,
- 2500 diagnostics,
- 200 anatomical locations,
- 500 gamuts

RESULTS
Three search modes are available:
- A search mode by gamuts, which allows the user to make a diagnosis in just a few clicks, through the use of more than 500 gamuts
- A search mode by anatomy, which lists all diagnoses present in database according to a simple but comprehensive anatomic classification
- A keyword search, which works like a conventional search engine, for which the user enters the name of diagnosis, allowing access to many images of the same diagnosis Diagnostig is present on social networks, and presents the ‘case of the day’ commented by radiologists worldwide.

CONCLUSION
www.diagnologic.com is a simple, rapid, and complete website, to solve diagnoses problems, even the most complex one

CLINICAL RELEVANCE/APPLICATION
Diagnostig.com is a free radiologic website to help and educate radiologists.
RESULTS
IHC analysis validated the proteomic data showing that hThy1 was expressed on the vasculature and significantly increased in PDAC tumors (score: 2.1±0.1, 81% of tumors were Thy1-positive) in contrast to normal pancreata (score: 0.5±0.1; Rh vivo binding of MBhThy1 to PDAC xenografts was assessed using US molecular imaging. A targeted signal using MBhThy1 of 7.7±2.3 au was observed in hThy1 expressing PDAC xenografts compared to 1.9±1.8 in control tumors and 1.4±2.2 using non-targeted MBs.

CONCLUSION
These results illustrate the development of a translational US-MB directed against a vascular tumor marker and the development of a novel, orthotopic human PDAC model expressing hThy1 within the tumor vasculature, which may eventually aid in earlier detection of PDAC.

CLINICAL RELEVANCE/APPLICATION
These results illustrate the development of a translational US-MB directed against a vascular tumor marker and the development of a novel, orthotopic human PDAC model expressing hThy1 within the tumor vasculature, which may eventually aid in earlier detection of PDAC.

SSA12-03 • Characterization of Perfusion and Therapeutic Resistance in a Renal Cell Carcinoma Mouse Model with Hyperpolarized 13-C-tert-butanol
Leo L Tsai MD, PhD (Presenter) *; Xiaoen Wang MD; Gopal Varma PhD; David C Allop PhD *; Rupal Bhatt; Aaron K Grant PhD

PURPOSE
To prepare targeted biodegradable nanoparticles to connect folic acid MRI contrast agent with appropriate size. To explore the feasibility of the macromolecular contrast agent for tumor targeting and the characteristics of imaging in vivo and in vitro with folic receptor-positive tumor cells in nude mice models.

METHOD AND MATERIALS
Xiaolong Gao PhD (Presenter); Peijun Wang MD, PhD; Chao Lin; Guoliang Wang

PURPOSE
To develop a targeted biodegradable nanoparticles MRI contrast agent for enhanced tumor imaging and non-viral gene delivery.

METHOD AND MATERIALS
To prepare targeted biodegradable nanoparticles to connect folic acid MRI contrast agent with appropriate size. To explore the feasibility of the macromolecular contrast agent for tumor targeting and the characteristics of imaging in vivo and in vitro with folic receptor-positive tumor cells in nude mice models.

RESULTS
In summary, SSPUA-DTPA-FA-PEG-Gd was successfully developed as a target specific, biodegradable and non-toxic delivery system of siRNA therapeutics. Treatment with SSPUA-DTPA-FA-PEG-Gd/siVEGF complex reduced VEGF mRNA and protein expression in vitro and in vivo, and it also retarded tumor growth in vivo. The SSPUA-DTPA-FA-PEG-Gd helps to intensify the effect in MR enhancement in nude mice models. Therefore, SSPUA-DTPA-FA-PEG-Gd might be effective non-viral gene vector for gene therapy.
SSA12-06 • In Vivo Reporter Imaging in a Large Animal Pre-clinical Model Demonstrates that Angiotensin II Improves Gene Expression Upon Intra-arterial Adenovirus Delivery

Vikas Kundra, MD, PhD (Presenter); Murali Ravoori; Lin Han; Sheela Singh; Katherine Dixon, RT; Rajesh Uthamanthil

**PURPOSE**
Gene therapy has been hampered by low levels of gene expression upon in vivo delivery. Using a somatostatin receptor type 2 (SSTR2)-based reporter, we assessed whether angiotensin II can improve gene expression by adenovirus upon intra-arterial delivery.

**METHOD AND MATERIALS**
A SSTR2-based reporter that can be imaged with the FDA approved radiopharmaceutical 111-In-octreotide was used to assess gene expression in vivo. 8 rabbits bearing VX2 tumors in each thigh were randomly injected intra-arterially with adenovirus containing a human somatostatin receptor type 2A (Ad-CMV-HA-SSTR2A) gene chimera + angiotensin II or control adenovirus containing green fluorescent protein (Ad-CMV-GFP). 3 days later, 111-In-octreotide was given IV after CT imaging using a clinical CT scanner and intravenous contrast. Tumor uptake of 111-In-octreotide was evaluated the next day using a clinical gamma camera. Gene expression was normalized to tumor weight and morphology from CT to obtain in vivo biodistribution.

**RESULTS**
SSTR2-based expression was readily visualized. VX2 tumors infected with Ad-CMV-HA-SSTR2 upon intra-arterial delivery with angiotensin II had greater in vivo biodistribution, thus greater gene expression, than without angiotensin II (P<0.005).

**CONCLUSION**
Angiotensin II can improve in vivo gene expression by adenovirus upon intra-arterial delivery. In vivo SSTR2-based reporter imaging can be used to compare methodologies for improving gene expression.

SSA12-07 • PSMA Imaging with 18F-DCFBC PET for Detection of Primary Prostate Cancer: Initial Evaluation Using MRI and Pathologic Analysis

Kenneth L Gage, MD, PhD (Presenter); Sheila Friedrich Faraj, MD; George Netto, MD; Katarzyna J Macura, MD, PhD; Martin G Pomper, MD, PhD; Steve Cho, MD; Ronnie Mease, PhD; Enrico Munari, MD; Akimosa Jeffrey-Kwanisi, MBA

**PURPOSE**
18F-DCFBC (DCFBC) is a novel low-molecular weight PET agent targeted to prostate specific membrane antigen (PSMA) that has previously demonstrated uptake at sites of metastatic prostate cancer (PC). We present our preliminary findings evaluating quantitation of DCFBC for the detection of primary PC.

**METHOD AND MATERIALS**
Eight patients with biopsy-proven PC with Gleason score (GS) >= 6 were imaged with both DCFBC PET and pelvic MRI (T2 and DWI) prior to prostatectomy. PET imaging with 35 min pelvic imaging (30 min 2D and 5 minute 3D) and whole body imaging was started 2 hrs after injection of 370 MBq (10 mCi) of DCFBC. Post-surgical prostatectomies were sectioned in 4mm planar increments from apex to base, divided into quadrants and analyzed by both HandE and PSMA immunohistochemistry (IHC). PET and MRI were visually correlated and co-registered for analysis, and compared with the anatomically reassembled pathology results. The area of highest GS (postsurgical) determined the location for analysis. The PET ROI (SUVmax) was correlated using Spearman’s rank correlation with Gleason score, MRI ADC values, H-score for PSMA IHC staining, degree of staining (strong, moderate, weak), and lesion size.

**RESULTS**
Three pts showed strongly positive (pos) intraprostatic DCFBC PET signal which correlated with signal on MRI and prostatectomy pathology with dominant GS of 4+5=9 tumor. Three pts were negative (neg) by DCFBC PET with low-grade disease (GS 6, 4+3=7, 3+4=7). Two additional patients had discernible but subtle uptake which also correlated with signal on MRI and GS 3+4=7 PC. DCFBC PET SUVmax on WB and 2D pelvic imaging was positively correlated with GS (r coeff=0.89, p=0.0079; r coeff=0.72, p=0.045, respectively), and trended toward significance when compared to PSMA IHC H-score results in this small dataset. MRI DWI imaging was able to localize sites of prostate cancer but ADC values did not correlate significantly with PC GS or PSMA IHC.

**CONCLUSION**
DCFBC PET imaging of primary PC demonstrates tumor PET SUVmax is positively correlated with GS and trended toward significance with tumor PSMA expression by IHC. These findings will need further confirmation in our ongoing clinical trial.

**CLINICAL RELEVANCE/APPLICATION**
PSMA imaging with DCFBC PET may provide a novel biomarker for noninvasive detection of high-grade primary prostate cancer and tumor PSMA expression.

SSA12-08 • MR Colonoigraphy with Intestine-absorbable Nanoparticle Contrast Agents in Evaluation of Colorectal Tumors

Yin Jin (Presenter); Jihong Sun, MD, PhD; Xia Wu; Xiaozhe Shi; Peng Hu; Xiaoming Yang, MD, PhD

**PURPOSE**
To develop a novel nanoparticle-based magnetic resonance (MR) colonoigraphy technique, which enabled us to evaluate colorectal tumors via transrectal administration of intestine-absorbable nanoparticle contrast agents.

**METHOD AND MATERIALS**
Solid lipid nanoparticles (SLNs) were synthesized with loading of gadolinium (Gd) diethylenetriaminepenta acetic acid (Gd-DTPA) and o-bcadamidine fluorescein isothiocyanate (FITC) to construct Gd-FITC-SLNs for histologic confirmation of MR findings. Twelve APCMin/+ female mice were treated with 1-2 administration cycles of 2% dextran sulfate sodium in the drinking water for 5-7 days to create the colorectal tumors. The neoplastic mice were administered by a transrectal enema with Gd-FITC-SLNs (40mg/ml). T1-weighted MR colonoographies using spin echo sequence (TR/TE, 840/15 msec) were then performed to detect various Gd-carrying SLNs within the colorectal walls. MRI findings were correlated with subsequent histological confirmation.

**RESULTS**
MR colonoographies demonstrated mild enhancement of the tumors masses and significant enhancement of normal colorectal walls. Confocal fluorescence microscopy demonstrated the delivered Gd-FITC-SLNs as highly-concentrated green fluorescence spots into the surface of the tumor masses with less spots within the tumor of APCMin/+ mice (Figure).

**CONCLUSION**
This study establishes the proofs-of-principle of a new MR colonoigraphy technique, which enables the differentiation of colorectal tumors from the normal colorectal walls based on various absorption capability of nanoparticle contrast agents. Solid lipid nanoparticle-based MR colonoigraphy may open new avenues for efficient management of colorectal tumors.

**CLINICAL RELEVANCE/APPLICATION**
Solid lipid nanoparticle-based MR colonoigraphy may open new avenues for efficient management of colorectal tumors.
**Multidirectional Instability**

**SSA13-01**  
**Sunday, 10:45 AM - 12:15 PM**  
**Musculoskeletal (Shoulder I)**

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**Musculoskeletal (Shoulder I)**

**SSA13 • AMA PRA Category 1 Credit ™:1.5 • ARRT Category A+ Credit:1.5**

**Moderator**

Michael J Tuite, MD  
Kirkland W Davis, MD

**SSA13-01 • The Detour Sign on MR Image for Subluxation of the Long Head of Biceps Tendon with Arthroscopic Correlation**

Eun Kyung Khil MD (Presenter); Jang Gyu Cha MD; Hyun Joo Kim MD; Kyung Dae Min; Hyun-Sook Hong MD, PhD; Beom Ha Yi; Jae Myeong Lee

**Purpese**

To determine whether detour sign at magnetic resonance (MR) imaging is an indicator of subluxation of the long head of the biceps tendon in the shoulder joint.

**Method and Materials**

This retrospective study evaluated 65 patients (M:F=29:36; age range: 49-79 years, mean: 58 years) who had shoulder pain and underwent arthroscopic surgery, between January 2012 and February 2013. All patients underwent 3T MR imaging for diagnosis of shoulder diseases, and the MR scans were independently reviewed by two musculoskeletal radiologists. When MR imaging showed a subscapularis tear with biceps pulley lesion (Habermeyer group 4)(criterion 1) or additional detour sign of the biceps (criterion 2) on the axial images, the lesion was considered to be a subluxation of the long head of the biceps tendon (SLBT). After MR imaging, shoulder arthroscopy was performed in all patients for a definitive diagnosis of SLBT. Descriptive statistics were calculated and the sensitivity values were compared by using the McNemar test. A kappa statistic was recorded for interobserver agreement regarding the presence of the detour sign, subscapularis tear, and pulley lesion on MR imaging.

**Results**

Arthroscopy showed SLBT in 18 patients. When MR imaging diagnosis was based on criteria 1 only, SLBT was diagnosed with a sensitivity of 44.4%, and an accuracy of 80.4%. When MR imaging diagnosis was based on both the criterion 1 and the criterion 2 using detour sign, SLBT was diagnosed with a sensitivity of 83.3% and an accuracy of 81.5%. By adding criterion 2 for diagnosis, 10 patients with SLBT were additionally diagnosed, of which 7 patients had been confirmed SLBT on arthroscopy. There is a significant difference (p < 0.05) in the detour sign, subscapularis tear, and pulley lesion on MR imaging.

**Clinical Relevance/Application**

The detour sign will make it easy to detect the lesion with only several images on the axial plane, and may improve the detection rate of SLBT and provide the reasonability for surgery.

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**SSA13-02 • ABER Position MR Arthrography of the Shoulder: Diagnostic Signs for Capsular Laxity in Patients with Atraumatic Multidirectional Instability**

Christoph Schaeffeler MD (Presenter); Simone Waldt MD; Jan S Bauer MD; Chlodwig Kirchhoff MD; Bernhard Haller; Michael Schroeder; Ernst J Rummeny MD; Andreas Imhoff; Klaus Woertler MD

**Purpese**

To retrospectively evaluate diagnostic signs for capsular laxity on ABER position MR arthrography (MR-A) of the shoulder in patients with atraumatic multidirectional instability.

**Method and Materials**

Clinical data of patients with 275 consecutive MR-Arthrographies including T1w ABER position were reviewed. Patients with MDI were identified through typical clinical history and instability in two or more directions. Patients with traumatic instability, previous surgery, overhead athletes (including postsuperior impingement), and age >45 years were excluded. The control group comprised patients with clinical stable shoulders. ABER position MR-A were independently assessed by three blinded radiologists for two defined signs (Figure); (1)
RESULTS
21 MR-A were added to the study group, 17 to the control group. Sensitivity for the crescent sign in the diagnosis of MDI was 57/62/48% (observer 1/2/3), specificity was 100/100/94% with excellent multirater-agreement (κ = 0.813); area under the ROC-Curve (AUC) was 0.78/0.810/0.709. Sensitivity for the triangle sign was 48/57/48%, specificity was 94/94/94% with excellent multirater-agreement (κ = 0.953) at AUC was 0.905/0.756/0.738/0. The presence of at least one of these laxity signs had a sensitivity of 86/91/81%, a specificity of 94/88/94% with an AUC of 0.899/0.894/0.875 (κ = 0.842); Intraobserver-agreement was excellent (κ = 1.000). Patients with a positive triangle sign showed significantly increased posterosuperior decentration of the HH.

CONCLUSION
Considered separately, the crescent and triangle sign showed inappropriate diagnostic performance. However, the presence of either the crescent or the triangle sign or both on ABER position MR arthrography of the shoulder allows for accurate diagnosis of capsular laxity in patients with atraumatic MDI.

CLINICAL RELEVANCE/APPLICATION
Functional MR-Arthrography of the shoulder including images in ABER position enables the radiologist to accurately assess laxity of the anteroinferior joint capsule by using simple and objective signs.

SSA13-03 • Correlation of MRI with Arthroscopy for the Diagnosis of Subscapularis Tendon Tears: A Musculoskeletal Division’s Experience
Soterios Gyftopoulos MD (Presenter); John S O’Donnell MD; Neil P Shah MD; James S Babb PhD; Michael P Recht MD

PURPOSE
To determine the accuracy of MRI for the diagnosis of subscapularis tendon tears utilizing arthroscopy as the gold standard.

METHOD AND MATERIALS
The MR and arthroscopy reports from 286 consecutive patients were reviewed with 3 inclusion criteria: 1) Non-contrast MRI performed at our institution, 2) Arthroscopy (OR) within 6 months of the MRI, and 3) No prior subscapularis surgery. 42 patients were excluded (6 non-specific OR reports, 4 tears of the inferior tendon, 32 MR arthographic studies). The MR and OR reports were reviewed for the presence and degree of tearing (partial (PT)/full-thickness (FT)). Only PT-articular tears were included, as tears that involved only the intrasubstance and/or bursal surface are not typically seen on arthroscopy as per our orthopaedists. Estimates of the accuracy, sensitivity, specificity, and positive and negative predictive values were derived for MRI using arthroscopy as the gold standard.

RESULTS
There were a total of 244 patients (161 men/83 women; mean age 48 years range 15-83) and 111-1.5T/133-3T MRIs. There were 25 (16 PT/9 FT) tears and 219 intact tendons on arthroscopy. Nineteen of the 25 arthroscopic tears (10/16 PT; 9/9 FT) and 200 of the 219 arthroscopic normal studies were correctly diagnosed on MRI. One tear was called FT on MRI, but was PT in the OR. There were 18 PT and 3 FT tears identified on MRI that were not seen in the OR as well as 5 PT tears found in the OR, but not on MRI. Without differentiating between PT and FT tears, our analysis demonstrated 80% sensitivity, 91% specificity, 90% accuracy, and 51% positive and negative predictive values. There was 91% accuracy for the diagnosis of PT tears and 99% accuracy for the diagnosis of FT tears. Retrospective review of the false positive cases demonstrated 3 common causes of reader error: volume averaging, misdiagnosis of an intrasubstance tear as an articular tear, and associated underlying advanced tendinosis.

CONCLUSION
MRI can be used to accurately diagnose subscapularis tendon tears utilizing arthroscopy as the gold standard.

CLINICAL RELEVANCE/APPLICATION
MRI is an effective tool in the evaluation of the subscapularis tendon. Familiarity with common causes of reader error (i.e. volume averaging) will decrease the likelihood of overcalling pathology.

SSA13-04 • Subscapularis (SSC) Tendon Tears: Diagnostic Performance and Inter-observer Reliability of Direct Magnetic Resonance Arthrography (MRA) among Observers with Varying Levels of Experience with Arthroscopic Correlation
Eugene Lee (Presenter); Jung-Ah Choi MD; Ju Han Oh MD; Eugene Joe; Sujin Kim; Sung Hwan Hong MD; Heung S Kang MD

PURPOSE
To retrospectively review the diagnostic performance and inter-observer reliability of direct MRA in the diagnosis of articular/bursal-sided partial thickness and full-thickness SSC tendon tears among observers with varying levels of experience.

METHOD AND MATERIALS
Preoperative direct MRAs of 297 consecutive patients with arthroscopic confirmation were reviewed. These included 100 with articular/bursal-sided partial thickness tears, and 219 with full thickness tears) were evaluated independently by three radiologists with differing levels of experience in interpretation of musculoskeletal images. Diagnosis was made on T1 axial and/or sagittal images with fat suppression regarding the following findings, i.e. defect, thinning, thickening, increased signal intensity, leakage of gadolinium with articular/bursal-sided partial thickness tears, and high grade partial (more than 50% thickness)/full thickness tear. Sensitivity, specificity, and diagnostic accuracy were calculated. Inter-observer reliability was also evaluated using ICC between each pair of observers.

RESULTS
For full thickness tears, sensitivity was 89.9% (observer 1/reader 1; reader 2/reader 3); specificity was 99.0% (observer 1/reader 1; reader 2/reader 3); accuracy was 94.2%/88.9%/94.2%. For partial thickness tears, sensitivity was 80% (observer 1/reader 1; reader 2/reader 3); specificity was 99.0% (observer 1/reader 1; reader 2/reader 3); accuracy was 94.2%/88.9%/94.2%. For normal SSC tendons, sensitivity was 80% (observer 1/reader 1; reader 2/reader 3); specificity was 99.0% (observer 1/reader 1; reader 2/reader 3); accuracy was 94.2%/88.9%/94.2%.

CONCLUSION
For diagnosis of SSC lesions on direct MRA, specificity was higher than sensitivity and accuracy for all three observers, especially for partial thickness tears. Accuracy was especially low in less experienced observer. Interobserver reliability varied according to level of experience, lower in observers with less experience.

CLINICAL RELEVANCE/APPLICATION
Depending on the level of experience of the radiologist, diagnostic performance of direct MRA in the diagnosis of subscapularis tendon tears varies, especially in diagnosis of partial thickness tears.

SSA13-05 • PASTA Lesion of Rotator Cuff Foot Print: Direct MR Arthrographic Findings in Surgically Confirmed Patients
Eun Hae Park (Presenter); Ja Young Kim; Young Han Lee MD; Sungjun Kim MD; Ho-Taek Song MD; Jin-Suck Suh MD

PURPOSE
To evaluate MR arthrographic (MRA) findings and to compare the MR findings with arthroscopic findings of characteristics, anatomical distribution and extent of PASTA (partial articular-sided supraspinatus tendon avulsion) in arthroscopically confirmed patients.

METHOD AND MATERIALS
Sep 2009 to Feb 2013, 62 patients arthroscopically confirmed as PASTA. We excluded one lesion mixed with arthroscopically full-thickness tear. Total 61 patients were enrolled, and all patients underwent MRA with using 3-T MR. Mean interval time between MRA and arthroscopy was 77.3 days. Two musculoskeletal radiologists retrospectively reviewed the MRA by consensus blind to arthroscopic findings. PASTA was defined as undersurface tendon discontinuity at the footprint with articular side contrast. Anatomical locations were divided by four: anterior, posterior, transition zone, inferior half of the middle facet of the greater tuberosity. Vertical extension divided into 3 grade: grade 1; involving 1-2mm of tendon insertion, grade 2; involving =50%, grade 3; involving >50%. Arthroscopies were done by one experienced orthopedic surgeon. Pearson correlation test was used to correlate the vertical grade and surgical percentage of the PASTA.

RESULTS
Of the 61 patients, 51 patients were diagnosed as PASTA (83.6%); anterior in 36 (70.6%), posterior in 10 (19.6%), and transitional zone in 5 (9.8%). There was no involvement inferior half of the middle facet. Grade 1 vertical extension were 12 (23.5%), grade 2 in 18 (35.3%), and grade 3 in 21 (41.2%). The Pearson correlation test between MR vertical extension grade and surgical percentage was 0.69 (p < 0.05).

CONCLUSION
PASTA lesion is well visualized on MRA as showing contrast filling at the partial articular-sided footprint avulsion at the greater tuberosity. The vertical extension grade was good correlation with surgical grade. In patients with extra-articular contrast leakage, the PASTA lesion could be misdiagnosed on MRA.

CLINICAL RELEVANCE/APPLICATION
PASTA lesion is well diagnosed on MRA and its extent was good correlation with surgical grade.

SSA13-06 • Postoperative MR Six Months after Rotator Cuff Surgery: Which MR Finding Is Correlated to Clinical Outcome?
Wool Kim (Presenter) ; Young Cheol Yoon MD ; Sanghee Lee MD

PURPOSE
The purpose of this study is to evaluate the correlation between various post-operative MR findings and clinical score.

METHOD AND MATERIALS
This retrospective study protocol was approved by our institutional review board and informed consent was waived. MRI examinations were performed on 180 shoulders of 178 patients who underwent rotator cuff repair surgery (64 males, 114 females; mean age, 60.2 years; age range, 22-80 years). The mean interval between MR and surgery was 160.6 (120-180) days. Two radiologists who were blinded to clinical score evaluated continuous variables (bone marrow edema-maximum, bone marrow edema-summation, thickness of repaired tendon) independently, and categorial variables (adhesive capsulitis, foot print coverage, subcortical cyst, fatty atrophy of rotator cuff muscles, subacromial enthesophyte, subacromial fluid, and signal intensity grade of repaired tendon) with a consensus. Each finding was correlated to American Shoulder and Elbow Surgeons (ASES) score and the Constant-Murley (Constant K) score of clinical outcome. Pearson correlation coefficient was calculated and p value less than 0.05 was regarded as statistically significant. Intra-rater coefficients were obtained for continuous values.

RESULTS
Thickness of repaired tendon (p=0.014 for reviewer 1, p=0.001 for reviewer 2 with ASES score; p=0.002 for reviewer 1, p=0.001 for reviewer 2 with Constant K score) was significantly correlated to clinical outcome at six-months after rotator cuff surgery.

CLINICAL RELEVANCE/APPLICATION
Attention should be paid to thickness of repaired tendon and fatty atrophy of rotator cuff muscle when evaluating post-operative MR after rotator cuff surgery.

SSA13-07 • Decentering Syndrome: An Important Cause of Isolated Teres Minor Atrophy
Scott Lenobel MD (Presenter) ; Michael Olson DO, MBA ; Jason E Payne MD ; Alan Rogers MD ; Erin Shropshire ; Barbaros Serdal DDS, PhD ; Joseph S Yu MD

PURPOSE
To evaluate imaging findings related to humeral head decentering as a potential cause of isolated teres minor atrophy.

METHOD AND MATERIALS
We retrospectively reviewed 500 shoulder MRI examinations performed from 2004-2013 to identify patients with isolated teres minor atrophy. We excluded patients with quadrilateral space or Parsonage-Turner syndromes and those with a history of posterior shoulder dislocation. 37 patients fit our selection criteria with 2 patients exhibiting bilateral disease. Decentering was defined as posterior humeral head subluxation at rest. The images were reviewed by a musculoskeletal radiologist and fellow for posterior labral tears, posterior capsular pathology, and humeral head decentering. Additional findings recorded were the presence of a rotator cuff, biceps tendon, and superior or anterior labral tear, and glenohumeral arthritis. An age and sex matched control group of 39 patients was identified in which each patient had a posterior labral tear but no teres minor atrophy.

RESULTS
The incidence of isolated teres minor atrophy is 1.6%. In our group of 39 patients (30 males/9 females; average age 54 years, range 33 to 79 years), 38 (97.4%) had a posterior labral tear, posterior capsular pathology, or humeral head decentering. Posterior labral tears were seen in 32 (82.1%), 14 (35.9%) had posterior capsular pathology, and 19 (48.7%) demonstrated posterior humeral head subluxation. 33 had a rotator cuff tear, none of which involved the teres minor, 11 had a biceps tear, 32 had an anterior labral tear, 29 had a superior labral tear, and 26 had glenohumeral joint arthritis. In the control group, 7 (17.9%) had posterior humeral head subluxation compared to 19 (48.7%) in the teres minor atrophy group (p value < 0.01).

CONCLUSION
Humeral head decentering is a frequent finding in patients with isolated teres minor atrophy in addition to secondary signs of posterior glenohumeral instability suggesting that traction on the teres minor nerve may be integral to this condition. A statistically significant difference in the presence of humeral head decentering was shown between patients with isolated teres minor atrophy compared to patients without isolated teres minor atrophy.

CLINICAL RELEVANCE/APPLICATION
Ours is the first project to identify a statistically significant association between posterior humeral head decentering and isolated teres minor atrophy.

SSA13-08 • Subcoracoid Impingement; Is the Consequence of Narrow(ed) Coracohumeral Interval or Narrow Coracohumeral Angle?
Eser Sanverdi MD (Presenter) ; Ali Oznur MD ; Mehmet Ali Gurses MD ; Safak Salvarli MD

PURPOSE
Subcoracoid impingement (SCI) is one of the most frequent reason of the anterior shoulder pain. Degeneration of subcoracoid muscle tendon secondary to repetitive microtrauma is the main problem. In this magnetic resonance imaging study we aimed to investigate if the angle between the free edge of the coracoid process and the humeral head (CHA), or the distance of the coracohumeral interval (CHD) was causative in the development of SCI.

METHOD AND MATERIALS

RESULTS

CONCLUSION
To our best knowledge, CHA was not assessed as an indicator of SCI until now. In the development of isolated subcoracoid tendinopathy, our findings suggested that CHA is more important than CHD. However, further clinical and radiological studies are needed.

CLINICAL RELEVANCE/APPLICATION
Coracoplasty indications and techniques might be influenced by the course of the coracoid.

SSA13-09 • Does Reducing the Concentration of Bupivacaine when Performing Therapeutic Shoulder Joint Injections Impact the Clinical Outcome? Our Experience after 1500 Injections

Michael G Fox MD (Presenter) *; James Patrie MS

PURPOSE
Since the chondrotoxicity of local anesthetics is dose dependent, we reduced the Bupivacaine concentration when performing therapeutic joint injections from 0.50% to 0.25% in 2011. This study determines if this lower Bupivacaine concentration impacted the 10 minute and 1 week post-injection pain scores in patients receiving steroid-anesthetic joint injections.

METHOD AND MATERIALS
This IRB approved HIPPA compliant study included all out-patient fluoroscopic guided glenohumeral injections performed by musculoskeletal (MSK) radiologists and/or MSK fellows between 9/09 and 3/13. Intra-articular placement was confirmed with iodinated contrast or rarely air. Patients received either 2.5 mL of Bupivacaine 0.5% (Group A) or 2.5 mL of Bupivacaine 0.25% (Group B). All injections included 0.5 cc of Kenalog 40mg/mL. Group A included 493 injections (210M:283F) (mean age 57) and Group B included 1049 injections (448M:601F) (mean age 57). The patients pain level was recorded by someone blinded to the Bupivacaine concentration on a numeric scale of 0-10 (0=no pain and 10=extreme pain) immediately prior to and 10 minutes post-injection (all injections) and 1 week post-injection (877 injections). Orthopedics referred 92.9% of Group A and 95% of group B injections. Statistical analysis was performed using linear mixed models.

RESULTS
The pre- and 10 minute post-injection mean pain scores (all injections) was 5.5/10 and 1.9/10 for Group A and 5.2/10 and 2.1/10 for Group B. The pre- and 1 week post-injection (877 injections) mean pain scores was 5.7/10 and 3.0/10 for Group A and 5.4/10 and 2.9/10 for Group B. Adjusting for sex, age and pre-pain level, the estimated mean difference in pain reduction between Groups A and B was 0.27 (95% CI: [0.03, 0.51]; p=0.030) 10 minutes post-injection and 0.46 (95% CI: [0.14, 0.78]; p=0.005) 1 week post-injection with greater pain reduction in Group A. Mean fluoro time was 20.5 sec in group A and 13.7 sec in Group B (p CONCLUSION
Patients reported statistically greater pain reduction both 10 minutes and 1 week after therapeutic glenohumeral injections when a higher concentration of Bupivacaine was utilized.

CLINICAL RELEVANCE/APPLICATION
Glenohumeral injections using a higher Bupivacaine concentration provided greater pain relief. However, the actual numeric estimated reduction in pain is small and may not be clinically significant.

Musculoskeletal (Tumor I)

Sunday, 10:45 AM - 12:15 PM • E451B

SSA14 • AMA PRA Category 1 Credit ™:1.5 • ARRT Category A+ Credit:1.5

Moderator
Mark D Murphey, MD

Moderator
Jim S Wu, MD *

SSA14-01 • Diagnostic Performance of Ultrasound Elastography in the Evaluation of Benign and Malignant Soft Tissue Tumors

Se Kyoung Park (Presenter); In Sook Lee; You Seon Song; Jeung Il Kim MD, PhD; Hoon Soo Kim

PURPOSE
To evaluate the diagnostic performance of ultrasound elastography for differentiating malignant from benign soft tissue tumors.

METHOD AND MATERIALS
From December 2012 to March 2013, 52 consecutive patients with soft tissue mass lesions underwent ultrasound including elastography by two musculoskeletal radiologists. One radiologist measured quantitatively the size, elasticity ratio between lesion and normal muscle tissue, the presence or absence of posterior enhancement and vascularity and margin not affected to differentiate between benign and malignant lesions (p < 0.05). Also, the locations of tumors did not affect to the elasticity ratio. By ROC analysis, only the size (AUC, 0.825; SE, 0.0611; 95% confidence interval, 0.694-0.916; p < 0.0001, criterion > 28 mm) was statistically significant.

CONCLUSION
Although the elasticity ratio of the soft tissue mass was not significant, the elasticity score by color pattern was helpful for differentiating between benign and malignant lesions on ultrasound elastography.

CLINICAL RELEVANCE/APPLICATION
The quantitative measurement such as elasticity ratio was not yet useful for differentiating between benign and malignant soft tissue tumors. However, the elasticity score by color pattern was helpful.

SSA14-02 • Cost-effectiveness of Advanced Cross-sectional Imaging in the Work-up of Newly Discovered Soft Tissue Masses

Sahar J Farahani MBBS (Presenter); John Eng MD; Christian Meyer; John A Carrino MD, MPH *; Laura M Fayad MD

PURPOSE
To determine the required accuracy of an advanced imaging modality to be cost-effective over biopsy in the work-up of new soft tissue masses (STMs) that have already undergone a conventional work-up.
SSA14-03  •  Detection of Soft Tissue Sarcoma Recurrence: Added Value of Functional MR Imaging Techniques at 3T

Filippo Del Grande MD, MBA (Presenter); Ty K Subhawong MD; Kristin L Weber MD; Michael R Aro MBBS *; Charles M Mugera MBBCN, HRCR; Laura M Fayad MD

PURPOSE
To define the added value of dynamic contrast-enhanced (DCE-MR) and quantitative diffusion weighted imaging (DWI) with apparent diffusion coefficient (ADC) mapping to detect recurrence of soft tissue sarcomas (STS) after surgical resection.

METHOD AND MATERIALS
The study is HIPPA compliant and approved by our institutional review board. 58 MR patients referred for post-operative surveillance following STS resection were studied with 3 T MR. The MR protocol included: T1-weighted, fluid-sensitive, contrast-enhanced T1-weighted, DCE-MR, and DWI with ADC map. Two readers independently reviewed for signal and morphologic characteristics on conventional sequence, the presence or absence of arterial enhancement by DCE-MR and ADC measurements of the surgical bed. Mass-like signal abnormality on conventional sequences, arterial enhancement by DCE-MR or a low signal mass on ADC maps were defined as recurrence. The readers reviewed first the conventional sequences, second the addition of DCE-MR, and third the DWI/ADC maps. The diagnostic performance of conventional MR for detecting recurrence was compared to that with the addition of functional sequences.

RESULTS
There were eight histologically-proven recurrences out of 58 studies. The sensitivity and specificity of MR for detecting tumor recurrence were 100% and 48.0%, 60.0% and 93.2%, and 100% and 90.7% for conventional sequences, for addition of DCE-MR, and for addition of DWI/ADC mapping, respectively.

CONCLUSION
The addition of functional MR sequences to a routine MR protocol increase specificity over 90%. In particular DCE-MR alone has a discrimination ability of 95% for distinguishing recurrent sarcoma from post-surgical scarring.

CLINICAL RELEVANCE/APPLICATION
For detecting recurrence, the improved specificity offered by functional sequences has the potential to reduce unnecessary biopsies and patient anxiety.

SSA14-04  •  Mural Nodule in a Postoperative Fluid Collection after Soft Tissue Sarcoma Resection at MRI: Not a Sign of Recurrent Tumor

Joshua Lantos MD (Presenter); Sinchun Hwang MD; David M Panicek MD

PURPOSE
To determine the prevalence and clinical significance of nodules within fluid collections at MRI after surgical resection of primary soft tissue tumors.

METHOD AND MATERIALS
This retrospective study includes 175 consecutive patients who underwent resection of primary soft tissue sarcoma at a tertiary cancer center and showed fluid collections at least 1 cm in largest diameter in the surgical bed at postoperative MRI. Images were reviewed to determine the presence of nodules within the collections, defined as a well-defined focus measuring at least 0.7 cm on T1-weighted and fluid-sensitive images. Collections were classified based on signal intensity (homogeneous, heterogeneous), and the presence of septa, blood products (hyperintense T1 signal), and rim (thin, thick, enhancing). The size, signal intensity, and contrast enhancement of nodules were reviewed. Nodules were classified as benign or malignant based on histologic results, or clinical or MRI follow-up.

RESULTS
Collections were present in 75 patients (43%). 43 collections showed homogeneous fluid intensity (57.3%) and 32 were heterogeneous (42.6%). Internal septa were present in 49 (65.3%) and blood products in 16 (21.3%). The majority of collections showed a thin rim (66.6%) and rim enhancement (90.6%). Nodules were present inside six (8%) collections. All collections that contained nodules were heterogeneous, and half showed an enhancing rim. Three (50%) nodules enhanced and two (33%) were T1-hyperintense. At follow-up MRI, three nodules resolved, two were stable in size, and one decreased in size. Nodules in two patients were biopsied, and surgically resected in another; all three nodules were benign. Two other patients had no recurrence at clinical or imaging follow-up, and another died within three months from metastases.

CONCLUSION
Nodules infrequently develop within a fluid collection at MRI after surgical resection of a primary soft tissue sarcoma, and are unlikely to represent local tumor recurrence.

CLINICAL RELEVANCE/APPLICATION
A nodule within a postoperative fluid collection at MRI after soft tissue sarcoma resection generally does not represent tumor recurrence; follow-up MRI is recommended rather than immediate biopsy.

SSA14-05  •  Magnetic Resonance Imaging of Incompletely Excised Soft Tissue Sarcomas

Anna McNaught MBBS (Presenter); Ali M Naraghi; Ravi Menezes PhD; Bader Alhariqi; Peter C Ferguson MD; Jay Wunder MD; Lawrence M White MD *

PURPOSE
A decision analytic model was developed to estimate quality-adjusted-life (QALY) and costs associated with biopsy and advanced imaging (such as MR spectroscopy) in differentiating between malignant and benign STMs for the first five years after diagnosis. The model incorporated prevalence of malignant and benign STMs at the community level, the performance characteristics of the imaging modality of choice, 1-5 year overall survival rate for the different stages at the time of diagnosis, and costs and effectiveness associated with each strategy. A discount rate of 3% was considered. An incremental cost per QALY gained was compared between two strategies. One-way sensitivity analysis was performed to evaluate the stability of the model to change in the clinically-plausible range for all the variables. Threshold analysis was used to determine the performance characteristic of the imaging tool, which could justify its utilization regarding costs and effectiveness instead of biopsy.

RESULTS
Considering a malignancy prevalence of 0.01 and sensitivity and specificity of 95% and 82% for the imaging modality, we ran a Monte Carlo model 10000 times. The results demonstrated that the incremental cost for one QALY gained by advanced imaging was $776, whereas by biopsy, was $1472. Threshold analysis revealed a required sensitivity of 83% and specificity of 75% for justifying advanced imaging over biopsy. One-way sensitivity analysis showed the model is stable to change in a clinically plausible range for the other variables.

CONCLUSION
For the work-up of new STMs, advanced imaging is a cost-effective non-invasive alternative to biopsy.

CLINICAL RELEVANCE/APPLICATION
Benign STMs present to Orthopaedic clinics 100 times more commonly than malignant STMs and are often unnecessarily referred for biopsy. Decision analysis proves the value of advanced imaging as the in
The aim of this study was to assess the utility of MRI in identifying the presence of residual disease in incompletely excised soft tissue sarcomas.

METHOD AND MATERIALS
Following IRB approval, 315 consecutive cases of incomplete excision of soft tissue sarcoma were identified from a surgical database. 237 patients with a positive margin at initial surgery who underwent MRI prior to re-excision were included. Two MSK radiologists, blinded to the final pathological finding at re-operation reviewed all MRIs in consensus. Pulse sequences varied but included axial and longitudinal T1 and fat suppressed fluid sensitive images in all cases. Post-gadolinium T1 fat-suppressed images were available in some. Imaging features evaluated included lesion morphology, location, fascial penetration, signal characteristics and enhancement. An overall consensus prediction was made regarding the presence of residual disease. The individual findings and the overall prediction were compared to the final pathology.

RESULTS
There were 98 females and 139 males with an average age of 55 years (range 17-89). The pathological diagnosis was malignant fibrous histiocytoma (n=67), leiomyosarcoma (n=47) and liposarcoma (28). The remaining 96 patients had undifferentiated sarcomas or rare subtypes. 120 patients had residual disease, 48 with microscopic foci and 72 with macroscopic foci greater than 10 mm in diameter. 117 patients had no residual disease on pathology. MRI had a sensitivity of 60%, specificity of 91%, PPV of 87% and NPV of 69%. When a mass was present on pathology, MRI had a high sensitivity (88%) and specificity (88%) and a high NPV (94%). There was a poor sensitivity (19%) in detection of microscopic residual disease.

82 lesions revealed 40 plaque and 42 reticular morphology. The presence of a nodule had a high specificity (89%) and PPV (84%) but a low sensitivity (58%). Plaque and reticular morphology had low sensitivities and predictive values.

CONCLUSION
MRI performs poorly in identifying those with microscopic disease but has a better performance in the presence of macroscopic disease. The presence of a nodule is the most specific morphologic predictor of residual disease.

CLINICAL RELEVANCE/APPLICATION
Many soft tissue sarcomas have positive margins at initial surgery. MRI is the modality of choice for re-evaluation. Further investigation of its utility in predicting disease is of value.

SSA14-06 • Comparison of 3T Diffusion-weighted MR Imaging and PET/CT in Bone and Soft Tissue Tumors: Quantitative Analysis of ADC and SUV

So-Yeon Lee MD (Presenter); Won-Hee Jee MD; Ie Ryung Yoo; Joon-Yong Jung MD; Yang-Guk Chung MD

PURPOSE
To retrospectively determine whether the apparent diffusion coefficients (ADC) on 3T diffusion-weighted magnetic resonance imaging (DWI) correlate with the standardized uptake values (SUV) on positron emission tomography (PET)/computed tomography (CT) in bone and soft tissue tumors.

METHOD AND MATERIALS
The institutional review board approved this HIPAA-compliant study, and informed consent was waived. This study included 45 patients (30 men, 15 women, mean age 57 years, range 17-90) with pathologically confirmed soft tissue (n = 34) and bone (n = 15) tumors who underwent 3T MRI imaging including DWI and whole-body fluorine-18 fluorodeoxyglucose PET/CT before treatment. Maximum (SUVMAX) and average (SUVAV) SUVs of the tumors were obtained by one nuclear medicine physician. Two musculoskeletal radiologists independently measured minimum (ADCmin) and average (ADCav) ADCs of tumors on the corresponding regions of the tumors where SUVs were obtained. ADC (ADCmus) of normal skeletal muscle was measured on the same axial plane. The ratios ADCmin/ADCmus and ADCav/ADCmus were calculated by ADCmin and ADCav of tumors divided by ADCmus, respectively. The Spearman rank correlation was obtained for statistical analysis. The differences in areas under the receiver operating characteristic curves (AUCs) were assessed.

RESULTS
There was significant, inverse correlation between SUVMAX and the ratio ADCmin/ADCmus (r = -0.435 for reviewer 1 and r = -0.449 for reviewer 2, respectively, P < .005). SUVAV and ADCav/ADCmus showed significant, inverse correlations (r = -0.44 for reader 1 and r = -0.440 for reviewer 2, respectively, P < .005). The AUCs of ADCmin/ADCmus and ADCav/ADCmus (0.955 for reviewer 1, 0.959 for reviewer 2, respectively) were significantly higher than those of SUVMAX and SUVAV (0.820 and 0.777, respectively) (P < .05).

CONCLUSION
There was significant correlation between ADC at 3T DWI and SUV at PET/CT in bone and soft tissue tumors and DWI showed better diagnostic performance than PET/CT for diagnosing malignancy.

CLINICAL RELEVANCE/APPLICATION
Quantitative DWI at 3T is comparable to PET/CT for evaluating bone and soft tissue tumors.

SSA14-07 • Dynamic Contrast Enhanced (DCE) Targeted MR-guided Biopsy of Soft Tissue Tumors at 3Tesla: Feasibility, Preliminary Results on Accuracy, and Correlation with Diffusion Weighted Imaging (DWI), and Multivoxel 1H-MR Spectroscopy (1H-MRS)

Iris-Melanie Noebauer-HuHmann MD (Presenter); Gabriele Amann MD; Martin Krssak PhD; Joannis Panotopoulos MD; Christian Czerny MD; Siegfried Trattnig MD

PURPOSE
To test the dynamic contrast enhanced (DCE) sequence of soft tissue tumor staging MR for intralesional targeting with subsequent minimally MR-guided biopsy at 3T, and to compare DCE hotspots with diffusion-weighted imaging (DWI) and multivoxel 1H-MR spectroscopy (1H-MRS).

METHOD AND MATERIALS
Fifty-six patients with suspected soft tissue tumors prospectively underwent preoperative staging MR with subsequent MR-guided core needle biopsy at 3T after written informed consent, according to Institutional review board approval. Surgical histology available in 54 patients revealed 53 soft tissue tumors (29m, 24f, mean age 54 years, range 19-90). DCE was conducted in 50/53 patients (contrast agents: Gd-BOPTA, Gd-DOTA, and Gd-DO3A-butil), DWI-MSh FH in 51/53 patients, and 1H-MRS in 37/53 patients. Matching of the most suspicious regions in DWI and 1H-MRS with DCE results was assessed.

RESULTS
DCE was heterogeneous in 42 cases, including all malignant tumors. In 2 cases, DWI was additionally used for targeting. In 6 cases appearing homogeneous on all sequences, biopsy was taken arbitrarily. 3 small lesions required no region selection. Diagnostic yield was 98.1% (52/53). The accuracy rates of biopsy were 100% (52/52) in predicting the dignity, 96.2% for definitive tissue diagnosis, and 92.3% for grade. DCE matched with preselected DWI regions in 87.5%, and with 1H-MRS in all assessable regions. The diffusion weighted sequence was of limited value for the selection of the biopsy area. Spectroscopy could be compared with the DCE target region in 23/37 patients only. Area match of 1H-MRS with the hotspots revealed by DCE was observed in all assessable cases, but, due to technical restraints, tumor coverage was not possible by 1H-MRS in feasible examination time.

CONCLUSION
Our preliminary study indicates, that biopsy of soft tissue tumors can be performed accurately and safely by DCE targeted MR-guidance at 3T, using the DCE staging sequence in combined staging/biopsy MRI in outpatients. DWI was of limited value. 1H-MRS results were promising, but the method cannot be recommended for biopsy targeting in its present form.
SSA14-08 • Preoperative Tractography Assessment of the Anatomic Relationship between Peripheral Nerve Sheath Tumors and Fibers within the Nerve of Origin Correlate with Intraoperative Findings

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PURPOSE
Magnetic resonance neurography (MRN) is an emerging tool for anatomic depiction of nerves and their pathology. To investigate the preoperative utility of MRN, including diffusion tensor tractography, we compared MRN findings to intraoperative findings and histopathology in 7 patients.

METHOD AND MATERIALS
Seven patients (ages 24-69 years) with a clinical/imaging diagnosis of peripheral nerve sheath tumor were referred by neurosurgeons for MRN at our institution in 2011-2013 and subsequently underwent surgical resection. Preoperative DTI was performed with 28 directions, and tractography was performed by placing seed points along the peripheral nerve proximal and distal to the mass, using FA minimum threshold of 0.18 and maximum turning angle threshold of 45°. The neuroradiologist and surgeon used the following categorical rating system to assess the spatial relationship of the dominant location of most of the peripheral nerve fibers relative to the mass: fibers predominantly anterior-1, medial-2, posterior-3, lateral-4, anterior and medial-5, posterior and medial-6, posterior and lateral-7, anterior and lateral-8. We calculated Cohen's kappa for agreement between neuroradiologist assessment of MRN tractograms and operative findings.

RESULTS
Seven resected masses consisted of 6 schwannomas (including 2 cellular schwannomas) and one neurofibroma. ADC within the solid portion of the masses was 1.9+/-0.8 x 10⁻³ mm²/sec (mean+/-SD), consistent with prior reports of relatively higher ADC within benign tumors. Six of seven cases were concordant for nerve fibers predominantly along the posterior and medial margins (n = 4), posterior margin (n = 1), or anterior and medial (n = 1) margins of the tumor. The discrepant case was interpreted as predominantly dorsal fibers on the MRN, with operative findings indicating both dorsal and medial fibers. Cohen's kappa for agreement between neuroradiologist and intraoperative findings was 0.73 (p = 0.006).

CONCLUSION
In the setting of nerve sheath tumors planned for resection, DTI tractography may be useful preoperatively to assess the spatial relationships of tumor to fibers within the nerve of origin and thereby reduce the risk of causing a functional deficit during surgery.

CLINICAL RELEVANCE/APPLICATION
This study is the first to demonstrate the application of DTI tractography in preoperative characterization of the relationship of peripheral nerve sheath tumors to fibers within the nerve of origin.

SSA14-09 • Differential MRI Diagnosis between Benign and Malignant Bone or Soft Tissue Tumors Using Dynamic Contrast-enhanced and Diffusion-Weighted Images

In Sook Lee (Presenter); You Seon Song; Se Kyoung Park; Jeung Il Kim MD, PhD; Hak Jin Kim MD; Jong Woon Song

PURPOSE
to evaluate the diagnostic performance of dynamic contrast-enhanced (DCE) and diffusion-weighted (DW) MR images for differentiation between benign and malignant bone or soft tissue tumors

METHOD AND MATERIALS
Forty-two patients with bone or soft tissue masses prospectively performed DCE and DW MR examinations addition to routine protocols. On DCE images using tissue 4D perfusion software, Ktrans (transfer constant), Kep (rate constant), Ve (volume fraction), and iAUC (initial area under curve) were calculated from quantitative analysis. Also, the graphs of VOI (volume of interest) about whole mass and region-of-interest (ROI) within the mass were automatically obtained. The types of graphs were classified into five. On DW and apparent diffusion coefficient (ADC) images, ROIs of masses were measured.

RESULTS
Twenty-three patients had benign tumors and nineteen had malignant tumors. The mean values of Ktrans, Kep, Ve, iAUC, and ROI in benign tumors were 0.0596, 0.308, 0.251, 3.761, and 1.801 respectively. Those in malignant tumors were 0.157, 0.476, 0.298, 10.471, and 1.801 respectively. Ktrans, iAUC and ROI values were statistically significant (p < 0.05) for differentiating benign and malignant tumors. By ROC curve analyses, Ktrans (AUC, 0.8; standard error (SE), 0.0696; 95% confidence interval (CI), 0.648-0.907; p < 0.0001, criterion > 0.117), ROI value on ADC (AUC, 1; SE, 0; 95% CI, 0.685-0.929; p < 0.0001, criterion = 0.97), Kep (AUC, 0.745; SE, 0.0779; 95% CI, 0.518-0.976; p = 0.0016, criterion > 0.287) and iAUC (AUC, 0.832; SE, 0.0632; 95% CI, 0.685-0.929; p < 0.0001, criterion > 4.908) were significant.

CONCLUSION
Ktrans, representing permeability into the extracellular space from blood plasma and contrast delivery (perfusion) on DCE images and ADC values were helpful for differentiating between benign and malignant bone or soft tissue tumors, quantitatively and semi-quantitatively.
Labyrinthitis ossificans (LO) is a pathologic process involving ossification of the membranous labyrinth leading to hearing loss. Prior studies describe multiple causes of LO including infection, inflammation, trauma, surgery, and hematologic etiologies. However, no prior study describes specific ossification patterns using CT scans of patients with LO.

METHOD AND MATERIALS

Patients with prior temporal bone CT scans acquired using a zUHR protocol who received a follow-up scan using the UHR+IR technique were identified. Left and right side of temporal bone images were reconstructed in axial, coronal and Poschl planes. Spatial resolution was evaluated independently by 3 neuroradiologists with focus on the following structures: round and oval windows, incudomallear joint, incudostapedial joint, spiral lamina in the basal turn, and scutum. The zUHR and UHR+IR images were displayed side by side, with the order randomized and blinded to the readers. The following grading scale was applied to the UHR+IR images (relative to the zUHR images): 1=slightly inferior resolution, degrades visualization, 2=slightly inferior resolution, not affect visualization, 3=equivalent, 4=slightly superior resolution, not affect visualization, 5=superior resolution, improves visualization. Image noise was measured in regions of interest over the posterior fossa and compared.

RESULTS

Eight patients with 16 sets (left and right side) of temporal bones were identified, of which 3 sets were excluded due to surgery between the two exams (13 left). The average scores across readers for spatial resolution on the UHR+IR images compared to zUHR were 3.4, 3.5, and 2.9 in the axial, coronal and Poschl planes, respectively, indicating comparable or slightly better spatial resolution using the UHR+IR technique. Wilcoxon signed-rank test showed significant differences (p<0.05) between the two exam sets in the same reader.

CLINICAL RELEVANCE/APPLICATION

Substantial dose reduction can likely be achieved for temporal bone CT imaging using the investigated combined UHR+IR technique.

SSA15-02 • The Dehiscent Bony Wall of Dural Sinus in Patients Presenting with Pulsatile Tinnitus: The Evaluation with CT Angiography and Venography

Pengfei Zhao MD (Presenter) ; Zhenchang Wang MD, PhD ; Junfang Xian MD ; Fei Yan ; Zhaohui Liu MD ; Hong Jiang MD ; Cheng Dong ; Han LV ; Xiaoyi Han

PURPOSE

To assess the imaging characteristics about dehiscent wall of dura sinus in patients presenting with pulsatile tinnitus (PT) on CT angiography and venography (CTA+V).

METHOD AND MATERIALS

Following approval of the institutional review board, we reviewed all hospitalized patients with PT from 2008 to 2013 who underwent thorough clinical and laboratory tests, including otomicroscopic and audiometric evaluations, CTA+V and DSA. Finally, 13 patients diagnosed with the dehiscent bony wall of dural sinus as the causative finding and cured by surgical reconstruction were enrolled. CTA+V images were blindly evaluated by 2 experienced neuroradiologists for the location, extent and amount of the bony dehiscence as well as the presence of arachnoid granulation, dominant venous system and high jugular bulb.

RESULTS

CONCLUSION

The dehiscence of dural sinus inducing PT mostly manifests as single defect of bony wall, involves the dominant side of venous system and the lateral wall of the dural sinus, coexists with a large arachnoid granulation beneath the transverse sinus and the high jugular bulb.

CLINICAL RELEVANCE/APPLICATION

This paper is about a new curable cause of PT. Our results benefit the intra-operative localization of the bony dehiscence of dural sinus so as to eliminate the symptom with less damage.
RESULTS
Of the 34 patients with LO: 19 patients had local infection/inflammation or surgery, 6 had history of meningitis, 4 had sickle cell disease, and 5 had other etiologies. Overall, the lateral semicircular canal had the highest degree of ossification and the vestibule had the least. In cases of local infection/inflammation all of the semicircular canals were most severely affected followed by the basal cochlea, middle cochlea, apical cochlea, and lastly, the vestibule. In cases of meningitis, the posterior and superior semicircular canals were most affected followed by the middle cochlea, apical cochlea, basal cochlea, lateral semicircular canal, and lastly, the vestibule. In cases of SCD, the lateral semicircular canal was most severely affected, then followed by the other structures in the membranous labyrinth with an equal distribution.

CONCLUSION
LO results in specific patterns of membranous labyrinth involvement. Overall, the lateral semicircular canals were most severely affected and the vestibules were the least affected. Different causes of LO may result in different ossification patterns.

CLINICAL RELEVANCE/APPLICATION
Etiology specific patterns of ossification appear to occur in LO. These findings may identify an underlying cause or predict progression of ossification in patients with labyrinthitis ossificans.

SSA15-05 • MR Imaging of Inner Ear Endo-perilymphatic Spaces at 3 Tesla after Intratympanic Contrast Agent Administration in Definite Meniere’s Disease

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PURPOSE
MRI findings in Meniere’s disease are not yet defined. The purpose of this study was to determine the main findings of endo-perilymphatic spaces in patients affected by Definite Meniere’s disease using Magnetic Resonance Imaging (MRI) with intratympanic administration of contrast agent.

METHOD AND MATERIALS
Twelve patients with Definite Meniere’s disease underwent 3 Tesla MRI. 3D FLAIR and 3D T2 SE sequences were acquired 24 hours after intratympanic administration of 0.4-0.5 ml of gadobutrol diluted eightfold with saline. Contrast agent was injected through the tympanic membrane with a 25 G needle. Multi Planar Reconstructed (MPR) images were analyzed. According to literature, vestibular endolymphatic hydrops was graded considering the ratio of the area of the endolymphatic space to the vestibular fluid space (sum of the endolymphatic space and perilymphatic space). Patients with no hydrops had a ratio of one third or less, those with mild hydrops had between one-third and a half and those with severe hydrops had a ratio of more than 50%. Cochlear and semicircular canals endolymphatic hydrops was defined as positive when a MRI signal void was detected.

RESULTS
No adverse events due to contrast agent administration were observed. Three patients didn’t show perilymphematic enhancement thereby they were not considered for data analysis. Vestibular endolymphatic hydrops was observed in 100% of patients and it was severe in 7 out of 9 patients and mild in 2 out of 9. Whereas posterior semicircular canal endolymphatic hydrops was observed only in 5 out of 9 patients; lateral and superior semicircular canals endolymphatic hydrops was observed only in 4 out of 9 patients; cochlear endolymphatic hydrops was observed only in 5 out of 9 patients.

CONCLUSION
Our study confirms that endolymphatic hydrops can be detected at 3T MR images after intratympanic contrast agent administration and is the main finding in patients with Definite Meniere’s disease. Moreover, our preliminary results seem to suggest that endolymphatic hydrops may affect more often the vestibule than cochlea or semicircular canals.

CLINICAL RELEVANCE/APPLICATION
3T MRI with intratympanic administration of contrast agent might open the door to objective evaluation of endolymphatic space and reveal Meniere’s disease pathophysiology improving diagnostic efficacy.

SSA15-06 • Correlation of Ear Symptoms with Increased Cochlear Fluid-attenuated Inversion Recovery Signal in Patients with Acoustic Neuroma

Dae Yoon Kim (Presenter); Jeong Hyun Lee MD, PhD; Won-Jung Chung; Young Jun Choi MD; Sohyun Jo; Jung Hwan Baek; Ka-Gyoung Yoon MD

PURPOSE
It is well-known that cochlear fluid-attenuated inversion recovery (FLAIR) signal is increased in patients with acoustic neuroma (AN). The purpose of this study was to investigate if cochlear FLAIR signal in patients with AN correlates with ear symptoms or audiometric findings, and if there is any difference in the cochlear signal according to the extent of AN in a large series.

METHOD AND MATERIALS
This retrospective study enrolled 102 patients with surgically confirmed or radiologically diagnosed AN from 2008 to 2012. There were 22 patients (M: F = 10: 12; mean age: 50 ± 13.2 years) with AN confined to the internal auditory canal (AN IAC) and 80 (M: F = 48: 32; mean age: 49.9 ± 12.3 years) with AN located in the cerebellopontine angle cistern as well as in the IAC (AN CPA). We quantitatively measured the signal intensity (SI) of the entire volume of the cochlea on the affected side by placing ROIs semi-automatically drawn on 3D T2-FLAIR images of the same slices. We compared the SI ratios (rSI) of the cochlea to the brainstem with ear symptoms including tinnitus, hearing disturbance or vertigo and with the audiometric findings in AN IAC and AN CPA patients, respectively.

RESULTS
The rSI of the cochlea was positively correlated with the audiometric findings in AN IAC (r = 0.471; p = 0.027), but showed no correlation in AN CPA (p = 0.427). The rSI of the cochlea was significantly higher with the presence of hearing disturbance or tinnitus only in patients with AN IAC (p = 0.001 and p = 0.004, respectively). There was no correlation between the rSI of the cochlea and the presence of hearing disturbance or tinnitus in patients with AN CPA (p = 0.600 and p = 0.506, respectively). Both AN IAC and AN CPA did not show any difference of the rSI of the cochlea whether they had vertigo or not (p = 0.082, p = 0.782, respectively).

CONCLUSION
Cochlear FLAIR signal is significantly higher with the presence of hearing disturbance or tinnitus and shows positive correlation with the audiometric findings only in patients with AN limited to the IAC.

CLINICAL RELEVANCE/APPLICATION
The results of this study suggest that functional evaluation of the cochlea could be possible with FLAIR images in patients with acoustic neuroma limited to the IAC.

SSA15-07 • Imaging of the Inner Ear in Menière’s Disease: Round and Oval Window Pathology as Possible Influential Factors for Restricted Contrast Medium Permeability

Wilhelm H Flatz MD (Presenter); Robert Guerkov; Maximilian F Reiser MD; Birgit B Ertl-Wagner MD *

PURPOSE
To prospectively evaluate MRI- and CT-findings of the temporal bone, including the middle and inner ear as well as adjacent soft tissue, as potential causes for restricted diffusion of Gad-DTPA into the inner ear.

METHOD AND MATERIALS
We retrospectively evaluated 32 patients with suspected Ménière’s disease who underwent both multislice-CT- and locally enhanced MR
imaging of the temporal bone. 24 hours prior to the MRI-scan intratympanic gad-DTPA was administered. In addition to structural MR-imaging of the brain, CISS-, FLAIR- and IQ-sequences of the temporal bone were acquired on a 3 T MR scanner using a 32 channel head coil. Slice thickness of FLAIR- and IR-images was 0.5 mm and 0.6 mm respectively. Signal intensities of the endolymphatic spaces of the basal turn of the cochlea were evaluated using ROI-based analysis. CT images were reviewed by two blinded radiologists with regard to temporal bone pathology including sclerosis of the round and oval window membrane, middle ear findings and soft tissue assessment. Thickening/sclerosis of the round and oval windows membrane were evaluated using a 6-point scale with 1 being no sclerosis and 6 high grade sclerosis.

RESULTS
In 9 respectively 13 patients CT-analysis of the round window respectively oval window was not possible due to acquired slice thickness. 11 of 19 patients demonstrated sclerotic changes of the oval window (grades 2 to 6). 8 of 23 patients showed sclerotic changes of the round window (grade 2 to 6). Significant differences were observed between measured signal intensities of perilymphatic spaces of the basal turn of the cochlea and degree of oval window sclerosis (P=0.0143), but not between sclerotic changes of the round window and signal intensities of the endolymphatic spaces of the basal turn of the cochlea.

CONCLUSION
Sclerotic changes of the oval window may be responsible for a restricted diffusion of contrast medium from the middle ear into the inner ear.

CLINICAL RELEVANCE/APPLICATION
Sclerotic changes of the oval window may be responsible for a restricted diffusion of a whole variety of substances from the middle ear into the inner ear, including therapeutic agents.

SSA15-08 • Volumetric Assessment of the Membranous Vestibular System in Patients Presenting with Vertigo

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PURPOSE
To assess the volume of membranous vestibular system in patients presenting with vertigo and to compare the volume with the vestibular system volume in patients with normal vestibular function using three dimensional (3D) reconstruction of the high resolution MR-Imaging sequences.

METHOD AND MATERIALS
The study was retrospectively performed on 153 patients (74 females and 79 males) with a mean age of 48.9 year (standard deviation: 25.4, range: 5 month - 88 year). Of the 153 patients 61 patients presented with vertigo and 92 patients presented with other diseases of the ear and normal vestibular function. High resolution MR-Imaging was performed using a T2-weighted SPACE sequence with 0.6 mm slice thickness. 3D reconstructions were performed using Advantage Workstation for diagnostic imaging. Assessed were the volumes of the semicircular canals and the volume of vestibule. The difference between the volumes in patients with and without vertigo (normal vestibular function) was tested using the Two-Sample t-Test.

RESULTS
Three dimensional reconstructions were successfully performed in all patients. In patients with vertigo the mean volume of the semicircular canals was 0.258 mm³ (SD: 0.061, Range: 0.130 - 0.430 mm³) and the mean volume of the vestibule was 0.069 mm³ (SD: 0.013, Range: 0.040 - 0.110 mm³). In patients with no vertigo (normal vestibular function) the mean volume of the semicircular canals was 0.306 mm³ (SD: 0.074, Range: 0.180 - 0.550 mm³) and the mean volume of the vestibule was 0.075 mm³ (SD: 0.016, Range: 0.040 - 0.13 mm³). There was a statistically significant difference between the semicircular canal volume and the vestibular volume in patients with and without vertigo (normal vestibular function) (p < 0.001 and p = 0.019 respectively).

CONCLUSION
Patients presenting with vertigo show a statistically significant smaller volume of the semicircular canals and vestibule compared to patients not presenting with vestibular dysfunction or vertigo.

CLINICAL RELEVANCE/APPLICATION
A reduced volume of the membranous vestibular system might be the reason for vertigo symptomatic in patients presenting with vertigo.

SSA15-09 • New Grading System for Patients with Congenital Aural Atresia Scheduled for Active Middle Ear Implants

Henning Frenzel MD, PhD (Presenter) ; Gerlig Widmann ; Dirk Petersen MD ; Barbara Wollenberg ; Christian Mohr MD

PURPOSE
Active middle ear implants (aMEI) are being increasingly used for hearing restoration in congenital aural atresia. The existing gradings used for CT findings do not meet the requirements for these implants. Some items are expendable, whereas other important imaging factors are missing. We aimed to create a new grading system that could describe the extent of the malformation and predict the viability and challenges of implanting an aMEI as well as the hearing outcome.

METHOD AND MATERIALS
103 malformed ears were evaluated using HRCT of the temporal bone. The qualitative items middle ear and mastoid pneumatization, oval window, stapes, round window, tegmen mastoiditum displacement and facial nerve displacement were included. An anterior- and posterior round window corridor, oval window and stapes corridor were quantified and novelly included. They describe the size of the surgical field and the sight towards the windows. 35 ears were implanted and evaluated for hearing outcome.

RESULTS
The ears were graded on a 16-point scale (16-13 easy, 12-9 moderate, 8-5 difficult, 4-0 high risk). The strength of agreement between the calculated score and the performed implantations with regard to the level of difficulty of the implantation was good. The comparison of the new 16-point scale with the Jahrsdoerfer score showed that both were able to conclusively detect the high-risk group; however the new 16-point scale was able to further determine which malformed ears were favorable for aMEI, which the Jahrsdoerfer score could not do. There was no correlation between the new 16-point scale and the hearing outcome using stapes attachment. The round window attachment in difficult cases may lead to inferior results.

CONCLUSION
The Active Middle Ear Implant Score for Aural Atresia (aMEI-score) allows more precise risk stratification and decision making regarding the implantation. The use of operative corridors seems to have significantly better prognostic accuracy than the Jahrsdoerfer score. The hearing outcome does not rely on the severity of deformation, once a successful coupling of the implant is achieved. The aMEI-score represents the likelihood of achieving a successful implantation.

CLINICAL RELEVANCE/APPLICATION
The Active Middle Ear Implant Score for Aural Atresia (aMEI-score) satisfies the new requirements for diagnostic imaging of congenital aural atresia with regard to active middle ear implants.
SSA16-01 • Dose and Image Quality in the CT Neck Using Automated Selection of Tube Potential

Boris Bodelle MD (Presenter) ; Martin Beeres MD ; Sebastian Scheithauer ; Claudia Frelesen ; Boris Schulz MD ; Firas Al-Butmeh ; Nagy N Naguib MSc ; Ralf W Bauer MD * ; Thomas Lehnet MD ; Thomas J Vogl MD, PhD

PURPOSE
To investigate the impact of automatic attenuation-based tube potential selection on image quality and radiation dose in patients undergoing CT of the neck.

METHOD AND MATERIALS
360 patients [median age 52 years (range 4–89)] underwent 128-slice CT of the neck. First group (n=40) was examined with fixed 120 kV with 180 ref.mAs and automated exposure control (AEC) modulating only mAs output. The second group (n=320) underwent CT with AEC and topogram-based automated tube potential selection (Care-kV) by the scanner software with either 80 kV/406 ref.mAs, 100 kV/223 ref.mAs, 120 kV/180 ref.mAs or 140 kV/125 ref.mAs. CTDIvol, DLP, BMI, organ enhancement, image noise, SNR and subjective diagnostic image quality (5-point scale, 2 readers in consensus) were compared between the groups and sub-groups using Mann-Whitney-U test and Cohen’s weighted kappa analysis for inter-observer agreement.

RESULTS
100 kV was automatically selected in 279 patients, 120 kV in 40 patients and 80 kV in 1 patient of the Care-kV group. Patients mean BMI (20 kg/m² at 80 kV, 24.2 kg/m² at 100 kV and 28.1 kg/m² at 120 kV) increased with higher kV settings. The average CTDIvol (9.7 vs. 12.2 mGy) and DLP (255 vs. 342 mGycm; p < 0.05) in the entire Care-kV group were 20%/25% lower than in group 1 with fixed 120 kV. This effect was even more pronounced in the patients in whom 100 kV was selected (CTDIvol 8.9 mGy, 27%; DLP 244 mGycm, 29%). Organ enhancement increased with lower kV, while image noise and SNR were at a stable level. Subjective diagnostic image quality (4.61 vs. 4.56, p>0.05) were not rated significantly different with a good interobserver agreement for all tube potential levels (k=0.5-0.8).

CONCLUSION
Software-based automated selection of the tube potential allows for significant dose savings in CT of the neck while image quality is maintained or even improved.

CLINICAL RELEVANCE/APPLICATION
Automated selection of tube potential in CT of the neck allows significant dose reduction and preserves image quality, which is relevant for staging patients with lymphoma or head and neck cancer.

SSA16-02 • Metal Artefact Reduction from Dental Hardware in Carotid CT Angiography Using Iterative Reconstructions

Fabian Morsbach (Presenter) ; Moritz Wurnig ; Andreas Krauss PhD * ; Bernhard Schmidt PhD * ; Spyros S Kollias MD ; Hatem Alkadhi MD

PURPOSE
To determine the value of a metal artefact reduction (MAR) algorithm with iterative reconstructions for dental hardware in carotid CT angiography.

METHOD AND MATERIALS
Twenty-four patients (6 female, mean age 70±12 years) with dental hardware undergoing carotid CT angiography were included. Datasets were reconstructed with filtered back projection (FBP) and using a MAR algorithm employing normalization and an iterative frequency-split (IFS) approach. Three blinded, independent readers measured CT attenuation values and evaluated image quality and degrees of artefacts using axial images, multi-planar reformations (MPR), and maximal intensity projections (MIP) of the carotid arteries.

RESULTS
CT attenuation values of the internal carotid artery on images with metal artefacts were significantly higher in FBP (324±104HU) datasets as compared to those reconstructed with IFS (278±114HU); P

CONCLUSION
The MAR algorithm with the IFS approach allowed for a significant reduction of artefacts from dental hardware in carotid CT angiography, hereby increasing image quality and improving the accuracy of CT attenuation measurements.

CLINICAL RELEVANCE/APPLICATION
Metal artefact reduction with an iterative frequency split approach can be used to increase diagnostic confidence in carotid CT angiography.

SSA16-03 • Variations in Carotid Bifurcation Geometry by MRI Are Associated with Carotid Atherosclerosis in Asymptomatic Individuals

Christopher Maroules MD (Presenter) ; Kevin S King MD ; Colby Ayers MS ; Ronald M Peshock MD ; Jarett Berry MD

PURPOSE
To investigate the relationship between objective measures of carotid bifurcation geometry and carotid atherosclerosis within asymptomatic individuals using MRI.

METHOD AND MATERIALS
We included 80 participants from the Dallas Heart Study (mean age 53 ± 9 years, 46% females) free of cardiovascular disease who underwent multi-sequence MRI of the distal common carotid artery (CCA), carotid bulb, and proximal internal and external carotid arteries (ICA and ECA, respectively) at 3 Tesla. Semiautomated techniques were used to define vessel wall contours, lipid-rich necrotic core (LRNC) volume, and the 3D geometry of the carotid bifurcation. We examined associations between carotid artery geometric parameters and both wall thickness and the presence of LRNC using Spearman correlation and multivariable logistic regression.

RESULTS
LRNC was identified in 11 participants (13.8%). After controlling for age, sex, hypertension, cigarette smoking, hypercholesterolemia, low high-density lipoprotein, diabetes, and body mass index, LRNC was associated with a lower ICA planarity [OR 95% CI: 13.3 (1.8-100.0) per SD, p=0.01] and a lower ICA/CCA ratio [6.7 (1.1-33.3) per SD, p=0.03]. LRNC was not associated with a lower bifurcation angle after multivariable adjustment [OR 95% CI: 2.2 (0.5-9.1) per SD, p=0.3]. Total LRNC volume within the carotid artery correlated with ICA/CCA diameter ratio (r = -0.32, p=0.03). Carotid bulb wall thickness correlated with ECA/CCA diameter ratio (r = -0.49, p

CONCLUSION
Objective geometric measurements of the carotid bifurcation by MRI are associated with carotid atherosclerosis and the presence of lipid rich necrotic core within carotid plaque. These findings support a geometric risk for carotid atherosclerosis.

CLINICAL RELEVANCE/APPLICATION
Variations in carotid bifurcation geometry by MRI are independently associated with carotid atherosclerosis, supporting a ‘geometric risk’ for atherosclerosis.

SSA16-04 • Atherosclerotic Plaque in the Left Carotid Artery Is More Vulnerable than at the Contralateral Side

Mariana Selwaness MD (Presenter) ; Quirijn v Bouwhuijsen ; Albert Hofman MD, PhD ; Oscar H Franco ; Jolanda J Wentzel
PURPOSE
Ischemic cerebrovascular events are most frequently reported in the left hemisphere compared to the right side. Whether this is related to an asymmetry in atherosclerotic plaque frequency and morphology in the carotid arteries is unknown. We investigated plaque distribution and composition in the left and right carotid artery in healthy individuals.

METHOD AND MATERIALS
1501 participants (=45 years) from The Rotterdam Study, a population-based cohort, with atherosclerotic plaque present on carotid ultrasound were selected. We used 1.5T Magnetic Resonance Imaging (MRI) with standard multisequence scanning protocol to assess plaque prevalence, thickness and predominant component: lipid core, intraplaque haemorrhage (IPH), calcification or fibrous tissue. Differences between left and right side were tested using Pearson chi-square test and Generalized Estimating Equations analyses adjusted for age, gender and carotid wall thickness.

RESULTS
Carotid MRI revealed 2775 atherosclerotic plaques, (bilateral 1274; right 76; left 151) corresponding with 5% higher prevalence of unilateral plaques left than right (P<0.01). We found an unequal distribution of atherosclerotic plaque size and composition in the carotid arteries. IPH and fibrous tissue were more frequently observed in the left carotid artery, whereas calcification was more often present in the right. Our findings suggest that the predilection of cerebrovascular disease to the left side may be explained by the vulnerable phenotype of plaques in the left carotid artery.

CLINICAL RELEVANCE/APPLICATION
We show for the first time that left and right plaque composition differ in carotid arteries. Understanding distribution patterns of atherosclerosis is important for stroke recognition and management.

SSA16-05 • Automated Interpretation of Carotid Plaque Composition Identifies High-risk Lesions: A Prospective MRI Study

Daniel S Hippe MS (Presenter) ; Xin Pu ; Hunter R Underhill MD, PhD ; Jie Sun ; William S Kerwin PhD * ; Wei Yu MD ; Yan Song MD, PhD ; Jianming Cai MD ; Xihai Zhao ; J. Kevin Demarco MD * ; Chun Yuan PhD * ; Thomas S HatsuKami MD *

PURPOSE
Carotid MRI is an effective modality for quantifying atherosclerotic plaque composition and identifying lesions associated with stroke/TIA. However, complexity of manual image interpretation and limited prospective data has hindered translation of carotid MRI into clinical practice. In this study we developed an automated technique for stratifying lesion severity and subsequently conducted a prospective study to determine if the algorithm predicts lesion growth or development of vulnerable features.

METHOD AND MATERIALS
Participants (N=536) from 17 institutions and centers in the US and China were imaged with an established multi-contrast carotid MRI protocol. A histologically-validated segmentation algorithm was applied to the MR images to automatically measure lipid-rich necrotic core (LRNC) and calcification (CA). Associations between manually identified high-risk features (i.e. intraplaque hemorrhage, IPH; and fibrous cap rupture, FCR) and clinical risk factors, plaque morphology, and composition were investigated to develop an optimized, automated carotid atherosclerosis score (ACAS) for stratifying lesion severity. Subsequently, ACAS was evaluated prospectively using an independent cohort of 73 asymptomatic subjects that underwent serial carotid MRI over a 3 year period.

RESULTS
During systematic analysis of potential risk factors, the most effective metric to detect lesions with IPH or FCR was percent size of LRNC (AUC=0.89). This metric was used to define ACAS from low to high risk: 1) LRNC absent; 2) LRNC < 30%; 3) LRNC 30-50%; and 4) LRNC > 50%. Applied prospectively, ACAS was associated with new FCR (AUC=0.84, p=0.1).

CONCLUSION
Automated plaque interpretation is an effective technique for stratifying lesion severity that predicts lesion growth and development of FCR and a key risk factor associated with stroke/TIA. Automated plaque analysis is expected to simplify carotid MRI interpretation, enabling the translation to clinical practice for improved management of patients with carotid atherosclerotic disease regardless of stenotic severity.

CLINICAL RELEVANCE/APPLICATION
The automated plaque interpretation technique developed is predictive of carotid plaque growth and fibrous cap rupture so utilization may improve management of patients over carotid stenosis alone.

SSA16-06 • Analysis of Association between Carotid Artery Plaque Volume and Cerebral Microbleeds

Luca Saba MD (Presenter) ; Michele Anzidei MD ; Lorenzo Mannelli MD, PhD ; Jasjit S Suri ; Michele Di Martino ; Mario Piga

PURPOSE
Cerebral microbleeds (CMBs), have become increasingly recognised with the widespread use of MRI techniques that are sensitive to iron deposits. The purpose of this work was to explore the association between carotid plaque volume (total and the sub-components) and CMBs.

METHOD AND MATERIALS
72 consecutive (males 53; median age 64) patients were prospectively analyzed. Carotid arteries were studied by using a 16-detector row CT scanner whereas brain was explored with a 1.5 Tesla system. CMBs were studied using a T2*-weighted gradient-recalled echo (GRE) sequence. Microbleeds were classified as absent (grade 1), mild (grade 2; total number of microbleeds, 1-5), moderate (grade 3; total number of microbleeds, 5-10), and severe (grade 4; total number of microbleeds, >10). Component types of the carotid plaque were defined according the following HU ranges: lipid < 60 HU; fibrous tissue from 60-130 HU; calcification > 130 HU and plaque volumes of each component was calculated. Each carotid artery was analyzed by 2 observers. Chi square, multiple logistic regression analysis as well as ROC was calculated.

RESULTS
The prevalence of CMBs was 35.3%. A statistically significant difference was observed between symptomatic (40%) and asymptomatic (11%) patients (p value = 0.001; OR = 6.07). Linear regression analysis demonstrated an association between the number of CMB and the symptoms (p = 0.0018). A statistically significant correlation was observed between the increase of the volume of the fatty component and CMBs (rho = 0.89; p = 0.001).

CONCLUSION
Results of this study confirm the association between CMBs and symptoms and that there is an increased number of CMBs in symptomatic patients. Moreover we found that an increased volume of the fatty component is associated the presence and number of CMBs.

CLINICAL RELEVANCE/APPLICATION
The presence of fatty components in the carotid artery plaque are associated with an increased prevalence of cerebral microbleeds.

SSA16-07 • Dual Energy Computed Tomography Quantification of Carotid Plaques Calcification: Comparison between Monochromatic and Polychromatic Energies with Pathology Correlation

Lorenzo Mannelli MD, PhD (Presenter) ; Lawrence MacDonald PhD ; Marina Ferguson MS ; Dongxiang Xu PhD ; William P Shuman MD * ; Chun Yuan PhD * ; Lee M Mitsumori MD, MS *
PURPOSE
To compare the size and number of carotid plaque calcifications identified on monochromatic spectral CT and polychromatic CT images with a pathological reference standard.

METHOD AND MATERIALS
Ex-vivo carotid endarterectomy specimens were imaged with spectral and conventional CT. Monochromatic CT images were reconstructed at 40, 60, 80, 100, 120, and 140 kVp. Conventional polychromatic images were acquired using 80, 100, 120, and 140 kVp. Cross-sectional area of the plaque calcifications was measured. The histological calcium areas were measured on digitized images of Toluidine-Blue/Basic-Fuchsin stained plastic sections. The CT images and corresponding histology sections were matched. Pearson's correlation coefficient for a linear relationship was calculated between the results from pathology and CT, and between different CT techniques. We also calculated the mean percent error (bias) and root-mean-square error (RMSE) in CT calcium size, taking pathology measurements as the gold standard. The mean percent error was calculated as (CT size - Pathology size)/Pathology size averaged over the calcifications found by the CT technique of interest.

RESULTS
116 pathologic sections were evaluated, the calcification area per section ranged between 0.20 mm² and 26.4 mm². Fig. 1 is a scatter plot of calcification sizes measured by pathology and CT for three CT image types (40 kVp, 140 kVp, and 120 kVp). Fig. 2 shows that when compared to pathology, the amount of calcification identified with polychromatic CT decreased with increasing energy level: at 80 kV 90% were found, at 100 kV only 77%; on polychromatic 120 kVp CT images 95% of the calcifications were found. Fig. 2 also shows the Pearson correlation coefficient. The RMSE and average percent error are shown in figure 3: there is an overestimation in calcium size by CT for lower monochromatic CT images, decreasing to an underestimation for higher keV monochromatic CT images and polychromatic CT images. Monochromatic 80 keV and 100 keV images show the lowest RMSE and %error.

CONCLUSION
The size and number of plaque calcifications detected by CT depends upon the energy level used for the image acquisition and reconstruction. Monochromatic 80keV images were the most comparable to histology.

CLINICAL RELEVANCE/APPLICATION
80 keV monochromatic images allow for a better evaluation of atherosclerotic calcifications; this may help characterizing the whole atherosclerotic plaque.

SSA16-08 ● Radiological Assessment of Thoracic Outlet Syndrome: Four Years of Institutional Experience
Dean Donahue; Omid Khalilizadeh MD, MPH; Julien Dinkel MD; Gaetano T Pastena MD; Martin Torriani MD; Rajiv Gupta PhD, MD (Presenter)

PURPOSE
Imaging studies play a significant role in assessment of thoracic outlet syndrome (TOS). In this study, we reviewed the spectrum of CT and MR imaging findings in patients with TOS in our institution, over a period of four years.

METHOD AND MATERIALS
Our study included a total of 349 consecutive TOS patients, referred to our hospital between December 2008 and December 2012. Patients with non-specific symptoms were excluded. All patients underwent a biphasic contrast-enhanced CT angiography of the thoracic outlet using a TOS-optimized protocol and an MR scan with a postural maneuver. A single radiologist (RG) assessed all the scans. The findings associated with TOS were classified under the categories of vascular (venous or arterial), neurologic (due to soft tissue, bone or anatomical space abnormalities causing mass effect on the brachial plexus) and a combination of the two, i.e. neurovascular (typically secondary to post-operative or traumatic insult).

RESULTS
Positive CT or MR findings were seen in 78.5% of patients. Overall, 6% of patients had vascular TOS (2% venous and 4% arterial), 7.4% had neurovascular, and 86% had neurogenic TOS. Bone abnormalities were the most common cause of neurogenic TOS. Narrowing of anatomic compartments (inter-scalene triangle and costoclavicular space) was seen in 43.7% of patients with neural TOS. C7 transverse process variations were the most common bone abnormality (67.9%). Fibrous bands were the most common soft tissue abnormalities associated with neurogenic TOS.

CONCLUSION
This study describes the range of CT and MR findings associated with TOS. Based on our experience, a combination of CT angiography and MR imaging (with a postural maneuver) effectively demonstrate TOS abnormalities.

CLINICAL RELEVANCE/APPLICATION
A combination of biphasic contrast-enhanced CT angiography and MR imaging (with a postural maneuver) effectively demonstrate TOS abnormalities.

SSA16-09 ● Bilateral Inferior Petrosal Sinus Sampling Using Desmopressin: A Single Center Experience
Amy R Deipolyi MD, PhD (Presenter); Bailin Alexander BA; Junsung Rho BSc; Zubin Irani MD; Stephan Wicky MD; Rahmi Oklu MD, PhD

PURPOSE
Bilateral inferior petrosal sinus sampling (BIPSS) following corticotropin-releasing hormone (CRH) stimulation is the current gold standard technique in the diagnosis of Cushing disease. However, as a result of CRH shortage, desmopressin (DDAVP) has become the current gold standard technique in the diagnosis of Cushing disease. Given the shortage of CRH, desmopressin has been safe and demonstrates similar diagnostic results.

CONCLUSION
DDAVP is a safe alternative to CRH producing satisfactory diagnostic results.

CLINICAL RELEVANCE/APPLICATION
BIPSS is the current gold standard technique in the diagnosis of Cushing disease. Given the shortage of CRH, desmopressin has been safe and demonstrates similar diagnostic results.
PURPOSE
The evaluation of substantia nigra (SN) and nigrostriatal fiber is essential to assess the severity of degeneration and efficacy of treatment protocols in Parkinson's disease (PD). The purpose of the present preclinical study was to investigate dopaminergic neurodegeneration by longitudinal voxel-based morphometry (VBM) and diffusion tensor imaging (DTI) at 7T MRI in the preclinical primate model of PD.

METHOD AND MATERIALS
The common marmosets (n=6) received 1-methyl-4-phenyl-1,2,3,6-tetrahydropyridine (MPTP) at the daily dose of 2, 2 and 1 mg/kg, s.c., respectively, for 3 consecutive days were used for the present imaging study. These marmosets showed long lasting and stable Parkinsonism such as moving tremor, immobility measured objectively as decreased locomotion counts, etc. Before and after several weeks after the MPTP administration, 3D T1WI (isotropic resolution of 200?m) and 2D DTI (in-plane resolution of 200?m and slice thickness of 1mm) were performed. After the acquisitions of longitudinal MRI, ex vivo microscopic DTI (isotropic resolution of 60?m) and histological examination with Klver-Barrera and tyrosine hydroxylase (TH) staining were also performed to the fixed brains (n=4). VBM and diffusion tensor tractography (DTT) were obtained with SPM8 and TrackVis software, respectively.

RESULTS
Volume decreases in SN were observed by longitudinal VBM with positive correlation with decreased locomotion counts, a central PD sign (P<0.01). Volume decreases in SN were observed by longitudinal VBM with positive correlation with decreased locomotion counts, a central PD sign (P<0.01).

CONCLUSION
Volume decreases in SN were observed by longitudinal VBM with positive correlation with decreased locomotion counts, a central PD sign (P<0.01). Volume decreases in SN were observed by longitudinal VBM with positive correlation with decreased locomotion counts, a central PD sign (P<0.01).

CLINICAL RELEVANCE/APPLICATION
This study provides neurologists with high sensitive, high signal to background ratio probe targeting to melanin for tracking the implanted RPE cells.
CONCLUSION
PIGD-group showed greater activation than non-PIGD group as referred to HC, mainly covering areas participating in premotor planning, vestibular attention for action and regulations for skeleton motor. As to intrasubgroup comparison, left SFG has been found associate to visual hallucination, imaginary motor, self-awareness and sensory organization. Thus, our study indicated that although PIGD-group patients behave abnormal posture and gait, the non-motor mental functions rather than motor functions should be responsible for those clinical performance.

CLINICAL RELEVANCE/APPLICATION
It is indicated that although PIGD-group patients behave abnormal posture and gait, the non-motor mental functions (i.e., vision, cognition, sensory, etc.) rather than motor functions should be noted.

SSA17-04 • Resting-state Causal Connectivity in Parkinson’s Disease with Depression: Aberrant within-network and between-network Pathways

Peipeng Liang (Presenter) ; Kuncheng Li MD

PURPOSE
Depression is a common problem in patients with Parkinson’s disease, but its neural mechanism is poorly understood. The goal of this study was to examine effective connectivity (EC) in Parkinson’s Disease with Depression (PD) based on Granger causality.

METHOD AND MATERIALS
Sixteen patients with PD, twenty patients of PD with no depression (NDPD), twenty-two patients with major depression (MD), and twenty-one healthy controls underwent 8-min fMRI scans while resting quietly. Correlation-purged Granger causality analysis was performed, based on four basic functional networks: default mode network (DMN), dorsal attention network (DAN), motor network (MN), and emotion network (EN), to compare the group difference.

RESULTS
It was found that the causal connectivity in patients with PD are significantly altered, as compared to NDPD, MD and healthy controls, with some causal pathways decreased (e.g., Hy?OFC/vACC) and some others increased (e.g., R DLPFC?R ITC). Some alterations are significantly correlated with neuropsychological measures.

CONCLUSION
The present study demonstrates the coexistence of causal disconnection and compensation in PD patients, and suggest that PD has different neural substrates from NDPD, MD and HC.

CLINICAL RELEVANCE/APPLICATION
These findings might provide insights into biological mechanisms of the disease.

SSA17-05 • Fractional Amplitude of Low-frequency Fluctuation Study of Resting-state fMRI in Parkinson’s Disease Patients with and without Resting Tremor

Min Xuan (Presenter) ; Peiyu Huang ; Quanquan Gu MD, PhD ; Xiaojun Xu ; Wei Luo ; Minming Zhang MD, PhD

PURPOSE
Resting tremor (RT) is present in 75-100% of Parkinson’s disease (PD) patients, but the explanation of this symptom still remains poorly known. Here we investigate how the functional changes happen in brains of PD patients with and without resting tremor, and whether these changes relate to the severity of resting tremor.

METHOD AND MATERIALS
15 PD patients with resting tremor (RT group), and 18 gender-, age-, duration-matched patients without resting tremor (non-RT group) participated in the resting-state functional magnetic resonance imaging (fMRI) analysis. We measured the fractional amplitude of low-frequency fluctuation (fALFF) between the two groups and investigated the correlation between RT scores and fALFF in the regions displaying significant group differences.

RESULTS
The RT group demonstrated an decreased fALFF in the right supplementary motor area (SMA), and bilateral prefrontal cortex compared to non-RT group. There was no significant correlation between RT rating and fALFF in right SMA.

CONCLUSION
Our results suggest that the generation of resting tremor may be related to the decreased brain activity of right SMA, but the severity of resting tremor may not.

CLINICAL RELEVANCE/APPLICATION
Used to help understand the causes of resting tremor of PD, may eventually contribute to the treatment of this symptom.

SSA17-06 • Alternation of Functional Connectivity and Global Disturbance of FNC of Parkinson’s Disease by Resting-state fMRI

Haibo Xu (Presenter) ; Yuhui Wang ; Dongling Jiang ; Cheng Luo ; Dan Zhang

PURPOSE
The aim was to estimate the alteration of brain functional connectivity in Parkinson’s disease (PD) during resting state of brain by resting-state fMRI.

METHOD AND MATERIALS
A total of 16 right-handed patients with PD diagnosed according to the UK Parkinson’s Disease Society Brain Bank diagnostic criteria, and 14 gender- and age-matched right-handed healthy controls were carried out on resting-state fMRI for two levels of analyses, that is functional connectivity within resting state networks (RSNs) and functional network connectivity (FNC) analysis. Using group independent component analysis, sixteen RSNs were identified, and selected for assessment of the difference of functional connectivity within RSNs and FNC between groups.

RESULTS
Compared with HC, the patients with PD showed decreased significant functional connectivity within the regions in the putamen network, thalamus network, cerebellum network, attention network and self-referential network in bilateral putamen, bilateral thalamus, left cerebellum, right superior frontal gyrus, left medial frontal gyrus (orbitofrontal area), left anterior cirugulated. The execution network was the only one revealing increased functional connectivity in bilateral paracentral lobule (P < 0.01). Furthermore, the results showed significant functional connectivity disturbance inter- RSNs in patients with PD. The PD had a trend to show increased functional connectivity within most of RSNs and decreased functional connectivity within a small part of RSNs. The caudate network showed increased functional connectivity with anterior DMN network and execution network and decreased functional connectivity with cerebellum network. Functional connectivity with execution network was significantly increased in DMN network, motion network, self-referential network and primary auditory network. The posterior DMN network showed decreased functional connectivity with thalamus network.

CONCLUSION
Our findings might suggest that decreased resting state functional connectivity and global disturbance of FNC are two remarkable characteristics of Parkinson’s disease.

CLINICAL RELEVANCE/APPLICATION
The multi-perspective analysis based on RSNs may be a valuable means to understand the underlying neuro-pathophysiological
SSA17-07 • Dysfunction of Central Olfactory Network in the Parkinson’s Disease
Kaiyuan Zhang MD (Presenter) ; Xuemin Wu ; Kuncheng Li MD ; Qing X Yang PhD ; Jianli Wang MD

PURPOSE
Olfactory dysfunction is prevalent in majority of idiopathic Parkinson’s disease (PD) patients. Even though typical PD pathology, Lewy pathology has been found in the olfactory structures. We cause of olfactory deficits in PD is still not clear. We hypothesized that in PD patients, the central olfactory network (CON) is deteriorated. In this study, we applied task related and resting state fMRI (rsfMRI) methods to study the functional deficit of the CON in the PD brain.

METHOD AND MATERIALS
Nineteen PD patients (HandY stage 1-4) and ten age-/gender-matched healthy controls (HC) received respiration-triggered olfactory fMRI with lavender odor as the stimulant and rsfMRI on a 3T scanner. The olfactory function was evaluated with University of Pennsylvania Smell Identification Test (UPSIT). The PD patient’s clinical status was evaluated with Unified Parkinson’s Disease Rating Scale (UPDRS). During the imaging protocol, there were no cues provided to the subjects and no tasks for the subjects to do. The olfactory fMRI data were preprocessed with qMRI V2.1 and then analyzed using general linear model approach with SPM8. The rsfMRI data were processed with DPARSF V2.2 for resting state functional connectivity (FC) analysis using the major activation cluster in the primary olfactory cortex (POC) from the HC group as the seed. The FC at the group level was processed with REST V1.8 for the correlation analysis with clinical status.

RESULTS
In response to the odorant stimulation, significant activation was shown in the POC and secondary olfactory structures of the HC brains (e.g., orbitofrontal and insular cortex), but not in the PD brains. Significant decrease of FC with POC was observed in the anterior cingulate and right inferior temporal cortex (two-sample t-test with age effect corrected, p<0.05).

CONCLUSION
The FC decrease within the CON contributes to the olfactory deficit in PD, and the connectivity change worsens when PD progresses.

CLINICAL RELEVANCE/APPLICATION
The findings in this study improve our understanding of olfactory deficits in Parkinson’s disease and provide a foundation for further clinical research in its diagnosis and treatment.

SSA17-08 • Quantitative Assessment of Iron Deposition in Parkinson’s Disease Using Quantitative Susceptibility Mapping at 3T: An In Vivo MR Study
Minako Azuma (Presenter) ; Toshinori Hirai MD ; Kazumichi Yamada ; Tian Liu PhD ; Yasuyuki Yamashita MD * ; Yi Wang PhD

PURPOSE
To evaluate the usefulness of assessing brain iron deposition in patients with Parkinson’s disease (PD) by quantitative susceptibility mapping (QSM).

METHOD AND MATERIALS
All MRI studies were performed with a multi-echo gradient-echo sequence on a 3.0 T Siemens scanner. We studied 8 PD patients (5 females, 3 males; age range 54-75 years, mean age 67 years) and 8 age-matched healthy controls. For QSM we used both the magnitude and phase components from all TEs in the morphology-enabled dipole inversion method. The mean susceptibility values (MSVs) of the bilateral substantia nigra (SN), red nucleus (RN), caudate nucleus (CN), globus pallidus (GP), and putamen (PT) was measured on QSM images. To place the region of interest (ROI) in the SN while avoiding contamination of the subthalamic nuclei we used coronal multiplanar reconstruction images with reference to the Schaltenbrand and Wahren atlas. Measurements were in the anteromedial and posterolateral (aSN, pSN) areas of the SN. Axial images were used for measurements in the other structures. In each patient, the most and least affected side was identified using the Unified Parkinson’s Disease Rating Scale Motor score (UPDRS-III). Measurement differences were assessed with the paired and independent t test; P < 0.05 was considered to indicate a statistically significant difference.

RESULTS
In healthy subjects the MSVs of both hemispheres for the GP, aSN, pSN, RN, PT, and CN were 157 ± 34, 152 ± 49, 94 ± 31, 122 ± 38, 82 ± 24, and 74 ± 14 ppb, respectively. In PD patients the MSVs of the aSN and pSN on the most affected side were 148 ± 54 and 130 ± 60 ppb, and on the least affected side were 126 ± 58 and 185 ± 65 ppb, respectively. On both sides of healthy subjects and on the least affected side of PD patients, the MSV was significantly higher in the aSN than pSN (P < 0.01). There was no significant difference between the aSN and pSN on the most affected side of PD patients. The MSV in the pSN on the least affected side of PD patients was significantly higher than the controls (P < 0.01); the difference was not statistically significant in the other structures between the two groups.

CONCLUSION
Our QSM study suggests that the iron deposition in the SN in PD patients is different from that in healthy subjects.

CLINICAL RELEVANCE/APPLICATION
QSM may provide useful quantitative information for evaluating brain-iron deposition in PD patients.

SSA17-09 • Difference in Phase Value of Putamen on SWI between Parkinsonian Syndrome and Age Matched Control
Jin Hee Jang MD (Presenter) ; Hyun Seok Choi MD ; Bum-So Kim MD, PhD ; Kookjin Ahn MD, PhD ; So L Jung ; Bom-Yi Kim MD

PURPOSE
Susceptibility weighted image (SWI) is sensitive to paramagnetic material such as iron. Iron deposition is considered not only as phenotype of neurodegenerative disease but also as normal aging. Decreased uptake of putamen on FP-CIT PET has been known as one of imaging biomarkers of Parkinson disease. The purpose of this study is to evaluate difference in phase value of putamen between patient with Parkinsonian syndrome and age matched control.

METHOD AND MATERIALS
We retrospectively enrolled patients of three groups with idiopathic Parkinson disease (IPD) (n=20), atypical Parkinsonian syndrome or 2ndary Parkinsonism (n=14), and age matched control (n=16). SWI were taken from all the enrolled subjects (n=50). Region of interest (ROI) was drawn on the mean susceptibility values of bilateral the anteromedial and posterolateral putamen on the axial images at the level of fornix of Monro. Patient with IPD (n=20) and atypical Parkinsonian syndrome or 2ndary Parkinsonism (n=14) underwent F-18 FP-CIT PET/CT. Tracer activity of ROI was measured in caudate, putamen and a reference region of occipital cortex. Statistical analyses were performed to compare phase values and tracer activity between groups.

RESULTS
Mean age was 64.7±8.3 year-old in idiopathic Parkinson disease; 66.1±1.5 year-old, in atypical Parkinsonian syndrome or 2ndary Parkinsonism; and 65.7±6.0 year-old, in control. The mean ages were not different among 3 groups. The phase values of right and left putamen in IPD (0.068±0.038, 0.062±0.031 radian) were higher than those of age matched control (0.030±0.030, 0.037±0.032 radian). The phase values of atypical Parkinsonian syndrome or 2ndary Parkinsonism (0.079±0.039, 0.084±0.039 radian) were higher than those of age matched control. There was no difference of phase value between IPD and atypical Parkinsonian syndrome or 2ndary Parkinsonism. However, normalized FP-CIT tracer activity of right and left putamen in IPD (3.1±0.6, 2.9±0.5) were lower than those of atypical Parkinsonian syndrome or 2ndary Parkinsonism (3.9±1.2, 3.9±1.2).

CONCLUSION
The findings in this study indicate the difference in putamen phase value between Parkinsonian syndrome and healthy controls.
Pre-treatment Whole-body Total Lesion Glycolysis and Metabolic Tumor Volume at FDG PET-CT as Prognostic Indicators in Advanced Cervical Cancer

Mohammad A Husainy MD (Presenter) ; Farhina Sayyed MRCS ; Helene Thygesen PhD ; Chirag Patel RCR ; Mark Barnfield ; Andrew F Scarsbrook FRCR

PURPOSE
To study the prognostic value of whole body total lesion glycolysis (TLG) and total metabolic tumor volume (MTV) derived from pre-treatment fluorine 18 fluorodeoxyglucose (FDG) positron emission tomography - computed tomography (PET-CT) in locally advanced cervical cancer.

METHOD AND MATERIALS
Patients with locally advanced cervical cancer who underwent pre-treatment FDG PET-CT from the year 2010-12 were identified from an institutional cancer database. Mean and maximum standardized uptake value and MTV of each primary tumor and any nodal or distant disease were determined. Whole body MTV was calculated by summation of individual tumor volume multiplied by mean SUV. Univariate analysis was performed to assess the prognostic significance of clinical stage, SUVmax, whole-body MTV and TLG on subsequent patient outcome.

RESULTS
34 patients were included in data analysis. Median follow up time was 2.2 years. The estimated median overall survival (OS) for the cohort was 2.1 years. The 1-year OS was 64.7% for patients with high whole-body TLG (> 385.29) and 88.2% for those with low whole-body TLG (67) and 88.2% for those with low whole-body MTV (14.7). Univariate Cox analysis showed that whole-body TLG, whole-body MTV and clinical stage were significant prognostic factors for OS. For statistical test, we used the confidence level 95%. Cox proportional hazard modeling showed a significant prognostic value of whole body-TLG (hazard ratio= 3.63; 95% confidence interval: 1.15, 11.43; p 0.02). "n
CONCLUSION
Whole-body TLG and MTV may be better prognostic indicators than primary tumor SUVmax for predicting outcome in advanced cervical cancer.

CLINICAL RELEVANCE/APPLICATION
Whole-body TLG and MTV may be better prognostic indicators in the advanced cervical cancer and could have a role for treatment stratification in the future.
RESULTS

60 patients were identified with FDG PET/CT and MDP bone scans performed prior to treatment of newly diagnosed ES. 44 primary malignancies demonstrated a lytic CT appearance, 3 were sclerotic, and 13 involved only soft tissue. 11/12 patients with osseous metastases were detected on PET/CT, with the 1 false negative occurring in a sclerotic primary tumor. 9/12 patients with osseous metastases were detected on MDP bone scan, with the 3 false negatives occurring in patients with lytic primary tumors. Only 1 of 13 patients with a soft tissue primary malignancy demonstrated bone metastases, evident on both bone scan and PET/CT. PET/CT also demonstrated 8 patients with lung metastases and 3 patients with lymph node metastases, which were not evident on MDP bone scan.

CONCLUSION

When ES is lytic, MDP bone scan does not add to staging performed by FDG PET/CT, thus MDP bone scanning may be omitted. However, when ES is sclerotic, MDP bone scan may detect patients with osseous metastases which are not detected by FDG PET/CT.

CLINICAL RELEVANCE/APPLICATION

Bone scan may be omitted from the staging of newly diagnosed ES when the primary tumor is lytic. When the primary tumor is sclerotic, MDP bone scan may detect osseous metastases missed on FDG PET/CT.

SSA18-04 • Prognostic Value of Concurrent Staging 18F-FDG PET/CT and Staging Endoscopic Ultrasound in Esophageal Cancer

Vinod Malik MBCh, MA (Presenter) ; Ciaran J Johnston MD ; Julie A Lucey PhD ; Zieta Claxton BSc ; Dermot O'Toole MD ; John V Reynolds MD

PURPOSE

Staging of esophageal cancer is improved by the concurrent use of 18F-fluorodeoxyglucose positron emission tomography/computed tomography (18F-FDG PET/CT) and endoscopic ultrasound (EUS). This study ascertained if these complementary adjuncts can enhance staging by proposing correlating independent prognostic factors in esophageal cancer.

METHOD AND MATERIALS

From December 2008 to May 2011, 150 patients with biopsy-proven cancer of the esophagus or esophagogastric junction underwent concurrent staging 18F-FDG PET/CT and staging EUS. 18F-FDG PET/CT obtained maximum standardized uptake value (SUVmax) and metabolic tumor volume (MTV) of the primary tumor was recorded. EUS evaluated the tumor for T stage (T1-T4), regional lymph node metastases (N0 or N+), and the presence or absence of celiac axis nodes and hepatic metastasis. Relationships between parameters were investigated using the spearman rho correlation coefficient, survival analysis performed using Kaplan-Meier and independent prognostic factors determined using Cox regression multivariate analysis.

RESULTS

A strong positive correlation between 18F-FDG PET/CT MTV and EUS T stage was demonstrated (r=0.566, p18F-FDG PET/CT MTV was noted between early EUS tumors (T1/T2) and late EUS tumors (T3/T4) (p=0.0013), 18F-FDG PET/CT SUVmax < 4.1 (p=0.0014), EUS T1 stage (p=0.01) and EUS N stage (p=0.01).

CONCLUSION

MTV, a volumetric parameter of 18F-FDG PET/CT is a valuable independent prognostic factor in esophageal cancer, more so than SUVmax and enhances staging when used in conjunction with EUS T stage and EUS N stage by predicting survival.

CLINICAL RELEVANCE/APPLICATION

Independent prognostic factors identified by staging 18F-FDG PET/CT and EUS in esophageal cancer may facilitate selection of patients to treatment regimens with the benefit of enhanced outcomes.

SSA18-05 • Intratumoral Heterogeneity of Tracer Uptake on 18F-FDG PET/CT for Characterization of Peripheral Nerve Sheath Tumors in Patients Suffering from Neurofibromatosis Type 1

Johannes M Salamon MD (Presenter) ; Peter Bannas MD ; Jasmin D Busch MD ; Jochen Herrmann MD ; Gerhard B Adam MD ; Victor F Mautner MD ; Thorsten Derlin MD

PURPOSE

Peripheral nerve sheath tumors (PNSTs) in patients with neurofibromatosis type 1 (NF1) may undergo focal malignant transformation, and heterogeneity of tumor composition is therefore a histopathological hallmark of malignant PNSTs (MPNSTs). MPNSTs usually demonstrate strongly increased and inhomogenous tracer uptake. The aim of this study was to evaluate the potential usefulness of intratumoral tracer uptake heterogeneity on 18F-fluorodeoxyglucose (FDG) PET/CT as compared to a cut-off SUVmax for characterization of PNSTs in NF1.

METHOD AND MATERIALS

50 patients suffering from NF1 underwent 18F-FDG PET/CT. Intravesional 18F-FDG PET/CT uptake was analyzed qualitatively and semiquantitatively by measuring the mean and maximum standardized uptake value (SUV). Heterogeneity of tracer uptake was evaluated by computing a SUV-based heterogeneity index (HISUV) and qualitatively graded using a three-point scale. Inter- and intrarater agreement was determined using Cohen s ?. Histopathologic evaluation as well as clinical and radiological follow-up served as reference standard.

RESULTS

Using either intravesional heterogeneity or SUVmax malignant tumors could be identified with a sensitivity of 100%. Qualitative intravesional uptake heterogeneity and malignant transformation in peripheral nerve sheath tumors showed a significant association (p<0.05). A strong positive correlation between SUVmax < 4.1 and histopathologic diagnosis of malignant PNSTs was demonstrated (r=0.566, p<0.05).

CONCLUSION

18F-FDG PET/CT reveals strong intratumoral heterogeneity of tracer uptake in MPNSTs in patients with NF1. Either a SUVmax cut-off value or a heterogeneity index can be used to identify malignant PNSTs with a sensitivity of 100%, however the approach using a cut-off value leads to a higher specificity. There is no significant improvement in diagnostic performance using both methods in combination.

CLINICAL RELEVANCE/APPLICATION

New imaging parameters for the characterization of peripheral nerve sheath tumors in NF1 patients may help reducing unnecessary morbidity due to biopsies or surgery.

SSA18-06 • Can I-124 PET/CT Predict the Uptake of Therapeutic Dosages of Radioiodine (I-131) in Differentiated Thyroid Carcinoma?

Gauke K Lammers MD (Presenter) ; P.C.M. Pasker ; M. E. Sanson-Van Praag ; John M De Klerk MD, PhD

PURPOSE

Follow-up of differentiated thyroid carcinoma (DTC) is currently mainly based on monitoring of serum thyroglobulin (Tg) levels. In the case of an elevated serum Tg level and suspected recurrent DTC, but negative diagnostic imaging, a so called blind I-131 therapy is recommended, followed by whole body scintigraphy to assess the extent of disease. Regrettably, in a significant number of patients this blind I-131 therapy results in no visible abnormal 1-131 uptake and hence in probably no beneficial therapeutic effect. Iodine-124 PET/CT is a promising tool for identifying patients who will benefit from I-131 therapy, by predicting iodine uptake. I-124 PET/CT could therefore be important in personalizing treatment for patients with DTC.

METHOD AND MATERIALS

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The results of 34 I-124 PET/CT scans performed in our hospital between 2007 and 2012 were retrospectively evaluated. All scans were made in patients under follow up, replacing the diagnostic I-131 scintigraphy. In all cases Tg was stimulated (by recombinant TSH or thyroid hormone withdrawal). A dosage of 40MBq I-124 was used, with scans at 24 hours and 96 hours after administration. Results were compared to subsequent I-131 post-treatment scans (6 cases) and a combination of follow up, stimulated Tg and other imaging tools results available to assess presence of recurrence.

RESULTS
Recurrence of DTC was found in 14/34 cases. I-124 PET/CT correctly detected recurrence in 2 cases, with false negative results in 12 cases. In 1 case a false positive I-124 PET/CT result was recorded. 15 true negative results were found. For I-124 PET/CT this meant a sensitivity of 14% and a specificity of 95%. PPV was 67%, NPV 61%. Post-treatment I-131 uptake (6 cases) was correctly predicted in 1 case, with false negative results in 4 cases and 1 true negative result.

CONCLUSION
In this study I-124 PET/CT did not reliably detect recurrent differentiated thyroid carcinoma. More importantly it failed to predict I-131 uptake on post-treatment scintigraphy in a significant number of cases, which would lead to under-treatment.

CLINICAL RELEVANCE/APPLICATION
I-124 PET/CT in follow up of differentiated thyroid cancer cannot reliably identify the patients who would benefit from I-131 treatment.

SSA18-07 • Whole-body MRI vs. Co-registered Whole-body FDG-PET/MRI vs. Integrated Whole-body FDG-PET/CT: Capability for TNM and Stage Assessment in Non-small Cell Lung Cancer Patients
Yoshiharu Ohno MD, PhD (Presenter) *; Shinichiro Seki; Mizuho Nishio MD *; Hisanobu Koyama MD; Maho Tsubakimoto MD; Hitoshi Yamagata PhD *; Kota Aoyagi *; Yumiko Onishi MD; Takeshi Yoshikawa MD *; Sumiaki Matsumoto MD, PhD *; Nobukazu Aoyama RT; Katsusuke Kyotani RT; Akiko Kusaka RT; Kazuhiro Sugimura MD, PhD *

PURPOSE
To directly and prospectively compare the capability for TNM and clinical stage assessments among whole-body MR imaging (MRI), co-registered FDG-PET/MRI and integrated FDG-PET/CT in non-small cell lung cancer (NSCLC) patients.

METHOD AND MATERIALS
70 consecutive pathologically diagnosed NSCLC patients (37 men, 33 women; mean age 73 years) prospectively underwent whole-body MRIs at 3T system, integrated FDG-PET/CTs, conventional radiological examinations, surgical biopsies and/or treatments, pathological examinations and follow-up examinations. Final diagnosis of TNM factors and clinical stage in each patient was determined according to all examination results. All co-registered FDG-PET/MRIs were generated by means of our proprietary software. Then, TNM factor and clinical stage on all methods were visually assessed by radiologists and nuclear medicine physicians. Then, final diagnosis in each patient was made by consensus of two readers on each method. To determine the agreements of TNM factor and clinical stage between each method and final diagnosis, kappa statistics were performed. To compare the diagnostic capability for operability assessment (T factor: T1 or T2 vs. T3 or T4, N factor: N0 or N1 vs. N2 or N3, M factor: M0 vs. M1, clinical stage: stage I or II vs. stage III or IV) among all methods, sensitivities, specificities and accuracies were statistically compared each other by using McNemar’s test.

RESULTS
Each agreement with final diagnosis was as follows: T factor, 0.90=±0.93; N factor, 0.60=±0.88; M factor, 0.78±0.93; clinical stage, 0.55=±0.87, respectively. When compared each operability assessment capability between all methods, accuracies (97.1 [%68/70] vs. 96.6 [%62/70]) % of N factor on MRI and FDG-PET/MRI were significantly higher than that on FDG-PET/CT (88.6 [%62/70], p<0.01). When compared each operability assessment capability according to TNM factor, accuracies (97.1 [%68/70] vs. 90.5 [%62/70] vs. 94.1 [%62/70] vs. 96.6 [%62/70]) % of N factor on MRI and FDG-PET/MRI were significantly higher than that on FDG-PET/CT (88.6 [%62/70], p<0.01).

CONCLUSION
Whole-body MRI and co-registered FDG-PET/MRI are more useful than integrated FDG-PET/CT and CT for TNM and clinical stage assessments in non-small cell lung cancer patients.

CLINICAL RELEVANCE/APPLICATION
Whole-body MRI and co-registered FDG-PET/MRI are more accurate than integrated FDG-PET/CT for TNM and clinical stage assessments in non-small cell lung cancer patients.

SSA18-08 • Correlations between FDG Uptake Indices and the Expression of Various Type Oncogenes (KRAS, BRAF, HIF-1, EGFR, CDH13, p53, Ki67, Glut 1 and Glut 3) in Biliary Cancer: A Comparison Study to MRI Diffusion Weighted Image Parameters
Shigeki Nagamachi MD, PhD (Presenter) ; Ryuichi Nishii MD, PhD; Youich Mizutani; Syogo Kiyohara; Nobuhiko Shibata; Katsuhiro Kondo ; Masahiro Kai; Shozo Tamura MD, PhD; Kazuo Chijiwa; Keichi Kawai; Seigo Fujita MD; Hideyuki Wakamatsu MD ; Shigemi Futami MD

PURPOSE
We investigated the correlations between FDG uptake and the expression of various type oncogenes in biliary cancer. In addition, we also calculated the correlation between parameters of diffusion weighted MRI image (DWI) and oncogenes expression. Then, we compared both correlation coefficients to find which imaging parameters were more associated with the expression of which oncogenes in biliary cancer.

METHOD AND MATERIALS
We investigated forty-three patients of biliary cancer who underwent both MRI and FDG-PET/CT before operation. Using Reverse Transcription-Polymerase Chain Reaction (RT-PCR) analysis, we measured the various DNA content (EGFR, CDH13, p53, Ki67, KRAS, BRAF, HIF-1, Ki-67, p53, Glut 1 and Glut 3) in surgically resected cancer tissues. We investigated the correlation coefficients between the expression of oncogenes DNA and FDG uptake parameters (SUV max early and SUV max delayed), or between the expression of oncogenes DNA and apparent diffusion coefficient (ADC mean and ADC min).

RESULTS
FDG uptake parameters (SUV max early and SUV max delay) were positively correlated with B-RAF (0.34 and 0.43), HIF-1(0.41 and 0.48), Glut1 (0.45 and 0.52) or Glut 3(0.35 and 0.48). In contrast, DWI parameters (ADC mean or ADC min) showed positive correlation only with HIF-1 (0.48 and 0.16). However, there was not any significant correlation in other parameters.

CONCLUSION
In biliary cancer, both SUV max and DWI parameters showed the close association with the expression of oncogenes related with hypoxia. In addition, SUV max was more associated with the expression of oncogenes associated with RAF/MEK/ERK signaling pathway.

CLINICAL RELEVANCE/APPLICATION
By the correlation analysis, we may estimate the expression of oncogenes such as B-RAF or HIF-1 by the values of SUVmax. We may estimate the expression of HIF-1 by ADC also.

SSA18-09 • Incremental Value Of FDG PET CT in Differentiating Benign and Malignant Cardiac Masses
Kavitha Yaddanapudi DMRD, MBBS (Presenter) ; Michael A Bolen MD ; Ahmed El-Sherief MD ; Carmela Tan MD ; Richard Brunken MD *

PURPOSE
To evaluate the incremental value of FDG-PET CT over contrast enhanced magnetic resonance imaging (CE MRI) and computed tomography (CT) in differentiating benign cardiac masses from malignant lesions.

METHOD AND MATERIALS
Retrospective evaluation of eleven patients with cardiac masses who underwent CE MRI (n=9), CT (n=2) and FDG-PET (n=11) was performed. The gold standard was histopathology after surgical excision (n=8) and long term follow up of more than 2 years (n=3).
Patients were divided into two groups: benign (n=7) and malignant (n=4) cardiac masses. On FDG PET CT the maximum standardized uptake values (SUV max) of the lesions was determined. A SUV max cutoff of 3.5 was used to differentiate benign from malignant lesions. MRI and CT characteristics as size, invasiveness and tissue characterization were evaluated. The ability of SUV max on FDG PET to differentiate benign and malignant lesions was then compared to morphological imaging diagnosis and correlated with pathology and follow up.

RESULTS
The mean SUV max for malignant lesions was 5± 2.5. The mean SUV for benign lesions was 0.85. No FDG uptake was seen in 5 of the 7 benign lesions (71%). The sensitivity and specificity for determining malignancy by FDG PET CT was 75% and 100% respectively. FDG PET CT has a 100% positive predictive value for diagnosing malignancy with a SUV max cut off of 3.5. Morphological imaging could not differentiate between benign and malignant lesions in 36% (n=4) cases. In 3 of these 4 cases FDG PET CT was able to differentiate between benign and malignant lesions. In one case of osteosarcoma of left atrium that was densely calcified both FDG PET CT and morphological imaging could not point towards the malignant nature preoperatively.

CONCLUSION
FDG PET CT is a useful adjunct to morphological imaging in differentiating benign from malignant cardiac masses. FDG uptake by the mass with a high SUV (>3.5) has a good positive predictive value for malignancy.

CLINICAL RELEVANCE/APPLICATION
FDG PET CT with a high positive predictive value can noninvasively differentiate benign from malignant lesions in most situations and is a powerful tool in the evaluation of cardiac masses.

Physics (CAD I)

Sunday, 10:45 AM - 12:15 PM • S403B

SSA19-01 • Virtual Colon Tagging Based Dual-energy Electronic Cleansing for Fecal-tagging CT Colonography

Wenli Cai PhD (Presenter); Se Hyung Kim; Da Zhang PhD; June-Goo Lee PhD; Yasuji Ryu MD; Hiroyuki Yoshida PhD *

PURPOSE
Material decomposition ability in dual-energy CT (DE-CT) provides a promising solution to identify tagged fecal materials in electronic cleansing (EC) for fecal-tagging CT colonography (CTC). The purpose of this study was to develop and evaluate a novel dual-energy electronic cleansing (DE-EC) scheme based on 'virtual colon tagging' (VCT) for minimizing EC artifacts in the cleansed CTC images.

METHOD AND MATERIALS
Based on our localized three-material decomposition model for DE-CT, we developed a DE-EC scheme denoted as VCT-EC, with the following steps: 1) DE-CT images were decomposed into three material mixture fields of luminal air, soft tissue, and iodine-tagged fecal material; 2) a Poisson-based derivative smoothing algorithm smoothed the gradients and implicitly smoothes each material mixture field; 3) VCT images were calculated by virtually elevating the CT value of luminal air to be as high as that of tagged fecal materials and thus virtually tagging the entire colonic lumen, and 4) the entire colonic lumen was segmented and thus cleansed by its high values in VCT images. Twenty-one patients underwent a bowel preparation with a low-fiber, low-residue diet, and oral administration of iodine contrast agents. Dual-energy CT scanning (SOMATOM Definition Flash) was performed at two photon voltages of 140 kVp and 80 kVp with the automatic dose exposure control module (CARE Dose 4D) in both supine and prone positions. Resulting DE-CTC data were subjected to VCT-EC scheme. For comparison purpose, we applied a conventional single-energy EC (SA-EC) to the standard fused DE-CTC images.

RESULTS
A visual assessment was performed by two radiologists for evaluating the cleansing quality by counting of the regions with distractive cleansing artifacts observed in the fly-through of the colon. Compared to SA-EC, the total number of EC artifacts in VCT-EC was reduced significantly by 72%. In specific, the numbers of three types of EC artifacts were reduced by 63% (type1 - caused by pseudo-enhancement), 75% (type 2 - caused by partial volume effect), and 70% (type 3 - caused by inhomogeneous tagging), respectively.

CONCLUSION
Our VCT-based DE-EC scheme provides an effective solution for significantly reducing EC artifacts by use of the material decomposition ability in dual-energy CT.

CLINICAL RELEVANCE/APPLICATION
New dual-energy EC method can substantially reduce EC artifacts and it may lead to artifact-free visualization of the colon.

SSA19-02 • Computer Aided Detection of Ureter Abnormalities on Multi-detector Row CT Urography

Lubomir M Hadjiiski PhD (Presenter); Heang-Ping Chan PhD; Elaine M Caoli MD, MS; Richard H Cohan MD *; Chuan Zhou PhD

PURPOSE
To develop a CAD system for automated detection of ureter abnormalities in multi-detector row CT urography, which potentially can assist radiologists in detecting ureter cancer.

METHOD AND MATERIALS
Our CAD system consists of two stages. In the first stage, an automatic tracking of the ureter is performed by previously proposed COnbined Model-guided Path-finding Analysis and Segmentation System (COMPASS). Given an initial starting point, the ureter is tracked by COMPASS based on the CT values of the contract filled lumen. In the second stage, lesion candidates are identified using histogram analysis within the ureter to differentiate the abnormality from the background, which is the ureter filled with contrast material. A uniformity measure is designed to detect non-uniformity of the CT values within the ureter volume. If an abnormality is present in the ureter, the uniformity of the CT values will be distorted and reduce the uniformity measure. The size and shape of the detected region further differentiate lesions from noise. In this pilot study, a limited data set of 15 patients (13 malignant and 2 benign) with biopsy-proven ureter lesions was used. Experienced radiologists identified 30 biopsy-proven ureter lesions (25 cancers and 5 benign) on the multi-detector row CT images. The average lesions size was 3.4 mm (range: 2.1 mm – 7.6 mm). The average conspicuity was 3.5 (range: 2 to 5) on a scale of 1 to 5 (5 very subtle).

RESULTS
The COMPASS successfully tracked the ureters in all patients. 90% (27/30) of the ureter lesions including 88% (22/25) of the ureter cancers were detected with 2.5 (37/15) false positives per patient. The three missed cancers were small lesions with average size of 2.2 mm.

CONCLUSION
The preliminary results show that our COMPASS and CAD system can track the ureter and detect ureter cancer of medium conspicuity.
The preliminary results show that our COMPASS and CAD system can track the ureter and detect ureter cancer of medium conspicuity and relatively small size. Further study is underway to improve the detection performance with a larger data set. This pilot study is a first step towards the development of a CAD system for detection of ureter cancer in multi-detector row CT urography.

**CLINICAL RELEVANCE/APPLICATION**

An accurate CAD system has the potential to assist radiologists in detection of ureter cancers at an early stage which usually are small in size with subtle appearance.

**SSA19-03 • Detecting Vertebral Degenerative Disease on 18F-NaF PET/CT Using a Novel Cortical Shell Map**

**Jianhua Yao PhD * ; Hector Munoz ; Joseph E Burns MD, PhD ; Karen A Kurzdien MD * ; Peter L Choyke MD * ; Le Lu PhD ; Ronald M Summers MD, PhD (Presenter) * **

**PURPOSE**

Vertebral degenerative disease can mimic metastatic disease on 18F-NaF PET/CT. The purpose of this study is to develop a computer system to automatically detect vertebral degenerative disease on 18F-NaF PET/CT.

**METHOD AND MATERIALS**

The dataset consisted of 46 18F-NaF PET/CT scans (36 men, 10 women, mean age 65±9 yrs). All patients were scanned on a Philips GEMINI TF scanner. The PET resolution was 4*4*4mm. The CT portion of the studies was performed with 5mm slice thickness and without intravenous contrast. The PET data was first resampled to have the same resolution as the CT data. The spine was segmented on the CT images. The cortical shell of each vertebral body was then extracted and unwrapped to a 2D map using a cylindrical coordinate system. The maps were stacked to form a panoramic map of the spinal column (figure). The novel panoramic cortical shell map converted the complex 3D detection problem to a 2D problem. Morphological and physiological features derived from both CT and PET were projected onto the map. A three-tier classification scheme was then applied to detect spinal degenerative osteophytes. The annotated location markers for the osteophytes were used as the reference standard to train the classifiers at each stage. The system was trained on 20 cases and tested on 26 cases. The performance was evaluated using ROC analysis.

**RESULTS**

The numbers of osteophytes larger than 5mm were 163 and 179 in the training and testing sets, respectively. The sensitivities and false positives per case were 82.2% and 4.7, and 77.1% and 4.6 for the training and test sets respectively. The performance with CT and PET data alone were 69% (4.7) and 59% (4.4) respectively. Missed osteophytes were most commonly due to image artifact. Common false positives include the costovertebral junction and partial volume averaging.

**CONCLUSION**

This is the first CAD system to detect spinal osteophytes on 18F-NaF PET/CT. The novel unwrapped cortical shell map facilitates the detection and visualization of degenerative disease. The combination of PET and CT features improved the performance of CAD.

**CLINICAL RELEVANCE/APPLICATION**

By enabling the detection of degenerative change on PET/CT, it may in future be possible to exclude such areas from the images to improve the ability of physicians to perceive metastatic lesions.

**SSA19-04 • Automated Axial Right Ventricle to Left Ventricle Diameter Ratio Computation in Computed Tomography Pulmonary Angiography (CTPA)**

**Germán Gonzalez PhD (Presenter) ; Kanako K Kumamaru MD, PhD ; Daniel Jimenez-Carretero MSC ; Elizabeth George MBBS ; Maria J. Ledesma-Carbayo PhD ; Frank J Rybicki MD, PhD * ; Sara Rodriguez-Lopez ; Raul San Jose Estepar PhD ; Dimitris Mitsouras PhD ; Arash Bedayat MD**

**PURPOSE**

The RV/LV diameter ratio is a proven metric of prognosis in patients with CT pulmonary angiography (CTPA) findings of acute pulmonary embolism (PE). The purpose of this report is to introduce and test, using radiologist and clinical outcomes reference standards, a completely automated algorithm to output the right ventricular to left ventricular (RV/LV) diameter ratio from CTPA images.

**METHOD AND MATERIALS**

A completely automated algorithm with the following six steps was designed to compute the RV/LV diameter ratio. Step 1: image pre-processing. Step 2: right and left heart detection based on machine-learning techniques. Step 3: detection on clustering and seed positioning. Step 4: septum detection. Step 5: right and left heart segmentation based on level-sets with curvature constraints and edge priors. Step 6: caliper positioning and ratio computation. Implemented in Matlab, the algorithm analyzes 600 CTPA reconstructed slices in 10 minutes (Intel i7 computer). Automated reports with snapshots of the slices where the RV and LV diameters are found are sent to the physician for reporting. The algorithm was tested in 198 consecutive patients with acute PE diagnosed with CTPA using (a) reference standard RV/LV radiologist measurements and (b) 30-day PE-specific mortality plus the need for intensive therapies.

**RESULTS**

Using radiologist reference standard, the algorithm correctly detected and segmented 96% (190/198) of CTPA studies. Even including failure cases, the correlation between the RV/LV diameter ratio obtained by the algorithm and that obtained by the radiologist was high (r=0.72). Compared to the radiologist, the algorithm equally achieved high accuracy in predicting 30-day PE-specific mortality plus the need for intensive therapies with area under the curve of 0.74 for the automated method and 0.77 for the radiologist measurements. Failure cases were readily identified by the output snapshots available to the radiologist.

**CONCLUSION**

An automated algorithm for determining the CT derived RV/LV diameter ratio in patients with acute PE has high accuracy when compared to measurements made by a radiologist and prognostic significance when tested against reference standard outcomes.

**CLINICAL RELEVANCE/APPLICATION**

An automated RV/LV diameter ratio algorithm has promise to generate data for prognosis in patients with acute PE that can be readily implemented into clinical reporting.

**SSA19-05 • Computer-aided Diagnosis (CADx) as a Surrogate Measure of Image Quality: Dependence of CADx Performance on Reconstruction Parameters in Dedicated Breast CT**

**Ingrid Reiser PhD (Presenter) ; Robert M Nishikawa PhD * ; John M Boone PhD * ; Karen K Lindfors MD * ; Kai Yang PhD**

**PURPOSE**

The purpose of this work was to investigate whether the performance of computer-aided diagnosis (CADx) of breast masses in CT images with different reconstructions parameters can serve as surrogate measure for image quality. The first step towards this goal is an investigation into the relationship between reconstruction parameters and CADx performance, which is presented here.

**METHOD AND MATERIALS**

The data set consisted of cone-beam breast CT data from 69 patients containing 78 masses (24 benign, 54 malignant). 3cm³ regions of interest (ROIs) were created on each mass. Images reconstructed with the FDK reconstruction algorithm were generated for two apodization filter cut-off values (L=1.0 and L=0.5) and three reconstructed image voxel sizes (150 mum, 300 mum and 450 mum isotropic). All parameters produced images that were visually judged to be of diagnostic quality. From each set of ROIs, lesions were segmented and feature analysis was performed using algorithms that were developed previously. Three features were manually selected to ensure that variation in CADx performance was due to different image parameters rather than different feature sets. ROC analysis was used to estimate CADx performance in the task of distinguishing benign from malignant lesions using a leave-one-out resampling
RESULTS
Visually, reconstruction parameters affected the sharpness and apparent noise of the images. As expected, L=0.5 produced smoother images than L=1.0, and images with smaller voxel size had a noisier appearance. CADx performance, measured as area under the ROC curve (AUC), ranged between 0.78 and 0.86, with larger reconstructed voxels, and smoother images (L=0.5) producing higher AUC values. This trend was also observed for individual features.

CONCLUSION
Our study indicates that CADx performance depends on reconstruction parameters and therefore it has the potential to measure the quality of the reconstructed images. The next step of this research is to measure the correlation between CADx and radiologists’ performance as reconstruction parameters are changed.

CLINICAL RELEVANCE/APPLICATION
This CADx methodology has potential for assessing clinical performance of reconstruction algorithms, and ultimately to improve diagnostic accuracy by optimizing CT reconstruction.

SSA19-06 • Computerized Risk Assessment Imaging System for Predicting the Likelihood of Breast Cancer

David Izhaky PhD (Presenter) *; Tamar Sella MD; Maya Cohen MD; Arnaldo Mayer PhD *; Tanir Allweis MD; Miriam Sklair-Levy MD *

PURPOSE
Early detection and prevention strategies for breast cancer depend on the ability to accurately identify individuals with significantly increased breast cancer risk. Currently, such risk assessment models are statistical in nature and rely mainly on clinical features such as genetic susceptibility, family history or mammography breast density. The purpose of this study is to develop a computerized imaging system and method for assessing the likelihood of a malignant tumor based on breast vascular maps.

METHOD AND MATERIALS
3D breast vascular maps of 334 women were included in the study. IRB approval was obtained. Vascular maps were acquired using a prototype 3D functional infrared imaging device (Real Imaging). Of these 334 women, 209 were healthy (mammography BIRADS 1), 36 had benign lesions (mammography BIRADS 2) and 94 had biopsy proven breast cancer. A linear discriminant classifier with feature selection which was previously trained to compute the cancer likelihood on image dataset was applied. Analysis was blinded to clinical and pathological diagnosis. The diagnostic accuracy of the breast cancer likelihood was evaluated using receiver-operating characteristic (ROC) analysis and bootstrapping.

RESULTS
An area under the ROC curve of 0.84 (95% CI 0.77-0.89) was obtained for determining the cancer likelihood.

CONCLUSION
A risk assessment model for predicting the likelihood of malignant tumor based on vascular maps was developed. The results warrants further evaluation in a larger population-based clinical trial.


Sumiaki Matsumoto MD, PhD (Presenter) *; Yoshiharu Ohno MD, PhD *; Takatoshi Aoki MD, PhD; Tae Iwasawa MD, PhD; Fumito Okada MD; Kota Aoyagi *; Hiroyasu Inokawa *; Hitoshi Yamagata PhD *; Kazuro Sugimura MD, PhD *

PURPOSE
To assess the effect of adaptive iterative dose reduction (AIDR 3D) on the stand-alone performance of a prototype computer-aided detection (CAD) system for lung nodules using CT data acquired at standard-, low-, and ultra-low-dose levels.

METHOD AND MATERIALS
This study used CT data of 60 patients who prospectively underwent a chest CT examination using a multidetector-row scanner with a protocol including standard-dose (125 mAs), low-dose (25 mAs), and ultra-low-dose (5 mAs) unenhanced scans. Each scanned data were reconstructed into 1-mm-thick images without and with AIDR 3D. The following groups of CT images, each consisting of 60 datasets, were thus obtained: (S-wo) at 125 mAs, without AIDR 3D; (S-w) at 125 mAs, with AIDR 3D; (L-wo) at 25 mAs, without AIDR 3D; (L-w) at 25 mAs, with AIDR 3D; (U-wo) at 5 mAs, without AIDR 3D; (U-w) at 5 mAs, with AIDR 3D. Two experienced chest radiologists carefully reviewed the group S-wo and determined a gold standard of nodules ranging 5-30 mm in diameter by consensus. Based on the gold standard, the sensitivity and false positive rate of the CAD system on all groups were determined. Regarding sensitivities, the group S-wo and each of the other groups were compared using McNemar’s test; similar comparisons regarding false positive rates were made using signed rank test.

RESULTS
The reference standard consisted of 198 (104 solid and 94 subsolid) nodules. The sensitivity and false positive rate (per patient) on the group S-wo were 58.6% and 0.97. The sensitivities (corresponding p values of the comparisons with the group S-wo) on the other groups (S-w, L-wo, L-w, U-wo, and U-w) were 67.7% (p=0.02), 65.7% (p=0.05), 66.3% (p=0.03), 66.2% (p=0.03), and 66.2% (p=0.03), respectively.

CONCLUSION
Regarding sensitivities, 25-mAs and 5-mAs groups with AIDR 3D were comparable to the 125-mAs group without AIDR, whereas 25-mAs and 5-mAs groups without AIDR 3D were inferior to the latter group; furthermore, the 125-mAs group with AIDR 3D was superior to that without AIDR 3D. Regarding false positive rate, corresponding comparisons showed no highly significant difference.

CLINICAL RELEVANCE/APPLICATION
In terms of the performance of a CAD system for lung nodules, standard-dose CT with AIDR 3D and low- or ultra-low-dose CT with AIDR 3D can respectively surpass and parallel usual standard-dose CT.

SSA19-08 • Computer-aided Detection of Colitis in Computed Tomography Examinations

Evrim B Turkbey MD (Presenter); Le Lu PhD; Jianhua Yao PhD *; Zhuoshi Wei PhD; Ronald M Summers MD, PhD *

PURPOSE
To develop a computer aided detection (CAD) tool for automated detection of regions with colitis in CT examinations.

METHOD AND MATERIALS
One representative axial CT image per patient passing through the cecum or ascending colon was selected from 17 colitis patients (mean age= 38±13 yrs, 8 women, 9 men) and 25 healthy subjects (mean age=44±13yrs, 18 women, 7 men). Colitis was defined as presence of colonic wall thickening (>3mm) accompanied by pericolonic fat stranding and was manually segmented by a radiologist. The CAD method was three-tiered. An image intensity and gradient checker, trained from annotated colitis regions, is used to quickly discard non-informative image areas. A discriminative scanning window detector using covariance descriptor, selective data resampling and extended Gaussian kernel support vector machine follows for image patch classification as colitis or not. Finally, the local patch detections with confidences are spatially aggregated to form statistical features per image that label the whole dataset as with or without colitis. A k-nearest neighbor classifier is used. Three-fold cross validation is employed for classification performance assessment.
RESULTS
The mean wall thickness at colitis segments was 9.3 mm (range: 4.2-20.2 mm) whereas it was 2.3 mm (range: 1.2-3.2 mm) at normal colon segments (P=0.0001). The overall per patient classification accuracy is 83.3%. For colitis patients, the sensitivity is 88.2% (15 out of 17). 19 out of 25 healthy subjects are classified correctly with the specificity of 76%.

CONCLUSION
The CAD tool introduced in the current study can detect colitis affecting the cecum/ascending colon region with high sensitivity and good specificity. The challenge of colitis image pattern being visually ambiguous is solved by the high description power of covariance descriptor, hard negative bootstrapping and the tiered classification at local and global image levels.

CLINICAL RELEVANCE/APPLICATION
Early diagnosis of colitis is critical to prevent bowel necrosis and perforation in immunosuppressive patients. A computer-aided detection tool may help to increase detection rates of colitis in CT.

SSA19-09 • A Computer-aided Diagnosis System for Detecting Renal Extracolonic Findings on CT Colonography

Jian Fei L Liu MD; Shijun Wang; Marius G Lingurarup DPhil, MS; Ronald M Summers MD, PhD (Presenter) *

PURPOSE
To accurately detect renal calculi and lesions on CT colonography (CTC) by computer-aided diagnosis.

METHOD AND MATERIALS
We studied 66 patients (age range, 43-72 years; mean 57±7 years) undergoing CT colonography. The slice thickness was 1 mm. There were 52 renal calculi (size range, 1-7mm; mean size, 2±1 mm) and 58 renal lesions (size range, 3-51mm; mean size, 16±10 mm). 36 lesions and 25 calculi were located in the left kidney, and 22 lesions and 27 calculi in the right kidney. We first segmented both kidneys on the supine CTC images. Total variational (TV) flow was used to remove image noise in the kidney regions for a maximally stable extremal region (MSER) detector to extract calculi candidates. We detected lesions by performing manifold diffusion on the kidney surface and searching for points with local maximum diffusion response. Both calculi and lesion candidates were finally classified by a support vector machine to determine the final detected calculi and lesions. There were 30 patients in the training dataset and 36 patients in the test set for renal calculi and lesion detection. The training set contained 20 calculi and 24 lesions, and the test set had 32 calculi and 34 lesions. We performed a free-response receiver operating characteristic analysis on the test set to validate the results.

RESULTS
There were 41 true detections on calculi (from 29 unique calculi) and 417 false positives. The sensitivity of renal calculi detection was 80% at 1 false positive per patient. There were 33 true detections on renal lesions (from 31 unique lesions) and 277 false positives. The sensitivity of lesion detection was 87% at 7 false positives per patient.

CONCLUSION
Detection of renal calculi and lesions is challenging on CTC images because the primary purpose of CTC is to screen for colon cancer and the studies are typically done with lower dose and without intravenous contrast. TV-flow and MSER detector are efficient means to detect renal calculi by reducing image noise and extracting image regions with high intensity values. The manifold diffusion efficiently detects kidney lesions based on their geometric properties. Our method can detect renal calculi larger than 1 mm with few false positives and renal lesions with moderate false positive rates.

CLINICAL RELEVANCE/APPLICATION
Our CAD system accurately detects renal calculi and lesions on CTC images and, with future clinical validation, may lead to improved diagnosis.
ASSA20-05 • Low-dose Pelvic CT Using Adaptive Iterative Dose Reduction 3D: A Phantom Study

Aaron So PhD (Presenter) ; Jiang Hsieh PhD * ; Jean-Baptiste Thibault * ; Kelley Branch MD * ; Ting-Yim Lee MSc, PhD *

PURPOSE
We validated the effectiveness of adaptive statistical iterative reconstruction (ASIR, GE Healthcare (GE)) for minimizing image noise in low dose quantitative myocardial perfusion (MP) imaging against microspheres MP measurement.

METHOD AND MATERIALS
Iodinated contrast (Iodine 370, 0.7 mgI/kg) was injected at 3 to 4 ml/s into 68±25 kg normal pigs via an ear vein and the heart was scanned using a GE Discovery 750HD scanner with a prospectively ECG triggered dynamic protocol (Snapshot Pulse, GE); axial scan every 1-2 heart beats for 22 scans using 140 kV, 0.35 s gantry period and 80 mA (normal dose). MP measurement was repeated with the x-ray tube current reduced to 20 mA (low dose). The normal- and low-dose SSP images were reconstructed using filtered backprojection (FBP), (SSP80) and both FBP (SSP280) and ASIR (SSP280 (ASM)) respectively. All images were corrected for beam hardening from which MP maps were generated using CT Perfusion (GE). After the CT perfusion studies, fluoroscopic microspheres were injected into the left atrial appendage of the heart to measure MP. Mean MP measured with microspheres and the three CT image sets in 45 segments from the lateral, apical and septal wall in 15 slices from three pigs were compared using linear regression and Bland-Altman analysis. Effective dose (ED) of each SSP protocol was estimated from the dose-length product provided by the scanner.

RESULTS
SP80 images exhibited the highest correlation with microspheres (R=0.69) compared to SSP20ASIR (R=0.60) and SSP20FBP (R=0.57). SSP80 images also showed the smallest difference in mean MP from microspheres and narrowest limits of agreement with microspheres (7.0 and -32.8 to 64.1 m/s^2) compared to SSP20ASIR (11.3 and -38.3 to 57.8 (93)) and SSP20FBP (15.7 and -32.8 to 64.1 (97)). ED of the SSP80 and SSP20 protocols were 4.5 and 1.1 mSv respectively.

CONCLUSION
Noise in low dose SSP images reconstructed with FBP was excessive which led to less accurate and reproducible MP estimation with CT Perfusion but such errors could be reduced with ASIR.

CLINICAL RELEVANCE/APPLICATION
With the proposed image acquisition and reconstruction approaches, MP measurement with low dose CT Perfusion is a feasible alternative to MRI and SPECT for studying ischemic heart disease.
SSA20-06 • Synergistic Radiation Dose Reduction by Combining Automatic Tube Voltage Selection and Iterative Reconstruction

Jeremy R Wortman MD (Presenter) ; Alexander J Adduci MD, Phd ; Tim O’Connell MD, MEng * ; Aaron D Sodickson MD, PhD

PURPOSE
To evaluate radiation dose and image quality in CT pulmonary angiography (CTPA) exams with automated tube voltage selection (CarekV) before and after implementation of sinogram affirmed iterative reconstruction (Safire).

METHOD AND MATERIALS
The cohort included: 1) 61 consecutive CTPAs performed on a Siemens AS+ scanner from 5/7/12 to 5/31/12 using CarekV (vascular image quality selection, reference kVp 120, reference mAs 180), and 2) 59 consecutive CTPAs performed from 7/1/12 to 7/18/12 using CarekV with reference mAs reduced to 120 and images reconstructed using Safire at strength of 3. All scans were performed with longitudinal and in-plane tube current modulation (CareDose 4D). CarekV on a vascular setting uses the topogram x-ray attenuation to select the scan kVp expected to produce the lowest achievable CTDIvol while maintaining the desired iodine contrast to noise ratio and respecting the maximum x-ray tube current limits. We measured patient size (effective diameter = sqrt(AP X Lat)), signal (mean CT density) and noise (standard deviation), and recorded local CTDIvol at the level of the main pulmonary artery. Linear regression models were created for the dependent variables ln(CTDIvol), signal, noise, and signal to noise ratio (SNR) as a function of independent variables size, age, gender, and reconstruction technique.

RESULTS
The 33% reduction in reference mAs in the Safire group allowed CarekV to select reduced kVp in larger patients than in the FBP group, with an overall reduction in 120 kVp scans from 42.9% to 0% and an associated increase in 100 kVp scans from 53.6% to 62.0% and 80 kVp scans from 3.5% to 38.0%. When controlling for size and demographics, the combination of Safire and CarekV yielded an overall CTDIvol reduction of 44.5% (p < .0001), a signal increase of 96 HU (p = .002), and an increase in image noise (p = .004) with no significant change in SNR (p = .70).

CONCLUSION
The combination of CarekV and Safire resulted in a 44.5% dose reduction, substantially greater than the 33% reduction that would be achieved by reducing the reference mAs alone. This is accomplished with preserved image quality as the reduced reference mAs allows CarekV to scan larger patients at reduced kVp.

CLINICAL RELEVANCE/APPLICATION
Synergistic dose reduction can be achieved by combining automatic kVp selection with global mAs reduction (as used in concert with iterative reconstruction) with no negative impact on image quality.

SSA20-07 • Systematic Dose Evaluation of Iterative Reconstructed Computed Tomography in a Contrast Enhanced Cadaveric Model

Tobias Penzkofer MD (Presenter) * ; Jonas C Apitzsch MD ; Yunus Alparslan ; Hong-Sik Na MD ; Timm Dirrichs ; Philipp Brunner MD ; Peter Isfort MD ; Andreas H Mahnken MD * ; Saskia Westphal ; Ruth Knuchel-Clarke PhD ; Christiane K Kuhl MD *

PURPOSE
To systematically test the potential for dose savings in computed tomography (CT) through iterative reconstruction in a contrast enhanced human cadaveric model.

METHOD AND MATERIALS
Fifteen human cadavers scheduled for contrast enhanced virtual autopsy were injected with hyperdense contrast agent through the iliac arteries. A series of thoracic and abdominal tube current scaled CT scans (11 scans, 20mAs/eff - 200 mAs/eff in steps of 20mAs) were performed and reconstructed using standard filtered back projection (FBP) and iterative reconstruction algorithms (IR) in soft and sharp reconstruction kernels. The imaging datasets were evaluated in randomly and blinded to the reconstruction method by defining minimally necessary doses for CT quality criteria as defined in EU16262 (36 items, 17 thoracic, 6 mediastinal, 13 abdominal) independently by three radiologists (36x15x3x4=6480 data points). Minimal doses for every of the two reconstruction methods and kernel types in their respective applications were compared statistically.

RESULTS
In all subjects a sufficient contrast filling for further analysis was achieved. Average minimal doses for soft tissue applications (soft kernels) were 132.3±44.6 mAs (FBP) vs. 115.6±46.7 mAs (IR, p=0.0001), for bone and lung applications (sharp kernels) 140.9±47.1 mAs (FBP) vs. 130.9±49.1 mAs (IR, p=0.0001). The achieved amount of tube current saving were 12.6% (soft kernels) and 7.1% (sharp kernels).

CONCLUSION
In a blinded, randomized study, iterative reconstruction yielded a statistically significant dose saving in soft tissue and sharp kernel applications. While many publications claim dose savings of up to 50% throughout the spectrum of CT vendors, the savings yield was...
CONCLUSION
Dose reductions up to 66% with no significant loss of image quality can be achieved using iDose compared to FBP algorithm. In the light of these promising results, iDose is increasingly used in our hospital. As dose and image quality should be balanced according to patient needs, we are presently studying the adequate choice of iDose level using clinical data.

Background
Radiation exposure from medical imaging has become a public health concern due to the increasing use of CT. Attempts to lower the radiation dose associated with CT studies are limited by image noise on FBP-based reconstructions. We assessed the dose reduction capabilities and in-phantom image quality metrics of a commercial iterative reconstruction algorithm.

Evaluation
We compared the performance of the iterative reconstruction algorithm iDose to the standard FBP algorithm supplied with the 256-slice MDCT brilliance iCT (Philips Healthcare). We used a Catphan 504 (The Phantom Laboratory) to assess image quality in terms of CT number calibration, image noise, low contrast detectability and spatial resolution. We reconstructed 35 helical acquisitions (varying kV and mAs/slice) using FBP and 6 noise reduction levels provided by iDose. We measured the dosimetric index CTDI_vol of all acquisitions using the solid state detector/multimeter CT Dose Profiler/Barracuda (RTI Electronics) and a phantom assembled with 3 standard PMMA body phantoms of 32 cm diameter and 3x15 cm length.

Discusison
CT number calibration obtained using iDose levels and FBP was compatible within 1%. iDose reduced image noise from 10% (iDose1) to 41% (iDose6) compared to FBP, regardless of the CTDI_vol of the study. Conversely, the dose reduction capability of iDose ranged from 19% (iDose1) to 66% (iDose6) maintaining the same image noise as FBP. These results are compatible with the manufacturer's specifications. We compared the iDose reconstructions to FBP reconstructions of the same acquisitions, we observed a marked improvement in noise reduction of 11% (iDose1) to 71% (iDose6). Spatial resolution improved slightly compared to FBP. However, we are now devising new measurements to fully quantify the iDose spatial resolution capabilities.

SA20-09 • Evaluation of TV-minimization-based Reconstruction for Low-dose Dedicated Breast CT

Junguo Bian PhD (Presenter) ; Kai Yang PhD ; Xiao Han MSc ; Karen Lindfors MD * ; Erik A Pearson BS, BEng ; Emil Y Sidky PhD ; John M Boone PhD * ; Xiaochuan Pan PhD *

PURPOSE
Current dedicated breast CT is of low SNR in projection data and high noise in reconstruction images because a small imaging dose is distributed into large number of projections. The small contrast and fine structure of breast tissues, together with low-SNR data has made reconstruction improvement from low-dose breast-CT data very challenging. We have developed and tailored a TV-minimization based reconstruction algorithm for breast CT and performed reconstruction for more than 10 patient cases. In the work, we evaluated the image quality of TV-minimization-based reconstructions against images currently reconstructed by use of FBP algorithm. We demonstrate that image quality can be improved over the currently used FBP-based algorithms for low-dose breast CT.

METHOD AND MATERIALS
The reconstruction is formulated into a constrained-TV-minimization problem. We developed and tailored an ASD-POCS algorithm for solving the problem. Patient data were collected during an ongoing clinical trial performed at UC-Davis. We performed reconstruction of the whole volume for more than 10 patient cases from the low-SNR data. Special attention was paid to minimize the blocky appearances that are typically observed in images reconstructed by use of TV-minimization-based algorithms from low-dose data sets. We use the difference between adjacent slices to quantify quantum noise and use the power-law exponent, Beta, fitted from log-log plot of the image power spectra to quantify anatomical noise. A smaller Beta value for the reconstruction images indicates a better observer performance on lesion detection. We also performed a 2AFC experiment in which the observers were asked their preference between images currently reconstructed by use of FBP and the proposed algorithms.

RESULTS
Visual inspection shows images reconstructed with proposed algorithm have improved contrast and details. The noise variances and Beta values are consistently smaller for image reconstructed with the proposed algorithm. The results of 2AFC study also show observers' preference of images reconstructed by use of the proposed algorithm over those currently reconstructed by use of FBP algorithms.

CONCLUSION
The results demonstrated that the proposed algorithm can improve image quality for current dedicated breast CT.

CLINICAL RELEVANCE/APPLICATION
The image quality improvement for the dedicated, cone-beam breast CT scanner may have impacts for breast cancer screening or diagnosis.
systematic TRUS biopsy. Biopsy needle guidance under TRUS is the most economical option, but spatial correspondence of MRI findings with TRUS is non-trivial. The accuracy of sampling MRI lesions under 2D and 3D TRUS and 3D TRUS fusion is quantified.

METHOD AND MATERIALS
Three experts performed simulated biopsies on 12 patients (Pros. Vol=37±11g, PSA=9.0±5.1ng/ml) with a total of 15 Bx-confirmed PCa MRI lesions (0.8±0.8g) who were selected from 90 patients undergoing MRI-3D TRUS fusion biopsy. Two core-biopsies were targeted at each MR lesion using 2D TRUS, 3D TRUS and MRI-3D TRUS fusion for needle guidance, using a validated Bx simulator. Additional single core-biopsies were directed toward common regional targets defined for all patients. Regions included: left-anterior transition zone (TZ), left mid-gland, right apex and right base. The simulated Bx core locations were compared to the original MRI to evaluate the sampling accuracy.

RESULTS
The 15 PCa tumors were distributed as follows: Base=4, Mid-gland=5, Apex=6, with 7 lesions along the anterior prostate. Only 44±4% and 51±14% of tumors were sampled with 2D and 3D TRUS, respectively, compared to 98±4% with fusion biopsy. Bx sampling rates were not significantly different between anterior and posterior tumors for any modality. The Bx sampling errors for the regional targets were significantly higher (po>90°).

CONCLUSION
Biopsy of prostate MRI lesions under 2D or 3D TRUS without MR-fusion may be inaccurate and lead to a falsely negative biopsy.

CLINICAL RELEVANCE/APPLICATION
Targeting biopsies at suspicious lesions seen on prostate MRI using 2D or 3D TRUS without image fusion is likely not accurate enough to adequately detect many significant prostate cancers.
PURPOSE
To test commercial and research ultrasound SWS systems to identify the sources and magnitude of bias and variability in SWS measurements.

METHOD AND MATERIALS
Eleven phantom pairs were built from stiff and soft batches of Zerdine® by CIRS. Larger phantoms were also prepared for correlative testing using magnetic resonance elastography. All phantoms were initially tested by one lab to determine manufacturing variation and were then shipped to 11 different labs for SWS measurements. At each site, 3-5 operators measure each phantom at three times at each of three depths according to a randomized schedule. Each measurement consists of the average of ten valid SWS acquisitions as has been reported in the clinical literature. The data are analyzed using crossed Gage R and R methodology with ANOVA. Bias is estimated by comparing the results with known values of elastic modulus (converted to SWS) from the manufacturer and from mechanical testing performed across a broad range of shear wave frequencies at two sites. Estimates of linearity can also be obtained since stiff and soft phantoms are tested at each site.

RESULTS
Mechanical test results from the two sites performing those measurements were in excellent agreement. Initial analysis of US SWS measurements shows overall variability of 5-7% in SWS mean values for several sites. ANOVA shows that site and measurement depth are the dominant sources of variation with operator variability being a minor component. Variation in SWS for all phantoms was 3-5% on initial testing of all phantoms. A 5-10% depth dependence (lower SWS at deeper depths) was also seen. Also, a small bias in SWS estimates of 5-6% was seen. Similar variability and bias are seen for both stiff and soft phantoms.

CONCLUSION
Initial results show a relatively small amount of variability in SWS estimates and also show that operator variability contributes little to total measurement variation. Phantom variation may be a significant source of the variability in measurements. Given these encouraging results, we will add measurements from additional sites, explore the causes of the depth dependence of SWS, and extend our work to lossy (viscoelastic) phantoms which more closely mimic human liver tissue.

CLINICAL RELEVANCE/APPLICATION
This work by QIBA is the first step in development of a protocol for US SWS measurement that gives accurate and repeatable results across a range of instruments for drug testing, clinical and research use.

SSA21-05 • Visualization of Vascularity in Breast Lesions Using US Contrast Enhanced 3D Subharmonic Imaging

Anush Sridharan ; John R Eisenbrey PhD ; Flemming Forsberg PhD (Presenter) * ; Priscilla Machado MD ; Daniel A Merton ; Kirk Wallace PhD * ; Carl Chalek PhD * ; Kai E Thomenius PhD *

PURPOSE
To develop a method for improving visualization of vascularity in breast lesions using 3D contrast-enhanced subharmonic imaging (SHI).

METHOD AND MATERIALS
A modified Logiq 9 (GE Healthcare, Milwaukee, WI) scanner with a 4D10L probe was used for 3D harmonic imaging (HI) and SHI of breast lesions in 72 patients after bolus injection of an ultrasound contrast agent (UCA; Definity, Lantheus Medical Imaging, N Billerica, MA; dose: 0.25mL for HI and 20?L/kg for SHI). Fifteen biopsy-proven malignant cases were selected for image processing. A region-of-interest (ROI) corresponding to UCA flow (within the lesion) and tissue in both 3D HI and SHI were selected for each case. A volumetric map of the time-intensity curve for each slice within the volume was generated over time. Slices showing presence of UCA were identified and isolated. To improve visualization of flow a volumetric background template was generated (from baseline) and used to filter out tissue signals. Contrast-to-tissue ratios (CTR) were calculated for 3D HI and SHI before and after background subtraction for vessel-tissue ROIs and also compared between the isolated slices and the entire volume.

RESULTS
Both 3D HI and SHI showed significant suppression of tissue signal after background filtering (p < 0.05).

CONCLUSION
3D SHI showed better visualization of vascularity in all cases via increased tissue suppression and sensitivity to UCA flow. The improvement in visualization of vasculature based on isolation of slices demonstrates the importance of 3D imaging to visualize breast cancer flow.

CLINICAL RELEVANCE/APPLICATION
Visualizing the vascular structure of breast lesions may help improve characterization.

SSA21-06 • Quantitative Biomarkers for the Assessment of Fibrosis Using M-Mode US and Shear Wave Elastography

Lauren Rosenblum BSc ; Priscilla Machado MD ; Patrick L O’Kane MD * ; Andrej Lyshchik MD ; Flemming Forsberg PhD (Presenter) *

PURPOSE
To determine if M-mode or Shear Wave Elasticity (SWE) imaging (independently or combined) provide quantitative markers of liver fibrosis compared to conventional grayscale ultrasound (US) imaging and pathology (the reference standard).

METHOD AND MATERIALS
Twelve subjects scheduled for an US-guided liver biopsy and 5 healthy volunteers were scanned with a broad bandwidth curvi-linear array using an IU22 (Philips Medical Systems, Bothell, WA; for grayscale and M-mode imaging) and an Aixplorer scanner (SuperSonic Imagine, Aix-en-Provence, France; for SWE imaging). The M-mode images were quantified using the scanners’ existing calculation software package and by a novel algorithm (implemented in Matlab; Mathworks, Natick, MA) extracting distances between lines of similar intensities (L2LD) as a quantitative biomarker of liver status. Liver stiffness (in kPa) was recorded from the SWE images, while a radiologist (blinded to the other results) scored the grayscale US for degree of fibrosis (on a 0-4 scale). ANOVA and Wilcoxon’s sign rank tests were used to compare the classification of liver fibrosis by SWE, M-mode (i.e., L2LD) and radiologists scoring with fibrosis determined by pathology as the reference standard.

RESULTS
In this pilot study, the radiologist was correct in 53% of assessments, which was not different from pathology when using a non-parametric test (p=0.3). SWE did not differentiate between degrees of fibrosis (p > 0.71), while the new L2LD biomarker was able to perform a correct classification (p = 0.044). The best differentiation was achieved between normal subjects (fibrosis score = 0) and the subjects with fibrosis scores greater than or equal to 1 (0.30 ± 0.041 vs. 0.43 ± 0.085; p < 0.005).

CONCLUSION
A new biomarker for noninvasive US evaluation of liver status, based on extracting distances between lines of similar intensities from M-mode images, have been developed. Initial results indicate this parameter can correctly classify degree of fibrosis; albeit based on a limited sample size.

CLINICAL RELEVANCE/APPLICATION
If these results are reproducible in a larger patient population, it may be possible to replace some liver biopsies with evaluations based on noninvasive, quantitative US biomarkers.

SSA21-07 • Dynamic Contrast-enhanced Ultrasound Parametric Maps for the Evaluation of Intratumoral Vascularity: Preclinical Study

Stephanie Pitre-Champagnat ; Ingrid Leguerney ; Jacques Bosq ; Fabian Kiessling MD ; Benedicte Coiffier (Presenter) ;
CONCLUSION
Parametric maps from raw linear data can be performed in short process time with moving average model, and reflect reliably the heterogeneous histological measures within tumor by considering the contribution of the vessel size in the variations of intratumoral blood volume.

Background
Parametric maps from Dynamic Contrast-Enhanced Ultrasonography (DCE-US) appear as a useful tool to describe the intratumoral vasculature and its heterogeneity. This study was designed to identify the best processing of parametric maps from raw data and to compare the results to histologic vascularity measurement.

Evaluation
DCE-US was performed on 17 melanoma-bearing nude mice after a 0.1mL bolus injection of SonoVue® (Bracco, Italy). Parametric maps treated intensity values (TIC) from raw linear data to extract pixelwise two parameters related to blood volume that were area under the curve (AUC) and peak intensity (PI). Three mathematical models were compared to fit the TIC in each pixel: a polynomial model used in clinical routine, a moving average model and a combination of two linear regressions. Parametric maps performed from the best fit approach were compared with histology for both region of interest (ROI) of whole tumor and several subROIs of 15mm2 within each tumor to reflect intratumoral vascular heterogeneity. As ground truth correlate, microvessel densities (MVD) were determined, and vessels size only for subROIs.

Discussion
The moving average approach was the best compromise between values determination and processing pixelwise time (40m (rAUC=0.90 (p=0.012) ; rPI=0.83 (p=0.041)).

SSA21-08 - Effects of Ultrasound Parameters on Cavitation-assisted Delivery of PLGA-PEG Nanoparticles into Tumors: Phantom Study and Preliminary In Vivo Results

Tzu-Yin Wang (Presenter); Jung Woo Choe; Steven B Machtaler PhD; Rammohan Devulapally; Butrus T Khuri-Yakub PhD; Ramasamy Paulmurugan PhD; Juergen W Willmann MD *

PURPOSE
Ultrasound(US)-microbubble(MB)-mediated drug delivery is a promising technique for image-guided, targeted cancer therapy. To optimize this technique for clinical translations, we performed a systematic study on effects of various US and MB parameters on cavitation and the corresponding delivery results of an FDA approved drug carrier, poly(D,L-lactide-co-glycolide)-block-poly(ethylene glycol) (PLGA-b-PEG-COOH) nanoparticles (NPs) into tumors.

METHOD AND MATERIALS
Cavitation was induced by exposing lipid-shelled, perfluorocarbon encapsulated MBs to 1.8-MHz US pulses. Cavitation was evaluated with passive detection of the inertial cavitation dose (ICD) and active imaging of MB destruction. Effects of peak negative pressure, pulse length, frequency, repetition frequency (PRF), MB concentration, and focal scanning strategies, on cavitation were studied in an agar tissue phantom. Preliminary in vivo studies were performed to study the feasibility of delivering PLGA-PEG NPs into hepatocellular tumors in mice.

RESULTS
Passive cavitation detection showed that the ICD increased with pressures increasing from 0.5 to 5MPa, and with PRFs increasing from 10 to 100 Hz (N=6 each). The ICD also increased with increasing MB concentration from 4x106 to 1x108 bubbles/mL, but saturated at higher concentration (N=6 each). No significant effect was found for pulse lengths below 15 cycles. Active cavitation imaging confirmed more MB destruction with increasing pressures. When the pressure exceeded 3MPa, more violent cavitation was observed as flickering bright spots at the focus of US. Compared to single focus treatment, electronic focal steering over a large target volume resulted in more homogeneous treatment (N=4 each). Preliminary in vivo experiments showed successful delivery of PLGA-PEG NPs to a hepatocellular tumor.

CONCLUSION
The pressure, PRF, MB concentration, and focal scanning strategies, have distinct effects on cavitation, while no significant influence was found for short pulse lengths. Preliminary in vivo results demonstrated the feasibility of delivering PLGA-PEG NPs into tumors for targeted cancer therapy.

CLINICAL RELEVANCE/APPLICATION
This study presents a clinically translatable systematic approach for spatially localized and optimized delivery of large drugs/carriers to target sites based on quantitative measurement of cavitation.

SSA21-09 - Comparing Immunohistochemical Markers of Angiogenesis to Subharmonic Imaging of Vascularity in a Murine Breast Cancer Model

Andrew Marshall; Jaydev K Dave PhD, MS; Flemming Forsberg PhD (Presenter) *; Valgerdur Halldorsdottir MSc; Anya I Forsberg; Manasi Dahibawkar BSc; Traci B Fox MS, RT; Ji-Bin Liu MD *

PURPOSE
To compare contrast-enhanced subharmonic ultrasound imaging (SHI) of breast tumor neovascularity to three immunohistochemical markers of angiogenesis in nude rats.

METHOD AND MATERIALS
Seventy athymic, nude, female rats were implanted with 5 x 106 breast cancer cells (MDA-MB-231) in the mammary fat pad. The contrast agent Definity® (Lantheus Medical Imaging, N Billerica, MA) was injected in a tail vein (dose: 36 ?l) and fundamental ultrasound imaging as well as pulse-inversion SHI was performed in triplicate with a modified Sonix RP scanner (Ultrasonix Imaging, Richmond, BC, Canada) using a L9-4 linear array (transmitting at 8 MHz and receiving at 4 MHz in SHI mode). Studies were performed 21, 24 and 28 days post implantation (based on our prior experience). After the experiments, specimens were stained for endothelial cells (CD31), vascular endothelial growth factor (VEGF), and cyclooxygenase-2 (COX-2). Fractional tumor vascularity (FV) was calculated from digital images as contrast enhanced pixels over tumor area (for SHI; averaged over the 3 injections) and staining over tumor area (for specimens). Results were compared using a linear regression analysis.

RESULTS
Of the 70 rats implanted 45 (64 %) exhibited tumor growth and 32 were successfully imaged. SHI depicted the tortuous morphology of tumor neovessels and delineated areas of necrosis better than fundamental ultrasound imaging, due to the marked suppression of tissue signals. VEGF varied significantly over time (p<0.05). Quantitative contrast-enhanced SHI measures of tumor neovascularity in a breast cancer xenograft models appear to provide a noninvasive marker for angiogenesis corresponding to the expression of VEGF; albeit based on a limited sample size.

CLINICAL RELEVANCE/APPLICATION
In the future SHI may be used to monitor response for patients treated with anti-VEGF drug therapies.
**SSA22-01 • Increased Risk of Chest Wall and Rib Toxicity in Lung SBRT Patients Treated with RT0G-0813 Protocol and Monte Carlo Based Planning**

Supriya Jain MS, BA (Presenter); Anil Sethi PhD; Edward Melian MD; Bahman Emami MD

**PURPOSE**
To evaluate Monte Carlo (MC) based lung stereotactic body radiotherapy (SBRT) plans for dosimetric parameters correlated with the development of chest wall pain and rib fracture.

**METHOD AND MATERIALS**
Twenty consecutive lung SBRT patients treated from 2010-2012 with heterogeneity corrected Pencil Beam (PB) plans were selected. Chest wall (CW) was contoured as a 3 cm expansion of the ipsilateral lung. Treatment plans were normalized to deliver 50 Gy PTV dose in 5 fractions using 7-12 non-coplanar, conformal, 6 MV fields. Using MC dose algorithm, each plan was optimized for PTV dose coverage as per RT0G-0813 protocol. Patients were classified based on PTV location: island tumors (8), adjacent to CW (9), or mixed (3); and PTV size (cc): small (< 25), medium (25-60), or large (> 60). Treatment plans were evaluated for toxicity risk based on four dosimetric thresholds - CW: Dmax < 50 Gy, V30 < 30 cc, V40 < 5 cc and Ribs: Dmax.

**RESULTS**
Tumor size and location were strong predictors of risk of toxicity to CW and ribs. With MC planning, 0% (0/6) of small, 50% (4/8) of medium, and 100% (6/6) of large tumors exceeded all four CW and ribs toxicity thresholds. 78% (7/9) of tumors located adjacent to CW surpassed every CW / ribs threshold vs. 67% (2/3) of mixed and 25% (2/8) of island tumors. Mean Dmax for ribs was significantly higher for tumors adjacent to CW than for island tumors (61.6±11.7 Gy vs. 45.00±11.7 Gy, p = .007). Transitioning from PB to MC planning resulted in a higher overall risk of toxicity. Mean relative dose increases from PB to MC plans were 32.4±12.7%, 24.8±10.4%, and 20.3±6.4% for small, medium, and large tumors, respectively, and 32.5±11.6%, 26.6%±8.8%, and 19.3±7.2% for island, mixed, and chest wall tumors respectively.

**CONCLUSION**
MC based lung SBRT plans that satisfy RT0G-0813 criteria for PTV dose coverage result in an increased risk of chest wall and rib toxicity. Large tumor size and proximity to CW predict highest absolute dose to CW and ribs. However, relative increase in CW / rib dose from PB to MC planning is directly proportional to tumor distance from CW and inversely proportional to tumor size. Low-risk small island tumors experience the greatest increase in CW/rib dose when planned with MC algorithm.

**CLINICAL RELEVANCE/APPLICATION**
With Monte Carlo based planning, revision of RT0G-0813 guidelines for PTV dose coverage may be necessary to prevent chest wall pain and rib fractures.

**SSA22-02 • Prospective Study Evaluating the Use of IV Contrast on IMRT Treatment Planning for Lung Cancer**
Hua Li PhD (Presenter); Beth Bottani; Todd DeWees; Daniel A Low PhD *; Jeff M Michalski MD; Sasa Mutic MS *; Jeffrey D Bradley MD; Cliff & Robinson MD

**SSA22-03 • Lung Injuries after Stereotactic Body Radiotherapy in Patients with Emphysema Who Had Stage I Non-small Cell Lung Cancer**
Moeko Ishijima (Presenter); Hitetsugu Nakayama; Yu Tajima; Sachika Nogi; Ryuju Mikami; Koichi Tokuyue MD, PhD; Soichi Akata MD

**SSA22-04 • Incidence of Radiation Pneumonitis after Stereotactic Body Radiation Therapy for Lung Cancer Patients with Pulmonary Interstitial Changes**
Tadamasa Yoshitake MD (Presenter); Katsumasa Nakamura MD, PhD; Tomonari Sasaki MD, PhD; Saiji Ohga MD; Kotaro Terashima; Kaori Asai; Yoshio Matsuo; Takeshi Kamitani MD; Hideki Hirata; Hiroshi Honda MD

**SSA22-05 • Stereotactic Body Radiation Therapy for Stage I Non-small Cell Lung Cancer: A Community Hospital Experience**
Charles C Vu BSE (Presenter); Janna Z Andrews MD; Karen Episcopia MS; Jeffrey G Schneider MD; Scott L Schubach MD; Jonathan A Haas MD *

**ABSTRACT**

**Purpose/Objective(s):** Stereotactic body radiation therapy (SBRT) has been shown to have increased local control and overall survival relative to conventional external beam radiation therapy in patients with medically inoperable stage I non-small cell lung cancer (NSCLC). Excellent rates of local control have been demonstrated both in clinical trials as well as in single-center studies at academic institutions. However, there is limited data on the experiences of community hospitals with SBRT for Stage I NSCLC. Our findings support that local control and overall survival at WUH, a community hospital, are comparable to that of academic institutions' published experiences with stereotactic body radiation therapy for Stage I NSCLC.

**SSA22-06 • Intensity-Modulated Radiotherapy Following Extrapleural Pneumonectomy for Malignant Pleural Mesothelioma: A Single Institution Experience**
Sameer Jhavar MD, PhD (Presenter); Mehul Patel; Divya Patel; Nitika Thawani MD; Dharniopathy Rangaraj; Philip Rascoe; Scott Reznik; Alan Gowan; W Roy Smythe; Subhakar Mutyala MD

**SSA22-07 • Volumetric-modulated Arc Therapy for Lung Tumors: A Dosimetric Comparison with 3d Technique**
Shino Kobayashi-Shibata (Presenter); Akihiro Haga; Hideomi Yamashita; Keiichi Nakagawa MD, PhD

**ABSTRACT**

**Purpose/Objective(s):** We compared a dose volume histogram (DVH) in stereotactic body radiotherapy (SBRT) and volumetric-modulated arc therapy (VMAT) and 3D conformal method.

**Materials/Methods:** The investigation period was from July 2010 to January 2013. The solitary lung module was 20 cases. SBRT was performed by 11 ports using non-coplaner beams, VMAT used a single arc. The prescription dose was 50Gy/4fr in 95% of PTV. The aspiration suppression was performed by abdominal pressure. We created respiration curves using ANZAI belt and deviated 10 phases by
RESULTS: The mean of GTV, CTV, and PTV were 2.7cc, 4.2cc, and 18.5cc. The mean of homogeneity index (HI) was 1.34 +/- 0.1 in multi-ports, 1.20 +/- 0.09 in VMAT, and 1.41 +/- 0.12 in 3D-conformal. The mean lung dose was 356.5 cGy in multi-ports, 373.3 cGy in VMAT, and 380.3 cGy in 3D-conformal. The mean of lung V20 (%) was 5.1%, 5.6%, and 4.8%. V15% was 7.1%, 7.9%, and 7.0%. V10% was 10.7%, 11.0%, and 10.3%. V5(cc) was 632.4cc, 553.2cc, and 703.5cc.

Conclusions: Lung VMAT SBRT was not inferior to multi-ports SBRT or 3D-conformal SBRT not only in the homogeneity but in lung low dose volume.

SSA22-08 • Are There Computed Tomography Features Predictive of Local Recurrence in Patients with Early Stage Non-small Cell Lung Cancer Treated with Stereotactic Body Radiation Therapy?

Darragh Halpenny MBBCh, MRCP; Carole A Ridge MD; Sara A Hayes MBBCh; Junting Zheng; Chaya Moskowitz; Andreas Rimner MD *; Michelle S Ginsberg MD

PURPOSE: Stereotactic body radiation therapy (SBRT) is a therapeutic option for patients with stage I non-small cell lung cancer who may not be surgical candidates. SBRT delivers highly targeted, high dose radiation. The post-treatment radiological appearance is different compared with conventional radiotherapy (CRT). The objective of this study is to identify computed tomography (CT) features predictive of local recurrence after SBRT.

METHOD AND MATERIALS: The institutional review board approved this study. 218 consecutive patients underwent SBRT (4000-6000 cGy, 3-5 fractions over 1-2 weeks) for local control of lung cancer from Jan 1, 2006-Mar 1, 2011. CT images were retrospectively, independently reviewed by 2 radiologists. CT studies prior to SBRT and at 6, 12 + 24 months after SBRT were evaluated. Signs of local recurrence recorded were: opacity with a new bulging margin, opacification of air bronchograms, new or enlarging pleural effusion, new or enlarging mass and increase in lung density at the treatment site. End points assessed were local recurrence (biopsy proven or on PET/CT) and death. Landmark analyses at 6 months, 12 months and 24 months were performed to examine the association between CT features and local recurrence free survival (LRFS).

RESULTS: 89 of the 218 treated patients were included as they had radiologic follow-up of at least 24 months. 10 (11.2%) patients had local recurrence. 31 (34.8%) patients died within the period of follow up. None of the 5 morphological features usually associated with CRT were significantly associated with LRFS after SBRT (p>0.05). Nodal recurrence at 12 and 24 months was significantly associated with LRFS. Nodal recurrence at 12 months conferred a 50% (95%CI: 19%-100%) chance of being event free at 36 months compared to those with no nodal recurrence (66%, 95%CI: 54%-79%, p = 0.023 both readers, kappa=1.00). Patients had a higher chance of nodal recurrence or death at 36 months when they had nodal recurrence at 24 months (47% vs 29%, p=0.026, and 64% vs 26%, p 0.002). Landmark analyses at 6 months, 12 months and 24 months were performed to examine the association between CT features and local recurrence free survival (LRFS).

CONCLUSION: No local recurrence features identified on CT associated with CRT were associated with SBRT. Nodal recurrence was significantly associated with local recurrence after SBRT.

CLINICAL RELEVANCE/APPLICATION: Radiological patterns of local recurrence associated with CRT may not be predictive of local recurrence in patients receiving SBRT for early stage lung cancer.

SSA22-09 • Stereotactic Body Radiation Therapy for Unbiopsied Early Stage Lung Cancer - A Multi-institutional Analysis

Matthew M Harkenrider MD (Presenter)

ABSTRACT: Purpose/Objectives: Medically inoperable lung cancer patients often have comorbidities that preclude pathologic diagnosis from being attained. We perform a multi-institutional analysis to determine if unbiopsied early stage lung carcinoma can be safely and effectively treated with SBRT.

Material/Methods: 34 patients with unbiopsied lung cancer treated with SBRT at the University of Louisville or University of Virginia. Patients had CT and PET imaging clinically consistent with lung malignancy. Median SBRT dose was 50 Gy (range 30-55 Gy) in a median of 5 fractions (range 3-10 fractions) with static field SBRT or VMAT.

RESULTS: Median follow up is 16.7 months. Primary tumors had a median longest dimension on the original CT of 1.6 cm (range 0.5-3.3 cm) and post-treatment CT scan of 1.25 cm (range 0.0-4.5 cm) (p=0.025). Median pretreatment SUV on initial PET scan is 4.6 (range 0.0-16.2) and at a median of 7.6 months after SBRT, decreased to 2.25 (range 0.0-10.9) on post-treatment PET (p=0.002). Crude local control is 97.1%. The estimated 2 year regional control is 80%, distant control 85%, and overall survival 85%. There were no Grade 3 or greater acute toxicities and only three Grade 3 chronic treatment-related toxicities.

Conclusions: In medically inoperable patients with unbiopsied lung cancer, local control can be achieved in with minimal to toxicity with the use of SBRT. The use of SBRT for unbiopsied early stage lung cancer patients should be performed in a multidisciplinary setting and after detailed discussion with the patient about risks and benefits of SBRT.

Vascular/Interventional (Embolotherapy/Guidance Technology)

Sunday, 10:45 AM - 12:15 PM • E350

SSA23 • AMA PRA Category 1 Credit™:1.5 • ARRT Category A+ Credit:1.5

Moderator
Constantino S Pena, MD *

Moderator
Johannes Lammer, MD *

SSA23-01 • A Catheter to Curb your Appetite? A Novel Observation of Weight Loss Following Left Gastric Artery Embolization in Humans

Andrew J Gunn MD (Presenter); Elizabeth J Hamilton; Rahmi Oklu MD, PhD

PURPOSE: Suppressing serum levels of ghrelin, a neuropeptide with powerful appetite-stimulating effects produced in the gastric fundus, is an intriguing potential means of controlling body weight. Since left gastric artery, which preferentially supplies the gastric fundus, is sometimes embolized in interventional radiology procedures, we assessed post-procedural weight loss in patients after left gastric artery embolization.

METHOD AND MATERIALS: Retrospective analysis of electronic medical records of patients who underwent left gastric artery embolization for upper gastrointestinal (GI) bleeding were compared to age-matched controls of similar patients that had undergone embolization of an artery other than left gastric artery for upper GI bleeding. Patients were included in the analysis if they had a recorded weight within two weeks prior to the embolization and within three months after the procedure. Differences in post-procedural weight loss between the groups were evaluated by a student’s t-test.
Liver Remnant Volume Gain

SSA23-02 • Transarterial Embolization of Renal Artery Pseudoaneurysms Following Partial Nephrectomy

Nakul Gupta MD (Presenter) ; Anish A Patel ; Kamran Ahrar MD ; Judy U Ahrar MD ; Aida L Tam MD * ; Michael J Wallace MD * ; Sanjay Gupta MD

PURPOSE
To describe the presentation, endovascular management, outcome, and effect on renal function of selective transarterial embolization of renal artery pseudoaneurysms and arteriovenous (AV) fistulae in patients following open or laparoscopic partial nephrectomy.

METHOD AND MATERIALS
The medical and imaging records of 25 patients who were referred for embolization of renal artery pseudoaneurysms or AV fistulae after partial nephrectomy were retrospectively reviewed for the following parameters: size and number of primary tumors, presenting symptoms, number and type of angiographic abnormalities, embolization technical details, outcome, and estimated glomerular filtration rates (eGFRs) prior to and at multiple time points following embolization.

RESULTS
24 patients had primary renal tumors, 1 patient had a pancreatic tumor directly invading the kidney. The median time between surgery and presentation was 11 days (range, 1 day to 502 days; mean, 38 days). Most patients (n=23; 92%) were symptomatic, presenting with gross hematuria, flank pain, or both. In 2 patients, pseudoaneurysms were found incidentally on follow-up CT scans. Angiography revealed pseudoaneurysms with (n=5) or without (n=20) AV fistulae. 16 patients (64%) had multiple pseudoaneurysms, often involving multiple segmental renal vessels. Selective embolization was performed with coils alone (n=20) or in combination with cyanoacrylate glue (n=5). Multiple vessels were embolized in 14 patients (56%). Cessation of bleeding was achieved after one (n=22) or two (n=3) embolization sessions in all patients. The median follow-up was 14 months. The mean eGFR values (in mL/min/1.73m²) prior to embolization, 2–7 days after embolization and at last follow-up were 59.2, 63.4, and 66.6, respectively. One patient had transient worsening of renal function 3 days after embolization.

CONCLUSION
Most patients with renal artery pseudoaneurysms after partial nephrectomy present in the immediate postoperative period with hematuria and/or flank pain. The majority of these patients show multiple pseudoaneurysms, often requiring selective embolization of multiple vessels. Transarterial embolization is a safe and effective treatment option with no long-term adverse effect on renal function.

CLINICAL RELEVANCE/APPLICATION
Transarterial embolization is a safe and effective treatment for renal artery pseudoaneurysms resulting from partial nephrectomy with no long-term adverse effect on renal function.

SSA23-03 • Particle only Embolization vs. Particle Embolization with Additional Plug/Coil Embolization - Comparison of Future Liver Remnant Volume Gain

Dominik Geisel MD ; Dirk Schnapauff MD ; Martin Stockmann MD ; Maciej Malinowski ; Timm Denecke MD ; Bernhard Gebauer MD (Presenter) *

PURPOSE
To analyze volume gain of the future liver remnant (FLR) after right portal vein embolization (PVE) in patients who received particle only embolization compared to patients who received particle embolization with additional central plug and/or coil embolization.

METHOD AND MATERIALS
Patients who received PVE in our institution were retrospectively analyzed. Right PVE was performed either with particle only (PO) embolization or additional central plug and/or coil embolization (CP/C). All patients enrolled had a CT or MRI scan before PVE and before operation, which were used for volumetry of the future liver remnant (FLR).

RESULTS
Of 75 patients 40 had PO embolization and 35 additional CP/C embolization. Age, sex, tumor entities and time from PVE to preoperative imaging were comparable in both groups. Tumor entities included cholangiocarcinoma (n = 52), metastasis from colorectal cancer (n = 14), hepatocellular carcinoma (n = 2) and other entities (n = 7). FLR volume before PVE was 329 ± 121 ml in the PO group and 333 ± 135 ml in the CP/C group and 419 ± 135 ml respectively 492 ± 165 ml before operation. Average volume gain was significantly higher in the CP/C than in the PO group with 53.3 ± 34.5 % vs. 30.9 ± 28.8 % (p = 0.002).

CONCLUSION
Right portal vein embolization with additional central plug and/or coil embolization leads to a significantly higher gain in FLR volume than embolization with particles alone.

CLINICAL RELEVANCE/APPLICATION
Right portal vein embolization with additional central plug and/or coil embolization should be preferred over particle only embolization.

SSA23-04 • Experimental Study of Selective Portal Vein Embolization for Nonalcoholic Steatohepatitis in Rabbit Model

Sadao Hayashi MD (Presenter) ; Yasutaka Baba MD ; Shunichiro Ikeda BS ; Hiroaki Nagano ; Tetsuya Shinohara ; Michiyu Higashi PhD ; Ryozo Kamimura ; Toshihiro Nakazono ; Teruo Komokata ; Masayuki Nakajo PhD

PURPOSE
Portal vein embolization (PVE) is now widely accepted as a useful preoperative procedure in selected patients undergoing extended hepatectomy. However, the influence of PVE on the liver parenchyma with steatohepatitis has not been fully elucidated. To evaluate the influence of PVE on the rabbit liver parenchyma with nonalcoholic steatohepatitis (NASH) compared with normal liver.

METHOD AND MATERIALS
Seventeen Male New Zealand rabbits were divided randomly into the normal control group (n = 6) which was fed with a standard diet for 2 weeks and the NASH group (n = 11) which was fed with a high-fat diet (standard diet + 10% lard + 2% cholesterol) for 8 weeks. Thereafter, PVE was performed for the left lobe of each group with 1 ml absolute ethanol and micro coils. All procedures were performed successfully. Rabbits were sacrificed 2 weeks after the PVE. All hepatic specimens were examined by HE staining and immunohistochemical staining of heat shock protein 70 (HSP70). NASH stage, NASH grade and sinusoidal obstruction syndrome (SOS) score were evaluated used by HE staining. When less than 20% were stained, the specimen was considered as HSP expression negative.
RESULTS
Two of 11 NASH rabbits died of liver failure 2 days after PVE. The embolized lobe showed significantly higher NASH stage (p=0.43) and grade(p=0.009) and severer SOS score(p=0.03) in the NASH group than in the normal control group. HSP70 expression was significantly lower in the NASH embolized lobe than in the normal control embolized lobe (p=0.04).

CONCLUSION
The rabbit fed with the present high fat diet can be a NASH model. PVE induced severer sinusoidal obstruction damage in the embolized steatohepatitis lobe than in the embolized normal lobe. HSP70 induction in the embolized lobe was suppressed in the NASH model. These findings suggest that the same severe damage may occur in the embolized lobe and the risk of unexpected fatal liver damage cannot be excluded in the patients with NASH after PVE.

CLINICAL RELEVANCE/APPLICATION
PVE should be performed carefully even for the patients with NASH.

SSA23-06  • Needle Interventions in a Phantom Model: Real-time 3D Fluoroscopy Guidance Using Cone-beam CT versus Conventional CT Guidance

Noboru Maeda (Presenter); Keigo Osuga MD; Masahisa Nakamura MD; Kentaro Kishimoto; Kaishu Tanaka; Yusuke Ono; Hiroki Higashihara MD; NoriYuki Tomiyama MD, PhD

PURPOSE
Cone-beam CT (CBCT) guided targeting system or XperGuide (Philips Medical Systems) is a real-time 3D navigation system on live fluoroscopy overlapped with CBCT image as a practical tool. The purpose of this study was to evaluate the accuracy and procedure time of this system compared to conventional CT guidance technique using a phantom model.

METHOD AND MATERIALS
A phantom was made of corn flour and clay that contained multiple 1cm kneaded erasers as targets. The target can be recognized at CBCT and CT images, but invisible under X-ray fluoroscopy. The needle path reaching the target was planned on CBCT or CT images of the phantom on 3D-workstation. Four interventional radiologists inserted a 19G 20cm needle to aim at separately five targets in different set angles under XperGuide or conventional CT guidance in one session. Each interventional radiologist performs needle interventions totally in two sessions under XperGuide and in two sessions under conventional CT guidance. To verify the accuracy of the puncture, the gap or distance between the needle tip and the center of the target was measured on CBCT or CT images obtained after each puncture. Procedure time was also measured.

RESULTS
All targets were successfully targeted with the first needle pass in all sessions using both techniques by four interventional radiologists. Mean distance from the surface puncture point to the target was 104±13 mm and 101±17 mm (p=0.54), mean gap was 1.88±0.83 and 4.06±1.22 mm (p<0.05). CONCLUSION
CBCT guided targeting system or XperGuide allows more accurate lesion targeting and quicker needle interventions in a phantom model compared to conventional CT guidance.

CLINICAL RELEVANCE/APPLICATION
CBCT guided targeting system or XperGuide allows accurate lesion targeting and quick needle interventions. This system will improve needle interventions.

SSA23-07  • 3T MRI-guided Transperineal Targeted Prostate Biopsy Using a Robotic Needle Guidance Template

Sang-Eun Song; Kemal Tuncali MD; Junichi Tokuda PhD; Andriy Fedorov PhD; Tobias Penzkofer MD*; Clare M Tempany-Afdhal MD; Fiona M Fenessy MD, PhD; Nobuhiko Hata PhD (Presenter)*

PURPOSE
Conventional needle guidance templates used in MRI-guided targeted prostate biopsy have limited targeting accuracy, typically 5 mm intervals, and are prone to human error in selecting holes. To overcome such problems, we developed and tested a motorized needle guidance template (Smart Template) that allows automated targeting without restriction in a 3T MRI.

METHOD AND MATERIALS
Fifteen men with suspicion of prostate cancer underwent 3T wide-bore MRI-guided transperineal targeted prostate biopsy in the lithotomy position using Smart Template and 3D Slicer navigation software. Target lesions were preoperatively identified on multi-parametric MRI (mpMRI) by three radiologists. The targets were re-identified on intraoperative MRI through registration. The navigation software provided the Smart Template guidance position and needle placement depth for each target. Insertion was performed manually and if needed, the guidance position was adjusted to achieve a satisfactory needle placement confirmed by MRI.

RESULTS
All procedures were performed successfully without adverse events and tissue samples were collected from targeted lesions in all cases. 2 to 6 targets were selected per patient, and an average of 2.4 ± 0.9 tissue samples were obtained from each target. The mean procedural time was 122 ± 27 min including 55 ± 18 min of in-MRI preparation time, which is similar to that of using a conventional template. 10 of the 47 sampled targets were positive for malignant tissue (21.3%), resulting in prostate cancer diagnosis for 53.3% (N = 8) of the patients.

CONCLUSION
Smart Template has been successfully integrated into the procedural workflow of existing MRI-guided transperineal targeted prostate biopsy. The robotic needle guidance demonstrated unrestricted access to any part of the prostate grand volume without noticeable image degradation, complexity or significant prolongation of the procedural time.

CLINICAL RELEVANCE/APPLICATION
A robotic needle guidance template has been used for 3T MRI-guided transperineal targeted prostate biopsy to aid needle placement.

SSA23-08  • Real Time Image Fusion with Contrast Enhanced CT, 18FDG-PET and US in Liver Percutaneous Ablations and Biopsies

Giovanni Mauri MD (Presenter); Luca Cova MD; Tania Tondolo; Tiziana Ierace MD; Enzo Di Mauro; S. Nahum Goldberg MD*; Luigi Solbiati MD

PURPOSE
To report our preliminary experience with real time image fusion between contrast enhanced CT, 18FDG-PET and US in liver percutaneous ablations and biopsies.

METHOD AND MATERIALS
24 patients with liver lesions detectable only at 18FDG-PET underwent percutaneous ablation (10 patients) or biopsy (14 patients) guided by a novel image fusion system that combines real-time US with fusion to previously acquired and fused contrast enhanced CT and 18FDG-PET images based upon magnetic field tracking and computer reconstruction of the targeting path (Esaote, Genoa, Italy). 18FDG-PET/CT was performed at 24 hours to assess the technical efficacy of thermal ablations (i.e. absence of uptake). Histological results (i.e. adequacy of the sample) was used to assess the result of percutaneous biopsies.

RESULTS
In all cases it was possible to obtain correct fusion between contrast enhanced CT, 18FDG-PET and US and to perform the procedure as
planned. At 24 hours 8/10 (80%) treated lesions demonstrated absence of uptake at 18FDG-PET/CT, while two lesions demonstrated partial peripheral uptake, being considered correctly targeted but incompletely ablated. A diagnostic sample was obtained in 12/14 (86%) patients who underwent percutaneous biopsy guided with this technique. No major complications occurred.

CONCLUSION Real-time image fusion between contrast enhanced CT, 18FDG-PET and US is feasible and allow for a precise targeting of many tumors detectable only at 18FDG-PET.

CLINICAL RELEVANCE/APPLICATION This method holds the potential for offering ablation and biopsy to additional patient populations.

SSA23-09 • Development and Clinical Evaluation of a Three-dimensional Ultrasound System for Pre-operative Assessment and Guiding Percutaneous Treatment of Focal Liver Tumors

Hamid Reza Sadeghi Nesbat MSc (Presenter); Derek W Cool MD, PhD *; Jeffrey Bax BENG *; Kevin Barker; Lori Gardi; Nirmal Kakani MD; Aaron Fenster PhD *

CONCLUSION Our 3D US system improves capabilities of conventional US by facilitating targeting of lesions identified in other modalities. Ongoing work includes automatic probe tracking and motion compensation.

Background Image-guided percutaneous ablation is a standard treatment for focal liver tumors deemed inoperable and to maintain eligibility for patients on transplant waitlists. Radiofrequency (RFA), microwave (MWA) and cryo-ablation technologies are all delivered via a needle-shaped probe inserted directly into the tumor. Planning is mostly based on contrast CT/MRI. While intra-procedural CT (iCT) is commonly used to confirm the intended probe placement, 2D ultrasound (US) remains the main imaging modality for needle guidance, and in some centers is the only modality used. Correlation of the intraoperative 2D US with iCT or pre-operative imaging is essential for accurate needle placement, however, correspondence can be challenging given the limited field-of-view (FOV) in 2D US. We have developed a passive tracking arm with motorized scan-head and software tools to improve guiding capabilities of conventional US by large FOV 3D US scans that can be overlaid and compared to planning and iCT.

Evaluation The developed scanner was tested on phantoms to confirm accuracy of 3D measurements and probe localization as compared to CT. For phase 1 clinical evaluation (IRB approved), a total of 17 tumors (1.0-4.5cm) were treated using 1-3 RFA or MWA probes without re-intervention in 14 cases. Contrast CT prior to ablation (for tumor measurements) and iCT after each probe insertion (for localization measurements) were acquired. Each CT was followed by a 3D US for comparison. 3D US and CT measurements corresponded well with tumor volume, angle and distance between probes differing by 7.7±4.5%, 4.2±3.2° and 2.1±1.3mm respectively.

Discussion Mechanically tracked 3D US provided comparable measurement results to CT in a single scan (3-8 seconds). The main limitation is for US occult tumors. In such cases, fusion of the US with the planning CT can be used to provide an insertion roadmap. 3D US facilitates co-registration by providing more structures visible in both modalities (e.g. vessels, surfaces) and tracker coordinates.

SSA24-01 • Portal Vein Thrombosis after Tips with the Viatorr Stent Graft: Imaging Frequency and Correlation with Site of Puncture

Jorge E Lopera MD (Presenter) *; Venkata S Katabathina MD; Martin Goros; Brian T Bosworth MD; Deepak Garg MBBS, MD; Ghazwan M Kroma MD; Andres Garza; Rajeev Suri MD

PURPOSE To study the incidence of portal vein thrombosis (PVT) after elective Tips using the Viatorr stent graft and determine if there is any potential relationship between the puncture site and development of PVT.

METHOD AND MATERIALS A retrospective review of medical records of patients that underwent elective Tips with the Viatorr stent graft was performed. Contrast enhanced cross-sectional imaging studies, performed within 1 year after Tips were evaluated for PVT. The puncture site for Tips was determined in direct portograms and classified as central or peripheral. Any potential relationship between the puncture site and the presence of PVT was determined.

RESULTS Elective Tips with the Viatorr was performed in 48 patients (ages 28-70 mean 54). Follow-up imaging demonstrated that the presence of branch PVT was very frequent (38/48, 79%), and affected the right anterior (n=6), right posterior (n=25) or left (n=7) portal veins. There were no main portal vein thromboses. Central punctures in 12 patients were associated with PVT in 9 occasions. More peripheral punctures at the confluence of the right portal branches in 22 patients, or in a more peripheral right branch in 14 patients, were associated with segmental PVT in 17 and 12 patients, respectively. In only in 1 patient there was a technical problem with stent placement. Overall there was no correlation between the puncture site and the presence of PVT ( Fisher Exact test p=0.1).

CONCLUSION Thrombosis of major portal vein branches is a very frequent imaging finding after elective Tips with the Viatorr stent graft. There was no potential relationship between the puncture site, central or peripheral, and the presence of PVT.

CLINICAL RELEVANCE/APPLICATION Thrombosis of major portal vein branches is a frequent imaging finding after elective Tips with the Viatorr stent. However, there is not correlation between PVT and the site of puncture.

SSA24-02 • The Outcome of Shunt Reduction after TIPS by the Parallel Technique: A Prospective Study

Bart De Keyzer MD (Presenter); Frederik Nevens MD, PhD; Sam Heye MD; Johan Vaninbroux MD; Chris Verslype MD, PhD; David Cassiman MD, PhD; Wim Laleman; Geert Maleux MD, PhD

PURPOSE Transjugular intrahepatic portosystemic shunt (TIPS) placement became the standard treatment for a subcategory of patients with
refractory ascites and variceal bleeding. It has the disadvantage of provoking chronic hepatic encephalopathy (HE) and, in some patients with limited liver function, TIPS-induced liver failure (LF). Reduction of the diameter of the TIPS stent is feasible by the parallel technique. However, the experience is still limited.

**METHOD AND MATERIALS**

TIPS reduction was performed by the placement of a 10 mm self-expanding stent along with a 5-6-7 mm balloon-expandable stent. After a learning group of 17 patients (Maleux G, JVIR 2007), 55 patients were included in this prospective study. Baseline characteristics included age, gender, cause of cirrhosis, MELD score, indication for TIPS, time interval between TIPS and reduction, and pressure gradient before and after reduction.

**RESULTS**

Patients with medical therapy resistant chronic HE: improvement of HE = 25/34 (74%), recurrence of initial indication = 9/34 (26%) and six month survival = 29/34 (85%). Patients with TIPS-induced liver failure: improvement 11/21 (52%) and survival 11/21 (52%), three of these patients received a liver transplantation.

**CONCLUSION**

Stent reductions with the parallel technique improved chronic hepatic encephalopathy in 74% of the patients and offered them a 6 months survival of 85%. In patients who developed TIPS-induced liver failure, 52% recovered and for this group, TIPS reduction can serve as a bridge to liver transplantation.

**CLINICAL RELEVANCE/APPLICATION**

TIPS-induced hepatic encephalopathy refractory to medical therapy can be improved by shunt reducing techniques in a majority of cases.

**SSA24-03 • Hepatic Infarction Following Transjugular Intrahepatic Portosystemic Shunt: An Analysis of Pathogenesis and Clinical Outcomes**

Fredrik J Balldin MD (Presenter) ; Jorge E Lopera MD * ; Ryan R Scott MD

**PURPOSE**

To assess clinical outcomes and examine potential factors leading to hepatic infarction following TIPSS.

**METHOD AND MATERIALS**

A retrospective review of all patients with follow-up cross sectional imaging after TIPSS was performed. The outcomes of patients with imaging findings suggestive of hepatic infarction were analyzed along with technical, demographic, and clinical data.

**RESULTS**

Out of 62 total patients with cross-sectional imaging after TIPSS performed between 6/2008 and 4/2012, seven (5 males and 2 females, average age of 54.7 years old (range 44-66)) were identified with imaging (6 CT, 1MRI) suggestive of hepatic infarction. All patients received PTFE stent-grafts. Average pre-TIPSS MELD score was 13.2 (range 6-20) and average post-TIPSS MELD score was 21.2 (range 9-38). Four patients developed worsening liver failure, of which two died early and two received liver transplants. One died of complications related to recurrent upper GI bleeding, one survived with intermittent hepatic encephalopathy, and one patient was lost to follow-up shortly after the procedure. Follow-up imaging revealed 5 patients had thrombosis of right portal vein branches and two had right hepatic vein thrombosis.

**CONCLUSION**

Hepatic infarction following TIPSS is a rare complication with high a mortality rate that may be associated with right portal vein and/or hepatic vein thrombosis.

**CLINICAL RELEVANCE/APPLICATION**

Currently there are only case studies of hepatic infarction after TIPSS. This case series aims to examine causes of this potentially fatal complication while analyzing the outcomes in 7 patients.

**SSA24-04 • Portal Vein Thrombosis after Elective TIPS. Incidence in Follow-up Imaging and Clinical Significance**

Jorge E Lopera MD (Presenter) * ; Venkata S Katabathina MD ; Brian T Bosworth MD ; Martin Goros ; Andres Garza ; Ghazwan M Kroma MD ; Rajeev Suri MD

**PURPOSE**

To study the incidence and clinical significance of portal vein thrombosis (PVT) in follow-up imaging after elective transjugular intrahepatic portosystemic shunt (TIPS).

**METHOD AND MATERIALS**

A retrospective review of medical records of patients that underwent elective TIPS was conducted. Contrast enhanced cross sectional images, obtained within 1 year after TIPS, were compared with previous axial images (n=59) or direct portograms (n=3) in order to assess the patency of the main portal vein (PV) and its major branches. The branches analyzed were the right anterior (RAPV), right posterior (RPPV), left (LPV) and main (MPV) portal veins. The presence of associated parenchymal changes was also recorded. Any possible association between PVT and MELD score, and PVT and major adverse events after TIPS, was also studied.

**RESULTS**

Sixty-two patients (15 female, 47 male, ages: 28-70, mean 54) were included in the study. Follow-up cross sectional images were obtained 1-346 days (mean 92 days) after TIPS. The incidence of PVT was 19 % for RAPV, 51% for the RPPV, 11% for the LPV and 1 % for the MPV. Combined thrombosis of two major branches was observed in 6 and three branches in 4 patients. Associated lobar parenchymal changes were lobar infarcts in 7 and heterogeneous contrast enhancement in 9 patients. The mean MELD score was 12.8 before and 16.8 one month after TIPS. Major adverse events within 6 months included hepatic encephalopathy requiring hospital admission in 18 and death in 8 patients. There was no significant correlation between PVT and the post-TIPS MELD score, or PVT and major adverse events after TIPS.

**CONCLUSION**

Thrombosis of major branches of the PV is a very common imaging finding after elective TIPS that can be associated with parenchymal changes. In most patients, branch PVT has no clinical significance.

**CLINICAL RELEVANCE/APPLICATION**

Thrombosis of major PV branches is a common imaging finding after elective Tips. In most patients, branch PVT has no clinical significance.

**SSA24-05 • Treating Portal Systemic Encephalopathy with Balloon-occluded Retrograde Transvenous Obliteration (BRTO) - A Road Less Travelled**

Amar Mukund (Presenter) ; S. Rajesh MBBS, MD ; Ankur Arora MD, FRCR ; Shiv Sarin

**PURPOSE**

To evaluate the efficacy of BRTO using foam sclerotherapy in managing symptoms arising due to spontaneous large porto-systemic shunts.

**METHOD AND MATERIALS**

20 sessions of BRTO was performed in 18 patients using sodium tetradecyl sulphate foam. All patients had cirrhosis along with history of recurrent hepatic encephalopathy requiring hospital admission. Porto-systemic communication in the form of gastro/lumo-renal shunt was
RESULTS
Technical success was achieved in 18 of 20 sessions (90%). Complete obliteration of varices was seen in 15 of 18 patients (83%) and partial obliteration in remaining 3, on follow up imaging. Immediate clinical improvement of hepatic encephalopathy was observed in 16 of 18 patients (89%) with post procedure decrease in serum ammonia levels, two patients had delayed improvement. Post-procedure complication consisting either of ascites, septicemia with acute kidney injury or deranged liver function tests was encountered in 5 patients. All the patients were clinically and symptomatically better on discharge and up to a follow up of 18 months (one month and thereafter 3, 6, 12, 18 months).

CONCLUSION
Our experience suggests portal systemic hepatic encephalopathy refractory to medical management can be effectively treated by BRTO.

CLINICAL RELEVANCE/APPLICATION
This study shows that BRTO may be offered as an alternative treatment to patients having recurrent portal systemic encephalopathy refractory to medical management.

SSA24-06  The Comparison of Balloon-occluded Retrograde Transvenous Obliteration for Gastric Varices Using Liquid and Foam Sclerosants

Jun Koizumi MD, PhD (Presenter) ; Tatsuya Sekiguchi ; Tamaki Ichikawa MD ; Chihiro Itou ; Takuya Harai MD ; Bertrand Janne d’Othee MD, MPH

PURPOSE
Liquid ethanamine oleate which has been used traditionally for balloon-occluded retrograde transvenous obliteration (BRT0) of the gastric varices (GV) may cause severe complications including hemolysis, allergy, etc. if overdosed. Thus, we introduced foam sclerotherapy to reduce the dose and compared the safety and efficacy of BRT0 using liquid and foam sclerosants.

METHOD AND MATERIALS
Forty three patients with gastric varices were performed BRTO since October 2001. Of these, three patients were excluded because simultaneous TACE or PSE was performed. Twenty patients using liquid ethanamine oleate with iodine contrast (EOI, Fig.1) before March 2005 and twenty patients using polidocanol foam (PDF, Fig.2) after May 2005 were included in this study. The success rates, side effects and complication rates were compared among the two groups.

RESULTS
Complete stasis of the gastric varices was obtained in all patients of both groups. Abdominal symptoms during BRTO were significantly (p<38.0) was also significantly (p<0.05).

CONCLUSION
Foam polidocanol provided less invasive BRTO than liquid ethanamine oleate with comparative clinical success.

CLINICAL RELEVANCE/APPLICATION
EOI which is traditionally used in BRTO may cause hemolysis and require haptoglobin. In the U.S. EOI is now replaced by foam sclerosant. This comparative study supports safer properties of foam.

SSA24-07  Clinical Efficacy of Portal Venous Stent Placement for Symptomatic Portal Hypertension Caused by Malignant Tumor Invasion

Takaaki Hasegawa (Presenter) ; Haruyuki Takaki MD ; Atsuhiro Nakatsuka MD ; Junji Uraki MD ; Takashi Yamanaka MD ; Masashi Fujimori MD ; Hajime Sakuma MD * ; Shuji Isaji ; Koichiro Yamakado MD, PhD

PURPOSE
To evaluate clinical outcomes of portal venous stent placement in patients with symptomatic portal hypertension caused by malignant tumor invasion.

METHOD AND MATERIALS
From Jury 2005 to January 2013, eleven patients with portal venous stenosis or occlusion caused by bile duct cancer (n=6), pancreatic cancer (n=4), and nodal metastasis from colon cancer (n=1) underwent portal venous stent placement because of gastrointestinal bleeding (n=4), ascites (n=4), liver dysfunction (n=2), and hypersplenism (n=1). Stents were placed across the stenotic (n=7) or occluded (n=4) lesions after percutaneous transhepatic portography. Technical success, changes in portal venous pressure, symptoms, complications, stent patency, and survival were evaluated. Complications were evaluated by using Common Terminology Criteria for Adverse Events (CTCAE).

RESULTS
Stent placement was technically successful in all patients (technical success rate: 100%, 11/11). The mean portal venous pressure gradient decreased from 12.6±4.8 mmHg (range, 5-20 mmHg) to 0.5±1.0 mmHg (range, 0-3 mmHg) (p<0.001).

CONCLUSION
Portal venous stent placement is feasible, safe, and effective technique to relieve symptomatic portal hypertension caused by malignant tumor invasion.

CLINICAL RELEVANCE/APPLICATION
Portal venous stent placement is an effective treatment option for patients with portal hypertension caused by malignant tumor invasion.

SSA24-08  Metallic Stent Placement for the Treatment of Hepatic Venous Outflow Block after Living-Donor-Liver Transplantation

Masashi Fujimori MD (Presenter) ; Shugo Mizuno ; Atsuhiro Nakatsuka MD ; Haruyuki Takaki MD ; Junji Uraki MD ; Takashi Yamanaka MD ; Takaaki Hasegawa ; Hajime Sakuma MD * ; Shuji Isaji ; Koichiro Yamakado MD, PhD

PURPOSE
To retrospectively evaluate the clinical efficacy of metallic stent placement for the treatment of hepatic venous outflow block after living-donor-liver transplantation (LDLT).

METHOD AND MATERIALS
This study was approved by our institutional review board, which waived the requirement for informed consent to use data for research purposes. From 2002 to 2012, 15 patients with a mean age of 51±30.8 years (range, 4-69 years) underwent stent placement for the treatment of outflow block 1-341 days after LDLT with a mean interval of 24±54.7 days. Venous stenosis with a pressure gradient of 10mmHg or more was found in the inferior vena cava in 7 patients, hepatic vein in 7 patients, and in both in 1 patient. Stents were percutaneously placed across stenosis. Technical success (pressure gradient<3mmHg), complication, improvement in clinical manifestation, stent patency, and survival were evaluated.

RESULTS
Technical success was achieved in all 15 patients (100%, 15/15). There was no death or major complications related to stent placement. The mean pressure gradient significantly decreased from 13±8mmHg (range, 10-24 mmHg) to 0.8±2mmHg (range, 0-2 mmHg) (p<0.001).

CONCLUSION
Stenting is a safe and useful treatment to resolve outflow block after LDLT and helps to improve prognosis of such patients.

CLINICAL RELEVANCE/APPLICATION
Optimal Protocol of Scanning Mode in the Portal Vein Angiography with a Low-Concentration Contrast Medium

Yan Liang MMed; Zhiren Chen MD (Presenter); Dongbin Shi; Yan Wang; Bin Li; Huizhi Cao; Ying Tong

PURPOSE
To explore the optimal protocol of CT scanning mode in the portal vein angiography with a low-concentration contrast medium.

METHOD AND MATERIALS
63 patients underwent enhanced urinary CT scan. All the patients were divided into 3 groups according to different body mass index (BMI). 21 patients of group A (BMI=22) received 80-100 kVp CT scan, automatic exposure control (3D Auto mA) and pitch of 0.984. All the images were reconstructed with adaptive statistical iterative reconstruction algorithm. 14 patients of group B (BMI=26) received single-source dual-energy spectral CT (SDCT) scan at the pitch of 1.375. Monochromatic images were reconstructed and optimal keV with best contrast-to-noise (CNR) was calculated. Another 28 patients of group C with routine 120 kVp CT scan. Low concentration of iodixanol (270 mg I/ml) was used in group A and B, and high concentration of iopamidol (370 mg I/ml) was adopted in group C. 70 ml of total amount of contrast was injected at 2.7 ml/s. ROIs were placed on abdominal aorta, renal artery, superior mesenteric artery and portal vein. Signal-to-noise ratio (SNR) and CNR was calculated.

RESULTS
In low-kVp Group, the SNR and CNR were (8.12±3.09) and (14.72±4.05) for trunk of portal vein, (6.59±2.13) and (13.40±4.68) for its left branch, and (7.24±2.19) and (13.56±4.99) for its right branch respectively. In SDCT Group, the SNR and CNR were (8.68±2.69) and (13.38±3.06) for trunk of portal vein, (9.31±2.88) and (13.58±3.21) for its left branch, and (9.53±2.66) and (13.72±3.03) for its right branch respectively. In 120kVp Group, the CNR and SNR were (6.68±3.41) and (12.82±4.41) for its left branch, and (7.09±2.04) and (12.55±4.36) for its right branch respectively. The image quality was slightly higher in SDCT Group than routine 120kVp Group and low-kVp Group, but no significantly different was found in among three groups (P>0.05). Compared with that in 120kVp Group (7.23±1.53 mGy), the radiation dose index was significantly lower in low-kVp Group (4.75±1.39 mGy) (P<0.05).

CONCLUSION
With a low-concentration contrast medium, the low-kVp and SDCT scanning mode is rationally via BMI without sacrificing image quality.

CLINICAL RELEVANCE/APPLICATION
With low kVp and spectral CT imaging of low iodine concentration or 120 kVp of moderate iodine concentration, higher intravascular enhancement can be achieved with good vessel display.

Optimal Protocol of Scanning Mode in the Portal Vein Angiography with a Low-Concentration Contrast Medium

Zhilian Zhao PhD (Presenter); Dongdong Rong; Xiangying Du MD; Kuncheng Li MD

PURPOSE
A novel non-rigid registration based motion correction algorithm (Snap-Shot-Freeze, SSF) has been recently introduced for coronary CTA with 64-row MDCT. The aim of this study was to evaluate the efficiency of SSF in coronary CTA with high heart rates, by comparing the image quality with that of single sector and bi-sector reconstructions.

METHOD AND MATERIALS
SSF can effectively improve the image quality of coronary CTA in patients with high heart rates.

CLINICAL RELEVANCE/APPLICATION
Successful motion correction of coronary CTA images may expand the use of this non-traumatic method to more suspected CAD patients.

The Feasibility of Half-cycle Reconstruction Improve Image Quality of Free-breathing 320-detector Multidetector CT Angiography

Zhen Wang BMSc, RT (Presenter); Jiahua Yuan MD; Xiang Zhong Ding MD

PURPOSE
In patients with heart rates above 65 beats per minute, 320-detector multidetector CT uses multi-cycle reconstruction to improve the effective temporal resolution by using data from more than one R-R interval of the cardiac cycle to reconstruct an image. Sometimes the heart does not follow the same pattern of motion with every beat (e.g. some patients cannot hold their breath). In the situation, the multi-cycle reconstruction might not improve image quality of coronary computed tomography angiography (CCTA) due to respiration artifacts. Our aim was to investigate the feasibility of Half-cycle reconstruction improve image quality of free-breathing CCTA in patients with heart rates above 65 beats per minute using with a 320-detector multidetector CT.

METHOD AND MATERIALS
A total of 1489 coronary computed tomography angiography were performed in patients with heart rates above 65 beats per minute during the study period from October 2010 to February 2013. All CCTA examinations were produced with the standard breath-holding method, but the images in 22 patients existed respiration artifacts. Half-cycle reconstruction image and multi-cycle reconstruction image were reconstructed for each patient. The quality scores for 15 segments of all coronary arteries were analyzed and defined as: 1 (excellent), 2 (good), and 3 (poor). The signal-to-noise ratio (SNR), contrast-to-noise ratio (CNR), and effective radiation dose of each image were compared between the two methods.

RESULTS
In patients with half-cycle reconstruction, diagnostic quality images (scores of 1 or 2) were obtained in 97.9% of the analyzed segments, compared with 69.5% in the group with multi-cycle reconstruction (p<0.001). The SNR and CNR were not significantly different between the two methods. The median effective radiation dose was 1.2 mSv for the group with multi-beat acquisition and simultaneous
CONCLUSION
Half-cycle reconstruction can improve image quality of free-breathing CCTA in patients with heart rates above 65 beats per minute using with a 320-detector multidetector CT. For patients with difficulties of breath-holding, free-breathing CCTA with single beat acquisition can be an alternative solution for coronary artery evaluation.

CLINICAL RELEVANCE/APPLICATION
320-detector MDCT offers new opportunities for the breathless patient by using half-cycle reconstruction.

SSC01-03 • Diagnostic Accuracy of Dual-source Computed Tomography for Selecting Coronary Artery Bypass Graft Surgery Candidates

Young Joo Suh MD (Presenter); Young Jin Kim MD; Sae Rom Hong MD; Yoo Jin Hong MD; Hye-Jeong Lee MD; Jin Hur MD; Byoung Wook Choi MD

PURPOSE
To investigate the diagnostic performance of dual-source computed tomography coronary angiography (CTCA) in terms of selecting coronary artery bypass graft surgery (CABG) candidates according to the 2011 American College of Cardiology Foundation and American Heart Association guidelines for CABG and to assess the added value of Syntax score for selecting CABG candidates.

METHOD AND MATERIALS
Institutional review board approval was obtained. We included 250 patients (mean age, 63.9 years; 150 men and 100 women) with a suspicion of coronary artery disease who underwent both dual source CTCA and conventional coronary angiography (CCA). We established eligible criteria for CABG based on 2011 American College of Cardiology/American Heart Association practice guidelines: 3-vessel disease, left main coronary artery disease, and proximal left anterior descending artery (pLAD) disease with other one major coronary artery disease. Results of CTCA and CCA were retrospectively reviewed. SYNTAX scores were obtained based on both CCA and CTCA. Diagnostic performances of CTCA, CT-based SYNTAX score and combining CTCA with SYNTAX score for selecting CABG candidates were calculated, with CCA as the reference standard.

RESULTS

CONCLUSION
Dual-source CTCA showed comparable diagnostic accuracy for selecting CABG candidates compared with CCA. Combining CT-based SYNTAX score with CTCA can be highly specific method for selecting CABG candidates.

CLINICAL RELEVANCE/APPLICATION
Dual-source CTCA showed comparable diagnostic accuracy for selecting CABG candidates and combining CT-based SYNTAX score with CTCA can be highly specific method.

SSC01-04 • Effect of Snapshot Freeze Motion Correction Algorithm on Image Quality of Retrospective ECG-triggered Coronary CT Angiography

Lijuan Fan (Presenter); Jiwang Zhang; Donghai Fu; Liren Zhang MD

PURPOSE
We assessed Snapshot Freeze Motion Correction algorithm for its effect on image quality of coronary CT angiography (CTA) with retrospective ECG-triggered.

METHOD AND MATERIALS
Thirty consecutive patients undergoing CCTA with retrospective ECG-triggered. Two types of reconstruction methods of standard (STD) and snapshot freeze motion correction (SSF) were used to produce the 75% and 45% R-R interval images. We compared image quality and interpretability between STD and SSF reconstructions of each heart cycle. CCTA images were interpreted with Likert 5-points score by two experienced radiologists. The image quality and interpretability were respectively assessed on per-patient, per-artery and per-segment levels. Comparisons of variables were performed with Wilcoxon rank sum test and McNemar test.

RESULTS

CONCLUSION
The use of SSF improves image quality and interpretability of coronary CTA. The image quality of the 45% R-R interval was best.

CLINICAL RELEVANCE/APPLICATION
The use of SSF improves image quality and interpretability of coronary CTA.

SSC01-05 • Improved Non-calcified Plaque Delineation on Coronary CT Angiography by Sonogram-affirmed Iterative Reconstruction with Different Strength and Relationship with BMI

Lei Zhao MD (Presenter); Fabian Plank; Andrea Klauser MD; Florian Wolf MD; Werner R Jaschke MD, PhD; Gudrun Feuchtner MD *

PURPOSE
To prospectively compare non-calcified plaque delineation and image quality of coronary artery computed tomography angiograms (CTTA) obtained with sonogram-affirmed iterative reconstruction (SAIR) with different strengths and filtered back projection (FBP).

METHOD AND MATERIALS
A total of 53 patients (body weight 90.4±21.6 kg, BMI 29.5±6.6) were investigated. CCTA was performed using 128-slice dual-source CT. Images were reconstructed with standard FBP and sonogram-affirmed iterative reconstruction using different strength (I2f, I3f, I4f). Image quality score (IQS) of overall CCTA exam and a non-calcified plaque outer border delineation scores (PDS) were evaluated respectively by using a 5-scale score: from 1=non-diagnostic to 5=excellent. Image noise, contrast-to-noise ratio (CNR) of aorta root, left main and right coronary artery proximal part, and the non-calcified plaques were quantified and compared among the 4 image reconstructions. IQS and PDS were compared between different BMI groups (BMI)

RESULTS
There were 69.8% patients in FBP, 98.0% in I2f, 98.1% in I3f and 100% in I4f who had good overall CCTA IQS. There were statistical differences in CCTA exam IQS among the 4 image reconstructions (P<0.05)

CONCLUSION
SAIR offers improved image quality and non-calcifying plaque delineation as compared with FBP, especially if BMI is increasing. Importantly, 18.3% of non-calcifying plaques were missed with FBP but detected by SAIR. I4f shows the best IQS and PDS among the different SAIR strength.

CLINICAL RELEVANCE/APPLICATION
SAIR improves non-calcifying plaque delineation and detection, and image quality in CCTA. In high BMI patients, highest SAIR strength 14f is most beneficial.

SSC01-06 • Enhanced Diagnostic Accuracy of In-stent Patency in Low-dose High-pitch Dual-source CT Angiography with Iterative Image Reconstruction

Jun-Jie Yang (Presenter)
Miszalski-Jamka Maciej Krupinski

Purpose
Recent studies demonstrated that sinogram affirmed iterative reconstructions can produce higher-resolution images with greater robustness for the reduction of various imaging artifacts. The aim of this study was to assess the diagnostic accuracy of in-stent restenosis (>50% luminal narrowing) using low-dose high-pitch dual-source CT coronary angiography (Flash CTCA) with sinogram affirmed iterative reconstructions (SAFIRE) in symptomatic patients referred for conventional coronary angiography (CCA).

Method and Materials
137 stents in 70 patients (average heart rate was 57±8 bpm), were prospectively evaluated. The interval between stenting and inclusion in the study was 21 ± 12 months. Before scheduled CCA, Flash CTCA was performed between September 2011 and December 2012. In-stent noise, signal-to-noise ratio (SNR) and stent-lumen attenuation increase ratio (SAIR), as well as subjective image quality score, were measured and compared between SAFIRE reconstruction (group A) and traditional filtered back projection (FBP) reconstruction (group B). CCA was served as the standard of reference to further analyze accuracy of both groups on detecting in-stent restenosis.

Results
Of the 137 stents, group A were superior to group B on in-stent noise (22.5±8.6 vs. 36.1±13.9; P<0.05). However, in subgroup of smaller stent (0.05). CCTA average effective dose was (1.41±0.45) mSv.

Conclusion
Low-dose high-pitch dual-source CT angiography can be performed well in the detection of in-stent patency. Iterative image reconstruction significantly improve diagnostic accuracy of in-stent restenosis even in smaller stents.

Clinical Relevance/Application
Iterative image reconstruction significantly improve diagnostic accuracy of in-stent restenosis even in smaller stents.

SCC01-07 • Use of 80kV, 100kV and 120kV in Coronary CT Angiography with Prospectively Electrocardiogram (ECG)-triggered Spiral Acquisition by Dual-source CT: Image Quality and Radiation Dose

Shuo Li MD (Presenter); Yining Wang MD; Lingyan Kong MD; Zhengyu Jin MD

Purpose
To compare the image quality (IQ) and radiation exposure using of 80kV, 100kV and 120kV tube voltage with prospectively electrocardiogram (ECG)-triggered spiral acquisition in coronary CT angiography.

Method and Materials
Totally ninety consecutive patients with irregular heart rate ( RESULTS
There was no difference in age, heart rate, mean scan time and body mass among the three groups (P>0.05). The mean tube current was 269.75±40.30 (80kV), 317±33.68 (100kV), 322.57±70.45 (120kV). That of 80kV group was remarkably lower than the other two groups. The average IQ score was 1.01±0.26 (80kV), 1.00±0.19 (100kV), and 1.14±0.38 (120kV). The IQ score was significantly higher for 120 kV group. No statistical difference was found between 80kV and 100kV groups (P>0.05). The mean effective radiation dose was 0.31±0.04 mSv (80kV), 0.77±0.10 mSv (100kV), and 1.31±0.30 mSv (120kV) respectively. There was statistical difference among them (P=0.00).

Conclusion
In patients with a low and stable heart rate (< 70bpm), use of low tube voltage reduces radiation dose and may result in improved image quality.

Clinical Relevance/ Application
As increased applications of CCTA continue to emerge, concerns exist in regards to patient radiation exposure. lowering the tube voltage, have been developed for lowering radiation dose with CCTA.

SCC01-08 • Sub-millisievert CT Coronary Angiography (CTCA) Using Adaptive Iterative Dose Reduction

Masoud Shariat MD (Presenter); Aparna Deshpande MBBS; Vikram M Raju MBBS, FRCR; Bahiyah Alnafisi MD; Narinder S Paul MD

Purpose
To determine whether Adaptive Iterative Dose Reduction (AIDR) increases the proportion of patients with diagnostic quality submillisievert CTCA studies compared to Filtered Back Projection (FBP).

Method and Materials
Retrospective analysis of 80 consecutive patients referred for CTCA. Group A (FBP) = 40 patients; (25 M), aged 60.2 ± 9.0 years, BMI 28.0± 5.1, and group B (AIDR) = 40 patients; (20 M), aged 59.4 ± 12.9 years, BMI 27.8± 6.6. All patients had the same preparation with oral/IV metoprolol 75-150mg/0-40mg to achieve a target heart rate (HR) of =60bpm and s/l NTG 300mcg. CCTA was performed using 320 x 140-160mm detector rows (Aquilion One, TMS, Otawara, Japan), gantry rotation of 350ms and power injection of 80cc iodinated CM at 6cc/s. In both groups, the X-ray tube settings (kVp, mA) were optimized to pre-defined levels of image noise using proprietary software (SureExposure, Toshiba Medical Systems). Assessment of image quality was performed by 2 level III trained cardiac radiologists independently, blinded to the scan parameters. Qualitative assessment used a 4 point visual score (1=excellent, 2=good, 3=adequate, 4=poor). Quantitative assessment compared the signal to noise ratio (SNR) in the ascending aorta. The console readout (CTDI, DLP) provided the radiation dose. Qualitative statistical analysis and two-tailed P test were performed to compare radiation dose and image quality.

Results
The patients were matched for age, gender and BMI. Radiation Dose: Group A, CTDI = 13.86± 5.99 (range 2.8-28mGy), DLP = 188.26± 81.60 (range 44.30-391.70 mGy.cm); Group B, CTDI = 10.40 ± 6.17 (range 2.3-22.9), DLP = 136.44± 80.65 (range 28.9-260 mGy.cm) resulting in a mean CTDI reduction of 25% with AIDR (p=0.019).

SNR: Group A = 20.84 ± 5.58 (range 1.19-28.74), Group B = 23.70± 7.80 (range 7.56-43.03), an increase of 14% (p=0.062). Visual score: Group A= 3.24±0.64, Group B = 3.27±0.67 (p=0.8466). Number of sub-mSv scans: Group A = 2 (5%), Group B = 10 (25%).

Table 1

Conclusion
CTCA performed using AIDR results in diagnostic image quality with an average dose reduction of 25% compared to an optimized FBP protocol and a five-fold increase in the number of sub-mSv scans.

Clinical Relevance/Application
CTCA accurately detects CAD. Radiation dose concerns restrict widespread use of CTCA but IR algorithms demonstrate significant dose reduction with preservation of diagnostic image quality.

SCC01-09 • Anomalous Origin of the Coronary Artery from the Wrong Coronary Sinus Evaluated with Computed Tomography

Maciej Krupinski (Presenter); Malgorzata Urbanczyk Zawadzka; Malgorzata Iryzk; Bartosz Laskowicz; Tomasz Miaszalski-Jamka; Robert Pawel Bany; Jan Baron

Purpose
Anomalous origin of coronary artery is an abnormality occurring in around 1% of patients. The aim of the study was to perform cardiac computed tomography (CT) evaluation of the coronary arteries originating from the wrong coronary sinus, including their anatomy.
Anomalous origin of coronary artery was found in 54 (0.76 %) patients (29 males, 25 females, mean age 60.9 ± 11.6 years). 22 (41%) patients presented circumflex artery originating from the right coronary artery sinus (ALCx), 16 (30%) patients right coronary artery originating from the left coronary artery sinus (ARCA), 13 (24%) patients left coronary artery originating from the right coronary artery sinus (ALCA) and 3 (5%) patients left coronary artery originating from the noncoronary artery sinus. The mean value of angle of takeoff was lower (p = 0.02).

Anomalous origin of the coronary artery from the wrong coronary sinus is a rare occurring anomaly in cardiac CT. High risk anatomy features are the most common in patients with right coronary artery originating from the wrong coronary sinus. Patients with ARCA also reveal higher prevalence of chest pain and cardiac events in the follow up than individuals with ALCA and ALCx.

**Clinical Relevance/Application**

Cardiac CT enables detection and evaluation of the anomalous origin of the coronary artery, including its high risk anatomy features.

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**Method and Materials**

7115 patients, who were scheduled for 64-slice or dual source cardiac CT were screened for the presence of isolated anomalous origin of the coronary artery from the wrong coronary sinus. Those, who revealed abnormal origin of coronary artery were evaluated for: high risk anatomy features (acute angle of takeoff, slitlike orifice, intramural course and course between aorta and pulmonary artery), presence and type of clinical symptoms and occurrence of cardiac events during follow up.

**Results**

Anomalous origin of coronary artery was found in 54 (0.76 %) patients (29 males, 25 females, mean age 60.9 ± 11.6 years). 22 (41%) patients presented circumflex artery originating from the right coronary artery sinus (ALCx), 16 (30%) patients right coronary artery originating from the left coronary artery sinus (ARCA), 13 (24%) patients left coronary artery originating from the right coronary artery sinus (ALCA) and 3 (5%) patients left coronary artery originating from the noncoronary artery sinus. The mean value of angle of takeoff was lower (p = 0.02).

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**Clinical Relevance/Application**

Cardiac CT enables detection and evaluation of the anomalous origin of the coronary artery, including its high risk anatomy features.
CLINICAL RELEVANCE/APPLICATION

A short period of HIT leads to significant changes in cardiac morphologic characteristics and function which are not associated with pathologic features predisposing for sudden cardiac death.

SSC02-03 • MRI Based Non-invasive Measures Correlates with Invasive Measurements of Left Atrial Diastolic Function in Atrial Fibrillation Patients

Irfan M Khurram MD (Presenter) ; Farhan Maqbool MBBS ; Roy Beinart MD ; Hugh Calkins ; Saman Nazarian MD * ; Stefan L Zimmerman MD

PURPOSE

Atrial fibrillation (AF) is the commonest cardiac arrhythmia and is a major source of morbidity due to diminished cardiac function. This study describes a novel methodology for non-invasive measurement of left atrial (LA) function in patients with AF.

METHOD AND MATERIALS

A total of 55 patients (81% male, 55% paroxysmal, age 60.4±10.2 years) underwent cardiac MRI prior to AF ablation. LA pressure was measured during sinus rhythm following trans-septal puncture for AF ablation. LA pressure (invasive) and volume (MRI derived) loops were prepared for all patients. LA diastolic function was assessed using a diastolic dysfunction score, defined as the ratio of the change in LA pressure to the change in LA volume during passive LA filling. Additionally, the ratio of pulmonary vein flow velocities during ventricular systole and diastole were obtained using phase contrast MRI (Figure, top panel, S/D ratio). LA volumes from 30 phases of the cardiac cycle were obtained from cine-MRI. LA systolic functions were calculated from the active emptying fraction during atrial contraction. Diastolic dysfunction scores greater than the 90th percentile (>1.6mmHg/ml) were considered to signify severe diastolic dysfunction.

RESULTS

The mean diastolic dysfunction score was 0.76±0.7 mmHg/ml. The score was higher (worst) in patients with persistent versus paroxysmal AF (1.0±0.9 versus 0.60±0.5, p=0.02). The mean S/D ratio was 1.04±0.6; and was lower in patients with persistent versus paroxysmal AF (0.9±0.5 versus 1.2±0.5, p=0.04). There was a negative linear association between diastolic dysfunction scores and S/D ratio measures (Figure, bottom panel, $R^2 0.262$, p

CONCLUSION

The non-invasive MRI derived ratio of pulmonary vein flow velocities during systole and diastole are associated with the MRI/ invasive derived diastolic dysfunction score, and appear to be a reasonable surrogate of LA diastolic function.

CLINICAL RELEVANCE/APPLICATION

Non-invasive PV flow characteristics by MRI yield comparable results to pressure/volume loops and may ease the assessment of LA diastolic function. More studies are needed to validate this association

SSC02-04 • A Qualitative and Quantitative Assessment of Ungated Free-breathing Cardiac Imaging Using Through-time Radial GRAPPA for Left Ventricular Functional Evaluation

Gunhild E Aandal MD (Presenter) ; Vidya Nadig MD ; Victoria Yeh ; Prabhakar Rajjah MD, FRCR ; Trevor Jenkins ; Abdus Sattar PhD ; Mark A Griswold PhD * ; Robert C Gilkeson MD * ; Vikas Gulani MD, PhD * ; Nicole Seiberlich PhD *

PURPOSE

To determine whether LV functional parameters and image quality of free-breathing, ungated scans reconstructed with through-time radial GRAPPA are comparable to those of gold-standard breathhold cine techniques.

METHOD AND MATERIALS

Volumetric data was collected in 78 subjects (14 volunteers, 64 patients) on a 1.5T MRI scanner. Both gold-standard breathheld cardiac functional scans with ECG gating (tailored to the patient with spatial resolutions between 1.4-2.6 mm² and temporal resolutions of 31-62ms) and free-breathing, ungated highly undersampled radial bSSFp scans (spatial resolution of 2.3mm², temporal resolution of 42.2ms) were acquired. Reconstruction of the radial data was performed with through-time radial GRAPPA. ESV, EDV, and EF were assessed using both methods, and correlation coefficients and Bland-Altman plots were generated. The images were rated by two cardiothoracic radiologists for specific features on a scale of excellent, good, poor, no visibility; obvious visual differences precluded blinded. Ordinal logistic regression analysis (corrected for clustering) of the radiologists’ ratings was performed.

RESULTS

Correlation coefficients indicated significant correlation between the methods (EF $R=0.97$, EDV $R=0.99$, and ESV $R=0.99$). Bland-Altman analysis showed that 72 of the 78 of the EF measurements were within the 95% limits of agreement (mean difference=-0.93%, SD=2.49%). Similar results were found for the EDV and ESV values. Radiologist ratings showed that the free-breathing method was preferred for depiction of endocardial borders (p<0.05), and mitral valve visualization and blood pool contrast with the breathhold method were preferred (p

CONCLUSION

Differences in EF, EDV, and ESV between the gold-standard and free-breathing, ungated images generated using through-time radial GRAPPA are not clinically significant. Radiologist review demonstrated that some features including endocardial Borders are better visualized with the free-breathing scan due to their reduced motion artifacts, while the breathhold method was preferred for valve visualization and blood pool contrast.

CLINICAL RELEVANCE/APPLICATION

Free-breathing ungated scans with through-time radial GRAPPA can be used to find LV functional parameters quickly and cost-effectively even for patients with difficulty breathholding or arrhythmia.

SSC02-05 • Fat Accumulation in Skeletal Muscle Quantified by MRS: Relationship to Global Myocardial Function

Radwa A Noureldin MD, MSc (Presenter) ; Ronald Ouwerkerk PhD ; Roderic I Pettigrew MD, PhD ; Ahmed M Gharib MBChB

PURPOSE

Obesity has a detrimental effect on cardiac function, we aimed to evaluate relationship between musculoskeletal fat deposition and myocardial function.

METHOD AND MATERIALS

Seventy-seven HIPPA-compliant subjects, without history of cardiac disease, were scanned after IRB approval and signing a written informed consent. We used a Siemens Verio 70cm bore 3T-MRI. Short axis (SA) and 4-chamber SSFP cine were obtained for evaluation of global myocardial function; EF, EDV, ESV, SV and LV mass, variables were indexed to BSA. Pericardial fat volume was quantified on SA images end systole, extended from level of mitral valve to the apex. MRS was performed using PRESS technique, TR/TE = 4000/24ms. PRESS voxel was targeting the vastus lateralis (VL), anterior tibial (AT) and soleus muscles. Musculoskeletal fat fraction (FF) was quantified using Amares/MRUI. IMCL was also calculated. Axial T1 weighted images at L4-L5 level were acquired for abdominal fat measurement.

RESULTS

CONCLUSION

In population without known cardiac disease, musculoskeletal fat accumulation (lipid fraction) is associated with decreased systolic ejection and diastolic filing (compliance).

CLINICAL RELEVANCE/APPLICATION

Early reduction of cardiac compliance is demonstrated in obesity and correlates with fat accumulation in skeletal muscles.
**SSC02-06 • Caffeine and Taurine Containing Energy Drink Improves Systolic Left-ventricular Contractility in Healthy Volunteers Assessed by Strain Analysis Using Cardiac Magnetic Resonance Tagging (CSPAMM)**

**Jonas Doerner** (Presenter) ; **Daniel Kuetting** ; **Claas P Naehle** MD * ; **Hans H Schild** MD ; **Daniel K Thomas** MD, PhD

**PURPOSE**

Energy drinks (ED) usually contain a high amount of caffeine, taurine, and sugar as their main ingredients. Although their consumption appears not uncritical, there is little or no regulation on ED sales so far. Concerns about adverse side effects especially focus on heart function in adolescents and young adults. In this study, we investigated the effect of ED consumption on myocardial function in healthy volunteers using MRI tagging and strain analysis.

**METHOD AND MATERIALS**

18 healthy volunteers (15 male, 3 female, mean age: 27.5 years) were investigated using cardiac magnetic resonance imaging (CMR). CMR was performed on a 1.5-Tesla whole body scanner directly before and 1h after consumption of a taurine (400 mg/100 ml) and caffeine (32 mg/100 ml) containing ED (168 ml/m² body surface area). For left-ventricular (LV) myocardial tagging, complementary spatial modulation of magnetization (CSPAMM) was used. Strain was calculated for peak strain (PS), peak systolic strain rate (PSSR) and peak diastolic strain rate (PDSR) using TagTrack (Gyrotools, Zurich, Switzerland). Steady state free precision (SSFP) cine imaging was used for determination of LV-function. Additionally vital parameters such as heart rate (HR) and blood pressure (BP) were recorded throughout the investigation.

**RESULTS**

PS and PSSR as parameters for systolic LV-contractility were significantly increased 1h after ED consumption compared to baseline (PS: w/o ED -22.33 ± 1.7; w ED -24.15 ± 2.4; p=0.01; PSSR: w/o ED -1.18 1/s ± 0.08; w ED -1.30 1/s ± 0.16, p=0.01). PDSR as a parameter for diastolic LV-relaxation was slightly, but not significantly higher compared to baseline (PDSR: w/o ED 1.90 1/s ± 0.33; w ED 2.09 1/s ± 0.44, p=ns). No significant changes were found for LV-function (LV-EDV: w/o ED 141 ml ± 31; w ED 145 ml ± 33; LV EF: w/o ED 64 % ± 4; w ED 66 % ± 8) and vital parameters (HR: w/o ED 63 1/min ± 9; w ED 62 1/min ± 7; BP: w/o ED 113/62 mmHg; w ED 117/64 mmHg).

**CONCLUSION**

This work reveals that ED consumption has a short-term impact on cardiac contractility, therefore further studies have to evaluate the impact of long-term ED consumption and the effect of ED on patients with heart disease to determine potential risks or benefits of ED consumption.

**CLINICAL RELEVANCE/APPLICATION**

ED consumption lead to changes in LV-activity, which can be assessed by CMR tagging and strain analysis.

**SSC02-07 • Left Ventricular Strain Analysis by Cardiac MR Using Deformation Field Analysis at Bright Blood Cine SSFP Imaging: A Comparison with Speckle Tracking Echocardiography**

**Kevin Kalisz** (Presenter) ; **Edouard Semaan** ; **Daniel H Katz** ; **Xiaoming Bi** PhD * ; **Marius Cordts** * ; **Christoph Guettler** PhD * ; **Marie-Pierre Jolly** * ; **Benjamin Freed** ; **Daniel Lee** * ; **Preeti Kansal** ; **Sanjiv Shah** MD * ; **Michael Markl** PhD ; **James Carr** MD * ; **Jeremy D Collins** MD *

**PURPOSE**

To demonstrate the feasibility of strain analysis using deformation field analysis on steady state free precession (SSFP) cardiac MR images with speckle tracking echocardiography (STE) as the reference standard.

**METHOD AND MATERIALS**

44 patients (29 males, average age 52 years) referred to CMR for scar assessment or evaluation of infiltrative disease were imaged on a 1.5T scanner (Magnetom Avanto or Aera, Siemens Healthcare, Erlangen, Germany). Bright blood cine short axis images (TR/TE 42/1.2, FA 79 degrees, frame rate 25, BW 930) were analyzed using prototype software (Siemens Corp., Corporate Technology, Princeton, NJ). Similar to speckle tracking, the spatio-temporal deformation of the LV muscle on cine images was used to derive deformation fields and quantify in-plane strain indices. A subset of images (15 patients) were analyzed again by the first reviewer and independently by a second reviewer.

**RESULTS**

CMR peak radial and circumferential strains demonstrated fair and good correlation with STE (r=0.36 and 0.63, respectively). CMR underestimated (p CONCLUSION

LV myocardial strain using deformation field analysis on cine SSFP CMR imaging is feasible with excellent and good inter- and intraobserver agreement for radial and circumferential strain respectively. Fair to good agreement was noted between LV global strain by CMR and STE, however. Work is ongoing to determine optimal cine SSFP acquisition parameters, to improve the deformation field algorithm for strain calculation, and to correlate CMR strain values with patient symptoms.

**CLINICAL RELEVANCE/APPLICATION**

Myocardial strain has been applied to predicting changes in cardiac function in a variety of disease processes. We describe the use of a novel algorithm to compute strain at cinecardiac MR.

**SSC02-08 • Cardiac Computed Tomography (CCT) for Predicting Left Atrial Appendage Occluder Device Size**

**Orly Goitein** MD (Presenter) ; **Grupper Avisahy** ; **Elia Di Segni** MD ; **Eli Konen** MD ; **Ashraf Hamdan** MD ; **Victor Guetta** * ; **Ilan Hai** ; **David Luria** MD * ; **Michael Glikson** MD

**PURPOSE**

Atrial fibrillation (AF) may cause thromboembolic stroke. The left atrial appendage (LAA) is the thrombi source in more than 90% of strokes. Several devices have been developed to occlude the LAA. Inaccurate LAA orifice sizing may lead to utilization of more than one device per procedure, or inadequate LAA occlusion.

The purpose of this study was to assess the contribution of cardiac Computed Tomography (CCT) measurements for LAA device sizing with.

**METHOD AND MATERIALS**

All subjects underwent ECG gated CT scans prior to LAA closure device insertion. CCT scans were performed using a 256-slice scanner with retrospective electrocardiographic gating. Assessed parameters included: LAA maximal and minimal diameters (mm), LAA depth (mm). These values were compared with final implanted device size. Echocardiographic follow up at six weeks was performed in order to document the presence of regurgitation, as evidence for incomplete LAA occlusion.

**RESULTS**

This study cohort included 22 chronic AF patients (9 males, average age 76 years). Two procedures failed, the maximal LAA diameter was 39 mm in both. The maximal LAA diameter of devices used was 22 mm in 20 patients (1.2 devices per patient). Mean maximal CCT and minimal diameters were 22±5 and 22±5 mm respectively. Mean LAA depth was 22±4.4. Good correlation was found between maximal CCT diameter and device size (Pearson correlation=0.045; p=0.04). No correlation was found between minimal LAA diameter, LAA depth and device size (Pearson correlation=-0.0.08; p=0.7 and -0.02; p=0.9, respectively). LAA diameter >30 mm (N=5) was associated with adverse device sizing; procedure failure (2/5) and incomplete LAA occlusion (2/5) with regurgitation on echocardiographic follow up.
CONCLUSION
CCT should be considered as an important adjunct modality for device sizing. LAA maximal diameter > 30 mm was predictive of unfavorable procedure outcome including procedure failure and incomplete LAA occlusion in 80% of cases with large LAA ostia.

CLINICAL RELEVANCE/APPLICATION
Cardiac CT is an important imaging modality before LAA occluder insertion. It allows accurate LAA size evaluation and can identify potential problematic cases prior to device implantation.

SSC02-09 • Characterisation of Myocardial Function and Structure in Patients with Rheumatoid Arthritis: A Cardiovascular Magnetic Resonance Study

Ntobeko A Ntusi MBCh, MD (Presenter); Jane M Francis; Paul M Matthews MD, DPhil; Paul B Wordsworth MBBS, FRCP; Stefan Neubauer; Theodoros D Karamitsos

PURPOSE
To assess global and regional left ventricular (LV) function and myocardial fibrosis in patients with rheumatoid arthritis (RA), using cardiovascular magnetic resonance (CMR) and examine the additional effect of traditional cardiovascular risk factors (CVRFs) in RA patients.

METHOD AND MATERIALS

RESULTS

CONCLUSION
CMR demonstrates impaired myocardial strain and a high incidence of non-ischaemic fibrosis in RA patients. The cardiac abnormalities in RA appear to be incremental to those due to traditional CVRFs.

CLINICAL RELEVANCE/APPLICATION
Cardiovascular disease is common in asymptomatic RA patients and traditional CVRFs need to be aggressively controlled as they appear to confer incremental risk in this cohort.

Cardiac (Quantitative Imaging)
Monday, 10:30 AM - 12:00 PM • S504AB

SSC03 • AMA PRA Category 1 Credit ™:1.5 • ARRT Category A+ Credit:1.5
Moderator
E. Kent Yucel, MD
Moderator
Suhny Abbara, MD *
Moderator
Pamela K Woodard, MD *

SSC03-01 • Role of 4D Flow MRI in Detecting Hemodynamic Changes in Patients with Pulmonary Arterial Hypertension

Pegah Entezari MD (Presenter); Susanne Schnell; Naomi C Chesler PhD; Christopher J Francois MD; Alejandro Roldan PhD; Oliver Wieben PhD; Jeremy D Collins MD *; James C Carr MD *; Alex Barker; Michael Markl PhD

PURPOSE
To evaluate peak velocity, net flow, vessel diameter and wall shear stress (WSS) in the proximal pulmonary arteries of normotensive controls and patients with pulmonary arterial hypertension (PAH) using 4D flow MRI.

METHOD AND MATERIALS

RESULTS

CONCLUSION
4D flow MRI illustrates distinct hemodynamic changes in PAH patients compared to a normal population. The significant reduction in net flow, peak velocity and an increase in PA lumen diameter in patients resulted in decreased WSS values, as compared to normal volunteers.

CLINICAL RELEVANCE/APPLICATION
Pulmonary hypertension is associated with right heart failure, but its effect on arterial diameter and hemodynamic factors (i.e. velocity, flow, WSS) and their role in disease progression is not clear.

SSC03-02 • Serum Biomarkers of Atherosclerosis and Myocardial Remodeling: Correlation with Quantitative Imaging Markers of Coronary Heart Disease at Cardiac CT

Lucas L Geyer MD (Presenter) *; Balazs Ruzsics; Aleksander Krazinski; Justin R Silverman; Christopher L Schlett MD, MPH; U. Joseph Schoepf MD *; Ulrich Ebersberger MD; Fabian Bamberg MD, MPH *; Maximilian F Reiser MD; Michael R Zile MD

PURPOSE
We aimed at correlating the plasma levels of several novel circulating biomarkers of atherosclerotic disease activity and myocardial remodeling with quantitative imaging markers of coronary heart disease obtained by coronary CT angiography (cCTA).

METHOD AND MATERIALS

In an IRB-approved, HIPAA compliant study, 75 patients with suspected coronary artery disease underwent contrast enhanced, retrospectively ECG-gated coronary dual-source CT angiography. Patients were evaluated for the type of coronary plaque and the presence and severity of coronary artery stenosis on a per patient and per segment basis. Semi-automated software was used for measuring the volume of non-calciﬁed and mixed plaques; lipid-rich and ﬁbrous contents were differentiated. Cardiac function parameters were obtained using cine CT reconstructions across the RR cycle. Plasma samples were collected from each patient and a cytokine and
In 70 consecutive patients, who underwent CAC imaging by 128-slice dual-source 128-slice CT, CAC volume, mass and Agatston score were calculated from images reconstructed by filtered back projection (FBP) without and with incremental degrees of iterative reconstruction (SAFIRE algorithm: 10-50%). We used the repeated measuring test and the Steel-Dwass test for multiple comparisons of values and the difference ratio among different SAFIRE groups, using the FBP (0% SAFIRE) as reference.

RESULTS
The median Agatston score (range) decreased with incremental IR: 163 (0.1 ~ 3393.3), 158.4 (0.3 ~ 3079.3), 137.7 (0.1 ~ 2978.0), 120.8 (0 ~ 2783.6), 102.6 (0 ~ 2468.4), and 84.1 (0 ~ 2186.9) for 0% (FBP), 10%, 20%, 30%, 40%, and 50% SAFIRE, respectively

CONCLUSION
SAFIRE noise reduction techniques significantly affected the coronary calcium quantification, with potential clinical consequences.

CLINICAL RELEVANCE/APPLICATION
Iterative reconstruction techniques should not be used, because it significantly reduced quantitative coronary calcium quantification.

Coronary Artery Calcification Scoring with CT Scanners from Four Different Vendors Results in Different Scores

METHOD AND MATERIALS
We evaluated the differences in coronary calcium scores between state-of-the-art CT scanners from four different vendors using fifteen ex-vivo human hearts placed in a commercially available anthropomorphic chest phantom. These hearts were scanned with unenhanced respectively ECG-triggered step-and-shoot protocols at equal radiation dose settings. Thickness and increment of slices were 3mm.

RESULTS
Agatston scores, calcification volume and mass scores were quantified with clinically used semi-automatic software from the same vendor as the CT system. Differences were analyzed with the Friedman test (significance level P < 0.05). The per-person ECV were calculated from images reconstructed by filtered back projection (FBP) without and with incremental degrees of iterative reconstruction (SAFIRE algorithm: 10-50%). We used the repeated measuring test and the Steel-Dwass test for multiple comparisons of values and the difference ratio among different SAFIRE groups, using the FBP (0% SAFIRE) as reference.

RESULTS
The per-person ECV were calculated from images reconstructed by filtered back projection (FBP) without and with incremental degrees of iterative reconstruction (SAFIRE algorithm: 10-50%). We used the repeated measuring test and the Steel-Dwass test for multiple comparisons of values and the difference ratio among different SAFIRE groups, using the FBP (0% SAFIRE) as reference.

CONCLUSION
Our study suggests that elevated levels of MPP-8 are associated with greater atherosclerotic plaque volume at cCTA. Moreover, IL-8 and TNF? may indicate more active myocardial remodeling with higher myocardial mass at CT.

CLINICAL RELEVANCE/APPLICATION
Integration of quantitative cardiac CT imaging with novel serum biomarkers of atherosclerosis and myocardial remodeling may enhance insights into the patho-mechanisms of coronary heart disease.
CONCLUSION
Women’s myocardial extracellular volume fraction is higher than men’s in healthy population.

CLINICAL RELEVANCE/APPLICATION
The higher myocardial ECV in healthy women than men indicates studies ideally consist of subgroups of each gender may help to interpret the research and clinical results involving myocardial ECV.

SSC03-06 • Automatic Quantification of Blood Flow from Real-time Phase-contrast MRI
Markus Huellebrand (Presenter) ; Anja Henнемuth MS ; Jens Frahm PhD * ; Lennart Tautz

PURPOSE
2D phase-contrast (PC) MRI is an established technique for the analysis of vascular hemodynamics. A recently developed real-time MRI technique allows for respective acquisitions under free breathing and without the need for ECG synchronization. However, quantitative evaluations become more complicated than for conventional methods because of potential changes in contrast, the management of multiple cycles without manual interference, and the influence of respiratory displacements. In order to overcome such problems, we developed a new method for the automatic analysis of blood flow parameters from real-time PC MRI.

METHOD AND MATERIALS
Real-time 2D PC MRI of the ascending aorta was performed in 5 healthy subjects (mean age 25 years) were at 3-T (TrioTim, Siemens, Erlangen, Germany). Acquisitions were based on a highly undersampled radial FLASH sequence with and without a bipolar flow-encoding gradient (VENC=200 cm/s, flip angle 10°) and image reconstruction by regularized nonlinear inversion. The spatial resolution was 1.33x1.33x6.0mm³ and the temporal resolution corresponded to 40 ms. The images were analyzed with use of the research software prototype CAIPIRINH. After an initial segmentation of the aortic vessel wall, the vessel contour is automatically propagated to all frames using a registration based on a quadrature filter. The results of the automatic analysis were compared to the manual results of three experts.

RESULTS
The segmentation results of the three observers and the automatic segmentation (duration 39 ± 4 s) were compared pair-wise. The average dice coefficient between observers and the algorithm was 0.86 ±0.04, the inter-observer comparison was 0.92±0.03. The average difference in absolute surface distance error was 1.09±0.4mm for the algorithm and 0.71±0.22mm for the observers. The mean absolute error of the stroke volume was 4.67±2.8ml for the algorithm and 6.14±3.5ml for the observers.

CONCLUSION
The comparison of the manual and automatic quantification shows good agreement. Because no manual correction is needed, the proposed method is suited for the automatic analysis of the temporal evolution of flow velocities, peak velocities, stroke volumes and flow rates over multiple cardiac cycles.

CLINICAL RELEVANCE/APPLICATION
Automatic quantification of real-time 2D PC MRI enables analysis of patients with aperiodic heartbeats (e.g. arrhythmias) and monitoring of hemodynamic responses to stress or physiologic maneuvers.

SSC03-07 • Normal Diastolic and Systolic Myocardial T1 Times at 1.5 T: Correlations and Blood Normalization
Ursula Reiter (Presenter) ; Gert Reiter * ; Katrin Dorr MD ; Andreas Greiser PhD * ; Ralph Maderthaner MD ; Michael H Fuchsjaeger MD

PURPOSE
To evaluate regional differences between systolic and diastolic myocardial longitudinal relaxation time (T1), and to investigate variances of myocardial T1 values associated with T1 time of blood to derive relations between blood normalized systolic and diastolic myocardial T1 times in healthy subjects.

METHOD AND MATERIALS
In the recent prospective study, approved by the local ethical review board, 40 healthy subjects (20 female, 20 male; age range 20-35 years) underwent ECG-gated 1.5 T magnetic resonance imaging. A modified Look-Locker inversion recovery (MOLLI) sequence was used to acquire basal, mid-ventricular and apical short-axis myocardial T1 maps in systole and diastole. Regional myocardial T1 times were evaluated in 16 AHA-segments, blood T1 values were derived from blood pool in the center of the left ventricular cavity. Linear regression slopes between myocardial and blood T1 values were employed to normalize measured myocardial T1 values to the mean blood T1 time of the study population. Means of T1 values were compared by t-test, considering p < 0.05 as significant.

RESULTS
Mean myocardial T1 times (984 ± 28 ms in diastole, 959 ± 21 ms in systole) as well as all segmental T1 values in diastole and systole differed significantly (p2 = 0.53 for diastole, R2 = 0.52 for systole). After blood normalization variances of segmental and mean myocardial T1 times decreased (to 17 ms in diastole and 13 ms in systole in case of mean myocardial T1 times) and significant differences in segmental and mean myocardial T1 times with gender completely disappeared. Blood normalized diastolic and systolic myocardial T1 values strongly correlated with each other on segmental (r = 0.72) as well as mean myocardial (r = 0.89) level.

CONCLUSION
In normal myocardium, diastolic and systolic myocardial T1 times significantly differ but strongly correlate with each other. Besides elimination of gender differences in myocardial T1 values, blood normalization reduces variability of myocardial T1 times.

CLINICAL RELEVANCE/APPLICATION
Blood normalization allows improving the definition of threshold values to distinguish normal from pathologically affected myocardium in diastole and systole.

SSC03-08 • 4-Dimensional Magnetic Resonance Velocity Mapping Based Evaluation of Elevated Mean Pulmonary Arterial Pressure: Comparison of Vector, Streamline and Particle Trace Flow Visualization
Ursula Reiter (Presenter) ; Gert Reiter * ; Gabor Kovacs MD ; Aurelien F Stalder * ; Mehmet A Gulsun * ; Andreas Greiser PhD * ; Horst Olschewski MD ; Michael H Fuchsjaeger MD

PURPOSE
To compare relative period of existence of vortical blood flow in the main pulmonary artery in patients with pulmonary hypertension (PH) from velocity vector field, streamline and particle trace visualization of time resolved three-dimensional (4D) magnetic resonance phase-contrast imaging (MR-PCI) data and to compare their linear relationship with invasively determined mean pulmonary arterial pressure (mPAP).

METHOD AND MATERIALS
This prospective study was approved by the local ethical review board. 23 patients with manifest PH underwent right heart catheterization (RHC) and 4D MR-PCI of the main pulmonary artery. Blood flow patterns were visualized as 3D velocity vector fields projected on 2D anatomical images (3D-vector visualization), as 3D streamlines and as 3D particle traces and evaluated for period of existence of vortical blood flow (t vortex in percent of the cardiac interval) in the main pulmonary artery. Dependence of t vortex on visualization and relation to mPAP were analyzed by means of correlation, linear regression and Bland-Altman analysis.

RESULTS
t\textsubscript{vortex} derived from different visualizations strongly correlated (r = 0.94 for 3D-vector versus streamline and r = 0.92 for 3D-vector versus particle trace visualization). Bias and 95%-limits-of-agreement were -4% and ±14% for comparison 3D-vector versus streamline visualization and were -3% and ±15% for 3D-vector versus particle trace visualization. In all techniques t\textsubscript{vortex} showed strong correlation with mPAP with small standard errors from regression lines (r = 0.96, SE = 3.4 mmHg for 3D-Vector, r = 0.95, SE = 3.6 mmHg for streamline, and r = 0.92, SE = 4.4 mmHg for particle trace visualization).

CONCLUSION
Although periods of existence of vortical blood flow determined from 3D-vector visualization correlated best with mPAP, visualization of streamlines and particle traces provide similar results.

CLINICAL RELEVANCE/APPLICATION
4D velocity mapping represents an emerging tool in the analysis of PH hemodynamics and enables estimation of elevated mPAP irrespectively of flow visualization technique.

SSC03-09 • 3T 1H-MR Spectroscopy of Myocardial Steatosis: Relationship to Fat Depots throughout the Body
Radwa A Noureldin MD, MSc (Presenter) ; Ronald Ouwerkerk PhD ; Roderic I Pettigrew MD, PhD ; Ahmed M Gharib MBChB

PURPOSE
To quantify amount of fat accumulated in the heart using high field MRH1 and to determine its relationship to metabolic lipid profile and other fat depots in the human body.

METHOD AND MATERIALS
After IRB approval, ninety HIPPA-compliant subjects, not known to have cardiac disease, underwent 1H-MRS using wide bore 3T scanner. B0 shimming parameters were optimized with a rapid B0 mapping method. MRS of heart was performed using ECG gated PRESS breath navigated technique, TR/TE = 1R-R/30ms. PRESS voxel was located in the septum at isovolumic phase of diastole planned on a 4-chamber SSFP with saturation slabs across subcutaneous and pericardial fat. The same sequence was used for musculoskeletal 1H-MR; PRESS voxel targeting the vastus lateralis, tibialis anterior and soleus muscles. Fat was quantified with Amares/MRUJ and related to water in unsuppressed spectra. Axial images of the heart were obtained at end systole for pericardial fat quantification. Axial T1 weighted images at L4-L5 level were acquired for abdominal fat measurement. All subjects had lipid profile assessment including serum cholesterol, HDL, LDL and serum triglycerides and were obtained within one month of the scan.

RESULTS
CONCLUSION
1H-MR spectroscopy quantifies ectopic fat deposition in the heart. In population with no cardiac disease, myocardial steatosis is correlated with high circulating triglycerides, musculoskeletal fat other fat depots in the human body.

CLINICAL RELEVANCE/APPLICATION
1H-MR spectroscopy is an important tool to investigate and monitor the effects of circulating serum lipids on fat metabolism and its accumulation within cardiac muscle and other ectopic fat depots.
RESULTS
For SOR, 160 solid and 61 non-solid lung nodules were totally identified. No significant difference in LND for nodules with the longest diameter of more than 6mm was shown between both methods, as area under ROC curve was 0.932±0.020 in ULDS and 0.948±0.020 in LDS. Similarly, for the entire solid nodules, LND was quite similar between both methods, as area under ROC curve was 0.844±0.017 in ULDS and 0.876±0.026 in LDS.

CONCLUSION
It was demonstrated that ULDS with AIDR3D has a sufficient potential to be used for lung cancer screening.

SSC04-04 ● Coronary ArteryCalcification as a Predictor of Mortality in the National Lung Screening Trial - American College of Radiology Imaging Network

Caroline Chiles MD (Presenter) ; Fenghai Duan PhD *; Gregory W Gladish MD ; James G Ravenel MD ; Scott Baginski MD ; Bradley J Snyder MD ; Sarah Baum MS ; Stephanie M Smith BA ; Reginald F Munden MD, DMD *

PURPOSE
Low dose CT (LDCT) screening for lung cancer offers an opportunity to evaluate coronary artery calcification (CAC), a predictor of cardiovascular events strongly associated with age and smoking history. This study examines mortality in NLST participants with quantitative and qualitative CAC scores.

METHOD AND MATERIALS
We conducted a retrospective, randomly selected, case-control study to analyze the relationship between baseline LDCT CAC, coronary heart disease (CHD) and all-cause (AC) mortality. Five cardiothoracic radiologists evaluated a total of 1,570 LDCTs from 3 groups: group 1 included 210 CHD deaths; group 2 included 314 AC deaths (excluding CHD); a control group included 1046 participants alive at conclusion of the trial. Of these, 133 were excluded for clinical/technical reasons. Readers performed quantitative analysis of CAC (Agatston scoring), as well as qualitative analysis, based on both an overall and a per-vessel visual assessment (none/0, mild/1, moderate/2, heavy/3), using a set of standard reference CT images.

RESULTS
A CAC Agatston score of 0 was present in 34% of controls, 12% of patients with CHD death and 18% of patients with ACM (p<0.001) were associated with hazard ratios (HRs) of 1.3 (p=.40), 3.5 (p<0.001). A visual assessment of CAC can be used for risk prediction of CHD death and ACM using non-gated LDCT for lung cancer screening, and is comparable to Agatston scoring. ACRIN receives funding from the National Cancer Institute through the grants U01 CA079778 and U01 CA 080098.

CLINICAL RELEVANCE/APPLICATION
CAC, a significant cause of mortality in the lung cancer screening population, can be evaluated by a simple visual assessment.

SSC04-05 ● Diagnostic Accuracy of Digital Tomosynthesis of the Chest for Nodules Detection in Lung Cancer Screening Program

Maurizio Grosso MD (Presenter) ; Liliana Comello ; Roberto Priotto MD ; Emanuele Roberto ; Luca Bertolaccini ; Alberto Terzi ; Stephane Chauvie PhD *

PURPOSE
Accrual of study participants started in December 2010 and ended in December 2011. Smokers or former smokers aged from 45 to 75 years, with a smoking history of at least 20 pack-years, without malignancy in the 5 years before the start of the study were eligible for the study. DTS were performed at baseline and at 1 year follow up. Subjects with lung nodules were addressed to other radiological examination (CT, contrast enhanced CT or PET/CT).

RESULTS
Of the 1919 candidates assessed, 1843 (96%) were enrolled into the study. The mean age was 61 years (ranging 48-73). A total of 1843 DTS studies were performed. Pulmonary abnormalities were detected in 268 (14.5%) subjects. First-line basal computed tomography (CT) was subsequently carried out in 132 (7.2%) subjects, 68 (4.9%) of which were referred for follow-up CT; PET/CT was performed in 27 (1.46%), and lung cancer was detected in 18 (0.98%) individuals.

CONCLUSION
The detection rate of non-calculated lung nodules for DTS was comparable to rates reported for CT. A small subgroup underwent low-dose CT and entered a follow-up program. Overall, lung cancer was detected in about 1% of cases. Chest DTS holds promise as a first-line lung cancer screening tool. With a low-dose protocol effective dose could be kept as low 0.1 mSv/exam.

CLINICAL RELEVANCE/APPLICATION
Tomosynthesis could find a role in lung cancer screening program

SSC04-06 ● CT Screening for Lung Cancer: Current Practice Patterns at Leading Academic Medical Centers

Phillip M Boiselle MD (Presenter) ; Charles S White MD ; James G Ravenel MD

PURPOSE
Evidence-based guidelines recommend that lung cancer screening be conducted at academic medical centers similar to the NLST sites, but several aspects of CT screening are not addressed by clinical guidelines. Thus, our purpose was to determine current practice patterns for CT screening at leading academic medical centers.

METHOD AND MATERIALS
An electronic survey was emailed in March 2013 to thoracic radiologists at 21 leading academic medical centers, which were identified from the 2012-2013 US News and World Report listings of top hospitals, cancer centers, and pulmonary medicine centers. Participants who reported that they currently offer lung cancer screening were asked additional questions about patient selection, referral requirements, self-pay charges, dose, number of patients screened, nodule management guidelines, use of CAD and volumetric analysis software, and inclusion of a smoking cessation program.

RESULTS
...
Of the 18 survey respondents (86% response rate), 15 (83%) currently have a CT screening program and 3 (17%) are planning one. Among the 15 respondents with an active screening program, almost all included a smoking cessation program (n=14, 93%) and did not employ CAD (n=13, 87%) or nodule volumetry software (n=14, 93%). Less uniformity was reported for: patient selection criteria (NLST criteria most common, n=11, 73%); required referral from a patent’s doctor (n=11, 73%); rate of self-pay charges ($300-$400 most common, n=10, 67%); choice of guidelines for nodule management (Fleischner Society guidelines most common, n=10, 67%); and estimated scan dose (1-2 mSv most common, n=7, 47%). One to 5 patients are scanned per week at 13 of the 15 sites, which is the same or fewer than 6 months ago.

CONCLUSION
Screening programs at leading academic medical centers routinely include a smoking cessation program and only infrequently employ CAD or volumetric analysis software. However, there is less uniformity in patient selection criteria, referral requirements, self-pay charges, scan dose, and choice of nodule management guidelines.

CLINICAL RELEVANCE/APPLICATION
The variability in screening practices at leading academic medical centers suggests the need for formalized radiology guidelines for CT screening for lung cancer.

**SSC04-07 • Solitary Pulmonary Nodule: Which Parameters Would Be Better to Assess for Quantitative Diagnosis on Diffusion-weighted MR Imaging with Multiple b-Values?**

**Hisanobu Koyama** MD (Presenter) ; Yoshiharu Ohno MD, PhD * ; Shinichiro Seki ; Mizuho Nishio MD * ; Sumiaki Matsumoto MD, PhD * ; Takeshi Yoshikawa MD * ; Nobukazu Aoyama RT ; Kazuro Sugimura MD, PhD * ; Masakazu Kanzawa RT

**PURPOSE**
To determine the appropriate parameter for quantitative differentiation of solitary pulmonary nodules (SPNs) by means of diffusion weighted MR imaging (DWI) with multiple b values.

**METHOD AND MATERIALS**
Thirty-two subjects (24 men and 12 women, mean age 68.2 years) with 36 SPNs (range: 5-30 mm) underwent DWI with multiple b values (b=0, 50, 100, 150, 300, 500, and 1000 s/mm2). According to the results from pathological and/or more than 2 years follow-up examinations, all SPNs were divided into two groups: malignant SPNs (n=27) and benign SPNs (n=9). Then, five quantitative parameters were determined from region of interest (ROI) drawn over each SPN as follows: apparent diffusion coefficient (ADC), true diffusion coefficient (D), perfusion fraction (PF) from all b-value data, and the signal intensity ratio between SPN and spinal cord on DWI with b-value at 1000 s/mm2 (LSR1000) and 500 s/mm2 (LSR500). To compare the quantitative parameter difference between malignant SPNs and benign SPNs, all parameters were compared by using Mann-Whitney U-test. To determine the each feasible threshold value, ROC-based positive test was performed. Finally, sensitivity, specificity and accuracy were compared each other by means of McNemar's test.

**RESULTS**
On comparison of each parameter between malignant and benign SPNs, both LSRs had significant difference between two groups (p < 0.05). For quantitative differentiation of SPNs on chest DWI, LSR evaluation is more useful and practical method than ADC, D, and PF assessment in routine clinical practice. In addition, b-value at 500 s/mm2 would be better to choose than b values at 1,000 s/mm2 in this setting.

**CLINICAL RELEVANCE/APPLICATION**
For quantitative differentiation of SPNs on chest DWI, LSR evaluation is more useful and practical method than ADC, D, and PF assessment in routine clinical practice.

**SSC04-08 • A Multicenter, Community Based Chart Review of the Management of Small (8-15 mm) Nodules by Pulmonologists**

**James G Ravenel** MD (Presenter) ; **Nichole Tanner** * ; **Anil Vachani** * ; **Gregory B Diette** * ; **Jyoti Aggarwal** ; **Charles Mathews** ; **Paul Kearney** ; **Kenneth Fang** ; **Gerard Silvestri** MD

**PURPOSE**
Increased utilization of CT along with a growth in lung cancer screening will result in the detection of many new small nodules. While there are defined algorithms for the management of small nodules in screening trials, little is known as to how small nodules are managed in the private practice setting. The purpose of this chart abstraction is to understand what diagnostic pathways are utilized to diagnose small pulmonary nodules in community practice.

**METHOD AND MATERIALS**
A chart review was conducted of ten community practice pulmonology clinics across the United States. This study was approved with a waiver of consent from the IRB and charts were reviewed and findings documented in a HIPAA compliant manner. Consecutive charts from patients with newly detected pulmonary nodules between 8 and 20 mm with either a confirmed diagnosis or two-years follow-up were included. Nodules >8 and...

**RESULTS**
One hundred ninety-five charts from 10 practices were abstracted. The average age was 64.7 years. 46% were male and 87% were...
Between benign and malignant nodules, there were significant differences in nodule's sphericity, discrete compactness and 3D roundness. Compared with malignant nodules, benign nodules showed significantly higher sphericity (0.767 vs. 0.653, p < 0.001).

**CONCLUSION**
Computerized 3D shape analysis such as nodule's sphericity has a potential as a differentiating tool between pulmonary benign from malignant ones.

**CLINICAL RELEVANCE/APPLICATION**
(Dealing with thin section chest CT) Computerized 3D shape analysis of lung nodules can differentiate benign from malignant ones; and is recommended as part of initial evaluation prior to the biopsy.

**Gastrointestinal (Hepatocellular Carcinoma Imaging)**

**Monday, 10:30 AM - 12:00 PM**

**SSC05 • AMA PRA Category 1 Credit™: 1.5 • ARRT Category A+ Credit: 1.5**

**MODERATOR**

**Keyanoosh Hosseinzadeh, MD** *
**MODERATOR**

**Steven S Raman, MD**
**MODERATOR**

**Elmar M Merkle, MD** *

**SSC05-01 • 'Delayed Washout' on the Hepatospecific Phase of Gd-BOPTA MRI in the Characterisation of Arterial-enhancing HCCs Lacking Washout on the Portal Venous and Equilibrium Phases**

**Kelvin Cortis**, **MD, MRCS, FRCR** (Presenter); **Rosa Liotta**; **Roberto Miraglia**, **MD**; **Settimo Caruso**; **Vincenzo Carollo**, **MD**; **Angelo Luca**, **MD**

**PURPOSE**
The current cornerstone of HCC diagnosis is the wash-in (WI)/wash-out (WO) enhancement pattern. However, there remain a significant proportion of hypervascular HCCs lacking WO on the portal venous and/or equilibrium phases. We investigated the possible role of the hepatospecific phase on gadobenate dimeglumine-enhanced MR imaging (Gd-BOPTA-MRI) in further characterising HCCs lacking the typical WI/WO pattern.

**METHOD AND MATERIALS**
Ninety-seven consecutive patients who underwent liver transplantation between 2004 and 2012 and Gd-BOPTA-MRI within three months of surgery were enrolled. Two experienced radiologists performed a nodule by nodule analysis, which was followed by liver explant correlation. *Delayed WO* was defined as hypointensity on the hepatospecific phase in arterial-enhancing nodules lacking WO on the portal venous and/or equilibrium phases.

**RESULTS**
Imaging was performed 41.7 ± 25.4 days prior to transplantation. 295 lesions were identified on histopathology, of which 240 were HCCs. 47 HCCs with massive necrosis after percutaneous treatment were eliminated. Of the remaining 193 HCCs, 48 were not detectable on imaging (24.9%). The 145 HCCs seen on imaging showed WI/WO (n = 68; 46.9%), arterial enhancement without WO (n = 55; 37.9%), and hypovascularity on arterial and venous sequences (n = 22; 15.2%). The WI/WO pattern was observed only in HCC. 23 of the 55 arterially-enhancing HCCs lacking WO (41.8%) showed delayed WO*. This pattern was only observed in 3 other nodules (2 cholangiocarcinomas, 1 regenerative nodule). Hypointensity on the hepatospecific phase was not sensitive in detecting hypovascular HCCs. Combining delayed WO* with WI/WO raises the sensitivity of HCC characterisation from 46.9% to 62.8%, with a minor decrease in the positive predictive value (PPV) (from 100% to 96.8%).

**CONCLUSION**
A significant proportion of arterially-enhancing nodules lacking WO demonstrate delayed WO* on the hepatospecific phase of Gd-BOPTA-MRI. When coupled with WI/WO, delayed WO* augments sensitivity of HCC characterisation with no significant compromise on the PPV.

**CLINICAL RELEVANCE/APPLICATION**
This delayed washout phenomenon increases the sensitivity of HCC characterisation when used alongside the cornerstone wash-in/wash-out pattern, with no significant compromise on the PPV.

**SSC05-02 • Differentiation of Small (≤2 cm) Hepatocellular Carcinoma from Small (≤2 cm) Benign Nodule in Cirrhotic Liver on Gadob Acid-enhanced and Diffusion-weighted MR Images**

**Gil-Sun Hong** **MD** (Presenter); **Jae Ho Byun** **MD**; **Heon-Ju Kwon** **MD**; **So Yeon Kim**; **Kyoung Won Kim** **MD**; **Hyung Jin Won** **MD**; **Yong Moon Shin**; **Pyo Nyun Kim** **MD**

**PURPOSE**
To identify characteristic imaging features that differentiate small (=2 cm) hepatocellular carcinoma (HCC) from small (=2 cm) benign nodule in the cirrhotic liver on gadobenate acid-enhanced and diffusion-weighted (DW) magnetic resonance (MR) images.

**METHOD AND MATERIALS**
This retrospective study was approved by our institutional review board, and informed consent was waived. We included 230 cirrhotic patients with 222 pathology-confirmed small HCCs and 61 benign nodules including 28 pathology-confirmed dysplastic nodules (diameter, 0.5-2 cm), who underwent gadoxetic acid-enhanced and DW MR imaging. In consensus, two radiologists analyzed signal intensity of the HCCs and benign nodules at each MR sequence and rim enhancement during the portal or equilibrium phases. The findings relevant as predictors of small HCCs were identified using univariate and multivariate logistic regression analyses. The combinations of significant MR findings in multivariate analysis were compared with American Association for the Study of Liver Disease (AASLD) practice guideline (a combination of arterial enhancement and portal or delayed washout) using McNemar test.

**RESULTS**
On multivariate analysis, arterial enhancement (adjusted odds ratio [OR], 8.7), T2 hyperintensity (adjusted OR, 6.2), and hyperintensity on DW images (adjusted OR, 2.6) were significant for differentiating small HCCs from benign nodules (P = 0.04). When two or all three findings of them were applied as diagnostic criteria for differentiating small HCCs from benign nodules, sensitivity and accuracy were significantly higher than those of AASLD practice guideline (91% vs. 81% and 89% vs. 83%, respectively; each P = 0.006).

**CONCLUSION**
On gadoxetic acid-enhanced and DW MR images, arterial enhancement and hyperintensity on T2-weighted image and on DW images are helpful for differentiating small HCCs from benign nodules in patients with liver cirrhosis.

**CLINICAL RELEVANCE/APPLICATION**
Our proposed criteria of MR images can be a potential alternative to the AASLD practice guideline in diagnosing small HCCs in patients with liver cirrhosis on gadoxetic acid-enhanced and DW MR images.
Clinical Features of Hepatocellular Carcinoma Showing Isointense or Hyperintense on Hepatocyte-phase of Gadoxetic Acid-enhanced Magnetic Resonance Imaging; Radiologic-pathologic Correlation in Surgically Resected Cases

Katsuhiro Sano MD (Presenter) ; Utoroh Motosug MD ; Hiroyuki Morisaka MD ; Shintaro Ichikawa MD ; Tomoaki Ichikawa MD, PhD *

PURPOSE
Hepatocellular carcinoma (HCC) commonly demonstrates hypointense on hepatocyte-phase of gadoxetic acid-enhanced magnetic resonance (EOB-MR) imaging. However, some cases of hepatocellular carcinoma show isointense or hyperintense on hepatocyte-phase of EOB-MR images, which is a pitfall for diagnosing HCC. The purpose of this study was to elucidate the radiological and histopathological features of HCC that appear isointense or hyperintense on hepatocyte-phase of EOB-MR images.

METHOD AND MATERIALS
In this study, 24 HCCs in 23 patients (mean age; 71.1, 18 males and 5 females, mean tumor size; 32.4mm) who were surgically resected from January 2008 to March 2012 were included. Inclusion criteria of HCC were more than 0.9 of EOB enhancement ratio (tumor to liver contrast on hepatocyte-phase / tumor to liver contrast on precontrast image). All tumors were retrospectively reviewed of enhancement of arterial-phase, bile juice production, histopathological grading, 1 and 3 year survival rate, and 1 and 3 year recurrence-free survival rate.

RESULTS
Twenty-one nodules (88%) showed hypervascular on arterial-phase of EOB-MR images. In gross pathologically, 13 (54%) cases showed green hepatoma producing bile juice. In histopathological findings, all cases were diagnosed as well to moderately-differentiated HCC with no case of poorly-differentiated HCC. The survival rate of 1 and 3 years are 100%. Recurrence-free survival rate of 1 and 3 years are 67% and 56%, respectively.

CONCLUSION
This study demonstrated that poorly-differentiated HCC was not included in the HCC showing isointense or hyperintense on hepatocyte-phase of EOB-MR images. HCC showing isointense or hyperintense on hepatocyte-phase of EOB-MR images tend to show good survival rate.

CLINICAL RELEVANCE/APPLICATION
In our study, clinical features of HCC showing isointense or hyperintense on hepatocyte-phase of EOB-MR images tend to show good survival rate.

Diagnostic Performance of Delayed Hepatobiliary Imaging Post Gadoxetic Acid Combined with DWI vs. Dynamic Contrast-enhanced Imaging for HCC Detection

Cecilia Besa MD (Presenter) ; Nancy A Cooper MD ; Sara Lewis MD ; Amita Kamath MD ; Sasan Roayaie ; Bachir Taouli MD *

PURPOSE
To compare the diagnostic performance of hepatobiliary phase imaging (HBP) post gadoxetic acid combined with diffusion-weighted imaging (DWI) vs. dynamic contrast-enhanced (CE) T1-weighted imaging (T1WI) for hepatocellular carcinoma (HCC) detection.

METHOD AND MATERIALS
203 consecutive patients at risk of HCC who underwent gadoxetic acid-enhanced MRI from 01/2011 to 12/2011 were included in this IRB approved retrospective single center study. Two sets of images were analyzed independently by 2 readers: HBP/DW-set (HBP + DWI using b 0-50-500-1000) and dynamic CE-set (pre-contrast, arterial, portal venous and late venous 3D T1WI after administration of 10 mL of gadoxetic acid). Reference standard was represented by consensus interpretation of 2 separate readers using combination of imaging, clinical and pathologic data. HCCs were defined as lesions > 1 cm with hypointensity on HBP and/or restricted diffusion (hyperintensity on b500/1000 and low ADC) on HBP/DW-set and typical wash-in/wash-out on the CE-set (AASLD criteria). Per lesion and per patient sensitivity, specificity, PPV and NPV were calculated for each image.

RESULTS
Initial data demonstrate similar sensitivity, slightly lower specificity and equivalent NPV when using a combination of HBP imaging post gadoxetic acid and DWI compared to ASSLD criteria for detection of HCC > 1 cm. This combination has potential for HCC screening.

CLINICAL RELEVANCE/APPLICATION
A fast post-contrast liver MRI protocol consisting of gadoxetic acid injection outside the MR room with DWI can be used for HCC screening, which could provide shorter and possibly less expensive exams.

Pilot Study to Evaluate the Diagnostic Per-patient Accuracy of a Limited Hepatobiliary Phase-gadoxetate Enhanced MRI for Hepatocellular Carcinoma Surveillance

Robert M Marks MD (Presenter) ; Andrew Ryan MD ; Elhamy R Heba BMBCh ; An Tang MD ; Claude B Sirlin MD * ; Mustafa R Bashir MD *

PURPOSE
To evaluate the diagnostic performance of an abbreviated gadoxetate-enhanced MRI protocol as a potentially low-cost alternative to conventional MRI for hepatocellular carcinoma surveillance in the setting of chronic liver disease.

METHOD AND MATERIALS
This pilot dual center retrospective cross-sectional study was IRB approved at both institutions where informed consent was waived. 299 consecutive patients at risk for HCC that were in an MRI-based HCC surveillance program between October 28, 2008 and January 31, 2010 were included in the study. For each patient, their first gadoxetate-enhanced MRI was evaluated as the index study. Two readers, blinded to the history and clinical interpretation of the study, independently read two image sets per patient: set 1 included T1w 20-minute hepatobiliary phase images and a T2w SSFSF sequence; set 2 included diffusion-weighted imaging and set 1. For each image set per patient, each nodule larger than 10mm was scored using a 5 point predetermined scoring grid and the highest scoring nodule was then used to give the image set a final score. The composite reference standard included pathologic proof after transplantation, hepatectomy, biopsy, empirical treatment based on the index MRI, and follow-up imaging within 12 months of the index MRI.

RESULTS
There were a total of 49 lesions considered positive for HCC. Inter-reader agreement was substantial for both image sets (κ=0.72 for both). Intra-reader agreement was excellent (κ=0.97 and 0.99). Reader performance for image set 1 (given as reader A/reader B) was: sensitivity 85.7%/79.6%; specificity 91.2%/95.2%; positive predictive value 65.6%/76.5%; negative predictive value 97.0%/96.0%; accuracy 90.3%/92.6%. Only one examination (out of 299) was scored differently on image set 2 compared with set 1, leading to nearly identical performance.

CONCLUSION
Due to its high negative predictive value, an abbreviated MRI protocol with T2-weighted SSFSF and hepatobiliary phase sequences may be an acceptable, low cost alternative to a complete MRI in the setting of chronic liver disease at centers that rely on MRI for HCC surveillance.

CLINICAL RELEVANCE/APPLICATION
Evaluation

SSCO05-06 • Radiopathological Correlation of Hepatocellular Carcinoma in Transplant Patients. MR Evaluation with Gadoxetic Acid

Claudia R Seuss MD (Presenter); Raneem Albazaz MBBCh; Andrew F Scarsbrook FRCR; Maria A Sheridan MD; James A Guthrie MBBCh *

PURPOSE
To evaluate the clinical performance of MRI using Gadoxetic acid in the detection of patients with hepatocellular carcinoma (HCC) and the disease burden within a transplant population.

METHOD AND MATERIALS
A retrospective analysis was performed of the MRI and explant histology reports of patients receiving liver transplants between January 2011 and April 2013. MRI and histologically detected HCC were recorded and correlated as were the indications for transplantation. Comparison was made with an initial cohort of patients and the total study population.

RESULTS
166 adult patients received a liver transplant over the study period. The indications included acute liver failure (6), alcoholic liver disease (45), primary biliary cirrhosis (16), primary sclerosing cholangitis (20), viral hepatitis (34), alcoholic liver disease and hepatitis (7) and miscellaneous (38). 131 patients had an MRI scan preoperatively for evaluation of HCC and 40 patients had image positive hepatocellular carcinoma. With histological correlation on a per patient basis, MRI was 100% sensitive and 98.9% specific in detecting HCC. One patient was diagnosed with multifocal HCC on MRI but only had multiple dysplastic nodules. A total of 83 histological HCCs were detected with 76 true positives, 7 false negatives and 9 false positives on imaging. This equates to a sensitivity of 91.6% on a per lesion basis. All patients transplanted had tumour burdens within Milan criteria on explant histology. There was no difference in the diagnostic performance between the early and total population.

CONCLUSION
Concerns in changing practice from a dual contrast technique using superparamagnetic iron oxide and gadolinium to a gadoxetic acid technique were unfounded. Performance in identifying patients with HCC within transplant criteria was high as was the per lesion correlation.

CLINICAL RELEVANCE/APPLICATION
Pre liver transplantation MRI with gadoxetic acid has a high sensitivity for detecting HCC on a per patient and per lesion basis.

SSCO05-07 • Detection of Hepatocellular Carcinoma (HCC) in Liver Transplant Candidates: Intraindividual Comparison of Gadobenate Dimeglumine (Gd-BOPTA) Enhanced MR Imaging and Multiphasic 64-slice CT

Michele Di Martino (Presenter); Rossella Di Miscio; Concetta V Lombardo; Bruna Cerbelli; Sandro Bosco; Maddalena D’Addario; Carlo Catalano MD

PURPOSE
To intraindividually compare gadobenate dimeglumine (Gd-BOPTA) enhanced MRI and 64-slice CT for detection of HCC in patients with cirrhosis.

METHOD AND MATERIALS
Informed consent and ethical approval were obtained. Eighty-five consecutive patients with 104 HCC nodules underwent MRI at 1.5T (Avanto, Siemens) and 64-slice CT (Sensation 64, Siemens) at a mean interval of 14 days (range, 10-20 days). All patients underwent transplantation within 60 days. MR acquisitions comprised unenhanced breath-hold T2W images and volumetric 3D Gd-BOPTA-enhanced (0.1 mL/kg; MultiHance, Bracco) T1W GRE images acquired at 25s, 60s, 180s (dynamic phase) and 90 min (hepatobiliary phase). 64-slice CT was performed with 0.6 x 64 mm collimation, 3-mm section thickness, 250 mAs, 120 kVp. A triple-phase protocol was started (0.1 mL/kg; MultiHance, Bracco) T1W GRE images acquired at 25s, 60s, 180s after achieving a trigger threshold of 150 HU above baseline CT number in the aorta. Image analysis was independently performed by three observers in two sessions separated by 4 weeks. Findings were compared directly with explanted liver pathology results. Diagnostic accuracy was evaluated using the receiver operating characteristic (ROC) method. Sensitivity, specificity, PPV and NPV with corresponding 95% confidence intervals were determined.

RESULTS
The mean area under the ROC curve for Gd-BOPTA MRI (0.78) was higher than that of CT (0.76). On a lesion-by-lesion basis, the mean sensitivity (73%) of Gd-BOPTA MRI was significantly higher than that of CT (63.4%) (P < 0.01). Gd-BOPTA-enhanced MRI is significantly more accurate and sensitive than 64-slice CT for the diagnosis of HCC in patients with cirrhosis prior to liver transplantation.

CONCLUSION
MR imaging with hepatobiliary contrast agent may improve the diagnostic accuracy of MR in the detection of focal liver lesions in cirrhotic patients.

SSCO05-08 • Retrospective Comparison of MRI Sequences for Prediction of Size of Hepatocellular Carcinoma Based on Explant Evaluation

Claudia R Seuss MD (Presenter); Min Ju Kim; Michael J Triolo MD; Cristina H Hajdu MD; Andrew B Rosenkrantz MD

PURPOSE
Size of hepatocellular carcinoma (HCC) is a critical feature in determining liver transplant allocation. The purpose of this study was to compare measurements of size of HCC on different MRI sequences with pathologic size of HCC determined from evaluation of liver explantation specimens.

METHOD AND MATERIALS
92 patients with HCC who underwent contrast-enhanced liver MRI between July 2005 and June 2012 within 90 days before liver transplantation were included in this retrospective study. One radiologist reviewed the imaging in conjunction with pathologic findings and created a map depicting the location of the dominant lesion in each case. Then, two separate abdominal radiologists (R1 and R2) used these maps to independently measure the size of the dominant HCC on the following sequences in different sessions: T2-weighted imaging (T2WI); b-500 diffusion weighted imaging (DWI); and arterial (AR), portal venous (PV) and equilibrium (EQ) contrast phases. Size measurements on the various MRI sequences were compared with explant measurements using Pearson’s correlation coefficients, paired T-tests, and Bland-Altman plots.

RESULTS
For R1, correlation with pathology was highest for PV (r = 0.89) and EQ (r = 0.83); for R2, correlation was highest for AR, PV, and EQ (r = 0.85-0.86). Absolute error was lowest for R1 on PV (4.3 mm, p)

CONCLUSION
When considering absolute and systematic error, we suggest use of portal venous phase images to obtain the most reliable measurements of size of HCC on MRI. Measurements on arterial phase images systematically over-estimated lesion size for both readers in our study.

CLINICAL RELEVANCE/APPLICATION
HCC size is critical for determining transplant eligibility and allocation. Our findings regarding the utility of size measurements in the portal venous phase may help standardize such measurements.
Stereotactic body radiotherapy (SBRT) is a loco-regional therapy for hepatocellular carcinoma (HCC). Radiotherapy to the liver must be planned carefully because of poor hepatic radiation tolerance especially in HCC patients with liver dysfunction and their eligibility for SBRT for HCC must be assessed carefully because radiation-induced liver disease can be fatal. At SBRT for HCC, V20, defined as the percentage of the liver volume exposed to >20 Gy, is usually planned to be ≤30%.

METHOD AND MATERIALS
We retrospectively studied 18 HCC patients who underwent SBRT; the dose was 48 Gy delivered in 4 fractions. We measured the signal intensity of the liver parenchyma during the hepatobiliary phase in a circular region of interest by referring to a dose distribution map and calculated the liver-spleen contrast (LSC) ratio for each radiation dose area. Then we calculated the weighted LSC (W-LSC) as W-LSC = \((\text{mean LSC}_{0-30Gy} \times \text{liver volume}_{0-30Gy} + \text{mean LSC}_{30Gy} \times \text{liver volume}_{30Gy}) / \text{total liver volume}\). We divided the patients into groups A (no change in the Child Pugh score 6 months post-SBRT) and B (increased Child Pugh score 6 months post-SBRT) and compared the W-LSC and V20 in the groups. We also calculated the optimal W-LSC cut-off value for predicting liver function transit using receiver operating characteristic analysis.

RESULTS
Of the 18 patients 13 were in group A and 5 in group B. There was no significant difference in V20 between the groups (10.36% vs 16.45%, p=0.15); in one patient it was below 10%. There was also no significant difference in W-LSC (1.81 vs 1.47, p=0.22), however, in all 5 group B patients it was below 2.0. At the optimal cutoff value for W-LSC (1.98), sensitivity and specificity for predicting liver function transit were 100% and 61.5%.

CONCLUSION
W-LSC may be a more useful quantitative parameter than V20 for predicting liver function transit.

CLINICAL RELEVANCE/APPLICATION
The value of W-LSC should be evaluated before SBRT to avoid radiation-induced liver disease.
RESULTS
A total of 1968 DCE-US were performed in 539 patients. The median follow-up was 1.65 year. The mean transit time (MTT) was the only significant parameter at day 7 (P=0.002). The best cut-point to predict tumor progression was 12 seconds (P=0.02), a MTT >12s being of good prognosis. Variations from baseline were significant at day 30 for several parameters. The area under the curve (AUC) was the parameter with the lowest P-value (P=0.00004); Patient with a decrease of more than 40 % had a better prognosis. The groups defined accordingly were different for both FFP (P=0.009) and OS (0.03). The analyses according to treatment suggested heterogeneity which could be attributed to 81 RCC patients treated by Sunitinib. We performed a separate analysis of this group: the best cutoff for AUC at 30 days was 0.1, corresponding to a decrease of 90%.

CONCLUSION
DCE-US is the first functional imaging technique that validated predictors of tumor progression in a large multicentric cohort.

CLINICAL RELEVANCE/APPLICATION
A large multicentric study confirms the potential of DCE-US to monitor different anti-angiogenic treatments in different type of tumors.

SSC06-03 • Acoustic Radiation Force Impulse Elastography for the Prediction of Chemotherapeutic Response in the Patients with Liver Metastases from Colon Cancer

Jae Young Lee MD (Presenter) ; Soo Yeon Kang ; Se Hyung Kim ; Joon Koo Han MD ; Byung Ihn Choi MD, PhD *

PURPOSE
To investigate if and when acoustic radiation force impulse (ARFI) elastography can predict chemotherapeutic response in patients with liver metastasis from colon cancer.

METHOD AND MATERIALS
The institutional review board approved this prospective study and informed consents were observed in all patients. 45 untreated metastatic liver tumors from colon cancer (mean, 3.6 ± 1.9 cm; =3 nodules per patient) of 26 patients (M:F=16:10; mean age, 58.6 ± 9.6 years) were included in this study. ARFI elastography was performed before chemotherapy and 48 hours, 1 week, 2 weeks and 4 weeks after chemotherapy for the same liver tumors along with measurement of tumor diameter. Shear wave velocities were obtained from the center, 12 o'clock, 3 o'clock, 6 o'clock and 9 o'clock direction within a tumor, two times per measurement point (total, 10).

RESULTS
Responders (n=10) showed significant interval drop in elasticity of metastatic liver tumors between pre-chemotherapy and post-48hr (mean difference, -0.23 m/s; 95% CI, -0.42 to -0.04 m/s) (P=0.016). There was no significant interval change between pre-chemotherapy and other time points in responders. No significant interval change between pre and any time points in nonresponders (n= 16) was noted. Rather, elasticity in liver tumors in nonresponders increased 48 hours after chemotherapy (mean difference, 0.08m/s; 95% CI, -0.21 to 0.39 m/s) (P=0.54). Significant size change of liver tumors in diameter was detected since 1 week after chemotherapy only in responders.

CONCLUSION
ARFI elastography might be used as a biomarker to predict chemotherapeutic response as early as 48 hours after initiation of chemotherapy in patients with colon cancer liver metastasis

CLINICAL RELEVANCE/APPLICATION
ARFI elastography might be used as a biomarker to predict chemotherapeutic response as early as 48 hours after initiation of chemotherapy in patients with colon cancer liver metastasis.

SSC06-04 • Diagnosis of Complete Response in the Colorectal Cancer Liver Metastasis (CRCLM) after Chemotherapy: Which Imaging Modality Should Be Used?

Min Jung Park (Presenter) ; Mi-Suk Park MD ; Seong Ho Park MD * ; Won Jae Lee MD ; Min Ju Kim ; Sung Eun Rha MD ; Chang Hee Lee MD ; Yoon Jin Lee MD ; Sumi Park ; Yang Shin Park MD ; Nurhee Hong MD

PURPOSE
To compare the accuracy of CT and MRI with liver-specific contrast agent for the evaluation of complete response in CRCLM after chemotherapy in a retrospective multicenter setting and to find out alternative role of non-contrast enhanced MRI (NE-MR) with Diffusion-weighted imaging (DWI) for the evaluation of complete response in CRCLM after chemotherapy.

METHOD AND MATERIALS
Among patients recruited for CRCLM between 2008 and 2011 at eight hospitals in Korea, 90 patients (63men, 27women; mean age, 57 years; age range, 36± 77 years) with the following criteria were retrospectively included: fewer than 10 liver metastases (LM) before chemotherapy; neoadjuvant chemotherapy followed by liver resection; disappearance of at least one LM on post-chemotherapy multidetector CT portal venous phase images with slice thickness=5mm; post-chemotherapy gadoxetic acid-enhanced MRI including DWI of b-value=500sec/mm2; time interval=4weeks between post-chemotherapy CT and MRI; follow-up at least 1 year after surgery. We retrospectively evaluated 445 LM in these patients on CT and MRI. Pathologic report of surgical specimen, sonographic finding on radiofrequency ablation and follow-up CT or MRI were served as reference standard. The diagnostic accuracies of MRI and CT were retrospectively evaluated 445 LM in these patients on CT and MRI. Pathologic report of surgical specimen, sonographic finding on radiofrequency ablation and follow-up CT or MRI were served as reference standard. The diagnostic accuracies of MRI and CT were determined and compared using the McNemar test.

RESULTS
In diagnosing complete response after chemotherapy, gadoxetic acid-enhanced MRI showed significantly higher accuracy (89%), sensitivity (75%), and specificity (94%) compared to CT (59%; 91%; 49%), respectively

CONCLUSION
MRI with liver-specific contrast agent is more accurate than CT for the evaluation of complete response in CRCLM after chemotherapy. And NE-MR with DWI could be an alternative tool as it is more accurate than CT.

CLINICAL RELEVANCE/APPLICATION
MRI with liver-specific contrast agent and diffusion weighted imaging is more accurate than CT for the evaluation of complete response in colorectal cancer liver metastasis after chemotherapy.

SSC06-05 • Formula-based Lesion Volume Estimation: Evaluation of the Agreement with Software-based Volumetry

Melvin D’Anastasi MD (Presenter) * ; Ruediger P Laubender MA, MPH * ; Julia Lynghjem * ; Volker Heinemann MD * ; Maximilian F Reiser MD ; Anno Graser MD *

PURPOSE
To evaluate the agreement between true tumor volume and tumor volume derived from (i) a new formula based on longest lesion (RECIST) diameter, (ii) a new formula based on longest diameter and longest orthogonal (WHO) diameter.

METHOD AND MATERIALS
89 baseline and follow-up CTS were available in 20 patients with metastatic colorectal cancer from the randomized phase II multicenter CIOX trial. Target lesions were defined at baseline and followed over time. Lesions were evaluated by (i) semi-automated volumetry using Siemens Syngo.via and (ii) volumetric assessment using a newly developed formula based on manual measurement of the longest diameter and the longest orthogonal diameter. True, WHO- and RECIST-based volumes were calculated. We compared the agreement of the true volume to the WHO-based volume and RECIST-based volume. We also compared the agreement between true and
RESULTS
A total of 151 lesions were evaluated. Using a variance components model it was shown that the difference between true and RECIST-based volume is statistically significant (p < 0.001) indicating a substantial constant bias. The same model showed a difference between true and WHO-based volume, which was not statistically significant (p = 0.50), indicating no substantial constant bias. Scatter-plots show that the RECIST-based volume overestimates lesion volume. The intraclass correlation between true and WHO-based volume relative changes was 0.95, showing nearly perfect agreement between methods.

CONCLUSION
Our proposed formula, if based on WHO-measurements, allows for a very good estimate of relative volume changes (the RECIST-based formula overestimates the true volume).

CLINICAL RELEVANCE/APPLICATION
Volumetric tumor information, in particular relative changes in volume during therapy, can be approximated using the proposed WHO-based formula if no volumetric software is available.

SSC06-06 • Novel Diffusion Kurtosis Imaging for Improved Evaluation of Treatment Response of Hypervascular Hepatocellular Carcinoma

Satoshi Goshima MD, PhD (Presenter); Yoshifumi Noda MD; Hiroshi Kondo MD; Hiroshi Kawada MD; Haruo Watanabe MD; Masayuki Kanematsu MD; Yukichi Tanahashi MD; Nobuyuki Kawai MD; Kyongtae T Bae MD, PhD *

PURPOSE
To determine the value of diffusion kurtosis imaging (DKI) of the liver for improved evaluation of treatment response of hypervascular hepatocellular carcinoma (HCC).

METHOD AND MATERIALS
During a five-month period, we prospectively recruited 62 patients with treated or untreated hypervascular HCC (48 men and 14 women; mean age, 73.4 years; range, 49-86 years) and evaluated their MR images. DKI was performed with a respiratory-triggered single shot echo-planar sequence at multiple b values (0, 100, 500, 1000, 1500, and 2000 sec/mm²). The duration of this imaging acquisition was five minutes. We computed the mean kurtosis (MK) and apparent diffusion coefficient (ADC) (10⁻³ mm²/s) over regions of interest encompassing the entire tumor using MATLAB software (Mathworks, Natick, Mass). The diagnostic performance of MK and ADC values for the evaluation of HCC viability were compared.

RESULTS
MR image acquisition and analysis were successful in all our study patients. Forty-nine HCCs were completely necrotic: 10 after transcatheter arterial chemoembolization (TACE) and 39 after radiofrequency ablation (RFA), whereas 22 HCCs revealed local recurrences: 18 after TACE and 4 after RFA. On the other hand, 41 HCCs remained untreated. MK was significantly higher in the untreated and local recurrent HCCs (0.81 +/- 0.11) than the necrotic HCCs (0.57 +/- 0.11) (P < 0.001). Mean ADC value was significantly lower in the untreated and local recurrent HCCs (1.44 +/- 0.42) than the necrotic HCCs (1.94 +/- 0.52) (P < 0.001). For the evaluation of HCC viability comparing between the MK and ADC, the sensitivity, specificity, and area under the ROC curve for the MK (85.7%, 98.0%, and 0.95; cutoff value of 0.710) were greater than those of the ADC (79.6%, 68.3%, and 0.77; cutoff value of 1.535).

CONCLUSION
Our study findings suggest DKI is superior to conventional diffusion MRI analysis for the evaluation of posttherapeutic response of HCC.

CLINICAL RELEVANCE/APPLICATION
When MRI is performed to evaluate the posttherapeutic response of HCC, diffusion kurtosis imaging may improve the diagnostic confidence of lesion characterization over conventional diffusion imaging.

SSC06-07 • Heterogeneity Analysis of Tumor Perfusion for Monitoring Antiangiogenic Therapy in Hepatocellular Carcinoma Using Fractal Analysis

Koichi Hayano MD (Presenter); Sang Ho Lee PhD; Hiroyuki Yoshida PhD *; Dushyant V Sahani MD

PURPOSE
Noninvasive imaging biomarkers that can quantitatively monitor physiologic changes in tumor microenvironment in response to antiangiogenic therapies will be of significant value. No in vivo study showed whether angiogenic agents can change the heterogeneity of tumor blood flow. The purpose of this study is to evaluate the change of heterogeneity in tumor perfusion during antiangiogenic therapy using fractal dimension analysis in hepatocellular carcinoma patients treated with bevacizumab.

METHOD AND MATERIALS
Twenty-three patients (15 men, 8 women; mean age: 61.0 years) and evaluated their MR images. DKI was performed with a respiratory-triggered single shot echo-planar sequence at multiple b values (0, 100, 500, 1000, 1500, and 2000 sec/mm²). The duration of this imaging acquisition was five minutes. We computed the mean kurtosis (MK) and apparent diffusion coefficient (ADC) (10⁻³ mm²/s) over regions of interest encompassing the entire tumor using MATLAB software (Mathworks, Natick, Mass). The diagnostic performance of MK and ADC values for the evaluation of HCC viability were compared.

RESULTS
MR image acquisition and analysis were successful in all our study patients. Forty-nine HCCs were completely necrotic: 10 after transcatheter arterial chemoembolization (TACE) and 39 after radiofrequency ablation (RFA), whereas 22 HCCs revealed local recurrences: 18 after TACE and 4 after RFA. On the other hand, 41 HCCs remained untreated. MK was significantly higher in the untreated and local recurrent HCCs (0.81 +/- 0.11) than the necrotic HCCs (0.57 +/- 0.11) (P < 0.001). Mean ADC value was significantly lower in the untreated and local recurrent HCCs (1.44 +/- 0.42) than the necrotic HCCs (1.94 +/- 0.52) (P < 0.001). For the evaluation of HCC viability comparing between the MK and ADC, the sensitivity, specificity, and area under the ROC curve for the MK (85.7%, 98.0%, and 0.95; cutoff value of 0.710) were greater than those of the ADC (79.6%, 68.3%, and 0.77; cutoff value of 1.535).

CONCLUSION
Our study findings suggest DKI is superior to conventional diffusion MRI analysis for the evaluation of posttherapeutic response of HCC.

CLINICAL RELEVANCE/APPLICATION
When MRI is performed to evaluate the posttherapeutic response of HCC, diffusion kurtosis imaging may improve the diagnostic confidence of lesion characterization over conventional diffusion imaging.

SSC06-08 • Significance of Pelvic Imaging in Computed Tomographic Surveillance of Hepatocellular Carcinoma

Kazim Narsinh MD (Presenter); Iris M Otani MD; Cynthia S Santillian MD; Claude B Sirlin MD *

PURPOSE
To retrospectively determine the frequency and clinical significance of the findings and recommendations derived from pelvic CT performed as part of multiphasic CT surveillance imaging for hepatocellular carcinoma (HCC) in patients at risk for the development of HCC.

METHOD AND MATERIALS
The study was HIPAA-compliant and approved by the institutional review board with waiver of informed consent. The cohort was comprised of 602 patients with either cirrhosis and/or hepatitis B who were referred for routine HCC surveillance by hepatologists from an academic medical center in southern California. Multiphasic acquisitions were performed using a multidetector 16-slice or 64-slice helical CT scanner (GE Lightspeed) to obtain non-contrast, arterial, portal venous, and delayed phase images. Reports from the initial abdominopelvic CT scan for each patient obtained between 2002-2007 were retrospectively reviewed for extrhepatic findings in the pelvis.
RESULTS
Screening was performed in 602 patients (mean age 54 years). Of these patients, 389 (65%) were male and 213 (35%) were female. Logistic regression indicated a lower likelihood of pelvic findings in patients that were young.

CONCLUSION
Pelvic CT included at the time of HCC surveillance does not uncover a statistically significant number of incidental pelvic findings that impact patient care. In light of the increased ionizing radiation dose to patients and unnecessary healthcare costs associated with pelvic CT imaging in this context, routine surveillance of patients with known risk factors for HCC should be performed with multiphasic abdominal CT only.

CLINICAL RELEVANCE/APPLICATION
Pelvic CT does not detect clinically meaningful pelvic pathology with sufficient frequency to warrant its routine inclusion in HCC surveillance protocols.

**SSC06-09 • Accuracy of mRECIST versus RECIST 1.1 in Predicting Outcome in Hepatocellular Carcinoma Treated with Sorafenib**

Giulia Gallus ; Rossella Di Misco ; Michele Di Martino (Presenter) ; Concetta V Lombardo ; Adolfo Attili ; Carlo Catalano

**PURPOSE**
To compare RECIST1.1 and mRECIST ability in the estimation of the response to therapy in patients with advanced HCC treated with Sorafenib.

**METHOD AND MATERIALS**
From August 2008 to July 2012, 58 cirrhotic patients with advanced HCC received Sorafenib at starting dose of 400 mg bid and were followed until death occurred. Using RECIST1.1 and mRECIST, 27 patients who had undergone a 4-phase CT scan/dynamic MR before and after (30-100 days) the start of treatment were retrospectively analysed. RRR was evaluated according to RECIST1.1 and mRECIST, to determine the ability of each method in predicting the response of HCC to Sorafenib, taking OS as end-point.

**RESULTS**
The objective response [OR= complete response (CR) + partial response (PR)], stable disease (SD) and progressive disease (PD) rates according to RECIST1.1 and mRECIST were 14%, 25%, 59% and 25%, 18%, 55%, respectively. In CR+PR versus SD+PD patients, median OS was 24.3 months (both with RECIST1.1 and mRECIST) versus 10.9 (with RECIST1.1) and 10.1 months (with mRECIST). OR was significantly associated with OS only according to mRECIST (p=0.007).

**CONCLUSION**
RRR according to mRECIST, but not to RECIST1.1, sensibly correlates to outcome in cirrhotic patients with HCC treated with Sorafenib.

**CLINICAL RELEVANCE/APPLICATION**
mRecist evaluation may help to select patient who try benefit from Sorafenib treatment.

**ISP: Genitourinary (New Methods for Characterization of Renal Masses)**

**Monday, 10:30 AM - 12:00 PM • N228**

**SSC07 • AMA PRA Category 1 Credit ™:1.5 • ARRT Category A+ Credit:1.5**

**Moderator**
Richard G Abramson , MD *

**Moderator**
Cary L Siegel , MD

**SSC07-01 • Genitourinary Keynote Speaker: Targeted Therapies for Renal Cell Carcinoma—Imaging of Treatment Response and Complications**

Richard G Abramson MD (Presenter) *

**PURPOSE**
The ascendancy of targeted anticancer agents has broad implications for clinical imaging. This short presentation discusses targeted therapies for renal cell carcinoma, highlighting important challenges for assessing response and identifying treatment-related complications. An understanding of targeted agents and their mechanisms of action can enhance the radiological interpretation and improve patient care.

**SSC07-02 • Radiogenomics of Clear-cell Renal Cell Carcinoma: Associations between CT Imaging Features and Mutations**

Christoph A Karlo MD (Presenter) ; Pier Luigi Di Paolo MD ; Joshua L Chaim DO ; A Ari Hakimi MD ; James J Hsieh MD, PhD ; Oguz Akin MD ; Hedvig Hricak MD, PhD

**PURPOSE**
To investigate associations between computed tomography (CT) features of clear-cell renal cell carcinoma (ccRCC) and mutations in VHL, PBRM1, SETD2, KDM5C and BAP1 genes were tested using Fisher's exact tests. Associations between mutations and size/enhancement were assessed using independent t-tests. Interreader agreements were calculated using Fleiss' Kappa.

**RESULTS**
Mutation frequencies among ccRCC were: VHL, 53.2% (124/233); PBRM1, 28.8% (67/233); SETD2, 7.3% (17/233); KDM5C, 6.9% (16/233); BAP1, 6% (14/233). Well-defined tumor margins (p=0.013), nodular enhancement (p=0.021) and evidence of intratumoral vascularity (p=0.018) were associated with VHL mutations. Mutations of KDM5C (p=0.022) and BAP1 (p=0.046) were associated with evidence of renal vein invasion. 3. While mutations of VHL (p=0.016) and PBRM1 (p=0.017) were significantly less common among multicystic ccRCC, mutations of SETD2 (p=0.373), KDM5C (0.375) and BAP1 (0.612) were absent when compared to solid ccRCC. Interreader agreements for CT feature assessments ranged from substantial to excellent (0.791-0.912).

**CONCLUSION**
This preliminary Radiogenomics analysis of ccRCC revealed associations between CT features and underlying mutations and therefore warrants further investigation and validation.

**CLINICAL RELEVANCE/APPLICATION**
The results of this study, which demonstrated clinical implications, allow for the generation of hypotheses regarding further Radiogenomics research in ccRCC.
Biopsy Proven Oncocytoma and Oncocytic Neoplasms: In Situ Natural History and Clinical Outcomes of 139 lesions

Manish Dhyani MBBS (Presenter); Sameer M Deshmukh MD; Adam S Feldman MD; Rosemary Tambouret MD; Debra A Gervais MD; Ronald S Arellano MD; Anthony E Samir MD;

PURPOSE
Renal oncocytomas (oncocytic adenoma/oxphilic adenoma/proximal tubular adenoma) account for 3-7% of all renal neoplasms and are the most common, solid renal neoplasms. Oncocytomas (OC) have a distinctive pathological appearance but other neoplasms such as chromophobe RCC and oncocytic papillary RCC can mimic this pattern, precluding tumor classification as Oncocytoma and instead classifying it as an Oncocytic Neoplasm (ON). OC are thought likely benign, but their long-term outcome has not been established with certainty. The purpose of this study was to review the in-situ natural history and clinical outcomes of biopsy proven OC and ON at our institution.

METHOD AND MATERIALS
We performed a retrospective review of patients who underwent percutaneous biopsy of a suspicious renal mass at our institution between 1998-2011. Lesions with a pathological diagnosis of (1) OC, (2) ON favoring a diagnosis of OC and (3) ON on percutaneous biopsy were identified. Surveillance follow-up and treatment outcomes were assessed.

RESULTS
A total of 1254 image-guided percutaneous renal biopsies were performed between 1998-2011. A total of 139 lesions (11%) in 135 patients (M:F = 86:49) with a mean age of 70 years (range: 24-91 years) were identified to have a pathological diagnosis of OC (n=90, 7%), ON favoring OC (n=20, 1.6%) and ON (n=29, 2.4%) on image-guided (US:CT = 8:131) percutaneous biopsy. The majority of lesions were solid (n=135, 97%) with a mean size of 2.7 cm (range: 0.8 - 10 cm).

110 lesions were followed with a minimum of one imaging study, 57 lesions were either stable or decreased in size during a mean 1.5±1.2 years of follow-up and have been summarized in Table 2. Of the 53 lesions that grew in size the mean rate of growth was 0.39±0.38 cm/year (follow-up interval = 2.7±2.3 years). Overall repeat pathology was available for 11/110 (10%) lesions that were followed. One pathological diagnosis of RCC was chromophobe on re-biopsy prompted resection in a lesion that was stable while all others were categorized as OC.

CONCLUSION
Renal lesions diagnosed as ON, ON favoring OC and OC usually remain stable or are slow growing. Our data suggests that lesions of this type can be safely followed with periodic imaging.

CLINICAL RELEVANCE/APPLICATION
Extremely little is known about Oncocytoma’s with the largest series in the literature describing 33 lesions. This larger series provides a better understanding of their in situ natural history.

Characterization of Focal Renal Masses Using Post-contrast-Enhanced Images Alone from a Dual Energy CT Data Set Acquired with Fast Kilovoltage-switching

Drew E Davis MD (Presenter); Daniele Marin MD; Achille Mileo MD; Kingshuk Roychoudhury; Rendon C Nelson MD *

PURPOSE
To evaluate the diagnostic performance of quantitative methods for characterization of focal renal masses using post-contrast enhanced images alone from a fast kilovoltage-switching single source dual energy CT (ssDECT) dataset.

METHOD AND MATERIALS
IRB approved study comprised of 58 patients (43 men, 15 women; age range, 43-82 years) with 63 focal renal masses measuring = 1.5-cm (mean diameter, 3.5 cm; range, 1.5-8.0 cm), who underwent noncontrast (NCCT) and contrast-enhanced fast kilovolt switching ssDECT from 11/2011-2/2013. Lesions were classified as: (a) simple cysts (=20 HU on NCCT and =15 HU enhancement)(n=42), (b) complex cysts (>20 HU on NCCT and =15 HU enhancement)(n=9) and (c) enhancing masses (>15 HU enhancement)(n=12). Synthesized monochromatic datasets were reconstructed at selected x-ray energies of 40 keV, 50 keV, 59 keV (mean energy for 120-kVp beam) and 140 keV. Material density reconstructions were also generated for iodine, calcium and water. All reconstructed datasets were analyzed using a region-of-interest drawn in the center of each renal lesion. Linear discriminant analysis was used for lesion classification using profiles of values obtained at different keV (spectral analysis) and material density reconstructions from post-contrast DECT images.

RESULTS
Material density analysis demonstrated characteristic features: (a) simple cysts: low iodine, low water; (b) complex cysts: low iodine, high water; and (c) enhancing masses: high iodine, high water. High diagnostic accuracy was achieved in differentiating enhancing renal masses from simple and complex renal cysts using: (i) spectral analysis at 40 and 140 keV (sensitivity/specificity 92%/100%) and (ii) iodine and water material density reconstructions (sensitivity/specificity 92%/98%). One enhancing renal lesion was misclassified as a complex cyst using both methods. Additionally, one complex renal cyst was misclassified as an enhancing lesion using the material density reconstruction only.

CONCLUSION
Focal enhancing renal masses may be accurately differentiated from simple and complex renal cysts using single-phase contrast-enhanced DECT alone. However, our data suggest a slight but important risk of misclassifying small enhancing renal masses.

CLINICAL RELEVANCE/APPLICATION
It is possible to accurately characterize focal renal masses using only post-contrast images from a fast kilovoltage-switching single source dual energy CT dataset.

Dual-energy CT in Renal Lesions. Which Are the Best Approaches and Thresholds to Evaluate the Iodine-uptake?

Achille Mileo MD (Presenter); Daniele Marin MD; Bernhard Krauss PhD *; Alfredo Blandino; Emanuele Scribano; Silvio Mazziotti; Giorgio Ascenti MD

PURPOSE
To compare the accuracy of different dual-energy CT approaches in evaluating the iodine-uptake in renal lesions using a single-phase nephrographic acquisition.

METHOD AND MATERIALS
IRB approval and waiver of informed consent were obtained for this HIPAA-compliant study. Fifty-nine patients (41 men, 18 women; mean age, 57.7 years) with 80 renal lesions underwent contrast-enhanced dual-energy CT during the nephrographic phase of enhancement. Renal lesions were characterized as enhancing or nonenhancing, using contrast-enhancement with thresholds of 15-HU and 20-HU and iodine quantification with threshold of 0.5 mg/mL. Accuracy of contrast-enhancement and iodine quantification was calculated, using histopathology or CT follow-up as reference standard. Differences in sensitivity and specificity were assessed by means of McNemar test and ROC analysis.

RESULTS
A significant difference was found between contrast-enhancement with thresholds of 15-HU (sensitivity, 91.4%; specificity, 93.3%; PPV, 91.4%; NPV, 93.3%) and 20-HU (sensitivity, 77.1%; specificity, 100%; PPV, 100%; NPV, 84.9%) (P = .008). Iodine quantification (sensitivity, 100%; specificity, 97.7%; PPV, 97.2%; NPV,100%) was significantly more accurate (P = .004) than contrast-enhancement with threshold of 20-HU. No significant difference in accuracy was found between iodine quantification and contrast-enhancement with threshold of 15-HU. Contrast-enhancement and iodine quantification showed an area under the ROC curve of 0.98 (95% CI: 0.92, 0.99).
CONCLUSION
Contrast-enhancement with threshold of 15-HU and iodine quantification are the most accurate dual-energy CT approaches to assess the iodine-uptake in renal lesions, using a single-phase nephrographic acquisition.

CLINICAL RELEVANCE/APPLICATION
Dual-energy CT may reduce radiation exposure, increases cost and patients’ anxiety from further tests, most frequently CT, that are usually needed when an unenhanced acquisition is not available.

SSC07-06 • Intimate Contact: CT Evaluation of Tumor Contact Surface Area and Its Role in Peri Operative Outcome Prediction
Scott Leslie MBBS; Inderbir S Gill MBBCh *; Andre L Abreu MD; Mihir Desai; Vinay A Duddalwar MD, FCR (Presenter); Darryl Hwang PhD

PURPOSE
The surface area of contact that a tumor has with the adjacent renal parenchyma considerably determines the extent of resection of kidney tissue during partial nephrectomy (PN), and thus may impact on peri-operative outcomes. We present a novel method of calculating renal tumor contact surface area (CSA) using image-processing technology and correlate it with peri-operative variables in patients undergoing PN.

METHOD AND MATERIALS
From 01/2010-08/2011, 162 patients underwent minimally invasive PN for tumor, and had CSA data available using image rendering software (3D Synapse © Fuji film©). CSA was correlated with baseline demographics and peri-operative outcomes.

RESULTS
Mean tumor size was 3.1 cm and mean CSA was 18.3 cm2. Univariate analysis demonstrated that CSA significantly correlated with blood loss (p=0.0001), operative time (p=0.003), length of hospital stay (p=0.0028), and post-operative eGFR (0.0124). On multivariable logistic regression CSA was an independent predictor of the above outcomes as well as overall complications.

CONCLUSION
In patients undergoing partial nephrectomy, tumors with greater contact surface area with surrounding renal parenchyma require a more extensive resection, thus impacting on peri-operative outcomes including blood loss, operative duration, complications and renal function. If these findings are validated in larger cohorts, future nephrometry systems could incorporate CSA measurements to objectively quantify renal tumor complexity and predict peri-operative outcomes of partial nephrectomy surgery.

CLINICAL RELEVANCE/APPLICATION
The contact surface area of a renal mass is a predictor of the amount of dissection needed during surgery and may predict operative outcomes. In patients undergoing partial nephrectomy,

SSC07-07 • Renal Lesions Causing Restricted Diffusion: Breaking the Myths!
Ankur Goyal MBBS, MD (Presenter); Raju Sharma MD; Ashu Seth Bhalla MBBS, MD; Shivanand R Gamanagatti MBBS, MD; Amlesh Seth MBBS, MCHIR; Ajay K Yadav MBBS; Prasenjit Das; Arun K Gupta MBBS, MD

PURPOSE
◆ To investigate the diffusion characteristics of focal renal lesions
◆ To assess which renal lesions demonstrate diffusion restriction and evaluate the utility of Diffusion-weighted MRI (DW-MRI) in their differentiation.

METHOD AND MATERIALS
The institutional ethics committee waived the requirement of informed consent for this retrospective study. 120 adult patients with 225 focal renal lesions underwent MRI with DW Imaging (at b-values of 0 and 500 s/mm²) from September 2008 to December 2012. In all, there were 65 malignant neoplasms (44 renal cell carcinomas RCCs, 10 transitional cell carcinomas TCCs, 11 miscellaneous) and 25 benign neoplasms (20 angiomyolipomas AMLs, 4 oncocytomas). In addition, there were 25 inflammatory lesions (including 19 abscesses), 45 pseudotumors (40 in diseased and 5 in normal kidneys), 15 hemorrhagic cysts and 50 benign cysts (Bosniak category 1, 11 and II). Lesion ADC values were determined, compared and receiver operating characteristic (ROC) curves were drawn to establish cut-off values.

RESULTS
Both benign and malignant renal neoplasms showed restricted diffusion with mean ADC values: RCC [1.56 ± 0.40 (× 10⁻³ mm²/s)], TCC [1.26 ± 0.12 (× 10⁻³ mm²/s)] and AML [1.32 ± 0.19 (× 10⁻³ mm²/s)]. Inflammatory renal lesions demonstrated lowest ADCs [1.1 ± 0.21 (× 10⁻³ mm²/s)] while hemorrhagic cysts showed wide range of ADC values [1.47 ± 0.81 (× 10⁻³ mm²/s)]. Pseudotumors and benign cysts showed unrestricted diffusion. Individually, AMLs and TCCs showed significantly lower ADC values compared to RCCs (p = 0.0133 and 0.0236 respectively). ROC analysis revealed an area under curve of 0.730 in differentiating RCC from AML and 0.809 in differentiating RCC from TCC.

CONCLUSION
The difference between the ADC values of different focal renal lesions was statistically significant and ROC analysis yielded cut-off values with high accuracy in making clinically relevant distinctions. Restricted diffusion in a renal mass does not always imply malignancy; rather benign neoplasms cause greater diffusion restriction. Renal abscesses depict lowest ADC values. Despite overlapping ranges, ADC values provide an additional paradigm for distinguishing AMLs and TCCs from RCCs.

CLINICAL RELEVANCE/APPLICATION
Diffusion restriction is not specific for malignancy; rather inflammatory renal lesions cause most marked diffusion restriction, followed by benign neoplasms and RCCs in ascending order of ADC values.

SSC07-08 • Dual Energy CT (DECT) for Assessment of Response to Antiangiogenic Treatment in Patients with Metastatic Renal Cell Cancer (mRCC)
Katharina Hellbach MD (Presenter); Alexander Sterzik; Wieland H Sommer MD; Martina Karpitschka MD; Jozefina Casuscelli; Michael Ingrisch; Michael Staehler MD; Anno Graser MD *

PURPOSE
To evaluate whether dual energy CT (DECT) allows for better assessment of response to antiangiogenic treatment with multi-kinase inhibitors (MKI) than standard contrast-enhanced CT.

METHOD AND MATERIALS
17 patients with mRCC (14 males, 62.1±10.9 years; 3 females, 64.3±5.1 years) underwent baseline and follow-up single-phase abdominal contrast enhanced DECT (100 kVp/Sn140 kVp) on a dual source scanner (Somatom Definition Flash, Siemens). DECT scans were performed immediately before and 10 weeks after start of treatment with MKI. Virtual non-enhanced and color coded iodine images were generated. 31 metastases were measured at the two timepoints. We determined Hounsfield unit (HU) values for VNE and iodine density (ID) as well as iodine content (IC) in mg/ml of tissue. These values were compared to the standard venous phase CT number of the lesions.

RESULTS
Between baseline and follow up, standard CT density and ID showed a significant reduction (CT: 76.3±20.7 HU vs 52.4±19.1 HU; and of 1.00 (95% CI: 0.95, 1.00), respectively (P = 0.31).

CONCLUSION
Contrast-enhancement with threshold of 15-HU and iodine quantification are the most accurate dual-energy CT approaches to assess the iodine-uptake in renal lesions, using a single-phase nephrographic acquisition.

CLINICAL RELEVANCE/APPLICATION
Dual-energy CT may reduce radiation exposure, increases cost and patients’ anxiety from further tests, most frequently CT, that are usually needed when an unenhanced acquisition is not available.
**SSC07-09 • Dual-energy CT: Evaluation of Hyperdense Renal Masses Incidentally Detected on Single-phase Postcontrast CT**

**Ji Ye Son** (Presenter); **Chan Kyo Kim** MD, PhD; **Dong Ik Cha** MD; **Sung Yoon Park**; **Byung Kwan Park** MD

**PURPOSE**
To determine whether dual-energy CT (DECT) can help characterize hyperdense (> 30 HU) renal masses incidentally detected on single-phase postcontrast CT.

**METHOD AND MATERIALS**
In 80 patients, 90 hyperdense renal masses (median size, 1.3 cm) that were incidentally detected on single-phase postcontrast CT were further evaluated with DECT. DECT protocols included true noncontrast (TNC), DE corticomedullary and DE late nephrographic phase imaging. Virtual noncontrast (VNC) and iodine overlay (IO) images were derived from DE corticomedullary and DE late nephrographic phases, respectively. The CT numbers of hyperdense renal masses were calculated on linearly blended and IO images from DE corticomedullary and DE late nephrographic phases and the results were compared. A minimum size of hyperdense renal masses was also investigated to accurately differentiate solid masses from benign cystic lesions.

**RESULTS**
47 benign cystic lesions (25 hemorrhagic cysts and 22 simple cysts) and 43 solid masses (24 renal cell carcinomas and 19 angiomylipomas) were analyzed. The mean CT numbers of the renal masses calculated on IO images from DE corticomedullary and DE late nephrographic phases were statistically not different from those on the corresponding linearly blended images (P > 0.05). For differentiating solid masses from benign cystic lesions, the sensitivities of IO images from DE corticomedullary and DE late nephrographic phases were 77.6% and 55.5%, compared with on the corresponding linearly blended images (95.7% and 80.1%), respectively (P = 0.004 and P = 0.001, respectively); the specificities of IO images from the two phases were 97.7% and 100%, compared with on the corresponding linearly blended images (97.7% and 100%), respectively (P > 0.05). The minimum size of the renal masses to accurately differentiate solid masses from benign cystic lesions without false-positive or false-negative enhancement on IO images was 1.5 cm. For the renal masses with 1.5 cm or greater, the mean CT numbers between TNC and VNC images were not significant different (P > 0.05).

**CONCLUSION**
DECT may be used to characterize hyperdense renal masses incidentally detected on single-phase postcontrast CT, particularly in cases with the size of 1.5 cm or greater.

**CLINICAL RELEVANCE/APPLICATION**
DECT can offer useful information in characterizing hyperdense renal masses on single-phase postcontrast CT, without the use of TNC images.

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**ISP: Health Service, Policy and Research (Radiology Education)**

**Monday, 10:30 AM - 12:00 PM • S102D**

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**SSC08 • AMA PRA Category 1 Credit ™: 1.5**

**Moderator**
**Paul P Cronin**, MD,MS

**Moderator**
**Pia Maly Sundgren**, MD *

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**SSC08-01 • Health Service, Policy and Research Keynote Speaker: Radiology Education**

**Paul P Cronin**, MD,MS (Presenter)

**SSC08-02 • Radiation Safety Knowledge and Perception among Residents: A Potential Improvement Opportunity for Graduate Medical Education in the United States**

**Galereh Sadigh** MD (Presenter); **Michael T Kassin** MD; **Ramsha Khan**; **Kimberly E Applegate** MD, MS

**PURPOSE**
To investigate residents’ knowledge and perception of ionizing radiation adverse effects, frequency of their education on radiation safety and their use of radio-protective equipment.

**METHOD AND MATERIALS**
Residents from 15 residency programs at Emory University received an invitation email to complete Resident Radiation Safety Survey through SurveyMonkey in September 2012. The associations between residents’ knowledge and use of radio-protective equipment with residents’ specialty and year of training were investigated.

**RESULTS**
173/532 residents responded to the survey (response rate of 32%). 39% reported radiation safety is discussed in their residency curriculum at least every six months. This rate was significantly higher among Radiology residents (84% vs. 20% in Medicine, 19% in Surgery and 30% in OB/GYN); P

**CONCLUSION**
A large proportion of residents are unaware of the adverse effects of ionizing radiation, especially during pregnancy and childhood.

**CLINICAL RELEVANCE/APPLICATION**
Increased education of non-radiology residents by Radiology faculties on radiation safety may lead to more informed ordering of imaging tests and commitment to use of radio-protective equipment.

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**Arguing Your Way to an Education: An Effective Method of Teaching Residents Health Economics**

**Stephen J Hunt** (Presenter); **Saurabh Jha** MD

**PURPOSE**
The study compares a new method of teaching residents health policy and economics, using faculty-moderated point-counterpoint resident debates, with traditional didactic lectures.

**METHOD AND MATERIALS**
A new method of resident-driven conference comprising an Oxford-style debate moderated by faculty was employed for the curriculum in
SSC08-04 • Emergency Department Musculoskeletal Study Interpretation: Can Performance on a Musculoskeletal Curriculum Predict Error Frequency When on Call?

Kevin B Hoover MD, PhD (Presenter) *

PURPOSE

Errors in initial radiologic interpretation can significantly affect patient management in the emergency department (ED). This retrospective study investigated test results and work parameters that could be helpful in predicting resident errors.

METHOD AND MATERIALS

A curriculum for residents during their first and second musculoskeletal radiology (MSK) rotations was began in July 2010. During both rotations, textbook reading, chapter specific slide presentations and chapter specific quizzes were assigned. The quiz results for each resident were placed into quartiles, based on the results so far obtained. The number of studies interpreted by a resident on service was also calculated and compared to like postgraduate year (PGY) residents and placed in a quartile. ABR written exam results and ACR inservice results for MSK were also tabulated for the residents in quartiles. Correlation between the percentage of minor and significant discrepancies on MSK studies when on call and the quartile of the above parameters was investigated. Significant discrepancies were defined as those that could cause an important change in patient management.

RESULTS

A total of 13,296 adult MSK studies were reviewed by 23 PGY3-5 residents out of which there were 458 discrepancies (3.4%), 380 of which were minor (2.8%) and 78 significant (0.6%). Out of these 23 residents, 15 completed the ABR written exam, 22 completed the ACR inservice at least once, 17 completed the curriculum and the number of cases per interpreted per day on service was calculated in 21 residents. Out of these variables, the only result to correlate with the minor and significant discrepancies was the quartile score on the curriculum. The quartiles for the first and second rotation curriculum together were negatively correlated with minor discrepancies (Spearman’s rho coefficient -.511, p<0.001). Residents rotating through MSK have an assigned curriculum that guides them through the basics of orthopedic radiology including MRI. The resident performance on the curriculum was the only parameter investigated that correlated retrospectively with the number of errors in the emergency department on MSK studies.

CONCLUSION

Resident performance in a novel MSK curriculum demonstrated correlation with the frequency of errors when interpreting MSK studies on call and may be a predictor of performance.

SSC08-05 • What Makes a Great Radiology Review Course Lecture? The Ottawa Radiology Resident Review Course Experience

Lily Cao MD, PhD (Presenter) ; Matthew D McInnes MD, FRCP(C) ; John G Ryan MD

PURPOSE

To objectively determine qualities of radiology review course lectures that are associated with positive audience evaluation.

METHOD AND MATERIALS

57 presentations from the Ottawa Resident Review Course (2012) were analyzed by a PGY4 radiology resident blinded to the result of audience evaluation. Objective data extracted were: slides per minute, lines of text per text slide, words per text slide, cases per minute, images per minute, images per case, number of audience laughs, number of questions posed to the audience, number of summaries, inclusion of learning objectives, ending on time, use of pre/post-test and use of special effects. Subjective data extracted were: speaker spontaneity, speaker tone and image quality. Mean audience evaluation scores for each talk from daily audience evaluations (up to 60 per talk) were standardized out of 100. Correlation coefficient was calculated between continuous variables and audience evaluation scores. Student T test was performed on categorical variables and audience evaluation scores.

RESULTS

Strongest positive association with audience evaluation scores was for image quality (r=0.57), followed by the speaker tone (r=0.47) and number of times the audience laughed (r=0.3). Strongest negative association was between images per case and audience scores (r=-0.25). Talks with special effects were rated better (mean score 94.3 vs. 87.1, p<0.001).

CONCLUSION

Many factors can make a great review course lecture. At the University of Ottawa Resident Review Course, high quality images, dynamic speaker tone, use of special effects, use of pre/post-test and humor were most strongly associated with high audience evaluation scores. High image volume per case may be negatively associated with audience evaluation scores.

CLINICAL RELEVANCE/APPLICATION

Resident review course lectures are challenging to give; this study identifies several strategies to improve these lectures and better educate residents.

SSC08-06 • The Role of Radiologists in Breast Cancer Medical Education: A Systematic Review of the Literature

Faezeh Sodagari MD ; Pedram Golanari MD (Presenter) ; Hamid R Baradaran MD, PhD

PURPOSE

To determine the role of radiologists in medical education research in the field of breast cancer

METHOD AND MATERIALS

A systematic search in bibliographic databases was performed using a sensitive search strategy with ©breast cancer© and ©medical education© as key words (from January 1 2000 to May 20 2011) without any language and/or methodological limitation. Medical
education research was defined as any research study pertaining to the medical students, residents, fellows, faculty members, curricular development, or program evaluation. Information regarding type of study, outcomes, and sample size (if applicable) were extracted using a checklist designed according to the coding sheet of Best Evidence in Medical Education (BEME) Collaboration. All citations stored and managed by EndNote X3. Descriptive data were produced by SPSS ver. 17 and also were qualitatively synthesized and reported.

RESULTS
The search strategy yielded 691 citations that 394 citations published after 2000 were reviewed. By title and abstract reviewing by two independent reviewers, 183 citations were excluded. Full-text articles for 211 citations were reviewed. Out of 161 studies in the field of breast cancer medical education, only 19 articles had radiologists as their subjects and were included in the review. The majority of the included studies (17 out of 19 studies), aimed to assess the capability of residents and radiologists in reading mammograms. Sample size of studies ranged from 3 to 364 with the median of 207 subjects. Only one study had an interventional design and most of studies (16 out of 19) were prospective cross-sectional studies. The majority of studies (15 out of 19 studies) assessed knowledge or skill of the participants. None of the studies considered a clinical outcome as an outcome of the medical education research.

CONCLUSION
Despite the paramount importance of radiology in screening, diagnosis, and follow up of breast cancer, current radiology practice has become increasingly based on the digital interpretation of volumetric multi-planar-reconstruction images (MPR-images). Nevertheless, assessment of radiological image interpretation skills in medical education and postgraduate radiology training is still mainly based on two-dimensional (2D) images (only one or two slices of a stack are presented). Consequently, the assessment lacks authenticity, which negatively impacts its quality. We hypothesized that using MPR images increases the assessment.

CLINICAL RELEVANCE/APPLICATION
Radiologists should actively participate in improving medical education research activities in the field of breast cancer to play an active role in the future of diagnosis and management of this disease.

SSC08-07 • Prevalence of Flawed Multiple-choice Questions in Major Radiology Journals’ Continuing Medical Education
Andres R Ayoob MD ; Lindsay E Williams MD (Presenter) ; David J Disantis MD

PURPOSE
Maintenance of Certification (MOC) requirements, the advent of all-computer-based Board examinations, and the ubiquity of CME-offering platforms make multiple choice questions (MCQs) an inescapable part of contemporary radiology, and indeed all medical disciplines. The result has been a burgeoning demand for well-constructed MCQs. The purpose of this study was to determine whether the CME MCQs in 3 major radiology journals comport with standard question-writing principles.

METHOD AND MATERIALS
CME questions from the January 2013 editions of the American Journal of Roentgenology (AJR), RadioGraphics, and Radiology were evaluated. The month was chosen at random, solely based on the current CME offerings at the time of manuscript preparation. The journals offered 181 print or on-line multiple choice items for their 22 CME-designated articles. Each question was analyzed by three radiologists to assess its adherence to question writing guidelines; disagreements were settled by consensus. From 31 validated MCQ-writing guidelines, we chose the seven previously identified as frequent flaws in medical CME questions. Example flaws included unfocused questions, negatively worded questions and options, and heterogeneous options.

RESULTS
78 of the 181 questions contained flaws (43%). 45 questions had one flaw, while 24 questions had two, eight questions had three, and one had four. Specific flaws varied widely in prevalence, but an unfocused question and heterogeneous options were the two most frequently violated writing principles.

CONCLUSION
Nearly half of CME questions from three major radiology journals violated standard MCQ item writing principles.

SSC08-08 • Potential Impact the American Board of Radiology’s New Core Examination Will Have on Resident Training: Resident and Faculty Perspectives
Brian J Clark MD (Presenter) ; Hima Prabhakar MD

PURPOSE
Assess radiology resident and faculty perspectives on the potential impact the ABR’s new core exam will have on resident training. Factors assessed include resident call schedule, protected time, fourth year focused training, and entering fellowship.

METHOD AND MATERIALS
A 5-point Likert scale survey was given to radiology residents and faculty at an academically-affiliated hospital radiology residency program. Question responses were: 5=strongly agree, 4=agree, 3=undecided, 2=disagree, and 1=strongly disagree. Faculty and resident responses were compared using the student t-test and summary statistics were generated.

RESULTS
Most surveyed were undecided or disagreed if the new exam format would better prepare residents for practice (89%, rating =4) and all thought it would shift to the third year (100%, rating =4) and 69% thought 6 to 8 weeks or more was adequate. All surveyed agreed third year residents should have protected study time (94%, rating =4) and 69% thought 6 to 8 weeks was appropriate. 63% surveyed disagreed with the APDR’s recommendation of no time off from clinical duties before the core exam (rating =4). Residents agreed they were likely to pursue research during fourth year subspecialty training (mean=4, p=0.01) and faculty were undecided if this would occur. Most surveyed thought that residents would continue to pursue fellowship training (93%, rating =4). Residents disagreed (mean=2.1, p=0.04) that the new exam format would affect fellowship choice while faculty were undecided.

CONCLUSION
Residents and faculty have similar views regarding the new board exam and were uncertain if it would better prepare residents. Board frenzy will likely shift to third year and most think 8 weeks of protected study time appropriate with fourth year residents taking more call to fill the gap. Residents are likely to pursue research during the fourth year and to continue to enter fellowships.

SSC08-09 • Quality Improvement of Radiological Image Interpretation Skills Assessment through Digital MPR Images in Medical Education
Cecile Ravesloot MD ; Anouk Van Der Gijs MD, PhD (Presenter) ; Marielle Van Der Schaaf ; Olle Ten Cate ; Jan P Van Schaik MD, PhD ; Christian Mol MSC ; Corinne Tipker ; Mario Maas MD, PhD ; Koen L Vincken PhD

PURPOSE
Current radiology practice has become increasingly based on the digital interpretation of volumetric multi-planar-reconstruction images (MPR-images). Nevertheless, assessment of radiological image interpretation skills in medical education and postgraduate radiology training is still mainly based on two-dimensional (2D) images (only one or two slices of a stack are presented). Consequently, the assessment lacks authenticity, which negatively impacts its quality. We hypothesized that using MPR images increases the assessment.
quality as reflected in its validity (the test assesses what it is intended to measure) and reliability (the accuracy of the test results, its reproducibility and little measurement error). Our aim was to evaluate differences in validity and reliability of assessment with 2D image questions versus MPR image questions.

METHOD AND MATERIALS
In 2012, 246 medical students, trained with MPR images, took a digital radiology test. There were two versions (A and B), both containing twenty 2D and twenty MPR image questions, concerning anatomy on CT-scans. Participants filled out a questionnaire to judge the authenticity of the assessment as an indication of validity. They also gave their opinion on the difficulty of 2D and MPR image questions. Mean scores and reliabilities (estimated with Cronbach’s alpha) of the 2D and MPR image subtests were compared.

RESULTS
Cronbach’s alphas on 2D image questions were .49 (A), and .65 (B), and alphas of MPR image questions were .65 (A), and .71 (B). Scores on MPR image questions (M 15.6, SD 2.6; M 14.9, SD 2.9) were lower than scores on 2D image questions (M 15.8, SD 2.2; M 16.8, SD 2.4). This difference between 2D and MPR scores was significant for version B. Assessment based on MPR images was considered more authentic (t (56) = -7.1, p < .001), and less difficult (t (58) = -4.2, p < .001) by the participants.

CONCLUSION
According to the participants, assessment with MPR images increases authenticity, which can contribute to validity. MPR image questions showed higher reliability than 2D image questions. Scores on MPR image questions in one version were significantly lower, but considered less difficult by participants.

CLINICAL RELEVANCE/APPLICATION
Valid and reliable assessments of image interpretation skills of radiology trainees, adds to patient safety. MPR image assessment seems to contribute to its validity and to its reliability.

ISP: Informatics (Enterprise Integration)
Monday, 10:30 AM - 12:00 PM • S402AB

SCC09 • AMA PRA Category 1 Credit ™:1.5 • ARRT Category A+ Credit:1.5
Moderator
Rasu B Shrestha, MD, MBA *
Moderator
Safwan Halabi, MD

SCC09-01 • Informatics Keynote Speaker: Enterprise Imaging-The U Pittsburgh Experience
Rasu B Shrestha, MD, MBA (Presenter) *

SCC09-02 • Effect of Computerized Evidence-based Clinical Decision Support (CDS) on the Use and Yield of Computed Tomography Pulmonary Angiography (CTPA) in the Inpatient Setting
Ruth M Dunne MBCh (Presenter) ; Ivan Ip MD, MPH ; Sarah K Abbett MD, MPH ; Ali Raja MD, MBA * ; Andetta R Hunsaker MD ; Ramin Khorasani MD * ; Esteban Gershanik MD, MPH *

PURPOSE
To determine the effect of evidence-based CDS on the use and yield of inpatient CTPA for acute pulmonary embolism (PE).

METHOD AND MATERIALS
This HIPAA-compliant study included all adult inpatients at a 793-bed quaternary care hospital between April 1, 2007, and June 30, 2012. The intervention incorporated previously validated decision rules regarding clinical suspicion for PE and D-dimer measurement in low/intermediate risk patients. CTPA utilization was obtained from the institutional radiology information system. Using a validated natural language processing algorithm, each study was classified as positive for acute PE or not based on radiology report analysis. Admission data was gathered from administrative claims database. Clinical data, including use of prophylactic anticoagulation, was obtained from patient’s electronic medical record. Primary outcome measure was quarterly utilization intensity of inpatient CTPA, defined as the number of examinations performed per quarter per case-mix-adjusted admissions (CMAAs), a product of gross number of admissions and Centers for Medicare & Medicaid Services’ case-mix index of diagnosis-related groups for each quarter. Secondary outcome was the imaging yield, defined as the percentage of examinations positive for diagnosis of acute PE. Outcomes were compared before and after CDS implementation in October 2009. Chi-square was used to assess for differences in CTPA use and yield between the pre- and post-implementation periods. A two-tailed p-value of .05 was considered significant.

RESULTS
Use of evidence-based CDS in the in-patient setting was associated with a significant decrease in use of CT pulmonary angiography for the evaluation of acute PE.

CONCLUSION
Use of CDS was associated with a significant decrease in use of CT pulmonary angiography for the evaluation of acute PE.

CLINICAL RELEVANCE/APPLICATION
Implementation of evidence-based CDS may significantly decrease the use of inpatient CT pulmonary angiography in the evaluation of acute PE without a decrease in study yield.

SCC09-03 • Replacement of a Conventional Alphabetic ORDER (PERFORM) PRIORITY System with a Stratified Numeric System: Implementation and Impact on EXAM PERFORM TIME at a Large Academic Medical Center
Dustin Boatman MD ; Ryan P McWey (Presenter) ; Michael Hanshew MS ; Cree M Gaskin MD *

CONCLUSION
A simple, defined, and hierarchical numeric exam order priority system was associated with desirable impacts upon exam perform time, including appropriate stratification by priority as well as improved uniformity amongst high priority orders, compared to results with a conventional alphabetic order priority system.

Background
Conventional radiology order priority systems often include alphabetic levels of priority, e.g., STAT, routine, and ASAP. Such choices offer potentially competing or ambiguous priorities. Informal polling of MD’s and chief techs at our site revealed lack of consensus on prioritization using the alphabetic system. Our institution switched to a strictly numeric system with defined hierarchy to better leverage the ordering provider’s level of concern for inpatient and ED exams and convey it more clearly to the technologists.

Evaluation
This QI project was not human subject research. We retrospectively reviewed the order-to-perform time (OTPT) parsed by order priority for all ED and inpatient radiology exams (n=136,652), excluding fluoroscopy, for the same six months (Mar-Aug) one year prior to and immediately after implementation of the numeric system. A hard stop requirement to choose a priority was also added.

Discussion
Prior to implementation of the numeric system, our 9 most commonly used alphabetic order priorities and their average (OTPT) in hours(std dev) for all modalities combined were ASAP 4.4(7.6), PRIOR1 0.9(2.15), PRIOR2 0.5(0.76), PRIOR3 0.9(1.4), PRIOR4 1.9(2.5),
SSC09-04 • Implementation of a Numeric READING PRIORITY System as a Distinct Step beyond Conventional Use of ORDER PRIORITY for Patient Prioritization of Radiology Exam Interpretation: Impact on STRATIFIED REPORT TURNAROUND TIME in a Large Academic Medical Center

Dustin Boatman MD (Presenter) ; Ryan P McWey ; Michael Hanshew MS ; Cree M Gaskin MD *

CONCLUSION
Addition of a numeric reading priority system as a step beyond order priority for prioritizing radiology exam interpretation was associated with more desirable stratification of RTAT, as well as improved (reduced) variability in RTAT for high priority exams.

Background
The prioritization of radiology exam interpretation is conventionally based upon the order priority set by the ordering provider. This may not allow for revision of priority based upon new information (e.g. pending clinic appointment or concerning imaging finding noted by the tech). It also yields competing priorities between inpt, outpt, and ED exams when folded into a common reading work list.

Evaluation
This QI project was not human subject research. Our institution implemented a numeric reading priority (1-9, with defined criteria) set by the tech at end exam in addition to the provider's order priority. We sought to determine the impact of this additional priority score on stratified report turnaround time (RTAT) (i.e. time between end exam and release of first report). We retrospectively reviewed RTAT for all exams, excluding fluoroscopy, (n=309,331) parsed by read priority for the same 6 mos (Mar-Aug) at 2 points: immediately following implementation (when radiologists continued existing patterns of prioritization, largely ignoring the new data) and 1 yr later (after they had adopted prioritizing interpretations with the new read priority score).

Discussion
With existing patterns of priority for interpretation, RTAT was not well stratified by hierarchical reading priority and demonstrated wider variation. Avg RTATs in hours(STD DEV) for all combined modalities, in order from most urgent (score 1) to least(score 9) were 11.9(6.1), 4.7(6.9), 13.6(31.4), 11.8(59.7), 17.4(21.5), 14.9(42.9), 28.8(13.8), 26.2(47.1), and 21.7(27.7). After radiologists adopted use of the read priority score, RTATs for the same priorities were 1.7(4.2), 1.3(2.5), 6.5(15.6), 6.6 (17.1), 13.4(20.6), 10.1(11.9), 18.9(16.2), 18.8(28.9), and 18.2(27.5). The high priority studies had the greatest improvements with reduced and more uniform RTAT. Included FIGURE demonstrates improvement across all priorities but most notably among high priority studies.

Kambrie Kato MD (Presenter) ; Joshua J Reicher MD * ; Alberto Kywi MS ; Michael A Trambert MD *

CONCLUSION
11 radiologists qualified attesting to the EHR Incentive Program in 2012, possibly making this group the first community hospital-based outpatient radiology practice in the U.S. to do so. Compliance was achieved using a complete cloud-based EHR. Benefits extend beyond the incentive payment, including real time access to clinical data by the radiologist and increased patient engagement.

Background
The Center for Medicare and Medicaid Services EHR Incentive Program provides financial incentives to providers who "meaningfully use" a certified EHR. Although temporary exemptions to penalties, which begin in 2015 are available, failure to comply threatens to isolate radiologists from physicians, patients, and hospitals that have rapidly adopted the specified technologies. With over 350,000 eligible providers participating as of 12/31/2012, the ability to exchange information according to these standards may soon be a "must have" feature of any successful radiology practice, though a minority of radiologists have attested to date.

Evaluation
Successful implementation of a complete cloud-based certified EHR in a community hospital-based outpatient radiology practice is reported, with shown benefits of greater clinical relevancy and direct patient engagement.

Discussion
The medical group discussed herein uses a cloud-based certified EHR system (DR Systems, Inc., San Diego, CA) that can be incorporated into any third party RIS or PACS. Cloud-based architecture results in rapid deployment of updates and the ability to communicate with patients via a personal health record (PHR) (Health Companion, Inc., San Diego, CA). As a result, patients can provide required data prior to the appointment and can automatically access required information via the web. An upstream electronic interface enables automated input of some data. Patients can pre-register using the PHR over the web, and data is collected via a single-page paper questionnaire. Relevant EHR data is single-click accessible to the radiologist during the exam interpretation. An unanticipated benefit was leveraging the EHR to satisfy a joint commission requirement for access to outpatient medication and allergy data.

SSC09-05 • Truly Meaningful Use

Nogah Shabshin MD, MBA (Presenter) * ; Sahar Darawshi ; Ifat Abadi-Korek PhD ; Martine Szyper-Kravitz MD ; Joshua Shenmer MD, MPH

PURPOSE
In recent years communicating radiology reports to patients directly through an internet portal is becoming more popular. Patients log into a portal with a personal password and can view the radiology report. Although online access is the fastest way to get the report, in our institution, after 5 years of using this technology, only 30% of patients log in to the portal. The purpose of this study was to investigate whether patients with abnormal studies who didn’t access their reports online received the results, and to examine whether they returned to the referring physicians for further work-up and treatment.

METHOD AND MATERIALS
A telephone survey was conducted with 1594 patients who had an abnormal CT or MRI between April and October 2012, and whom received a password for the internet portal but did not log in. Patients were asked the following questions: ‘Did you receive the report?’ If answered yes: ‘did you return to your referring physician after receiving the report?’

RESULTS
Two hundred and twenty of 1594 (14%) patients with abnormal studies that did not log into the portal did not receive the results although these were available to them. Of the 1374 patient that did get the results 190 (14%) patients did not return to their referring physician.

CONCLUSION
Despite the availability of the reports online, and despite studies reporting that patients prefer to receive results fast, preferably online, the utilization of this technology is surprisingly low and most patients receive the results in an alternative way. When patients receive abnormal reports not through their physician, the compliance for further work-up and treatment is concerning and may lead to delay in diagnosis and treatment.

CLINICAL RELEVANCE/APPLICATION
SSC09-07 • Impact of a Point-of-Care Electronic Clinical Decision Support (CDS) Tool on Adherence to Departmental Guidelines for Follow-up of Incidental Pulmonary Nodules on Abdominal CT

Michael T Lu MD (Presenter); David A Rosman MD *; Carol C Wu MD *; Tarik K Alkasab MD, PhD; Jo-Anne O Shepard MD *; Giles W Boland MD; Matthew D Gilman MD

PURPOSE
The indeterminate pulmonary nodule is a common incidental finding on abdominal CT. While the abdominal radiologist plays a critical role in recommending appropriate follow-up, we have previously demonstrated that the majority of recommendations deviate from best practice guidelines. We implemented an automated decision support tool to provide evidence- and consensus-based recommendations at the point-of-care for further imaging based upon the Fleischner Society guidelines. The goal of this study was to evaluate the effect of the CDS tool on adherence to guidelines for follow-up of incidental pulmonary nodules.

METHOD AND MATERIALS
The RIS was mined for abdominal CT reports from 10/22/12 4/4/13 with a solid, noncalcified, pulmonary nodule that did not have a prior abdominal CT or prior or concurrent chest CT. History of smoking or malignancy, whether follow-up chest CT was recommended, and the time interval for follow-up were recorded. Concordance between the radiologist’s recommendation for follow-up and departmental guidelines was compared between three groups: reports where the CDS tool was used, those where it was not used, and 268 historical controls prior to the implementation of the CDS tool.

RESULTS
Out of 7,713 consecutive abdominal CT reports, 243 described a pulmonary nodule. Manual review of these reports yielded 141 consecutive patients who met inclusion criteria. The CDS tool was used in 40% (57/141). When used, 95% (54/57) of the recommendations were concordant with guidelines. In the remaining 5% of cases (3/57), the radiologist overrode the CDS tool and recommended more aggressive follow-up. Concordance with guidelines was significantly greater for the CDS group than the non-CDS group (45%, 38/84, p < 0.01) and historical pre-intervention controls (50%, 133/268, p < 0.01).

CONCLUSION
A point-of-care CDS tool improved adherence to departmental guidelines for follow-up of incidentally detected pulmonary nodules.

CLINICAL RELEVANCE/APPLICATION
Real time, point-of-care CDS tools can decrease the variability of radiologist recommendations, which may impact patient outcomes and cost.

SSC09-08 • Impact of a Multi-screen Decision Support Alert on Repeat Use of CT

Stacy D O’Connor MD (Presenter); Aaron D Sodickson MD, PhD; In Ji MD, MPH; Ali Raja MD, MBA *; Luciano Prevedello MD, MPH; Wendy Mar; Michael J Healey MD; Louise I Schneider MD; Ramin Khorasani MD *

PURPOSE
Evaluate the impact of a multi-screen decision support alert on repeat use of CT.

METHOD AND MATERIALS
This institutional review board-approved, pre-post study was conducted at a 776-bed academic medical center with computerized physician order entry and decision support systems. Previously, a single-screen alert notified orderers in real-time if the patient’s same body part had been imaged with the same modality within 90 days. Providers could ignore the alert and proceed, or drop the order. The intervention was a multi-screen repeat decision support alert. Orderers ignoring the single-screen alert received a second screen requiring selecting a clinical justification from a predetermined menu to complete the order, otherwise it was dropped. All 28,420 CT orders triggering a repeat alert in 2010, excluding those for malignancy restaging (n=11,862), were included. Primary outcome was proportion of dropped orders, evaluated with the Chi-square statistic. Multiple logistic regression assessed effect of care setting, orderer role, patient age and gender.

RESULTS
682/6,542 (10.4%) of CT orders triggering single-screen alerts were dropped; the multi-screen alert resulted in a 12.9% (1,290/10,016) drop rate (23% relative decrease; p

CONCLUSION
A multi-screen decision support alert requiring clinical justification to proceed with a repeat CT order prevented 1 in 8 CT orders, significantly enhancing the impact of a single-screen alert which prevented 1 in 10 repeat CT orders.

CLINICAL RELEVANCE/APPLICATION
Multi-screen decision support (DS) significantly reduces repeat CT orders; some proportion of dropped orders are likely unnecessary exams. Our study helps inform optimum DS design and implementation.

SSC09-09 • An Enterprise Class Computer Aided Detection Platform Scalable from Laptop to Cloud

Mark Hinton (Presenter) *; Olga A Kubassova PhD, MSc *; Mikael Boesen MD, PhD *

CONCLUSION
The challenges of handling large image datasets and real-time overlay calculations have been addressed through a novel architecture. Our validation in real clinical practice has shown that our cloud based architecture gives the same or better performance than a workstation. Further it supports multi-center collaboration and seamless data sharing. There are low costs to deploy the software. Development of new functionality is faster and automatically deployed to all users.

Background
To achieve efficiency in analysing medical images many radiology units use cloud based computer aided detection (CAD). The problem is to keep calculations and image overlays up to date whilst providing good user experience across bandwidths and latencies that are not controlled. Further, to support new developments the architecture of the software must support easy integration of algorithms without compromising performance. We present a novel approach to multi-tier architecture, Dynamika, which has successfully addressed the problems and been validated in radiology practices.

Evaluation
The architecture of Dynamika makes use of a classic back end framework of Spring and Hibernate to give robust server side scaling and performance. It uses Spring Webflow to control the path through the application. Webflow has been enhanced to allow for tightly controlled batch processing, which is utilized in clinical trials or routine analysis. The front end is based on Google Web Toolkit to give high performance in the client, desktop like behavior through AJAX and the power of HTML5. 3D visualization and animation is achieved through WebGL.

Discussion
Software using the new architecture has been bench marked against a conventional workstation solution for user experience and development efficiency. The performance of the cloud is comparable or better than the workstation in scrolling images with complex overlays and making calculations such as image registration, saving clinician time. To implement new algorithms, which was measured by recording time of code and test, was up to 10 times less in the cloud architecture. The cloud architecture properly supports collaboration and sharing and supports any device with network access.
Treatment of Osteoid Osteoma: Experience on 27 Consecutive Cases

SSC10-01 • MR-guided High-intensity Focused Ultrasound Ablation of the Femoral Bone: MRI and CT Evaluation of Structural Changes

Matthew D Bucknor MD (Presenter); Viola Rieke PhD; Thomas M Link MD, PhD *; Mark W Wilson MD; Sharmila Majumdar PhD; Maythem Saeed DVM, PhD

PURPOSE
To evaluate hyperacute structural changes (HSC) in the femur after MRgHIFU for the treatment of osteoid osteomas.

METHOD AND MATERIALS
Experimental procedures were performed on a group of 8 pigs. The median follow-up was 2.8 months. The MRgHIFU procedure was performed using a single sonicaton (360°C, 5 Hz) to the targeted bone. CT and MRI images were obtained before and after the procedure. The CT images were evaluated for changes in the bone density, and the MRI images were evaluated for changes in the bone marrow signal intensity and the presence of hypointense areas.

RESULTS
The MRgHIFU procedure resulted in a decrease in the bone density and an increase in the bone marrow signal intensity. The CT images showed a decrease in the bone density, and the MRI images showed a decrease in the bone marrow signal intensity.

CONCLUSION
MRgHIFU is an effective treatment for the treatment of osteoid osteomas in the femur.

Clinical Relevance/Application
MRgHIFU is a promising treatment for the treatment of osteoid osteomas in the femur.

SSC10-02 • Thermal Ablation Techniques for Curative Treatment of Bone Metastases

Frederic Deschamps (Presenter); Geoffroy Farouil; Lambros C Tselikas MD; Thierry J De Baere MD *

PURPOSE
To determine prognostic factor(s) for complete thermal ablation (TA) of bone metastases.

METHOD AND MATERIALS
The medical records of all the patients who had undergone curative-intent TA of bone metastases in our Institution between September 2001 and February 2012 were retrospectively reviewed. The goal of the TA was to achieve a local tumor control in order to cure all bone metastases in oligometastatic patients or to prevent the occurrence of skeletal-related events in long life expectancy cancer patients. We have analyzed the rate of complete treatment at 1 year according to the patients' details -gender, age, site of the primary tumor-and the bone metastases characteristics -synchronicity with the primary tumor, already treated by external radiotherapy, local evolution within 3 months before the procedure (RECIST criteria), location (axial vs. appendicular), maximal diameter at baseline CT, condensation aspect at CT (lytic vs. sclerotic), bone cortical erosion, critical neurological structures in the vicinity (less than 10mm), TA technique used (radiofrequency ablation vs. cryoablation).

RESULTS
Eighty-nine consecutive patients underwent TA in a curative-intent of 124 bone metastases. The median follow-up was 22.8 months [12.2 to 44.4 months]. We report a 67% of complete treatment at 1 year. In multivariate analysis the good prognostic factors for complete treatment were: metachronous bone metastasis (p=0.004), no progression within 3 months before (p=0.004), no cortical erosion (p=0.01), maximal diameter (p=0.004).

CONCLUSION
Thermal ablation techniques are effective to cure small (CLINICAL RELEVANCE/APPLICATION)
Thermal ablation techniques must be considered in oligometastatic patients or in long life expectancy cancer patients with bone metastases.

SSC10-03 • Radiofrequency Thermoablation versus Magnetic Resonance Guided Focalized Ultrasound Surgery (MRgFUS) in the Treatment of Osteoid Osteoma: Experience on 27 Consecutive Cases

Francesco Arrigoni (Presenter); Armando Conchiglia; Lorenzo Maria Gregori; Luigi Zugaro; Antonio Barile; Carlo Masciocchi

PURPOSE
To compare the clinical and morphological results, two years after the procedure, of the treatment of 27 osteoid osteomas with Magnetic Resonance guided Focused Ultrasound Surgery (MRgFUS) versus the treatment with Radiofrequency thermoablation (RF).

METHOD AND MATERIALS
From March 2011 we treated 27 osteoid osteomas, 12 using MRgFUS (ExAblate InSightech, Israel) and 15 using RF (LeVeen Needle Electrode Boston Scientific - USA). The osteoid osteomas treated with MRgFUS were located in the femour (n=8), tibia (n=3) and in the talus (n=1). The lesions treated with RFs were located in the femour (n=9), talus (n=2), vertebral body (L3 and L2) and tibial plateau (n=2). All the lesions were diagnosed by plain films, CT and MRI and controlled after the procedure by MRI and CT. The clinical evaluation was performed by VAS scale.

RESULTS
All the patients treated with RF thermoablation showed a regression in painful symptomatology with a mean VAS decreasing from 8 to 1.2 two years after the treatment. The treatment with MRgFUS was successful in 10 out of 12 patients (mean VAS dropped from 8.1 to 1.3 two years after the treatment). The two cases unresponsive were re-treated successfully with RF. The MRI evaluation showed a disappearance of bone edema already to the first controls at 6 months after the treatment in all the patients treated successfully. In the CT controls no substantial changes were found, except for the disappearance of the central calcification of the nidus in the 40% of cases treated with MRgFUS.
CONCLUSION
Although further studies with a longer term and a larger number of cases are needed, our experience demonstrates the effectiveness of the treatment of osteoid osteomas with MRgFUS. In particular, this treatment is successful in the 83% of cases. The main limit is today represented by the accessibility of the lesion by the ultrasound. However, the treatment is repeatable and does not preclude treatments with other techniques (with the RFs, the percentage of success is of 100%).

CLINICAL RELEVANCE/APPLICATION
This study explain an innovative and non-bloody technique to treat osteoid osteoma of bone.

SSC10-04 • MR-guided Focused Ultrasound (MRgFUS) for Treatment of Painful Bone Metastases: Can ADC Be Used to Predict Clinical Outcome?

Fabrizio Boni (Presenter); Alessandro Napoli MD; Michele Anzidei MD; Vincenzo Noce MD; Daniel R De Oliveira; Carlo Catalano MD

PURPOSE
To evaluate potential of diffusion-weighted magnetic resonance imaging (DWI) with apparent diffusion coefficient (ADC) maps in the assessment of molecular changes in bone metastasis micro-environment caused by MR guided Focused Ultrasound (MRgFUS), and to correlate these modifications with clinical outcomes.

METHOD AND MATERIALS
23 patients with bone metastases underwent MRgFUS using the ExAblate 2100 system (InSightec). Minimal required imaging work-up consisted of CT and MR imaging to determine imaging size and location of the lesions. Skeletal metastasis imaging was performed with a 3-T MR imaging unit (Discovery 750, GE; gd-BOPTA, Bracco). After treatment, all patients were scheduled to undergo clinical follow-up examinations at 1, 3 and 6 months post-treatment. To evaluate treatment efficacy in terms of symptoms palliation, pain severity and pain interference scores were determined using Visual Analogue Scale (VAS) score. Additionally, all patients underwent follow-up MR imaging at 1, 3 and 6 months after treatment. The margins of metastatic lesions were tracked manually on the baseline ADC. As a quantitative parameter of treatment response, we calculated percentage of change in ADC (ADC%)

RESULTS
No adverse events were recorded. We found an effective pain relief, with mean VAS score drop from an average baseline of 7.09±1.8, to 2.65±1.1 at first month follow-up to 1.04±1.91 at third month and to 1.09±1.99 at sixth month. Furthermore, patients treated with MRgFUS showed a mean increase in ADC value of +4.89% at first month follow-up (p < 0.05).

CONCLUSION
Our preliminary data showed that incremental ADC values positively correlated with MRgFUS clinically successful outcome in patients with bone metastases; a different percentage increase in ADC was evident among our population (partial vs complete responders). ADC value might play as an important early marker surrogate for clinical outcome in patients undergoing MRgFUS for painful bone metastasis.

CLINICAL RELEVANCE/APPLICATION
MRgFUS treatment determines bone metastasis cell damage, correlate with clinical outcomes, as demonstrated by linear ADC modification.

SSC10-05 • MR-guided Focused Ultrasound (MRgFUS) Ablation for Non-spinal Osteoid Osteoma Treatment: A Prospective Multi-centric Cohort Study

Daniel Geiger MD (Presenter); Alessandro Napoli MD; Armando Conchiglia; Alberto Bazzocchi MD; Ugo Albisinni MD; Carlo Masciocchi; Carlo Catalano MD

PURPOSE
Purpose of this study was to evaluate MR-guided focused ultrasound (MRgFUS), in terms of success rate, for painful non-spinal osteoid osteoma treatment.

METHOD AND MATERIALS
This IRB approved prospective multi-centric cohort study, performed at three university hospitals, included thirty patients (M:21; Mean age: 24±11). Between May 2010 and April 2012 thirty painful non-spinal osteoid osteomas, diagnosed at imaging (including ce-dynamic MR; Ct/gRFA, or open surgery (1/30) were then treated. A single session treatment was sufficient in 93% (28/30) of cases to achieve clinical success. Two cases required MRgFUS retreatment. Types of anesthesia were spinal (21), peripheral (5) and general (4; in pts.=16yo). Mean sonications number was 6±3; mean energy 1080±727 J. No complications were observed immediately after treatment or during follow-up.

CONCLUSION
This multi-centric prospective cohort study demonstrated that MRgFUS has a high success rate (90%) and a relatively short learning curve for non-spinal osteoid osteoma treatment. Our results suggest that MRgFUS may be considered as an effective, totally non-invasive and safe alternative approach in osteoid osteoma interventional management.

CLINICAL RELEVANCE/APPLICATION
The safety and effectiveness of MRgFUS encourages its adoption in treating non-spinal osteoid osteoma. This procedure, differently from other ablative technique, is totally non-invasive.

SSC10-06 • Cryoablation of Perineural Musculoskeletal Tumors: Use of Intraprocedural Motor Evoked Potential (MEP) Monitoring to Improve Safety

Anil N Kurup MD (Presenter); Jonathan M Morris MD; Grant D Schmit MD; Thomas D Atwell MD; Adam J Weisbrod MD; Matthew R Callstrom MD, PhD *; Andrea J Boon; Rickey Carter PhD; C. T Wass MD; Peter Rose MD

PURPOSE
To describe the use of MEP monitoring to minimize risk of neural injury during image-guided cryoablation of perineural musculoskeletal tumors.

METHOD AND MATERIALS
Between May 2011 and March 2013, 59 cryoablation procedures were performed to treat 64 perineural musculoskeletal tumors, defined as those within 2 cm of the spinal cord or major motor nerve, in 52 unique patients. Total intravenous general anesthesia, CT guidance, and MEP monitoring were employed. Patient demographics, tumor characteristics, MEP findings, and clinical outcomes were assessed.

RESULTS
The cohort included 26 males and 26 females with median age of 61 years (range, 4-82). Tumors were located in the spine (27; 3 cervical, 14 thoracic, 10 lumbar), sacrum (3), pelvis (23; 8 periacetabular, 6 other iliac, 4 pubic, 3 ischial, 2 gluteal), and extremities (8; 5 upper, 3 lower). Among the 64 tumors, 50 (78%) were metastases. 21 different tumor histologies were represented, most commonly...
Cementoplasty

distribution of 61.1 years). We used TPS to reconstruct the 3D image of vertebrae metastatic tumor and work out the number and the dose rate of the tumor.

METHOD AND MATERIALS

We retrospectively analyzed 20 cases with vertebrae metastatic tumor, including 9 men and 11 women aged 50-79 years (mean age, 61.1 years). We used TPS to reconstruct the 3D image of vertebrae metastatic tumor and work out the number and the dose rate of the tumor.

RESULTS

We performed treatments for 20 cases, with 39 combined procedures. In the total of 107 procedures, there were three thoracic cage (1 rib, 3 clavicle and 4 scapula), 28 in the pelvis and 15 in the spine (8 sacral, 4 lumbar, 3 thoracic). In 50 patients (66%) only one embolization was performed, two embolization in 18 patients (24%) and three in the remaining 7 cases (18%), for a total of 107 procedures.

CLINICAL RELEVANCE/APPLICATION

Combined cementoplasty is a useful tool in the treatment of lytic acerbular metastatic disease for both palliation of pain as well as stabilization and prevention of fracture.

SSC10-08 • Selective Arterial Embolization of Aneurysmal Bone Cyst (ABC) of the Skeleton with N-2 Butyl Cyanoacrylate: Revisited Results, Recurrences and Outcomes in 75 Patients

Giuseppe Rossi MD; Eugenio Rimondi MD (Presenter); Giancarlo Facchini; Paolo Spinnato MD; Patrizia Pelotti; Teresa Calabro; Pietro Ruggieri; Daniel Vanel; Alberto Bazzocchi MD

PURPOSE

To emphasize the role of arterial embolization with N-2 butyl cyanoacrylate as single and resolving treatment for ABC. We evaluated the effectiveness and complications of the procedure in 75 patients at the IRizzoli Institute.

METHOD AND MATERIALS

From April 2003 until April 2013, 75 patients with ABC were treated (41 males and 34 females, range 3 - 40 years). Each case was histologically proven. Twenty-four were sited in the appendicular skeleton (5 in the superior and 19 in the inferior limb), 8 affecting the thoracic cage (1 rib, 3 clavicle and 4 scapula), 28 in the pelvis and 15 in the spine (8 sacral, 4 lumbar, 3 thoracic). In 50 patients (66%) only one embolization was performed, two embolization in 18 patients (24%) and three in the remaining 7 cases (18%), for a total of 107 procedures.

RESULTS

Regardless of the number of the embolizations, the treatment was effective in 69 patients (92%): medium follow-up 59 months ± 12 months. In four patients the procedure was not finalised for anatomical concerns. In two patients needing integrative embolization treatment was shifted to surgery because of skin necrosis (clinical decision) or patient's choice. In the 107 procedures, there were three complications (3%): two skin necrosis and one transient pharesis. However all the complications were solved one after surgical support.

CONCLUSION

Arterial embolization is the treatment of choice for aneurysmal bone cysts. The use of cyanoacrylate seems to be determinate for the excellent outcome of embolization, allowing permanent effect and well-controlled procedure. Embolization is less invasive, cheaper, simpler, faster, more secure for skilled operators and it is easily repeatable.

CLINICAL RELEVANCE/APPLICATION

In the past Aneurysmal Bone Cyst (ABC) was treated surgically or with a combination of surgery and embolization. Nowadays the sole embolization with N-2 butyl cyanoacrylate is the gold standard.

SSC10-09 • Clinic Efficacy of CT-guided Iodine-125 Seed Implantation Therapy in Patients with Advanced Vertebrae Metastatic Tumor

Zhijin Chen (Presenter); Zhongmin Wang; Ju Gong

PURPOSE

The purpose of this study was to examine the safety and clinical efficacy of CT-guided radioactive iodine-125 seeds implantation treatment in patients with vertebral metastatic tumor.

METHOD AND MATERIALS

We retrospectively analyzed 20 cases with vertebral metastatic tumor, including 9 men and 11 women aged 50-79 years (mean age, 61.1 years). We used TPS to reconstruct the 3D image of vertebrae metastatic tumor and work out the number and the dose rate distribution of seeds. The number of 125 I seed implantation was 90-130Gy. 24 Vertebrae metastatic tumor were treated by CT-guided
RESULTS
20 cases were followed up for a median of 12 months (4-26 months). The rate of pain relief was 95%. The 6 months and 12 months local control rates were 80% and 30%, respectively. The median local control time was 9 months. Overall survival rates for 6 months and 12 months were 95% and 45%. The median survival time was 10 months.

CONCLUSION
CT-guided radioactive iodine-125 seeds implantation treatment in patients with vertebrae metastatic tumor is a safe, effective, and minimally invasive method.

CLINICAL RELEVANCE/APPLICATION
CT-guided radioactive iodine-125 seeds implantation treatment in patients with vertebrae metastatic tumor is a safe, effective, and minimally invasive method.
Grading of intracranial astrocytomas using histopathology alone is affected by sampling error and inter- and intra-observer variability. Under-grading can result in less aggressive therapy and potentially a worse prognosis. We propose that incorporating MRI into grading will predict patient survival better than the current gold standard of histopathology alone.

**METHOD AND MATERIALS**

Patients with a new diagnosis of a WHO grade II-IV fibrillary astrocytoma or oligoastrocytoma were identified through the ACCORD neuro-oncology database of The Royal Melbourne Hospital. Pre-operative MRIs performed between September 2007 and December 2010 were independently reviewed on PACS by two readers, blinded to the histological grade, and an MRI grade was given. The grade was assigned similarly on the basis of the post-contrast appearances, with supplementary information from both standard and advanced sequences. The MRI and histopathological grades were compared against patient survival, adjusted for patient age.

### RESULTS

A total of 245 patients met the inclusion criteria. Correlation between the two MRI readers was high, at 95% (kappa 0.87). Correlation between the MRI consensus grade and the histological grade was moderate, at 82% (kappa 0.58). Patients with MRI appearances consistent with a grade IV tumour but lower grade (II or III) histology had significantly worse survival than patients with the same histology but lower grade MRI appearances (p = 0.001 for grade II histology and p = 0.013 for grade III). Taken as a group, the survival of all the patients up-graded from lower grade histology to grade IV based on MRI was equivalent to those patients with grade IV tumours on both histology and MRI (no significant difference, p = 0.896). Therefore, the tumours up-graded to grade IV based on MRI behave as grade IV tumours, and at least some may truly be grade IV tumours under-graded by histology.

### CONCLUSION

MRI is a better predictor of survival than histopathology for high grade gliomas, with high inter-observer agreement. Incorporating MRI into grading can therefore decrease the risk of under-grading. This has the potential to guide optimal therapy and thus substantially improve patient survival.

**CLINICAL RELEVANCE/APPLICATION**

MRI is currently under-utilised in the management of intracranial astrocytomas. Adding MRI information to the current histopathological grading system allows more accurate grading of astrocytomas.

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**SSC11-04 • 2-hydroxyglutarate (2HG) Level Is Associated to Tumor Progression in Gliomas Carrying IDH Mutations**

Liya Wang MD (Presenter); Juliya Kalinina; Shaoxiong Wu PhD; Chad A Holder MD; Erwin G Van Meir; Hui Mao PhD

**PURPOSE**

Mutation in the isocitrate dehydrogenase (IDH) is a common feature of a major subset of primary low grade gliomas. The IDH mutation specific metabolite 2-hydroxyglutarate (2HG) can be detected and quantified by magnetic resonance spectroscopy (MRS). This study investigates whether the 2HG concentration, a possible marker for IDH mutant activity, is related to tumor progressions.

**METHOD AND MATERIALS**

2HG in 28 gliomas carrying IDH1/2 mutations were detected and quantified using 2D correlation MRS. Tumor volumes were determined from routine clinical MRIs, performed on each patient based on the enhancing portion of mass in post-contrast T1-weighted imaging. Tumor grade and Ki-67 proliferation index (MIB) data were obtained from histopathology analysis. Two-tailed Spearman (P)

### RESULTS

Higher 2HG concentrations were found in tumors with higher grades. Higher 2HG level appears associated with the increased tumor volume and MIB index. However, 2HG levels in Grade IV tumor, which is considered as the secondary glioblastum multiforme (GBM) and different from low grade gliomas, is lower than those of Grade III gliomas. In all four cases with follow-up MRI and repeated biopsy, 2HG concentrations were increased when tumor progression took place from grade II to grade III two years later. In all four cases, routine MRI exams showed increased tumor volume and more pronounced contrast enhancing effect in tumors after two years. In comparison, 2HG levels from MRS showed more than 2-fold of increase. These results provided patient specific examples demonstrating that the 2HG level is increasing with the elevated tumor grade in low grade gliomas carrying IDH mutations.

### CONCLUSION

Findings of this study provide the evidence that IDH mutation specific 2HG level has a strong correlation with several clinically important prognostic measurements, such as tumor size and MIB index value. Excess 2HG accumulated in tumors may contribute to formation and malignant progression of glioma.

**CLINICAL RELEVANCE/APPLICATION**

Association of increased 2HG level and tumor progression features suggests 2HG as a MRS detectable marker for predicting glioma prognosis.

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**SSC11-05 • Development of an Unbiased, Semi-automated Method of Tumor Volume Segmentation Using Image Processing Software in Glioblastoma before and after Resection**

Chad A Holder MD (Presenter); James S Cordova BS; Eduard Schreibmann PhD*; Constantinos G Hadjipanayis MD, PhD; Ying Guo PhD; Hyunsuk Shim PhD

**PURPOSE**

This work aims to standardize and evaluate an MR signal-based approach for tumor segmentation using an FDA 510k-approved software package (Velocity AI) that allows the rendering, fusion, and analysis of multi-modality 3D medical images.

**METHOD AND MATERIALS**

Currently, glioblastoma (GBM) volume measurements rely on the product of orthogonal tumor diameters on post-contrast T1w MRI; however, it is difficult to measure post-resection tumor in this manner, especially when hyperintense, nonneoplastic lesions are present. Though the need for objective volumetric analysis was highlighted by the NeuroOncology Working Group (Wen, PY et al. JCO 2010; 28, 1963-1972), a standardized image display, processing, and analysis protocol has not been developed for a clinically-utilized volume rendering software. We applied our volume determination method to compare the extent of resection (EOR) using 5-ALA-guided resection to EOR of standard resections. Datasets consisted of high-resolution pre- and post-op MR images (T1w images pre- and post-contrast) from 13 randomized patients in an Emory ALA study and 13 controls matched for tumor location. To tabulate preop tumor volume, a coarse ROI was drawn around the tumor and the software was used to segment volumes of hyper- and hypointensity on T1w MRI in the ROI in a semi-automated fashion. To estimate residual post-op tumor, image difference maps were produced by subtracting co-registered, pre- and postcontrast T1w MRI to correct for postop blood.

### RESULTS

The average EOR without ALA-guidance expressed as percent residual tumor was 10.69 ± 7.45%, while that of ALA-guidance was 4.85 ± 3.98%. These values were found to be significantly different at p

### CONCLUSION

These results support the use of this semi-automated method for the unbiased and reproducible generation of contrast-enhancing tumor volumes in GBM pre- and post-resection. In addition, this technology allows the selection of voxels in discrete tumor regions on T1w MRI for the quantitative analysis of treatment-induced metabolic changes in spatially-coregistered, high-resolution MR spectroscopic images.

**CLINICAL RELEVANCE/APPLICATION**

This method allows quantitative analysis of brain tumor response to chemo-, radiation, and surgical therapies, offering a precise tool for the longitudinal monitoring of patients in clinical trials.

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**SSC11-06 • Imaging Genomic Mapping Using Perfusion UnCOVERS Potential Genomic Targets Involved in Angiogenesis and Invasion**

Hyunsuk Shim
PURPOSE
To create an imaging genomic map, linking MR imaging traits with gene- and miRNA expression profiles, in patients with GBM to determine genomic correlates of a MR perfusion radiophenotype to possibly find new genomic targets for GBM treatment. Increases in angiogenesis demonstrate increases on MRI perfusion relative cerebral blood volume (rCBV) maps. Increases in angiogenesis are seen in patients with highly aggressive and hypervascular tumors. Here, we present the first study examining in a quantitative way the perfusion imaging genetics in GBM to determine novel and targetable angiogenic biomarkers in GBM.

METHOD AND MATERIALS
We identified 30 GBM patients from The Cancer Genome Atlas (TCGA) who had both genetic expression profiles and neuroimaging. All morphological image analyses were done using slicer 3.6 (slicer.org) and functional analysis using NordicICE, and reviewed in consensus by 2 neuropathologists. Quantitative perfusion parameters where obtained using the region of interest (ROI) method. ROIs were placed in the previously segmented regions of contrast enhancement, necrosis, and non-enhancing perilesional FLAIR hyperintensity- the latter reflecting a mixture of edema/tumor infiltration. Biostatistics analysis was performed for gene and miRNA sets whereas the median CBV values of each of the segmented regions were taken as the cutoff to define high and low groups. These groups were then analyzed by Comparative Marker Selection (Broad Inst.). Among the whole gene set the most upregulated mrnas/miRNAs, were analyzed with ingenuity pathway analysis (IPA).

RESULTS
IPA identified molecular networks, as well as canonical and functional pathways highly associated with cancer, angiogenesis, and invasion in those patients with high tumor rCBV.

CONCLUSION
The perfusion radiophenotype identified genes and miRNAs and corresponding molecular networks that were highly associated with angiogenesis and invasion. By these means we were able to identify possible key genes and miRNAs involved in the latter regulation. The uncovered genes and miRNAs represent new insight into tumors with high perfusion seen on MRI and the underlying molecular mechanisms in GBM for growth and treatment response.

CLINICAL RELEVANCE/APPLICATION
The discovery of imaging biomarkers reflecting specific genomic tumor compositions in necrosis is clinically relevant as they can determine aggressivity and tumor growth.

SSC11-07 • Validating MRI as a Screening Tool for Genomic Target Discovery for Therapeutic Drug Development
Rivka R Colen MD (Presenter) ; Prateesh Sathy ; Ashok J Kumar MD ; Pascal O Zinn MD

PURPOSE
The search for an effective therapy of Glioblastoma Multiforme (GBM) continues. Imaging Genomics, a newly emerged field, links gene expression profiles with MRI phenotypes (Zinn et al, 2011). MRI-FLAIR was found to correlate with cellular invasion in GBM; thus, whole genome microarray functional imaging analysis can reveal functional microRNA-gene regulatory networks as novel targets for cellular invasion in GBM. We sought to validate MRI as a screening tool for genomic target discovery.

METHOD AND MATERIALS
We performed radiogenomic mapping of MRI- and corresponding genomic data in 78 TCGA patients. The top microRNA-gene regulatory network was biologically validated by functional and mechanistic in-vitro and invivo orthotopic xenograft model studies using gain and loss of function. Small animal 7T MRI-T2/FLAIR was used for imaging-genomic validations.

RESULTS
The top up-regulated gene in high invasion MRI phenotypes was PERIOSTIN (POSTN). The top down-regulated microRNA (miR-219) was validated to bind to POSTN. MRI-T2/FLAIR signal highly correlated with POSTN levels and the degree of cellular invasion in orthotopic xenograft models. Furthermore, high POSTN and a high POSTN/miR-219 signature resulted in decreased survival and shorter time to progression (P=0.0001).

CONCLUSION
In this study, we validated a novel noninvasive diagnostic method to screen for functional networks of cellular invasion. POSTN inhibition can be a novel therapeutic approach to target invasion in GBM. Furthermore, targeted individualized molecular therapies can be based on diagnostic imaging-genomics and can be monitored through-out the treatment period.

CLINICAL RELEVANCE/APPLICATION
Imaging, specifically MRI, can be used as a screening method in order to identify genomic targets that are clinically meaningful and can potentially go on to develop genomic based therapeutics.

SSC11-08 • MRI and PET Measurements of Oxygen Extraction Fraction in Patients with Brain Tumors
Parinaz Massoumzadeh PhD (Presenter) ; Dhanashree Rajderkar MD ; Hongyu An DSc ; Jonathan E McConathy MD, PhD * ; Joshua S Shimony MD, PhD ; Abraham Z Snyder PhD ; Yi Su PhD ; Andrei Vlassenko MD, PhD ; Xiaodong Zhang PhD ; Jon J Christensen ; Sarah C Jost MD ; Daniel S Marcus PhD * ; Keith M Rich MD ; Tammie S Benzinger MD, PhD *

PURPOSE
To quantify and compare the cerebral oxygen extraction fraction (OEF) measurement in the normal brain and brain tumors using 15O positron emission tomography (PET) and oxygen sensitive magnetic resonance (MR).1,2 Imaging.

METHOD AND MATERIALS
30 participants (20 with brain tumors) were recruited. MRI included standard clinical sequences plus OEF-MR1: a two-dimensional multi-echo gradient spin echo sequence. Concurrent with the MR acquisition, subjects with brain tumors underwent PET scanning, which included 2 sets of 3 scans with serial inhalation of air with 40-75 mCi radiolabeled carbon monoxide (15CO), 40-75 mCi radiolabeled oxygen (15O2), and injection of 25-50 mCi radiolabeled water (H215O). MR and PET data were post-processed off line and registered to the anatomic T1 pre-and post-contrast images. Regions of interest were drawn based upon contrast-enhancing tumor areas, contra-lateral normal white matter (NWM), and normal gray matter (NGM). Ratios of OEF (rOEF) were obtained for lesions compared to normal tissue.

RESULTS
There is very good correlation between two OEF-PET measurements for tumor (R=0.90 with slope of 0.82), and for rOEF (R=0.93 and slope of 1.14). The OEF values of NWM are not significantly different between the OEF-PET measurements. OEF-MR and OEF-PET correlates well when subjects with SWI abnormalities (blood clot, hemorrhage, calcification) are excluded (R=0.73).

CONCLUSION
Both MR and [15O] PET can measure OEF in brain tumors and in peritumoral edema. Variable OEF measurements for tumor and edema may be implication for tumor grade and prognosis. BOLD MR fails in regions with signal loss on SWI or T2*. Both techniques have tremendous potential and may offer new insight into the underlying physiology of brain tumors and in the treatment without requiring radiation or injected contrast. References:

CLINICAL RELEVANCE/APPLICATION
Both MR and [15O] PET can measure OEF in brain tumors and in peritumoral edema and have potential to predict treatment response.
SSC11-09 • Creating a Radiogenomics Map of Multi-omics and Quantitative Image Features in Glioblastoma Multiforme

Olivier Gevaert PhD (Presenter); Lex A Mitchell MD; Achal Achrol; Jiajing Xu MS; Gary K Steinberg MD, PhD; Samuel H Cheshier; Sandy Napel PhD*; Greg Zaharchuk MD, PhD*; Sylvia K Plevritis PhD

PURPOSE
To create mappings between quantitative image and genomic features for glioblastoma multiforme (GBM) and to assess the prognostic association of significant correlations.

METHOD AND MATERIALS
We obtained multi-omics data from 251 patients and MR image data from a subset of 55 patients in the Cancer Genome Atlas (TCGA) and The Cancer Imaging Archive (TCIA) GBM databases. A board certified neuroradiologist traced 2D regions of interest (ROI) around necrotic and enhanced parts of the largest lesion in a selected slice from a T1 post-contrast MR, and around the region of hyperintensity obtained from the enhancement on the matched T2 FLAIR slice. These ROIs were used to compute quantitative image features from their shapes and pixel values. We used a module network algorithm that integrates copy number, DNA methylation and gene expression data into 100 co-expressed gene modules, modeled by sparse linear regression of driver genes, which were selected based on a significant correlation of copy number or DNA methylation with their respective gene expression. We established a radiogenomics map by correlating the modules with the quantitative image features, and correlated the image features from this map with significant correlations with survival using Cox proportional hazards modeling.

RESULTS
A total of 28 quantitative image features were extracted for each of the necrosis, enhancement and edema ROIs in each patient. The radiogenomics map between modules and quantitative image features revealed 14, 10 and 16 significant gene-module associations with necrosis, enhancement and edema ROIs respectively. For example we found a significant correlation between Module 64, enriched with genes in neuronal differentiation, and the compactness of the necrosis (p=0.0145). Also, we found that the amount of necrosis vs. enhancement or edema is correlated with Module 74, enriched in metabolism related genes (p

CONCLUSION
Creating radiogenomics maps provides multi-scale insight by associating image features with molecular function. Moreover, these maps may provide additional insight for image features with prognostic correlations.

CLINICAL RELEVANCE/APPLICATION
Associating activation of molecular pathways with image features has the potential of allowing non-invasive assessment of the molecular properties of a tumor at the time of diagnosis.

SSC12 • AMA PRA Category 1 Credit™:1.5 • ARRT Category A+ Credit:1.5

Moderator
Pratik Mukherjee, MD, PhD*

Gerard Riedy, PhD, MD

SSC12-01 • Six Hour Repeat Head CT for Trauma Patients on Antiplatelets and/or Anticoagulation

Jackson Cheung MD (Presenter); Armando S Herradura MD; Stephen R Baker MD*

PURPOSE
To determine the efficacy of repeat six-hour head CTs for trauma patients on antiplatelets and/or anticoagulation for delayed intracranial hemorrhage (ICH)

METHOD AND MATERIALS
Retrospective analysis was conducted on all head CTs performed at our institution from the years 2007-2012. Inclusion criteria included availability of initial, repeat head CTs within a six hour period, and data on the type of antiplatelet and/or anticoagulation. Data were obtained from electronic medical records, PACS, and radiology reports. Cases which identified a new ICH on the repeat study were examined for changes in patient management, hospital course, and outcomes.

RESULTS
Preliminary analysis of the 11,562 head CTs performed at our institution during the year 2012 yielded 128 cases meeting inclusion criteria. Incidence of ICH on repeat examination was 1.5% regardless of antiplatelet/anticoagulation type, consistent with previously published studies. Further evaluation of these cases demonstrated that the repeat study did not alter patient management and outcomes.

CONCLUSION
Repeat six hour head CTs for patients on antiplatelet and/or anticoagulation therapy was low-yield for delayed ICH and did not affect patient outcomes. More comprehensive analyses are required to determine the full cost-benefit analysis of a repeat head CT and to identify certain populations which can benefit from a repeat scan.

CLINICAL RELEVANCE/APPLICATION
Our analysis demonstrates these repeat head CTs are unnecessary and only result in increased radiation exposure and costs.

SSC12-02 • The Use of Coronal and Sagittal Reformats in the Evaluation of Post-traumatic Intracranial Hemorrhage

Anil Syal MD (Presenter)

PURPOSE
Evaluate if coronal and sagittal reconstructions are helpful in the evaluation of post-traumatic intra-cranial hemorrhage.

METHOD AND MATERIALS
Approximately 317 cases of acute, post-traumatic intracranial hemorrhage from a level II trauma center over a 16-month period were reviewed. These positive cases were interspersed with an equal number of negative controls. A board-certified neuro-radiologist, a body radiologist and two residents, a PGY-3 and a PGY-4, evaluated each case without any history other than post-traumatic. Evaluators were told to read each study using only axial 5mm slices. After completing the studies, the interpretations were compared to the original readings (which were re-evaluated prior to this study by a separate neuro-radiologist), which were designated as the control report. Any cases of missed post-traumatic intra-cranial hemorrhage were then re-evaluated by the test subject one month later, with the additional aid of coronal and sagittal reformats. Any discrepancies with their original reads were documented. As well, any missed post-traumatic intracranial findings were then viewed in light of their clinical significance, via documented follow-up studies and clinical course.

RESULTS
Diffusion Tensor Imaging and Neuropsychological Performance in Post-acute Blast-induced Traumatic Brain Injury

Preliminary results indicate only a small difference between the rate of positive post-traumatic intracranial bleeds when using only axial images, versus with the aid of coronal and sagittal reformats.

CONCLUSION
The industry standard protocol for a post-traumatic head CT typically includes 2.5 or 5mm axial cuts; where protocols differ is in the use or absence of digital coronal and sagittal reformats. In a review of approximately 600 cases from a level II trauma center, there was minimal difference in the number of positive reported cases. Furthermore, the clinical relevance of these missed findings seen only in one, reformatted plane is of questionable significance, based upon patient outcomes.

CLINICAL RELEVANCE/APPLICATION
Axial images alone are satisfactory in diagnosing clinically relevant post-traumatic intracranial hemorrhage.

**SFC12-03 • Utility Assessment of Repeat Head CT in the Setting of Mild Traumatic Brain Injury Using a Natural Language Processing Tool**

Jason M Johnson MD (Presenter); Tarik K Alkasab MD, PhD; Daniel Yeh MD; Pamela W Schaefer MD

PURPOSE
To assess the rate of which repeat head CT following mild traumatic brain injury revealed worsening of imaging findings using a natural language processing tool.

METHOD AND MATERIALS
Utilizing our institutional trauma registry, 824 adults with blunt TBI who arrived within 24 hours of injury, with arrival GCS of >12 with initial head imaging positive for traumatic findings were identified. Patients with initial operative management were excluded, and all head CTs performed within 7 days of injury was identified. Each exam was evaluated using a natural language processing (NLP) tool designed for high sensitivity to identify reports describing worsening findings. Imaging reports for 114 patients were manually assessed by an experienced neuroradiologist and a Kappa score was calculated for agreement between the NLP tool and a human reader.

RESULTS
Of the 819 patients identified, 164 were removed for additional review for having less than 2 CT scans. An additional 30 patients were removed due to initial operative management. Of the remaining 625 patients, 287 had 2 CTs, 172 had 3 CTs and 166 had >3 CTs. Review of the NLP revealed 86% (98/114) algorithm concordance with neuroradiologist review. The majority of the errors (81.3%; 13/16) were NLP overcalls based on the report. Of the 626 patients with at least two CT scans, the second CT scan contained language suggesting worsening in 263 cases (42.0%).

CONCLUSION
A supervised NLP tool can be used in conjunction with a patient registry to identify language associated with worsening head CT findings. We expect to use this tool to further explore clinical factors associated with worsening imaging findings to improve imaging utilization patterns.

**SFC12-04 • Quantitative DTI for Prediction of Neurocognitive Outcome in Severe Traumatic Brain Injury: A Five-year Prospective Cohort**

Omid Khalilzadeh MD, MPH (Presenter); Julien Dinkel MD; Vincent Perlbarg PhD; Louis Puybasset MD, PhD; Damien P Galanaud MD, PhD *; Rajiv Gupta PhD, MD

PURPOSE
Prediction of long-term neurocognitive outcome in patients with traumatic brain injury (TBI) is challenging. In this study, we evaluated the prognostic value of DTI, performed in acute-phase after TBI, for prediction of long-term neurocognitive sequelae. For this purpose, we tracked the changes in quantitative DTI parameters over a span of 5 years after the injury.

METHOD AND MATERIALS
Sixteen patients with severe TBI who were admitted to the intensive care unit were enrolled in this prospective study. A baseline MRI was acquired as soon as clinically feasible (within 6 weeks). The MRI scans were repeated at 2 and 5 years after the injury. Patients underwent a neuropsychological evaluation and we assessed the cognitive sequelae and the level of disablement based on Glasgow outcome scale, the disability rating scale and the modified Rankin scale. Healthy controls (n=8) were scanned at baseline and at 2-year intervals. Automated segmentation software calculated axial/radial diffusivity and fractional anisotropy in 20 predefined white matter regions. The DTI parameters were normalized using a large set of DTI data from healthy controls. The association of DTI changes with patients' clinical outcome was evaluated.

RESULTS
TBI patients had significantly lower fractional anisotropy and higher radial diffusivity in selected white matter tracts compared with healthy controls. Baseline changes in fractional anisotropy and radial diffusivity in the brain stem, corpus callosum and corona radiata were significantly (p < 0.05).

CONCLUSION
Acute changes in fractional anisotropy and radial diffusivity after severe TBI can predict long-term neurological sequelae with high confidence. DTI changes in the body/genu of the corpus callosum provide the best long-term prognostic value for severe TBI.

CLINICAL RELEVANCE/APPLICATION
Quantitative DTI can be used as a prognostic tool for prediction of long-term neurocognitive outcome in severe traumatic brain injury.

**SFC12-05 • Diffusion Tensor Imaging and Neuropsychological Performance in Post-acute Blast-induced Traumatic Brain Injury among U.S. Military Veterans**

Thomas M Malone BA (Presenter); Jacob Bolzenius BA; Mark Colijn MS; Evan Schulze BA; P. T Roskos PhD; Richard R Bucholz; Jeffrey D Stout MD

PURPOSE
Operations Iraqi Freedom and Enduring Freedom have resulted in a returning veterans with an approximately 20% exposure rate to Operations Iraqi Freedom and Enduring Freedom have resulted in a returning veterans with an approximately 20% exposure rate to blast-induced mTBI. Standard neuroimaging (MRI/CT) lacks sensitivity to mTBI; however, some research has shown evidence that Diffusion Tensor Imaging (DTI) can identify white matter injury [2, 3]. DTI measures the local diffusion profile of tissue and can characterize the microstructural integrity of white matter. In this study, we compared DTI derived fractional anisotropy (FA) values in veterans with post-acute blast mTBI versus healthy controls (HCs) and examined the association between FA and neuropsychological measures.

METHOD AND MATERIALS
Data were acquired using a 3T Philips Achieva scanner. Participants included: 10 veterans with blast mTBI (average of 51.30 months post-injury) and 10 HCs. DTI data were pre-processed using FSL 5.0 and regions of interest (ROIs) were hand-traced using FSLview. The ROIs consisted of the genu and splenium of the corpus callosum and the anterior and posterior limbs of the internal capsule, bilaterally. Average FA values from each ROI were calculated for statistical analysis.

RESULTS
Comparison of FA values using independent sample t-tests showed significant differences between groups in the posterior limb of the internal capsule, bilaterally (p < 0.05).
CONCLUSION
Results indicate that DTI is sensitive to group differences in blast-related mTBI, even in the post-acute phase. This suggests presence of a long-term impact of blast injury on the brain. Paradoxically, higher FA values and lower neuropsychological scores were found among veterans with mTBI.

CLINICAL RELEVANCE/APPLICATION
DTI shows promise in enhanced sensitivity for detecting mTBI compared to MRI/CT. Identification of changes in specific brain regions may help in diagnosis and treatment of mTBI among veterans.

SSC12-06 • Association of Thalamic Iron and Frontal White Matter Diffusion Changes: Longitudinal Findings after Mild Traumatic Brain Injury (mTBI)

Martin Kopec MD (Presenter) ; Yulin Ge MD ; Robert I Grossman MD ; Yvonne W Lui MD

PURPOSE
Thalamic iron has been shown to be elevated after a single concussive episode. The thalamus is a hub for numerous cortical connections, particularly of interest in mTBI are frontocortical connections to areas responsible for executive function. Fractional anisotropy (FA) is a sensitive measure of white matter microstructural integrity after concussion. It is not known whether iron accumulating from secondary injury is related to degree of white matter structural change. The purpose of this study is to correlate thalamic iron using magnetic field correlation imaging (MFC) and frontal white matter microstructure changes using Diffusion Tensor Imaging (DTI) in a cohort of mTBI patients over the first year after injury.

METHOD AND MATERIALS
27 patients with documented MTBI determined by American College of Rehabilitation Medicine criteria were prospectively enrolled with longitudinal follow up. At 14 subjects with evaluation included 3 Tesla MRI performed at 1 month and 1 year after injury. Microscopic MFC, an iron marker, and DTI were performed. Thalamic microscopic MFC values using region of interest analysis and frontal white matter FA (FWM-FA) were obtained at both time points. Pearson correlation coefficient was calculated.

RESULTS
27 subjects studied at the first time point (21 males, 6 females; mean age of 33.2 years) and 14 followed at both time points (11 males, 3 females; mean age of 34.6 years) were imaged at a mean of 27 and 422 days after injury. Average thalamic microscopic MFC was 123.5 and 126.2 at 1 month and 1 year, respectively. Average FWM-FA was 0.378 and 0.381. At 1 month, no correlation was found between thalamic microscopic MFC and FWM-FA; however, at 1 year, thalamic microscopic MFC values were highly correlated with a reduction in FWM-FA (r= -0.7, p= 0.0007).

CONCLUSION
1 year after injury an association emerges between higher thalamic iron measures and frontal white matter microstructural changes. This demonstrates the first reported connection between white matter injury and iron accumulation in mTBI.

CLINICAL RELEVANCE/APPLICATION
We demonstrate a link between thalamic iron metrics and frontal white matter microstructural changes. These data suggest iron may contribute to secondary injury after mTBI.

SSC12-07 • Linking Microstructural Injury and Functional Outcome in Mild Traumatic Brain Injury (mTBI): A Role for Resting fMRI

Susan Sotardi MD, MS (Presenter) ; Jeremy Smith PhD ; Michael L Lipton MD, PhD

PURPOSE
To characterize brain network alterations related to prefrontal traumatic axonal injury (TAI) in mTBI patients. We hypothesized that prefrontal resting network connectivity related to left dorsolateral prefrontal cortex, previously associated with TAI and executive dysfunction in this patient group, would be abnormal in comparison to uninjured controls.

METHOD AND MATERIALS
Informed consent was obtained from 11 mTBI patients (ages 21-62) within 2 weeks of injury and 9 healthy control subjects, in compliance with HIPAA. Using a GE-EPI time series (TE=40; voxel size 8ul), resting fMRI was performed on a Philips Achieva TX 3.0T MR scanner. Preprocessing was performed in FSL, including motion and slice timing correction, nuisance vector (noise and CSF) regression, FILM prewhitening and registration to the Johns Hopkins University template. Mean signal timescources from right- and left-hemisphere dorsolateral prefrontal cortex (DLPFC; BA 9/46) and rostral prefrontal cortex (RPFC; BA10) were used as seed regions (predictors) in voxelwise correlation analyses for each subject. Comparison between mTBI patients and controls was performed using unpooleed, unpaired t-tests, with Bonferroni correction.

RESULTS
We have previously demonstrated low left DLPFC fractional anisotropy and impaired executive function (Austen maze and CPT) in this patient group. Using resting fMRI, left DLPFC was significantly more highly correlated with both right and left RPFC (t-stat -5.67 and -5.61, p

CONCLUSION
We demonstrate enhanced correlation of resting state fMRI activity within left prefrontal networks implicated in executive function. Enhanced correlation among resting networks has been described in pathologic states, including TBI, as evidence of reduced network functional efficiency. The spatial and functional relationship between resting fMRI findings (DPFC-RPFC network), previously demonstrated DTI evidence of TAI (DLPFC) and functional impairment (executive dysfunction), reveals physiologic consequences that can link microstructural pathology to functional consequences in mTBI patients.

CLINICAL RELEVANCE/APPLICATION
Resting fMRI reveals brain network dysfunction that links TBI pathology and functional consequences. This approach can facilitate integrative assessment of brain substrates of post-TBI dysfunction.

SSC12-08 • Altered White Matter Microstructure as Vulnerability Factors and Acquired Signs of Traffic Accident-induced PTSD

Yawen Sun (Presenter) ; Yan Zhou PhD ; Zhen Wang ; Weina Ding ; Zhi Guo Zhuang ; Yong Zhang ; Yijun Liu ; Jianrong Xu

PURPOSE
White matter (WM) microstructures changes have been found in patients with chronic and new onset posttraumatic stress disorder (PTSD). Whether such WM changes are stress-induced or not, precursors for this vulnerability remain unclear. The aim of the current study was to identify susceptibility factors relating to the development of PTSD and to examine the ability of these factors to predict the course of longitudinal PTSD.

METHOD AND MATERIALS
A total of 62 participants who experienced traffic accidents underwent diffusion-weighted imaging using a 3.0T MRI system within 2 days after the accident. Among them, 21 participants were diagnosed with PTSD, at 1 month or 6 months using the Clinician-Administered PTSD Scale (CAPS), and 10 patients with PTSD underwent the second MRI scanning up diagnosis. Voxel-based analysis (VBA) was performed on fractional anisotropy (FA) images to assess the differences in the WM microstructures across the whole brain between the groups. Assessing the relationship between PTSD symptom severity and WM microstructures, the correlation between the CAPS at diagnosis and the FA values in the brain regions of interest was also examined.
RESULTS
Compared with the trauma-exposed control group, the PTSD group showed lower FA values in the right anterior cingulate cortex, right middle temporal gyrus, right midbrain, and left gyrus rectus/medial orbitofrontal cortex within 2 days after trauma. Importantly, the reduced FA values in the left gyrus rectus at the acute phase predicted greater future CAPS scores. In addition, we found decreased FA values in the left insula in the follow-up scan in the patients with PTSD, which correlated with the decrease in FA values in the left gyrus rectus in their first scan.

CONCLUSION
These results suggested that the WM microstructure has already changed within 2 days after the initial trauma in the individuals who would later on develop PTSD. Furthermore, the reduced FA values in the ventromedial prefrontal cortex region could be established as a vulnerability neuroimaging marker that predicts future development of PTSD symptoms and might also provide an outcome prediction of the acquired signs of PTSD, focusing on reduced FA values in the insula.

CLINICAL RELEVANCE/APPLICATION
Identify the susceptibility factors relating to the development of PTSD and examine the ability of these factors to predict the course of longitudinal PTSD.

SSC12-09 • Clinical Implication of Early 3T-MR with Susceptibility Weighted (SWI) and Blood Flow (ASL) Imaging in Collegiate Athletes with Mild Traumatic Brain Injury: Preliminary Report

Anna Ellermeier MD (Presenter); Heather Spader; Zahid Jethani; Jason T Machan PhD; William C Lafrance; Michael Worden; Kaspr De Johst; Michael J Hulstyn; Neha Raukar; Jeffrey M Rogg MD

PURPOSE
Mild traumatic brain injury (mTBI) in young adults accounts for the 2nd highest rate of brain injury in RI State, with increasing emphasis placed on the immediate and long-term effects of these injuries. We report the results of 3T-MR susceptibility weighted (SWI) and cerebral blood flow (CBF) pulsed arterial spin labeled (ASL) imaging for diagnosis and prognosis assessment in mTBI.

METHOD AND MATERIALS
Following IRB approval, prospective consent was obtained from right-handed collegiate football and rugby athletes. Fourteen (14) athletes with sports-related concussions (GCS 13-15) were enrolled. 3T-MR imaging (Siemens Trio) performed 1-month clinical follow-up; 8 had >3-month clinical and MR follow-up. T1/FLAIR and SWI MR reviewed blindly by a CAQ Neuroradiologist. ASL vascular territory ROI analysis performed using Osirix software, with a general linear model treating MR parameters as multivariate-Gaussian distribution used for statistical analysis.

RESULTS
All subjects had headache, memory/concentration difficulty and/or decreased energy, 36% (5/14) severe; 21% (3/14) had persistent symptoms at 1-month, 14% (2/14) severe. None had abnormal T1 or FLAIR. Two of 14 had SWI hemorrhage (punctate peri-genu and peri-splenium CC) and severe presentation with clinical and imaging resolution at 1-month. ASL showed significantly increased minimum and decreased standard deviation in hippocampus (HIP) CBF post-injury as compared to >3-month delayed intra-subject control (Fig. 1).

CONCLUSION
Our mTBI subjects clinically parallel existing literature. Standard T1 and FLAIR 3T-MR had no relevant findings in the 14 athletes. Though both subjects with SWI blood had severe symptoms, their full recovery suggests prognosis is not affected by SWI findings. ASL showed statistically increased HIP CBF in the acute state, an intriguing finding as existing literature shows elevated baseline HIP CBF in PTSD subjects to correlate with symptom severity. Clinical significance is considered by implication of HIP dysfunction on memory, concentration and mood stability, all associated with mTBI.

CLINICAL RELEVANCE/APPLICATION
In mTBI, 3T-MR SWI may show hemorrhage but does not predict prognosis. We use ASL to show increased hippocampal CBF, supporting literature that suggests this may be clinically relevant.

SSC13 • AMA PRA Category 1 Credit ™:1.5 • ARRT Category A+ Credit:1.5

Moderator
Michael F McNitt-Gray, PhD *

Moderator
James T Dobbins, PhD *

SSC13-01 • Experimental Validation of Shaped Filter Design with Variable Source-to-Filter Distance for Breast CT with Respect to Image Quality and Dose

Ferdinand Lueck Dipl Phys *; Daniel Kolditz PhD (Presenter) *; Martin Hupfer PhD *; Willi A Kalender PhD *

PURPOSE
To validate the use of a single shaped filter with variable source-to-filter distance (SFD) for dedicated breast CT (bCT) and arbitrary breast sizes.

METHOD AND MATERIALS
The shaped filter was designed using simulations of a dedicated bCT system with the goal to achieve noise homogeneity and dose reduction for breast diameters of 80 to 180 mm. This was accomplished with a filter design method that aims to achieve a homogeneous detector noise but considering a correction factor for the filtered back projection process. According to the simulations a single shaped filter designed for the largest breast diameter works for all breast diameters if SFD can be adjusted. To validate these results the filter was manufactured of an aluminum alloy. The measurements were performed on a bCT prototype with breast phantoms (80% adipose, 20% glandular tissue) of diameters from 80 to 180 mm. The filter was positioned at SFDs from 54 to 112 mm according to the phantom diameter. Image quality was evaluated for the reconstructed volume by assessing CT value accuracy, noise homogeneity and spatial resolution. Furthermore, scatter distribution was determined with the use of a beam-stop phantom with and without shaped filter. Dose reduction was measured using a calibrated ionization chamber in the center and in the periphery of the phantom.

RESULTS
The results with a single shaped filter at variable SFD resulted in improved noise homogeneity and dose reduction for all breast diameters: noise homogeneity was improved from 15% down to 5% and the overall dose was reduced by about 30 to 40% for all breast diameters. Furthermore, scatter reduction of about 60% was achieved, which reduced cupping artifacts and improved the CT value accuracy. Spatial resolution was not affected by the shaped filter.

CONCLUSION
By means of shaped filters designed for bCT, significant dose reduction can be achieved and image quality can be improved by reducing noise inhomogeneity as well as scatter-induced artifacts. A single shaped filter designed for the largest breast diameter used with variable SFD appears to be a good solution for bCT.

Back to Top
SSC13-02 • An Automated Method to Estimate Organ Dose from Tube Current Modulated (TCM) CT Scans Using Software to Extract Regional Tube Current Values

Maryam Khatonabadi (Presenter) * ; Tim O’Connell MD, MEng * ; Aaron S Dodickson MD, PhD ; Michael F McNitt-Gray PhD *

PURPOSE
Regional CTDIvol has proven to be a valuable metric for estimating dose from TCM CT scans; however, its practicality has not been established. The purpose of this study was to evaluate an automated landmark recognition software which can be used to extract basic landmarks within a CT exam to calculate both regional CTDIvol, and regional water equivalent diameter (WED) metrics to enable automated organ dose estimates.

METHOD AND MATERIALS
Image data and tube current modulation data were collected from 10 patients who underwent either an abdomen/pelvis (N=4) or thorax (N=6) exams. An automated software program was used to analyze each patient’s image data and identify the type of exam and to extract image numbers corresponding to important landmarks of regional anatomy: for thorax, locations of the lung apices and the top of the diaphragm were extracted; for A/P, locations of the top of the diaphragms and iliac crests were extracted. The extracted image numbers were used to calculate a regional CTDIvol based on DICOM header-reported mAs values as well as the WED of each image. Regional CTDIvol and WED were used to estimate dose to lungs and breasts from thorax and dose to liver, kidneys, and spleen from abdomen exams, using a predictive model capable of estimating organ dose using regional information. For these same patients, the image data was used to create voxelized models used in Monte Carlo simulations in which dose to each of the relevant organs was estimated. Estimated organ doses from automated method were compared with those obtained through simulations and a Root Mean Square error between methods was calculated.

RESULTS
Estimated doses using the automated method resulted in RMS error of 33%, whereas estimates using the manual approach resulted in lower RMS error of 15% across all organs.

CONCLUSION
This work has demonstrated that automated methods to estimate organ dose for CT scans performed with tube current modulation yield reasonable results in a small number of patients having either A/P or thorax exams. Further work is needed to improve automated extraction of regions, especially for extraction of regional data to estimate thoracic organ doses (particularly breast dose), where tighter organ-specific regions would be preferable.

CLINICAL RELEVANCE/APPLICATION
Automated body landmark recognition can facilitate the calculation of multiple regional CTDIvol values from a single TCM exam for use in organ dose estimation.

SSC13-03 • Phase Based Dose Modulation for Improved Dose Efficiency in Cardiac CT

Adam Budde MS (Presenter) * ; Brian E Nett PhD *

PURPOSE
In cardiac half-scan reconstruction a smooth weighting function is typically used to weight the sinogram data. We assess if knowledge of this weighting function and the prescribed cardiac phase can be used to improve dose efficiency.

METHOD AND MATERIALS
In prospectively triggered cardiac CT, data is typically acquired such that a prescribed phase and some adjacent phases can be reconstructed (e.g. prescribed phase and nominal phase padding). During the reconstruction process of any given phase a smooth weighting temporal weighting is applied to reduce motion artifacts. In this work a phase based mA modulation is proposed, such that less dose is delivered to the views which will receive a down weighting during the reconstruction process. The base protocol for comparison was a half scan acquisition with a gantry rotation period of 280ms with 50ms of phase padding on each side. A comparison, using numerical simulations of a 20cm water phantom, was performed between the standard and the phase based dose modulation, where the integral of the mA was conserved between the two acquisitions.

RESULTS
The image noise at the center of the phantom was assessed through region of interest measurements of the variance of voxel values, as this metric varies inversely with dose. Modulating the mA while keeping the total dose constant reduced the image variance by 12.2% at the center reconstructed phase, 12.0% at the reconstructed phase 25ms from center, and by 6.2% at the reconstructed phase 50ms away from the prescribed phase.

CONCLUSION
Prospective phase based dose modulation enables improved dose efficiency for cardiac CT scanning.

CLINICAL RELEVANCE/APPLICATION
Radiation dose reduction in cardiac CT can be achieved while maintaining the same level of image noise through phase based modulation.

SSC13-04 • Method to Achieve Specific Image Quality and Dose Targets over a Range of Patient Sizes by Optimizing CT Tube Current Modulation Parameters

David B Larson MD (Presenter) * ; Daniel J Podberesky MD *

PURPOSE
Automated tube current modulation (ATCM) can reduce CT radiation dose by adjusting the tube current according to patient size. However, ATCM does not establish image quality or dose targets nor does it ensure that those targets are met. Our purpose was to develop a method for achieving specific image quality targets over a range of patient sizes by adjusting the ATCM parameters of standard deviation of noise ($\sigma$), $\sigma^2$, and minimum and maximum mA values.

METHOD AND MATERIALS
A mathematical optimization model, based on a 320-detector row scanner (Aquilion ONE, Toshiba, Otawara, Japan), was developed to predict noise and size-specific dose estimates (SSDE) based on scanner settings, including ATCM parameters, which has been presented previously. The model was applied to a quantitative noise target curve as a function of patient size, which has also been presented previously. The three ATCM variables (SD and minimum and maximum mA) were adjusted in the model to enable explicit matching of predicted image noise with target image noise over a range of patient sizes. Mean deviation and mean absolute deviation (MAD) of the predicted from the target noise and SSDE were obtained for water-equivalent diameters corresponding to weight ranges of 0-15 kg, 16-30 kg, 31-45 kg, 46-70 kg, 71-100 kg, and 100+ kg. Values obtained using mA limits were compared to those not using mA limits.

RESULTS
The ATCM noise curve without mA limits resulted in excessive noise (insufficient dose) for smaller patient diameters and lower-than-necessary noise (excessive dose) for larger patient diameters (Fig. 1). MAD for noise and SSDE not using mA limits were 1.88 HU and 1.57 mGy, respectively. Values obtained using mA limits were 0.32 HU and 0.30 mGy, respectively. Use of mA limits decreased MAD for noise and SSDE by 83% and 81%, respectively.

CONCLUSION
Predicted CT image noise and SSDE can be closely matched to target noise and SSDE curves over a specified size range by adjusting the
MODULATION

Using Precalculated Organ Dose Databases

SSC13-06 • Towards Accurate Monte Carlo Simulations of Tube Current Modulation CT Dosimetry: Model Validation and Technical Considerations

Kyle McMillan (Presenter) *; Maryam Khatonabadi *; Christopher H Cagnon PhD; John J Demarco PhD; Michael F McNitt-Gray PhD *

PURPOSE
The purpose of this study is to establish the appropriate level of detail needed within Monte Carlo models to accurately simulate dose from tube current modulation (TCM) CT scans of patients.

METHOD AND MATERIALS
A Monte Carlo model was developed in MCNPX for use in CT dose quantification. In order to validate the suitability of this model to accurately simulate patient dose from a TCM CT scan, a two-part validation scheme was devised. In the first phase, relatively simple geometries requiring varying levels of x-, y- and z-modulation were explored, including a cylindrical CTDI phantom, an elliptical body phantom and a rectangular water equivalent phantom. In the next phase, a more complex anthropomorphic phantom was investigated. Each phantom was scanned in a Siemens Sensation 64 scanner under the conditions of fixed tube current (FTC) and TCM. Dose measurements were made at various surface and depth positions within each phantom. Simulations using each phantom were performed for FTC, full x-y-z TCM and z-axis (along patient length) only TCM, and dose was tallied at the same locations where measurements were obtained.

RESULTS
For simple geometries, the average absolute difference between the FTC measurements and simulations was 4.6%. The difference between TCM measurements and full TCM and z-axis only TCM simulations was 4.1% and 9.7%, respectively. Dose differences in the water equivalent phantom, whose rectangular shape contains considerably more x-y modulation than the other phantoms, were as high as 37.2% when z-axis only TCM was simulated. For the anthropomorphic phantom, the difference between TCM measurements and full TCM and z-axis only TCM simulations was 1.2% and 8.9%, respectively. For FTC measurements and simulations, the difference was 1.6%.

CONCLUSION
This work exhibited good agreement between measured and simulated values under both simple and complex geometries including an anthropomorphic phantom. This work also showed the increased dose differences for z-axis only TCM simulations, which demonstrates the importance of using full TCM data for Monte Carlo simulations.

CLINICAL RELEVANCE/APPLICATION
Results from this investigation highlight details that need to be included in Monte Carlo simulations of TCM CT scans in order to yield accurate, clinically viable assessments of patient dosimetry.

SSC13-05 • Monte Carlo Patient Dosimetry for Computed Tomography Examinations with Automatic Tube Current Modulation Using Precalculated Organ Dose Databases

Daniel J Long PhD (Presenter); Elliott J Stepusin BS; Lindsay Sinclair PhD; Wesley E Bolch PhD

PURPOSE
The demand for accurate, easily-accessible patient dosimetry for computed tomography examinations has been on the rise in recent years. Programs utilizing precalculated organ dose databases such as CTDosimetry and CT-Expo have seen widespread use for their ease-of-use; however, they fail to inherently account for modern examinations which use automatic tube current modulation (ATCM). This work seeks to develop a methodology by which to account for ATCM in patient dosimetry within the framework of a precalculated organ dose database program.

METHOD AND MATERIALS
Organ dose measurements using OSL detectors were made at Shands Hospital at the University of Florida on three female cadavers of varying BMI (17.4, 35.2, and 43.9) for four standardized CT protocols (CAP, chest, abdomen, and pelvis) utilizing ATCM. Voxel phantoms were then created for each cadaver by segmenting anatomy from the CAP exam image sets, and slice-by-slice organ dose databases were created for each through the use of a Monte Carlo model of a Toshiba Aquilion ONE CT scanner. In addition to doses, average photon attenuation was calculated for each slice of anatomy in the databases, which was then used to create weighting factors by which the doses for each slice in the desired exam range were scaled. By using the reported average effective mAs delivered for each exam, simulated in-field organ doses for each cadaver were calculated and compared to those experimentally measured.

RESULTS
Simulated and measured in-field average organ doses for each cadaver and CT exam type were compared by percent difference calculations using the measured doses as the accepted standard. Average magnitudes of percent differences over all exam types were 10.6 ± 2.5%, 9.2 ± 4.0%, and 11.5 ± 2.7% for the cadavers of BMI 17.4, 35.2, and 43.9, respectively.

CONCLUSION
This work establishes the feasibility of a methodology by which to account for automatic tube current modulation in Toshiba patient CT examination dosimetry within the bounds of a precalculated organ dose database program. This study lays the foundation for additional work to create a more robust methodology spanning various CT makes and models.

CLINICAL RELEVANCE/APPLICATION
The tools and methodology outlined in this work are a step closer to providing accurate and clinically-feasible patient organ doses in computed tomography examinations with automatic tube current modulation.

SSC13-07 • Realistic Dose Distribution in Helical Abdominal/Pelvis Scans - Fixed mA vs. Z-directional and Angular mA Modulation

Da Zhang PhD (Presenter); Xinhua Li PhD; Wenli Cai PhD; Bob Liu PhD

CONCLUSION
Direct dose measurements inside the Abd/Pelvis region of an anthropomorphic phantom provided realistic dose distributions, and demonstrated the significant difference between scans with fixed mA and with mA modulation.

BACKGROUND
Helical CT scans with automatic tube current modulation are widely utilized clinically. However, in the regions where the preset maximum mA is reached, the scan is conducted with constant mA. Due to the complex nature of scanning motion, mA modulation, and patient shape and composition, the dose distribution inside the scanned volume is not well understood. We want to investigate and compare the dose distribution under a scan with fixed mA and a scan with both z-directional and angular mA modulation.

EVALUATION
We sampled the doses experimentally inside an anthropomorphic phantom (CIRS 701 ATOM) by embedding an array of optically stimulated luminance dosimeters in it. We scanned the abdominal/pelvis region of the phantom at a GE LS 16 Pro scanner, using the
routine protocol of our institution for this region (at 120 kVp, 0.5s rotation time, 16x1.25 mm beam collimation, and pitch of 1.375). The first scan employed Auto-mA and Smart-mA with a noise index of 15 and the widest available mA range, and the second scan was with a fixed 170 mA. For each scan, we acquired 16 readings along the central z-axis of the phantom, 13 readings along the peripheral z-axis near the anterior surface, and 22 readings on each of the two selected axial planes where many radio-sensitive organs are located.

Discussion
With both fixed mA and mA modulation, large fluctuations were observed on the peripheral doses along the z-direction, which was attributed to the ripple effect resulting from x-ray attenuation and beam divergence. With fixed mA, the central doses of all slices showed small fluctuation around about 85% of the reported CTDIvol. The central dose changed significantly when Auto-mA is used for compensating the change of cross-sectional shape and size of the subject. The doses on the same axial plane in both scans ranged from 70% to 160% of the reported CTDIvol, and were asymmetrically distributed.

**SSC13-08 • Evaluating the Complex Relationship of Automated Tube Current Modulation, Noise Index, Image Noise and Phantom Size**

**Xiujiang J Rong** PhD (Presenter); **Eric P Tamm** MD; **Vesna Gershan** PhD; **Dianna D Cody** PhD *; **Xinning Liu** PhD; **Erik K Paulson** MD; **Vikas Kundra** MD, PhD *

**PURPOSE**

To determine the influence of phantom size on automated tube current modulation (ATCM) performance.

**METHOD AND MATERIALS**

Four tissue equivalent abdominal CT dose phantoms (CIRS 007TE) were scanned using a GE HD750 scanner. To simulate an extra-large size patient, a 5th phantom was created by wrapping a fat-ring around the Large Adult phantom. Abdominal CT protocol: 120kVp, 0.8s rotation time, 40mm beam width, 0.984 pitch, 2.5 mm image thickness and Large Scan Field-of-View. With Auto-mA and Smart-mA enabled, Noise Index (NI) was varied resulting in various levels of image quality. Images were reconstructed using Standard algorithm. For each phantom size/NI combination, ROI (n=3/image) and noise measurements (standard deviation of ROI) in 10 consecutive images of the central portion of the phantom were performed. The relationship of average noise versus NI was plotted for each phantom size.

**RESULTS**

For each phantom size, noise increased linearly as NI value increased ($R^2 = 0.9898$-$0.9996$). However, the slopes (ranged 0.47-1.26) differed among phantom of different sizes. Using a constant NI value, and hence the same scan protocol, noise levels decreased with phantom size. For the 15 year old to medium phantom sizes (circumference of 71, 86, and 96cm), the differences in slopes (1.26, 1.21, and 1.11) were relatively minor, indicating that the measured noise values were similar as a function of NI value. The slopes (0.68 and 0.47) of the large and extra-large phantoms (circumference of 116 and 136cm) were substantially less compared to the small-medium size phantoms, and also quite different from each other, resulting in three distinct sets of lines on the noise vs NI plot. Accordingly, for large and extra-large phantoms at a given NI, image noise is less than anticipated. Counter intuitively, this suggests that for large and very large phantoms, a higher NI could be used for maintaining adequate image quality while achieving lower radiation dose.

**CONCLUSION**

ATCM was limited in obtaining the same noise across phantoms of different size when using the same NI. Utilization of ATCM requires NI value be optimized based on patient size for optimal performance.

**CLINICAL RELEVANCE/APPLICATION**

Using a fixed NI across the entire range of patient sizes will likely result in great variability in image noise. Choice of an appropriate NI therefore must take into account patient size.

**SSC13-09 • Dose to Radiosensitive Organs during Routine Chest CT: Effects of Standard and Organ-based Tube Current Modulation**

**Federica Zanca** PhD (Presenter); **Xochitl Lopez-Rendon** MSC; **Walter Coudyer**; **Raymond H Oyen** MD, PhD *

**PURPOSE**

To quantify the effect of standard and organ-based tube current modulation (TCM) on dose to radiosensitive organs (breasts, lungs, heart, thyroid gland) and on image quality in adult female patients of various sizes undergoing chest CT examinations.

**METHOD AND MATERIALS**

Four (underweight, normal, overweight and obese BMI index) female cadavers (one 15-year old, four adults) were scanned using a GE HD750 scanner. To simulate an extra-large size patient, a 5th phantom was created by wrapping a fat-ring around the Large Adult phantom. Abdominal CT protocol: 120kVp, 0.984 pitch, 2.5 mm image thickness and Large Scan Field-of-View. With Auto-mA and Smart-mA enabled, Noise Index (NI) was varied resulting in various levels of image quality. Images were reconstructed using Standard algorithm.

**RESULTS**

Four tissue equivalent abdominal CT dose phantoms (CIRS 007TE) were scanned using a GE HD750 scanner. To simulate an extra-large size patient, a 5th phantom was created by wrapping a fat-ring around the Large Adult phantom. Abdominal CT protocol: 120kVp, 0.8s rotation time, 16x1.25 mm beam collimation, and pitch of 1.375. The first scan employed Auto-mA and Smart-mA with a noise index of 15 and the widest available mA range, and the second scan was with a fixed 170 mA. For each scan, we acquired 16 readings along the central z-axis of the phantom, 13 readings along the peripheral z-axis near the anterior surface, and 22 readings on each of the two selected axial planes where many radio-sensitive organs are located.

Discussion
With both fixed mA and mA modulation, large fluctuations were observed on the peripheral doses along the z-direction, which was attributed to the ripple effect resulting from x-ray attenuation and beam divergence. With fixed mA, the central doses of all slices showed small fluctuation around about 85% of the reported CTDIvol. The central dose changed significantly when Auto-mA is used for compensating the change of cross-sectional shape and size of the subject. The doses on the same axial plane in both scans ranged from 70% to 160% of the reported CTDIvol, and were asymmetrically distributed.

**SSC14-10 • Evaluating the Complex Relationship of Automated Tube Current Modulation, Noise Index, Image Noise and Phantom Size**

**Xiujiang J Rong** PhD (Presenter); **Eric P Tamm** MD; **Vesna Gershan** PhD; **Dianna D Cody** PhD *; **Xinning Liu** PhD; **Erik K Paulson** MD; **Vikas Kundra** MD, PhD *

**PURPOSE**

To determine the influence of phantom size on automated tube current modulation (ATCM) performance.

**METHOD AND MATERIALS**

Four tissue equivalent abdominal CT dose phantoms (CIRS 007TE) were scanned using a GE HD750 scanner. To simulate an extra-large size patient, a 5th phantom was created by wrapping a fat-ring around the Large Adult phantom. Abdominal CT protocol: 120kVp, 0.8s rotation time, 40mm beam width, 0.984 pitch, 2.5 mm image thickness and Large Scan Field-of-View. With Auto-mA and Smart-mA enabled, Noise Index (NI) was varied resulting in various levels of image quality. Images were reconstructed using Standard algorithm. For each phantom size/NI combination, ROI (n=3/image) and noise measurements (standard deviation of ROI) in 10 consecutive images of the central portion of the phantom were performed. The relationship of average noise versus NI was plotted for each phantom size.

**RESULTS**

For each phantom size, noise increased linearly as NI value increased ($R^2 = 0.9898$-$0.9996$). However, the slopes (ranged 0.47-1.26) differed among phantom of different sizes. Using a constant NI value, and hence the same scan protocol, noise levels decreased with phantom size. For the 15 year old to medium phantom sizes (circumference of 71, 86, and 96cm), the differences in slopes (1.26, 1.21, and 1.11) were relatively minor, indicating that the measured noise values were similar as a function of NI value. The slopes (0.68 and 0.47) of the large and extra-large phantoms (circumference of 116 and 136cm) were substantially less compared to the small-medium size phantoms, and also quite different from each other, resulting in three distinct sets of lines on the noise vs NI plot. Accordingly, for large and extra-large phantoms at a given NI, image noise is less than anticipated. Counter intuitively, this suggests that for large and very large phantoms, a higher NI could be used for maintaining adequate image quality while achieving lower radiation dose.

**CONCLUSION**

ATCM was limited in obtaining the same noise across phantoms of different size when using the same NI. Utilization of ATCM requires NI value be optimized based on patient size for optimal performance.

**CLINICAL RELEVANCE/APPLICATION**

Using a fixed NI across the entire range of patient sizes will likely result in great variability in image noise. Choice of an appropriate NI therefore must take into account patient size.

**SSC14-01 • Accurate Quantitative DCE-MRI of Prostate at 3T Using High-order B1 Field Correction**

**Kyunghyun Sung** PhD (Presenter); **Daniel J Margolis** MD *; **Holden H Wu** PhD; **Yutaka Natsuaki** *; **Steven S Raman** MD

**PURPOSE**

In the quantitative analysis of dynamic contrast-enhanced MRI (DCE-MRI), a critical step is to convert dynamic MR signal into contrast agent concentration, based on knowledge of the pre-contrast T1 values. We demonstrate improved T1 measurements by using a novel B1 field correction method and show more accurate quantitative DCE-MRI analysis of prostate cancer at 3T.
METHOD AND MATERIALS
Variable flip angle (VFA) imaging is commonly used for T1 mapping but known to be highly sensitive to transmit B1 field variation. We have recently developed a novel method that can simultaneously measure T1 and B1 maps, reference region VFA (RR-VFA), assuming that the fat T1 value is well characterized, and the B1 variation in the prostate is sufficiently approximated by high-order polynomials. The RR-VFA method computes B1 maps using conventional VFA images without additional scanning. Experiments were performed on 3.0T Siemens MRI systems in a total of 11 prostate cancer patients and one healthy volunteer. We used 4 flip angles (2°, 5°, 10°, and 15°) for VFA imaging and compared T1 maps with and without compensating for B1 variation. Quantitative DCE-MRI analysis was performed on OsirIX using our previously developed DCE-MRI plug-in.

RESULTS
In 12 subjects, the average T1 in the prostate was 1985.8 ± 363.8 ms without B1 correction and 1557.6 ± 110.3 ms with B1 correction. The uncorrected T1 values are overestimations of the prostate T1 and vary with different subjects and MRI systems, while the corrected T1 values are consistently in a good agreement with previous observations from the literature. Figure 1 shows a representative example of the overestimation of the prostate T1 without B1 correction. The average B1 variation in the prostate was 123%. Without B1 correction, the T1 overestimations can cause underestimations of contrast agent concentration resulted in a T1 map that was unsuccessful in depicting the prostate cancer (see the arrows), while the B1-corrected T1 map with B1 correction nicely depicts two cancer regions (see the arrows). Gleason scores are 3+3 (Region 1) and 3+4 (Region 2) based on the whole mount pathology.

CONCLUSION
We have demonstrated that B1 compensation using a novel RR-VFA technique can improve the accuracy of quantitative DCE-MRI analysis of prostate cancer at 3T.

CLINICAL RELEVANCE/APPLICATION
Quantitative DCE-MRI with B1 correction at 3T can improve detection and characterization of prostate cancer.

SSC14-02 ● MR-compatibility of Stents: Measuring RF Induced Heating and MR-artifact according to ASTM Standard F2182-11a and F2119-07
Felix V Guettler (Presenter) ; Andreas Heinrich ; Ina Kaufhold; Florian Schlesies; Maximilian De Bucourt MD ; Ulf K Teichgraeber MD

CONCLUSION
Up to date MR-based in-stent lumen measurement is limited to a small number of systems and field-strength of 1.5 T. It does not allow accurate measures. According to ASTM RF-induced heating, depending on the antenna effect, is within acceptable ranges for the measured stent lengths.

Background
The background of this study is to measure radio frequency (RF) induced heating and artifact in MR-images at 1.5T and 3T for commonly used stents in angiography according to standardized test methods of ASTM. Furthermore the MRI-based measurability of the in-stent lumen was assessed.

Evaluation
Currently nine stents (IDEV Supera 8x100mm, Cook Medical Zilver PTX 7x80mm, Gore Tigris 6x30mm, 6x40mm, 7x30mm, 7x100mm, TERUMO Misago 8x60mm, 8x80mm, 8x100mm) were compared on a 1.5T and 3T MRI (Magnetom Avanto and Trio, Siemens, Erlangen, Germany). The signal loss was measured according to ASTM F2119 for a TSE (TR/TE 500/26ms) and Flash (TR/TE 100/15ms) sequence. The artifact border is defined as grey value shift if a pixel differs more than 30% of the reference value (solvent) to the next pixel. The visualization of in-stent lumen (inside-diameter) was determined the same way. The stents were placed parallel and antiparallel to the static magnetic field (B0). The largest external diameters and in-stent lumen were measured at five points. For safety aspects the RF induced heating was measured according to ASTM F2182 with a TrueFISP (TR/TE 3.04/1.52ms, scan time 15min).

Discussion
With none or very limited MR-arts MR-based in-stent lumen measurement might become feasible for a broad spectrum of clinically used MR sequences. Compared to other MR-compatible implants or instruments made from NiTi-based alloys modern stent systems show potential for further improvement.

SSC14-03 ● Reduction of Susceptibility Artifacts in R2' Measurements Using Z-shimming Based Multi-echo Asymmetric Spin-Echo (Z-MASE) Sequence at High Fields
Xiaoming Zhang PhD (Presenter) ; Yuai Hua PhD ; Hongtu Zhu PhD ; Yasheng Chen PhD ; Jue Zhang ; Xiaoying Wang MD ; Weili Lin PhD ; Hongyu An DSc

PURPOSE
In this study, we proposed a rapid method, dubbed as Z-shimming based Multi-echo Asymmetric Spin-Echo (Z-MASE), to estimate and correct the B1 effects for an accurate estimation of R2'.

METHOD AND MATERIALS
In this method, three Z-shimming tables were applied sequentially prior to echo 1, 2 and 3 of a triple-echo ASE EPI sequence, respectively [1]. And the Z-shimming tables were only applied once for a specific 180° pulse offset t. Then a sinc function is usually assumed to characterize signal loss induced by [2]. Finally, an estimate of R2' was obtained without the effects of macroscopic field variation [3]. A small testing tube containing contrast agent was attached to a large phantom to induce B1 effect. Our approach can also be adapted as a rapid (24 sec) standalone B1 mapping method if B1 maps are needed for other DTI or MR studies.

REFERENCE

CLINICAL RELEVANCE/APPLICATION
The ability to simultaneous measurements of R2' and reduction of susceptibility artifacts may have the profound clinical application for studies of disordered brain oxygen metabolism.
June-Goo Lee PhD (Presenter); Bruce R Whiting PhD; Chan Hong Moon PhD; H. Michael Gach PhD; Jin Hong Wang MD; Kyongtae T Bae MD, PhD *

**PURPOSE**

To develop a multi-atlas method for deriving pseudo CT (pCT) from MR images independent of MR sequences and to evaluate the compatibility of pCT images against the reference CT (rCT) images

**METHOD AND MATERIALS**

We retrieved head CT images from 20 patients and used them as CT atlases. Ten of these patients also had matching MR images of the head at 4 different MR sequences: fluid attenuated inversion recovery (FLAIR), magnetization-prepared rapid acquisition with gradient echo (MPRAGE), T1 weighted (T1), and T2 weighted (T2). The MR-CT pairs were aligned using a rigid and non-rigid registration scheme. The realigned CT images were saved as the rCT images.

The CT atlases were registered to each test MR image. The registration scheme was in two steps, initial alignment with affine transform and refinement with B-spline non-rigid transform. The registered atlases were sorted on the basis of the Hessian analysis on MR and atlas images. After selecting the registered atlases showing more than 80% of maximum Hessian response score, the median based merging process was applied to derive pCT for each test MR image. For evaluation, pCT and rCT images were converted to attenuation value and radon transformed to generate sinograms. In these sinograms, the sinogram value was exponentiated for a correction value. The mean and standard deviation of the ratio of the correction values of pCT and rCT were calculated.

**RESULTS**

pCT images were successfully generated from all test MR images at different MR sequences. The mean of the ratio of correction values of pCT and rCT was close to 1 and standard deviation was small (mean, std.): (0.993±0.012, 0.062±0.016) for 10 FLAIR MRI; (0.999±0.010, 0.054±0.014) for 6 MPRAGE MRI; (0.991±0.015, 0.046±0.009) for 6 T1 MRI; and (0.987±0.012, 0.053±0.013) for 8 T2 MRI.

**CONCLUSION**

We have developed a multi-atlas method to derive pCT images from MR images independent of MR sequences. The pCT images of the head were in good agreement with the real CT images.

**CLINICAL RELEVANCE/APPLICATION**

A robust method for deriving CT equivalent information from MRI is needed for attenuation correction in PET/MRI applications.

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Rajakumar Nagarajan PhD (Presenter); Daniel J Margolis MD *; Steven S Raman MD; Manoj K Sarma PhD; Robert E Reiter MD; Michael A Thomas PhD

**PURPOSE**

Magnetic resonance spectroscopy (MRS) enables recording major prostatic metabolites, such as citrate (Cit), creatine (Cr) and choline (Ch), and it has been shown to significantly improve detection of tumors in the peripheral zone, primarily by improving specificity. The external coil assembly is favored because of no image deformation and less inconvenience compared to an endorectal coil. The endorectal coil is not recommended very soon after radiation therapy, is not feasible after rectum resection. The major goal of the study is to compare the performance of 3T endorectal coil with that using an external receive body array coil.

**METHOD AND MATERIALS**

Twenty patients (mean age 63.1yo) with prostate cancer (PCa) who underwent endorectal MR imaging and proton MR spectroscopic imaging were included in this study in 3T MRI. After the endorectal scan, patients were scanned with the external body array coil for the comparison study. MRSI parameters of endorectal and external body coil were as follows: TR 750ms, TE 145ms, acquisition bandwidth 1250 Hz, 6 averages, and 512 spectral data points with the voxel resolution of 0.3ml. For the external body array, the voxel resolution was 0.35ml.

**RESULTS**

Peak areas for Ch, Cr, and Cit were calculated by using numeric integration. Metabolic maps of (Ch + Cr)/Cit were generated. Voxels were considered suitable if they consisted of at least 75% peripheral zone tissue, did not include periurethral tissue. Both endorectal coil and external body array metabolites ratio were significantly higher in cancer locations compared to non-cancer locations. Also the coefficient of variance was higher in external body array than the endorectal coil due to larger size of the coil and increased distance from the prostate. The sensitivity and accuracy of endorectal coil is higher than (82% and 79%) the external body array (70% and 75%).

**CONCLUSION**

These preliminary findings confirmed that the use of endorectal coil significantly improves spectral line width and coefficient of variance of metabolite ratios when compared with external body array.

**CLINICAL RELEVANCE/APPLICATION**

In patients with rectal diseases or patients who could not tolerate the discomfort with insertion of an endorectal surface coil, use of the phased array coil may be recommended.

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Ryohei Nakayama PhD (Presenter); Masaki Ishida MD, PhD; Motonori Nagata MD, PhD; Tatsuro Ito MD; Kakuya Kitagawa MD, PhD; Hajime Sakuma MD *; Mio Uno MD; Yoshitaka Goto MD

**PURPOSE**

Coronary MRA permits noninvasive assessment of coronary artery stenoses without radiation exposure. However, several technological considerations restrict image resolution of coronary MRA. Conventionally, resolution of MRA is usually enhanced using bicubic interpolation (BCI). Recently, Super-Resolution (SR) technique has been proposed to increase MR image resolution. The purpose of this study was to investigate the value of high resolution reconstruction of coronary MRA using SR technique.

**METHOD AND MATERIALS**

Whole-heart coronary MRA was acquired with 32-channel cardiac coils in 35 patients at 1.5T (n=16) and 3.0T (n=19). Images with 256x256 matrices were generated as original images by down-sampling the source 512x512 images reconstructed by MR imager. The resolution of original images was restored to 512x512 matrices by using SR technique or BCI. With SR approach, the original images were further downsampled to 128x128 matrices (LR: low-resolution images). Each original and LR image was represented as a set of overlapping patches with the same number using 14x14 matrices for original and 7x7 matrices for LR images. Training dictionaries, which include the relation information in each corresponding pair of patches, were constructed using 5 slices including the target slice in the middle. Using 256x256 original image as a input, high-resolution image was generated by employing 7 pairs of patches that were the nearest neighbors in the feature vector space from training dictionaries. The source 512x512 images were used as gold standard to determine the fidelity of 512x512 images generated by SR approach in comparison with that by BCI.

**RESULTS**

With BCI, root mean square error, signal to noise ratio, and structural similarity index for 1.5T MRA were 3.12, 20.0dB, and 0.983, whereas those for 3.0T MRA were 3.05, 20.4dB, and 0.985. With SR approach, those for 1.5T MRA were 2.55, 21.9dB, and 0.988, whereas those for 3.0T MRA were 2.50, 22.4dB, and 0.990. The each result was significantly improved (p < .001) by SR technique as compared with BCI.
CONCLUSION
The high resolution reconstruction with SR technique developed in this study achieved highly improved image quality of coronary MRA at both 1.5T and 3.0T.

CLINICAL RELEVANCE/APPLICATION
The high resolution reconstruction generated by our SR technique may be useful for identifying coronary artery stenoses on whole-heart coronary MRA and for reducing the interpretation time.

SSC14-07 • Self-consistent Flip Angle Mapping Using Multi-spectral Synthetic MRI
Hernan Jara PhD (Presenter) *; Stephan W Anderson MD; Jorge A Soto MD *; Osamu Sakai MD, PhD *

CONCLUSION
A self-consistent FA mapping technique has been developed that is based on image processing only. It could be useful for increasing qMRI accuracy, streamlining MRI examinations, and improving image quality at ultrahigh field strengths. 1. Wade T, McKenzie CA, Rutt BK. Flip angle mapping with the accelerated 3D look-locker sequence. Magnetic Resonance in Medicine 2013.

BACKGROUND
Quantitative MRI (qMRI) accuracy can be degraded by deviations of the actual flip angles (FA) in the patient relative to the nominal-FA values of the pulse sequence. Several FA mapping techniques have been described in the literature (1): these involve a separate scan. We hypothesize that FA can be mapped as an application of multi-spectral Synthetic MRI without needing a separate scan. Because Synthetic-MRI allows for the generation of images of arbitrary contrast weighting, in particular the directly acquired (DA) images can be resynthesized and compared to the true DA reference images. If done systematically as a function of varying FA for every pixel, the actual FA will correspond to the minimum pixel value difference between the synthesized minus the true DA image.

EVALUATION
We used images of the head (1.5T Achieva, Philips Healthcare) with the mixed turbo spin echo sequence, which begins with an inversion pulse. The DA images were processed qMRI algorithms for generating maps of PD, T1, and T2. Our Synthetic MRI contrast navigation algorithm was modified for automated loop operation as a function of increasing inversion pulse FA from 0-180°. The synthesized pixel values were subtracted from the corresponding DA pixel value (Fig. 1, top row), and the FA that minimizes the absolute value of the difference was found. Performing this procedure on a pixel-by-pixel basis, lead to maps of the mixed-TSE actual inversion FA (Fig. 1, bottom row).

DISCUSSION
There is increasing need for using FA mapping for improving qMRI accuracy and for correcting B1 inhomogeneity artifacts. At the same time, because of growing financial pressures there is a need for shortening and streamlining MRI examinations. The FA mapping technique described herein could be instrumental in alleviating the above technical and financial needs.

SSC14-08 • Method of Characteristic Response Curves (CRC): An Accelerated Computational Method for Accurate Quantitative Magnetic Resonance Imaging (qMRI)
Jonathan E Scalera MD (Presenter); Stephan W Anderson MD; Osamu Sakai MD, PhD *; Hernan Jara PhD *

CONCLUSION
A twofold accelerated T1 qMRI processing algorithm based on the CRC method was developed and tested with a large imaging dataset. The methodology is very general and could be used for the computation of other qMRI parameters. CRC could be instrumental for incorporating computationally intensive qMRI algorithms into routine clinical practice.

BACKGROUND
Relaxometry is often performed with intricate qMRI pulse sequences, which can lead to complicated magnetization dynamics. In some cases the magnetization dynamics is such that the Bloch equations may not have closed-form analytical solutions, and consequently the resulting qMRI relaxometry algorithms may be solvable only by iterative numerical methods, which can be very slow. For multislice high spatial resolution applications this can lead to long computational times, which may be clinically impractical. The purpose of this work was to develop a faster qMRI processing algorithm methodology whereby the most time consuming operation is performed only once for generating the Characteristic Response Curve (CRC) of the qMRI pulse sequence and this CRC model is then used as the common solution applicable by interpolation to all pixels in the imaging dataset.

EVALUATION
The CRC method is very general and in principle applicable to any Bloch equation solution, nevertheless we describe here its application to T1 relaxometry with the mixed turbo spin echo (mixed-TSE) pulse sequence. A computer program was developed in MathCad (PTC, Needham, MA) and applied to MR images obtained with the mixed turbo echo pulse sequence using a 1.5T MRI scanner (Intera, Philips Healthcare, Cleveland, OH). The head scan of a research subject: 80 slices, 256x256 matrix, and voxel size 0.9375x0.9375x3mm³.

DISCUSSION
T1 maps generated with the exact pixel by pixel and the CRC algorithms are shown in Fig. 1 below. Both maps are visually indistinguishable. The processing times of the standard and CRC algorithms for all 80 slices were 86s and 43s, respectively. The accuracy of the CRC algorithm relative to the standard algorithm is compared in Fig. 2 in terms of whole brain histograms revealing the same overall bimodal shape with minor differences.

SSC14-09 • A Controllable and Stable Denoising Filter for Magnetic Resonance Imaging
Xin Zhou PhD (Presenter); Yanli Song; Miaofei Han; Qiang Li PhD *

CONCLUSION
The TWE is an excellent method to control the noise reduction levels in NLM filter.

BACKGROUND
Non-local means (NLM) filter is considered as one of state-of-the-art denoising methods. A big issue in NLM is that it is nearly impossible to automatically set its parameters for removing noise to a specific level, as the denoising level of NLM depends heavily on multiple parameters. We embedded a total-weight equalization technique in NLM filter (TWE-NLM) to adaptively control the denoising level by use of a single parameter of total weight. With this technique, we can automatically reduce noise standard deviation of the output image to any specific level of that of input noisy image.

EVALUATION
A total of 146 magnetic resonance (MR) scans in 12 major body parts were obtained from a 1.5T MR scanner with various imaging sequences. For each body part, 4 representative images were selected for objective and subjective evaluation of image quality in the study. Standard NLM was used as a baseline method for comparison with TWE-NLM. Three denoising levels of sharp, medium, and smooth that highlight, reduce, and remove noise respectively were tested. In TWE-NLM, the only adjustable parameter of total weight was automatically determined to be 1.5, 2.0, and 3.0 for the 3 denoising levels. For standard NLM, multiple parameters were manually adjusted by a physicist with a trial-and-error method in order to achieve the 3 denoising levels. Statistical analysis results show that the consistency and robustness of denoising levels achieved in TWE-NLM was markedly higher than that of NLM with manual parameter selection. A blinded subjective evaluation with more radiologists from multiple hospitals will be conducted in the coming months.

DISCUSSION
A key issue in denoising is the easy selection of parameters and the robustness of selected parameters. We embedded a TWE approach into NLM to automatically control the denoising level through a single parameter. In addition to its simplicity for parameter selection, the
**SSC15-01 • Assessing Response to Radiochemotherapy Treatment on 18F-FDG PET in Non-small Cell Lung Cancer Using Approaches of Histogram and Gray Level Co-occurrence Matrix**

Changsheng Ma MS (Presenter) ; Yong Yin

**ABSTRACT**

**Purpose:** The aim of this study was to propose and investigate gray level histogram and texture features information provided by 18F-FDG PET to assess patient's imaging response to radiochemotherapy in non-small cell lung cancer (NSCLC).

**Methods:** Twelve patients with newly diagnosed NSCLC treated with combined radiochemotherapy were involved in this study. Patients were categorized under three headings (non-responders, partial responders and complete responders) by experienced radiologists on the basis of RECIST according PET scans changes between pretreatment and 1 month after treatment. We analyzed the percentage variation of PET density using histogram analysis approach which characterizes global change of tumor region on PET. Texture parameters variation between pretreatment and 1 month after treatment completion which describe local voxel spatial distribution were extracted from Gray Level Co-occurrence Matrix (GLCM). Correlation between characteristics' variation and three type response status were analyzed.

**Results:** The uniformity of gray level histogram on the whole and the maximum percentage decrease in histogram was well associated with tumor shrinkage and response status. The above indices derived from histogram were capable to differentiate three groups tumor response to radiochemotherapy. Texture parameters variation (ASM, ENT and IDM) were able to differentiate the 3 response groups considering a high correlation with response status.

**Conclusion:** We demonstrated that histogram and texture analysis methods on baseline 18F-FDG PET scans provided robust, discriminative stratification in assessing response to combined radiochemotherapy and may have a good application prospect in clinical practice.

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**SSC15-02 • SPECT-based Functional Lung Imaging for the Prediction of Radiation Pneumonitis: A Clinical and Dosimetric Correlation**

Douglas Hoover (Presenter) ; Robert Reid ; Eugene Wong PhD ; Eric Sabondjian ; George Rodrigues ; Brain P Yaremko

**SSC15-03 • Pleural Invasion by Lung Cancer: Evaluation with 3 Dimensional CT**

Yoshiyuki Takahashi (Presenter) ; Shodayu Takashima ; Hodaka Numasaki PhD ; Daisuke Morimoto ; Binghu Jiang

**P Urpose:** We studied the value of computer-aided 3 dimensional (3D) CT for diagnosing pleural invasion by lung cancer.

**METHOD AND MATERIALS**

This series included 207 peripheral lung cancer of 3 cm or smaller in 205 consecutive patients (mean age, 67±9 years; 125 men and 86 women) who had contrast enhanced 16-slice MDCT with 1-mm collimation before surgery. All nodules were in contact with the pleura on CT images. Greatest transverse and vertical diameters of nodules, greatest contact length and contact areas between nodules and pleura, and incidence of pleural thickening, angle patterns (acute or obtuse) of nodules and pleura, and our originally classified 4 3D rendering patterns of the pleura (flat, skirt-like, rectangular solid, and waving) were compared between nodules with and without pleural invasion and statistically significant factors were assessed with stepwise logistic modeling to study the most significant factor for predicting pleural invasion and then its diagnostic statistics were calculated.

**RESULTS**

Pleural invasion was pathologically verified in 61 (29%) of 207 nodules. Greatest transverse diameters of nodules (p < 0.05) and statistically significant factors were assessed with stepwise logistic modeling to study the most significant factor for predicting pleural invasion and then its diagnostic statistics were calculated.

**CLINICAL RELEVANCE/APPLICATION**

3D rendering analysis of the pleura may provide useful information on staging of lung cancer and therefore may contribute to management of patients with peripheral lung cancer.

**SSC15-04 • Rate of 18FDG-PET Parameter Decline Early During Radiotherapy Predicts Clinical Outcomes in Locally-advanced Non-small Cell Lung Cancer (LA-NSCLC)**

Victor Mangona MD (Presenter) ; Larry L Kestin MD ; Dan Ionascu PhD ; Ovidiu Marina ; Bor-Tau Hung ; Mackenzie C McGee MD ; Ching-Yee O Wong MD, PhD ; Di Yan ; Inga Grills MD

**P Urpose:** To determine on-treatment (OT) 18FDG PET-CT parameters predictive of clinical outcomes for response-based adaptive radiotherapy (RT).

**METHOD AND MATERIALS**

16 consecutive patients from 2009-11 with node+ cstage IIIA (n=9) and IIIB (n=7) NSCLC received1.5Gy BID RT with concurrent chemotherapy on a prospective phase I/II protocol. RT dose was 60-72 Gy (n=12) (54 Gy if neoadjuvant, n=4) using IMRT with daily online CBCT. 4D dual-phase PET-CTs were obtained weekly during RT. Actual and %baseline max dimension (cm), bidimensional product (BDP, cm²), SUVmean, SUVmax, PET volume (vol), and total glycolytic activity (TGA=SUVmean x PETvol) were assessed. Rate of change of multiple metabolic parameters within the first 3 wks of treatment carry potential for predicting long-term outcomes after RT for NSCLC. In this sample, TGA was most predictive for LRR, DM, and DOD. During-treatment response-based adaptation of dose is worthy of investigation.

**RESULTS**

Overall and potential FU was 19.4m (30.4 in living pts) and 33m (25-42) , age 66y, dose 65Gy, max dim. 6.2 cm, vol 40cc, and 4 OT PETs per pt (66 total). At 2y, 7 of 16 had locoregional recurrence (tumor/LNs, LRR); 5 distant metastasis (DM); 8 death, and 5 death of disease (DOD). Time until LRR, DM, death, and DOD events were 10.8, 7.6, 11.4, and 11.8 mos, respectively. Despite higher baseline SUVmean (7.3 v 5.5) and SUVmax (13.8 v 10.2) (p < 0.05).

**CONCLUSION**

TWE method also achieved a higher uniformity in noise reduction inside an images and a higher consistency across different images.
Comparison of Auto-segmented PET Volumes in Lung Tumors with CT Based Manual Contours: Implications in Radiotherapy Planning

Madhava Kanakamedala MD (Presenter); Shankar P Giri MD; William N Duggar; Srinivasan Vijayakumar MD

ABSTRACT

Purpose/Objective(s): The aim of this study was to compare GTV volumes drawn manually on CT scans with GTV delineation on FDG PET scans utilizing an automatic threshold (SUVR 3) and gradient-based (PET Edge) auto-segmentation methods in lung tumors and discuss implications in radiation planning.

Materials/Methods: Nineteen patients with lung carcinoma treated with radiation therapy, whose PET scans were done within 30 days of simulation CT were enrolled. FDG-PET/CT and planning CT were transferred to the MIM software (MIM Vista Corp, Cleveland, OH) and fused using a deformable image registration algorithm. For each patient three GTVs were defined. GTV for CT was manually contoured on CT scans using lung window for lesions well within the lung parenchyma and a mediastinal window when it was adjacent to mediastinum or chest wall. For GTV SUV3, a circle of interest was created with a margin around the lesion, excluding blood pool (heart) and auto segmented with SUV window for lesions well within the lung parenchyma and a mediastinal window when it was adjacent to mediastinum or chest wall. For GTV PET-Edge, it was auto segmented using a PET Edge tool centered on the hyper metabolic area. Statistical Methods: Spearman correlation coefficients were constructed to view relationships between variables, and sign tests were used for inference.

Results: Among 19 patients 3 were small cell, 16 were non-small cell carcinomas (9 squamous cell and 6 adenocarcinoma). As per the AJCC 7th Ed, 7- they had 3 stage I, 8 stage II and 8 were stage IIIA. Only two patients had associated consolidation and atelectasis. Median GTV volume for all lesions was 18.96 (range 0.82-630.9), PET Edge median 8.9 (range 0.74-507.6), SUV3 median 26.93 (OS8-723.15). Correlation between CT and SUV 3, SUV 3 and PET edge, CT and PET Edge were 0.9474, 0.9526 and 0.9211 respectively. No significant differences between CT and SUV 3 volumes (p=0.648). But PET edge volumes were significantly less compared to CT volumes (p=0.032). On average PET edge volumes were 10.06 cc less than the CT volumes.

Conclusions: CT overestimates GTV volume in lung tumors with no additional or negative margins required to create CTV (Chan et al). Surgical pathologic studies determined CTV margins of 6mm for SCC and 8mm for ADC, beyond gross pathologic tumor. In phantom studies auto segmentation using PET edge tool was shown to be superior to other methods and better correlated with pathology. In our study the GTV based on CT and SUV 3 was similar while the GTV based on PET edge was consistently smaller. PET SUV 3 is valuable when contouring a GTV using PET/CT fusion as it could include tumor and microscopic extensions. The use of PET edge tool needs to be studied clinically to assess if the smaller volume maybe useful in small low risk tumors suitable for SBRT. Surgical pathological studies with larger number of patients are required to further confirm the CTV margins based on the GTV volumes generated on CT and PET auto segmented tools.

Evaluation of 4D CT Images in Defining Contours Using QUASUR Programmable Respiratory Motion Simulation Platform and Lung Phantom

Changsheng Ma MS (Presenter)

Purpose:
To analyze 4D CT images in defining contours of lung phantom using Programmable Respiratory Motion Simulation Platform.

Method and Materials:
Acquiring 4D CT images of the respiratory motion lung phantom using varian Real-time Position Management (PRM) system. The lung portion from the Computerized Imaging Reference Systems (CIRS) phantom (Computerized Imaging Reference Systems, Inc., Norfolk, VA), was scanned using a CT scanner (Philips Big core CT) to obtain a CT HU-density table as for baseline dose calculation and stability comparison. The Quality Assurance System for Advanced Radiotherapy (QUASARTM) supports the testing of a wide variety of dosimetric and nondosimetric functions of Radiation Therapy Planning Systems and CT Simulators using a set of innovative quality assurance tools. The phantom was performed followed by a 4D CT scan of simulating free breathing phantom on a 16-slice CT scanner (Philips Brilliance Bores CT). The Translation Stage amplitude is fixed at 40mm peak to peak for the moving chest wall platform. The Display shows the speed of motion in breaths per minute 20 BPM and seconds per breath 3 SPB.

Results:
Compared to the actual movement, lung density phantom geometry center displacement for X axis is 1mm, 2mm for Y axis and 1mm for Z axis in 4D CT reconstruction image.

Conclusion:
SCLC15-08 • Radiation-induced Fibrosis after Lung Stereotactic Body Radiation Therapy (SBRT) Is Correlated with Radiation Treatment Parameters: A Timeline of Computed Tomography (CT) Changes

Mary M Salvatore MD (Presenter) ; Miriam Knoll MD ; Ren-Dih Sheu PhD ; Sarah L Kerns PhD, MPH ; Abraham Knoll MD ; Yeh-Chi Lo PhD ; Kenneth E Rosenzweig MD *

PURPOSE

Patients treated with stereotactic body radiation therapy (SBRT) for lung cancer are followed by computed tomography (CT), and most patients are found to have evidence of radiation-induced fibrosis (RIF) surrounding the treated tumor. There is no consensus regarding the size and anatomic pattern of RIF and we investigated whether treatment isodose levels could predict RIF.

METHOD AND MATERIALS

We selected 37 lung lesions in 32 patients who were treated with SBRT and had received post-treatment follow up CTs (FU-CT). Each FU-CT was fused with the patient’s original simulation CT, and treatment isodose levels were overlaid onto the CT. The RIF surrounding the treated lesion was contoured. The fibrosis extension index (FEI) was defined as the total volume of RIF on FU-CT and was expressed as a percentage.

RESULTS

32 patients underwent SBRT to the planned target volume (PTV) to a total dose of 45-54 Gy in 3-5 fractions. The 1st, 2nd, and 3rd FU-CT were at a median of 6 (n=36), 10 (n=26), and 16.5 (n=6) months. The mean RIF volume at 1st, 2nd, and 3rd FU-CT was 69, 47, and 42 cc. Univariate analysis using Pearson’s correlation revealed that the PTV was positively correlated with RIF volume (correlation coefficient [CC]=0.629 and p<0.0001 at 1st FU; CC=0.401 and p=0.021 at 2nd FU; CC=0.265 and p=0.306 at 3rd FU). FEI40 Gy at 1st FU was significantly positively correlated with FEI40 Gy at subsequent FU-CTs (CC=0.689 and p<0.01 at 2nd and 3rd FU; 0.901 and p=0.020 comparing 2nd and 3rd FU). A similar trend was seen for FEI120 Gy, FEI130 Gy and FEI135 Gy, where the RIF volume positively correlated with 2nd and 2nd FU positively correlated with 3rd FU. 96% and 94% of the RIF was found within the 20 Gy isodose line at the 1st and 2nd FU, respectively. 65% of patients were found to have a decrease in RIF at 2nd FU.

CONCLUSION

We have shown that radiation-induced fibrosis evolves over time and 1st FU-CT correlates well with subsequent CTs. 96% of the RIF can be found to occur within the 20 Gy isodose line, which may prove beneficial to radiologists attempting to distinguish recurrence vs. RIF.

CLINICAL RELEVANCE/APPLICATION

Communication of treatment isodose information to radiologists may improve the accuracy of reporting CTs after SBRT, and may aid with distinguishing recurrence vs. RIF.

SCLC15-09 • Application of Bone Suppression Technique to Real-time Tracking Radiotherapy

Rie Tanaka PhD (Presenter) ; Shigeru Sanada PhD * ; Makoto Oda ; Mitsutaka Suzuki ; Keita Sakuta RT ; Hiroki Kawashima MS

PURPOSE

A recently developed image processing methodology, the bone suppression technique, can suppress the conspicuity of bones on chest radiographs, creating soft-tissue images obtained by the dual-energy subtraction technique. This study was performed to evaluate the usefulness of bone suppression fluoroscopy in real-time tracking radiotherapy.

METHOD AND MATERIALS

Dynamic chest radiographs of 9 patients with lung nodules during respiration were obtained using a flat panel detector (FPD) system (CXDI-50RF; Canon Inc.) (120 kV, 0.1 mAs/pulse, 5 fps, SID = 1.0 m). Commercial bone suppression image-processing software (SoftView version 2.0; Riverain Medical) was applied to the dynamic chest radiographs to create corresponding bone suppression images. A recently developed image processing methodology, the bone suppression technique, can suppress the conspicuity of bones on chest radiographs, creating sort of soft-tissue images obtained by the dual-energy subtraction technique. This study was performed to evaluate the usefulness of bone suppression fluoroscopy in real-time tracking radiotherapy.

RESULTS

The accuracy of target tracking was significantly improved in 8 of 9 cases. For better accuracy, the ROIs and search area were set to a larger size than for conventional images. The average maximum tracking errors in bone suppression and conventional fluoroscopic images were 1.3 ± 1.0 mm and 3.3 ± 3.3 mm, respectively. The bone suppression technique was especially effective in the lower lung area with complex movements of lung structures and ribs.

CONCLUSION

The bone suppression technique improves tracking accuracy without special equipment and additional patient dose in real-time tracking radiotherapy. The results indicated its usefulness especially in the lower lung area with complex movements of lung structures and ribs.

CLINICAL RELEVANCE/APPLICATION

Bone suppression fluoroscopy is a useful new technique for respiratory displacement of the target. Automatic target tracking can be conducted without rib shadows.
underlying the effects of embolization with a rat model of orthotopic hepatocellular carcinoma.

METHOD AND MATERIALS
All protocols were approved by the animal research committee of Fudan University and met NIH guidelines. In vitro study, the hepatoma cell line McA-RH7777 marked by GFP (Green Fluorescent Protein) were cultured under hypoxic and normoxic conditions. Forty male buffalo rats were implanted with McA-RH7777 tumor in the left lateral lobe of liver. After laparotomy and retrograde placement of catheter into the gastroduodenal artery (14 days after implantation), TAE used with lipiodol (0.2 ml/kg) were performed. Tumor volumes were measured before (on day 14) and after (on day 28) treatment with magnetic resonance imaging (MRI). Tumor growth and lung metastases were further observed using fluorescence imaging and the macroscopic characteristics were correlated with histological findings. The migration and invasion of HCC was observed by invasion assay in vitro. The molecular changes of hypoxia-inducible factor (HIF)-1?, VEGF, E-cadherin, N-cadherin, and vimentin in residual tumor cells were evaluated by western blot, PCR, or immunohistochemistry in vitro and in vivo respectively. The Mann-Whitney U-test or ?2 was used for statistical comparisons.

RESULTS
In vitro invasion assay indicated that the numbers of invading hypoxic McA-RH7777 cells were 30.8±4.74, which were significantly higher than normoxic cells (10.3±3.59, P < .05). Successful implantation was achieved in all rats, which was confirmed by MRI. The metastatic potential of tumor cells by hypoxia or interventional procedure was enhanced by significantly reducing the expression of E-cadherin and up-regulation of HIF-1?, VEGF, N-cadherin, and vimentin in vitro and in vivo. But the number of metastatic lung nodules were 11.3±4.26 in TAE group and 9.3±3.8 in control group, which showed no significant different ( P=.057).

CONCLUSION
Hypoxia always occurring residual tumor after the TAE can increase invasiveness and metastatic potential of HCC, and targeting to the molecular changes induced by hypoxia may augment the therapeutic effects of TAE.

CLINICAL RELEVANCE/APPLICATION
The study may help to design of mechanism-based combination therapies or new therapeutic regimes to improve the effect of TACE in the clinical treatment of HCC.

SSC16-02 • Bimodal Treatment of Aerobic and Glycolytic Metabolism by Particle Embolization Combined with Anti-glycolytic Compound Improves Treatment of N1-S1 Hepatocellular Mouse Model
John R Haaga MD (Presenter) ; Hanping Wu MD, PhD
PUPPOSE
To determine if combination treatment of aerobic metabolism by embolization and anti-glycolytic drugs compared to embolization alone provides better treatment of N1-S1 hepatocellular carcinoma in a rat model.

METHOD AND MATERIALS
Two separate laparotomies were performed, one for subcapsular tumor implant and the second for retrograde placement of catheter into the gastroduodenal artery for 5 different treatments. Treatments were: 1)Control (n=5, 1ml NS); 2) TAE (n=4, 10mg 50-150μm PVA particle in 1ml NS); 3) TAE+AG-B (n=5, 10mg PVA in 1ml AG-B); 4) TAE+AG-F (n=5, 10mg PVA+30mg AG-F in 1 ml NS); 5) TAE+AG-C (n=5, 10mg PVA+30mg AG-C in 1 ml normal saline). Tumor length (L), width (W), and height (H) was measured by 2D-ultrasound before treatment and twice a week till 4 weeks after treatment. Tumor volume (V) was calculated by the formula: V= 0.5*L*W*H. Relative tumor volume after treatment was calculated as the percentage of pre-treatment tumor volume. Kruskal-Wallis test was used to compare the difference of relative tumor volume between 5 groups on each observation time point.

RESULTS
The initial tumor sizes in each group were statistically not significantly different. Three animals in the control group were euthanized before the end of observation due to rapid tumor growth and anorexia. In TAE group, one kept growing after treatment. In other 3 TAE+AG groups, the tumor volumes decreased after treatment with significant differences between control group and 3 TAE+AG groups on all observation time point except TAE+AG-F group on 3.5 and 4 weeks. At 4 weeks after treatment, the median relative tumor volumes were 3.17±5.5% in control group, 58.2% in TAE group, 9.6% in TAE+AG-B group, 23.8% in TAE+AG-F group, and 13.4% in TAE+AG-C group.

CONCLUSION
Bimodal embolic treatment of hepatocellular cancer is more effective than embolic Rx alone. Further study of these propriety agents is warranted because agents target enzymes specific to cancer. Optimization of drug form, dose and route administration (IV, oral) are needed. Safety studies must be completed before human use.

CLINICAL RELEVANCE/APPLICATION
Clinical relevance is enormous. Agents should be effective against all cancers with little effect on normal tissues. Mode of delivery can be arterial, intravenous and/or oral. Challenge is funding.

SSC16-03 • Effects on Apoptosis in Rabbit Hepatic VX2 Carcinoma after Transcatheter Arterial Chemoembolization Using Alginate Microspheres-Adriamycin (ADM): Experimental Study
Kaiyuan Xu (Presenter)
PUPPOSE
To evaluate effects on the apoptosis of transcatheter arterial chemoembolization (TACE) with alginate microsphere-adriamycin in experimentally induced liver tumor.

METHOD AND MATERIALS
Thirty New Zealand White rabbits were randomly divided into five groups and VX2 carcinoma was grown in the left lobes of the livers. TACE was performed with normal saline(Group A), alginate microsphere(Group B), alginate microsphere-adriamycin(Group C), Lipiodol- adriamycin(Group D), and Lipiodol- adriamycin(ADM). Three weeks later, the animals were killed and apoptotic index were calculated on the basis of findings. Effects on intrahepatic and distal metastasis in all groups were examined.

RESULTS
CONCLUSION
Alginate microspheres can potentially serve as embolizing agents and drug delivery vehicles for local slow-release. With embolization and chemotherapy effect of doxorubicin,alginate microspheres induce and promote apoptosis of tumor cells, which reduce residual areas of tumor, the recurrence rate and metastasis rate.

CLINICAL RELEVANCE/APPLICATION
Chemoembolization with Alginate microsphere-ADM is an effective antitumor treatment of hepatic carcinoma.

SSC16-04 • Evaluation of a Combined Protocol of Sorafenib and Transarterial Chemoembolization (TACE) vs. TACE vs. Sorafenib Protocol Alone in Advanced Stage Hepatocellular Carcinoma (HCC): Retrospective Study at Three German Liver Centers
Thomas J Vogl MD, PhD (Presenter) ; Jorg Trojan MD ; Markus Goller ; Mark Op Den Winkel ; Eckart Schott ; Martin W Welker ; Stefan Zangos MD ; Wolf-Otto Bechstein ; Stefan Zeuzem MD ; Frank T Kolligs MD
PUPPOSE
To compare combined Sorafenib and transarterial chemoembolization (TACE), TACE alone and Sorafenib alone for treatment of patients
Hepatocellular Carcinoma

SSC16-07  •  Quantitative Measurement of the Hepatic Blood Flow before and after Transcatheter Arterial Chemoembolization of Hepatocellular Carcinoma

Yi-Yang Lin MD (Presenter); Rheun-Chuan Lee MD; Hsiao-Shan Tseng; Chien An Liu MD; Wan-Yuo Guo MD, PhD *; Cheng-Yen Chang MD

PURPOSE
To quantitatively measure the hemodynamic change of hepatic artery before and after transcatheter arterial chemoembolization (TACE) of hepatocellular carcinoma (HCC) by quantitative color-coding analysis (QCA).

METHOD AND MATERIALS
This prospective study was performed from December 2012 to February 2013. 64 patients (mean 67.5 year old; male 50, female 14) who were diagnosed with HCC and underwent TACE with doxorubicin and lipiodol emulsion or with microspheres were enrolled if superselective segmental TACE was technically feasible. The endpoint of TACE was sluggish of antegrade arterial flow. QCA (syngo iFlow; Siemens) was used to determine the maximal density time (Tmax) of selected intravascular region of interest (ROI). Relative Tmax (rTmax) was defined as the Tmax at the selected ROI minus the time of contrast medium spurt from the catheter tip. The catheter tip was placed in common hepatic artery, proper hepatic artery or lobar hepatic arteries before and after TACE with the same acquisition and injection protocols. The rTmax of treated and proximal hepatic arteries were analyzed before and after embolization.

RESULTS
The pre- and post-treatment rTmax of the landmarks at the treated segmental artery and proximal right hepatic artery were 1.84~2.08s, 2.7~3.59s (p < 0.001) and 1.4~1.64s, 1.55~1.89s (p < 0.001).

CONCLUSION
QCA is feasible to quantify embolization endpoint by comparing the rTmax in selected hepatic arteries before and after TACE. The rTmax of treated segmental artery was significant prolonged after optimized procedures.

CLINICAL RELEVANCE/APPLICATION
QCA is able to quantitatively determine the adequate embolization endpoint in HCC patients.

SSC16-06  •  Does Safety Margin Reduce Local Recurrence in C-arm CT-assisted Chemoembolization for Small Nodular Hepatocellular Carcinoma?

Hyo-Jin Kang (Presenter); Jin Wook Chung MD *; Hyo-Cheol Kim MD; Hwan Jun Jae MD; Saebeom Hur MD

PURPOSE
To test the hypothesis that safety margin may reduce local recurrence in superselective chemoembolization for small nodular hepatocellular carcinoma (HCC).

METHOD AND MATERIALS
To test the hypothesis, the consecutive patients who underwent both C-arm CT assisted superselective chemoembolization using an iodized oil for small nodular (1-3cm in size and 3 or less in number) HCC as the initial treatment and immediate thin-section iodized-oil CT were identified from the prospectively registered electronic database. From March 2009 to March 2011, 96 nodules in 80 patients (60 men, 20 women; mean age, 61.5 years) were included in this study. On immediate iodized-oil CT, we analyzed the presence or absence of defect in iodized-oil uptake in the tumor and completeness of safety margin in the surrounding liver parenchyma. Univariate and multivariate analyses were performed to determine prognostic factors for local recurrence. Potential determinant factors included Child-Pugh class, tumor size, tumor vascularity, definition of tumor boundary, tumor depth from surface to hilum, selectivity of chemoembolization, pattern of oily portogram, lipiodol uptake intensity, and lipiodol uptake homogeneity.

RESULTS
The median follow-up time was 26.4 months (range, 1-46.1 months). 37 nodules in 33 patients showed local recurrence. 1- and 2-year cumulative local recurrence rates were 61.9% and 81%, 9.3% and 20.2% for nodules with defect (n=21) and for nodules without defect (n=75), respectively (p=0.001). Among the 75 nodules without defect, 1- and 2-year cumulative local recurrence rates were 11.1% and 22.2%, 7.7% and 17.9% and for nodules with complete safety margin (n=36) and for nodules with incomplete safety margin (n=39), respectively (p=0.901). In multivariate analyses using Cox proportional hazard model, lipiodol uptake homogeneity (HR = 0.266; 95% CI: 0.11, 0.65; P < 0.05), lipiodol uptake defect (HR = 3.76; 95% CI: 1.53, 9.27; P < 0.05) remained significant in local recurrence.

CONCLUSION
In case of complete lipiodol uptake in the tumor, safety margin did not affect local recurrence rate in C-arm CT assisted chemoembolization for HCC.

CLINICAL RELEVANCE/APPLICATION
In case of complete lipiodol uptake in the tumor, additional effort to ensure complete safety margin as in RF ablation is not justified in superselective chemoembolization for small nodular HCC.

SSC16-07  •  Volumetric Tumor Assessment Predicts Survival in Patients Treated with Transarterial Chemoembolization for Hepatocellular Carcinoma

Vania Tacher MD (Presenter); Mingde Lin PhD *; Nikhil Bhagat MD; Constantine Frangakis; Hooman Yarmohammadi MD *; Rafael Duran MD; Michael Chao; Rongxin Chen; Zhijun Wang MD; Jean-Francois H Geschwind MD *

PURPOSE
Tumor response in patients with hepatocellular(HCC) treated by transarterial chemoembolization(TACE) can be measured quantitatively using 3D quantitative European Association for the Study of the Liver (qEASL) and volumetric Response Evaluation Criteria in Solid Tumor
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Moderator
Nicolas Grenier, MD

Comparison of Nine Prognostic Staging Systems

SSC16-09 •

Nicolas Grenier

RESULTS

Among 9 prognostic staging systems, CLIP may be the most important prognostic system for estimating the prognosis of patients with HCC treated with HACE. CLIP was the most informative prognostic staging system for estimating the long term survival of patients with HCC treated with HACE.

CONCLUSION

The mean survival period was 33 months. In a multivariate analysis, tumor number (>=4), tumor diameter(>=3cm), vascular invasion (+), ascites (+), albumin(−), age and sex were statistically significant factors for estimating the prognosis of patients with HCC treated with HACE.

CLINICAL RELEVANCE/APPLICATION

3D tumor enhancement assessment model can be used to assess target tumor response and overall tumor response and can predict survival in HCC patients after the first TACE session.
Whole body diffusion Weighted Imaging in Hepatologic Malignancies
Alain Luciani MD, PhD (Presenter) * ; Emmanuel Itti MD ; Alain Rahmouni MD

Whole body diffusion Weighted Imaging in Hepatologic Malignancies
Alain Luciani1,2, Emmanuel Itti3,2, Alain Rahmouni1,2
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Imaging biomarkers are important tools for the detection and characterization of cancers as well as for monitoring the response to therapy. Whole-body molecular imaging, in particular using 18F-fluorodeoxyglucose (FDG) positron emission tomography (PET), has been proven useful in the evaluation and management of lymphoma patients. FDG-PET has evolved as a valuable biomarker in aggressive lymphomas, which is the current state-of-the-art technique for response assessment at the end of treatment. Whole-body magnetic resonance imaging (MRI) providing high-resolution anatomical information with multicompartment surface coils mounted on a movable table and parallel imaging technique has been feasible in clinical routine in the recent five years. Functional MRI probing tumor neoangiogenesis and cell density diffusion-weighted MR imaging (DWI) have been recently used on a whole body scale. Parameters derived from DWI namely the apparent diffusion coefficient (ADC) are able to capture non-invasive, does not require any exogenous contrast agents, does not use ionizing radiation yet is quantitative and can be obtained relatively rapidly, and is easily incorporated into routine patient evaluations. Hence, like PET, DWI provides both qualitative and quantitative information. For lymphomas, where disseminated disease with both nodal and/or extranodal involvement is common, technical development and optimization of whole-body DWI could potentially add complementary information to current state-of-the-art imaging techniques and prove to be helpful in patient management.

The aim of this lecture will be to review technical requirements of whole body MR imaging, as well as on-going and future hepatologic malignancies applications.

Discussion:

1. WB-MRI can allow combination of morphologic and functional data on a whole body scale.
2. Further optimization of MR instrumentation, standardization of MR protocols are mandatory.
3. Large-scaled prospective studies are needed before this new potential imaging-based biomarker can be validated. References:
There are various treatments for liver metastases from primary colorectal cancer including surgical resection, non surgical ablative treatments, and chemotherapy. Yet, surgical resection with perioperative chemotherapy has been shown to be the best treatment option for cure in these patients. Therefore the role of the Radiologist in the Multidisciplinary Team is key and can be split in four topics: 1) diagnosis of liver lesions as metastases, 2) extrhepatic staging including nodal metastases, peritoneal implants, regional or local recurrent or residual disease, and pulmonary metastases, 3) intrahepatic staging which aims to define number and extent of liver metastases in the segmental and lobar distribution in order to evaluate surgical resectability or feasibility of non surgical ablative treatments, 4) and eventually response to chemotherapy with or without targeted therapy. Multimodal imaging is needed to answer all these questions. The most important imaging modalities are CT, MR imaging and PET. Multidetector CT is particularly helpful for whole body investigation and anatomic information for surgical planning. MR imaging is better than CT for lesion detection and lesion characterization in the liver in particular with diffusion-weighted images and sequences using liver-specific agents. Pretherapeutic and intraoperative contrast-enhanced ultrasound may complete the work-up.

**SSE01-01 • Lesion Characteristics, Malignancy Rate, and Follow-up of BI-RADS 3 Lesions Identified on Breast MRI: Implications for MRI Interpretation and Management**

Sona A Chikarmane MD (Presenter) ; Catherine S Giess MD ; Patricia S Poole MD ; Dorothy A Sippo MD ; Robyn L Birdwell MD

**PURPOSE**
To 1) evaluate the incidence of BI-RADS 3 assessment in screening and diagnostic breast MRI; 2) review types of findings considered BI-RADS 3; and 3) determine outcomes of BI-RADS 3 studies, including BI-RADS upgrades, downgrades and biopsy results.

**METHOD AND MATERIALS**
IRB approved, retrospective review of breast MRI database (2009-2011) with 5778 studies in 3360 patients, was performed to identify all breast MRIs assigned BI-RADS 3 for one or both breasts. 679/5778 (11.8%) studies had at least one BI-RADS 3 finding. Cases in which initial BI-RADS 3 assessment was given prior to 2009 were excluded. Breast MRI reports and electronic medical record were reviewed to obtain patient demographics and outcome data including tissue diagnosis, imaging and/or clinical stability for at least 24 months, or decrease/resolution during imaging surveillance.

**RESULTS**
570 findings (483 studies) were assigned initial BI-RADS 3 assessment during study period. Indications (n=483) included 257 (53%) high risk screening and 226 (47%) diagnostic studies. BI-RADS 3 lesions (n=570) included mass (171, 30%), focus (141, 24.7%), moderate/marked background parenchymal enhancement [BPE] (131, 23%), NMLE (96, 16.8%), post-treatment changes (18, 3%), and other (13, 2.5%). Outcomes data was available in 508/570 (89%) lesions, including 408 (72%) without imaging evidence of malignancy > 24 months, 29 (5%) prophylactic mastectomy (all benign), and 71 (12%) upgraded to BI-RADS 4, with 11 cancers. Cancer rate for BI-RADS 3 lesions was 2.1% (11/508); all invasive cancers were diagnosed in < 12 months of surveillance and in women with genetic mutation or personal history of breast cancer. Cancer morphology (n=11) included mass (3, 27%), focus (4, 36.5%), and ductal or linear NMLE (4, 36.5%). No cancer was detected in cases of moderate/marked BPE.

**CONCLUSION**
Approximately 12% of breast MRI studies had findings assessed as BI-RADS 3, with a 97.9% negative predictive value for cancer. Although it may interfere with cancer detection, marked diffuse background enhancement does not require a BI-RADS 3 assessment.

**CLINICAL RELEVANCE/APPLICATION**
In a population with an elevated breast cancer risk, breast MRIs assigned BI-RADS 3 assessment had an acceptably low cancer rate which may be further reduced by careful adherence to BI-RADS lexicon.

**SSE01-02 • Probably Benign Lesions Detected at Dynamic Contrast Enhanced Breast MRI: Prevalence of BIRADS III Diagnoses and Malignancy Rate**

Yunus Alparslan (Presenter) ; Simone Schrading MD ; Christiane K Kuhl MD *

**PURPOSE**
Aim of this study was to analyze the malignancy rate of MRI-BIRADS III lesions.

**METHOD AND MATERIALS**
Between 06-2010 and 12-2011 a total of 3154 breast MRI studies were performed at our institution. Among those 107 MRI studies in 107 patients (3.4%) were rated as MRI-BIRADS III and were further analyzed. The time interval between the initial MRI and the follow-up examination, BIRADS category in the follow-up study and histologic results of possible biopsies were recorded to calculate the malignancy rate of MRI-BIRADS 3 lesions.

**RESULTS**
Follow up MRI was performed in 87% (93/107) of the 107 patients after a mean time interval of 10 month (median 9.6, range [4;25]). At this follow up exams MR-BIRADS 3 lesions were stable or regressive and downgraded to BIRADS 1/2 in 96% (89/93). MR-guided biopsy was performed by patients request in 7 of these stable lesions. All of these yielded benign changes at histology, including 2 papillomas. Four MR-BIRADS III lesions were progressive (4%) and upgraded to MR-BIRADS IV in the follow up exam. All of those underwent MR-guided vacuum biopsy. Histology revealed an invasive lobular carcinoma (pT1b, 0.7 cm, pN0 (0/2sn), G2) in one, borderline lesions in two patients (atypical ductal hyperplasia and papilloma) and benign changes in one patient (adenosis). Accordingly the malignancy rate of MR-BIRADS III lesions was 1.1% (1/93).

**CONCLUSION**
Therefore the role of the Radiologist in the Multidisciplinary Team is key and can be split in four topics: 1) diagnosis of liver lesions as metastases, 2) extrhepatic staging including nodal metastases, peritoneal implants, regional or local recurrent or residual disease, and pulmonary metastases, 3) intrahepatic staging which aims to define number and extent of liver metastases in the segmental and lobar distribution in order to evaluate surgical resectability or feasibility of non surgical ablative treatments, 4) and eventually response to chemotherapy with or without targeted therapy. Multimodal imaging is needed to answer all these questions. The most important imaging modalities are CT, MR imaging and PET. Multidetector CT is particularly helpful for whole body investigation and anatomic information for surgical planning. MR imaging is better than CT for lesion detection and lesion characterization in the liver in particular with diffusion-weighted images and sequences using liver-specific agents. Pretherapeutic and intraoperative contrast-enhanced ultrasound may complete the work-up.
CLINICAL RELEVANCE/APPLICATION
The malignancy rate of MR-BIRADS III lesions is low. To avoid early invasive tissue sampling, the observation with short-term MR-follow up is a valid approach in the management of these lesions.

SSE01-03 • Can Breast Cancer Molecular Subtype Help Select Patients for Preoperative MRI?
Lars J Grimm MD (Presenter) *; Mary Scott Soo MD; Jay A Baker MD *; Karen S Johnson MD *

PURPOSE
To determine whether breast cancer molecular subtype can help predict which patients will benefit from preoperative breast MRI.

METHOD AND MATERIALS
305 consecutive preoperative breast MRIs were retrospectively reviewed. Patients with prior breast cancer therapy or surgery were excluded. The presence of multicentric/multifocal disease, contralateral disease, skin/nipple involvement, chest wall/pectoral muscle invasion, and lymph node involvement was correlated with the pathology report. Estrogen receptor (ER), progesterone receptor (PR), and human epidermal growth factor receptor-2 (HER2) status were recorded from the pathology report. Molecular subtypes were defined as luminal A (ER+ and/or PR+, HER2-), luminal B (ER+ and/or PR+, HER2+), HER2 (ER- and PR-, HER2+), and basal (ER-, PR-, and HER2-). MR findings that could potentially alter clinical management were correlated with molecular subtypes.

RESULTS
The 305 cases were classified as 202 (66.2%) luminal A, 33 (10.8%) luminal B, 17 (5.6%) HER2, and 53 (17.4%) basal subtype. Multicentric/multifocal disease was significantly more common (p = 0.015) detected by MRI in luminal B (16/33, 48.5%) and HER2 (10/17, 58.8%) subtypes, compared to luminal A (62/202, 30.7%) or basal (13/53, 24.5%) subtypes. Compared to luminal A subtype, preoperative MRI was 2.1 (p = 0.049, 95% confidence interval [95% CI], 1.0-4.5) and 3.2 times (p = 0.022, 95% CI, 1.2-9.3) more likely to detect multicentric/multifocal disease in luminal B and HER2 subtypes respectively. Although there was no significant difference (p = 0.167) between lymph node involvement among all groups, luminal B (14/33, 42.4%) subtype was 2.4 times (p = 0.026, 95% CI, 1.1-5.2) more likely to have lymph node involvement than luminal A (47/202, 23.3%) subtype. There was no significant difference in contralateral disease, skin/nipple involvement, or chest wall/pectoral muscle invasion between subtypes.

CONCLUSION
Preoperative breast MRI is significantly more likely to detect multicentric/multifocal disease in luminal B and HER2 molecular subtype breast cancer, while lymph node involvement is more commonly detected in luminal B than luminal A molecular subtype breast cancer.

CLINICAL RELEVANCE/APPLICATION
Breast cancer molecular subtypes could help tailor utilization of pre-operative breast MRI.

SSE01-04 • Does Breast Biopsy Affect Lesion Enhancement Characteristics or Accuracy of Tumor Measurement on MRI?
Nikki Tirada MD (Presenter); Anjeza Chukus MD; Stuart S Kaplan MD *

PURPOSE
The objective of this study is to determine the effect ultrasound, stereotactic, and MRI-guided biopsy may have on lesion morphology, size measurement, and qualitative and quantitative dynamic kinetic features. It is our hypothesis that inflammatory changes and possible tumor burden reduction related to biopsy will alter tumor appearance on MRI. Discordance in imaging characteristics can lead to inaccuracy of size measurement and tumor extension, which could have significant impact on surgical and treatment planning.

METHOD AND MATERIALS
A retrospective review of patients who had contrast-enhanced Breast MRI performed either before or after biopsy of a suspicious lesion between January 2010 and January 2013 were included in the study. Patients who had neo-adjuvant chemotherapy prior to MRI were excluded. Imaging characteristics evaluated include time-signal intensity curve and changes in degree of enhancement were evaluated. In patients who also underwent surgical excision, the size of tumors measured on MRI was compared with pathology measurement. Using a paired Student’s t test, differences were considered significant where P < 0.05. Approval for this study was obtained from Mount Sinai Medical Center Institutional Review Board.

RESULTS
To date, we have identified 36 eligible patients. The mean age was 58.2 years. 8 of 36 lesions (22%) demonstrate changes in enhancement pattern after biopsy: 3 lesions (8.3%) with homogenous washout kinetics became heterogenous, 3 lesions (8.3%) with homogenous washout became persistent, 1 lesion (2.8%) with progressive curve became plateau, and 1 lesion (2.8%) with plateau became indeterminate (hematoma cavity). There was no significant difference between radiologic and pathologic size of the tumor (2.47 vs 2.31; P = 0.69).

CONCLUSION
Breast biopsy leads to changes in enhancement pattern but does not significantly impact the accuracy of diagnosis or tumor size measurement.

CLINICAL RELEVANCE/APPLICATION
Breast MRI is frequently performed after the diagnosis of breast cancer has been established. Therefore, it is important to assess any potential effect prior biopsy may have on imaging characteristics.

SSE01-05 • Breast MRI Background Parenchymal Enhancement and Tumor Characteristics
Janice S Sung MD (Presenter); Jennifer Brooks PhD; Valencia King MD; Jennifer B Kaplan MD; Eve Burstein; Mark E Robson MD *; Jonine L Bernstein; Malcolm Pike; Elizabeth A Morris MD *

PURPOSE
To examine the relationship between fibroglandular tissue (FGT) and background parenchymal enhancement (BPE) on MRI and histopathological and immunohistochemical features of breast cancers.

METHOD AND MATERIALS
IRB approved retrospective review identified 712 women diagnosed with unilateral invasive ductal breast carcinoma consecutively between February 2008 & February 2011 who had a pre-treatment MRI of the unaffected breast, were not taking hormonal medications, and did not have a history of breast cancer. Women with known menopausal status or with tumors with unknown receptor status or tumor grade were excluded (N = 51). Clinicopathologic data was obtained from the electronic medical records. Two breast imaging radiologists blinded to clinical data independently assessed BPE and FGT using BI-RADS criteria. Odds ratios (OR) and 95% confidence intervals (CI) were generated using logistic regression models adjusting for age, menopausal status and body mass index.

RESULTS
Of 661 tumors, 522 (79%) were estrogen receptor positive (ER+), 491 (74%) progesterone receptor positive (PR+) and 117 (18%) human epidermal growth factor receptor positive (HER2+). Women with dense breasts heterogeneously/extremely dense were more likely to have ER+ (OR = 1.9, 95% CI 1.0, 2.5; p = 0.05) or PR+ tumors (OR = 1.7, (1.1, 2.7); p = 0.01) compared to women with less dense breasts (predominantly fatty/scattered fibroglandular densities). Women with dense breasts were less likely to have triple negative breast cancer compared to luminal A (OR = 0.5, (0.3, 0.8); p = 0.008). No association between these factors and BPE was observed. Results did not differ when stratified by menopausal status.
CONCLUSION
FGT on MRI is associated with an increased likelihood of having ER+ and PR+ breast cancer, which is consistent with some studies that have shown a similar association between mammographic density and ER+ disease. No association between BPE and subtype was observed.

CLINICAL RELEVANCE/APPLICATION
FGT on MRI may be a much greater risk factor specific to ER/PR+ disease. Although BPE has been shown to be a breast cancer risk factor, this appears to be independent of subtype.

SSE01-06 • Prepectoral Edema as a Morphological Sign in MR-mammography

Clemens G Kaiser MD, BA (Presenter) ; Michael Herold ; Julia Krammer MD ; Matthias Dietzel MD ; Pascal A Baltzer MD ; Klaus Wasser MD ; Stefan O Schoeneng MD, PhD * ; Werner A Kaiser MD, PhD

PURPOSE
Morphological and kinetic signs of breast lesions contribute to diagnosis and differential diagnosis in MR-Mammography. Prepectoral edema in patients without any history of previous biopsy, operation, radiation or chemotherapy has been detected as a new diagnostic sign during clinical routine. The purpose of this study was to evaluate the role of this morphological sign in the differential diagnosis of breast lesions.

METHOD AND MATERIALS
Between 11/2001 and 10/2006 a total of 1109 MRM exams have been performed in our institution. Patients had no previous operation, biopsy, intervention, chemotherapy, hormone replacement therapy or previous mastitis. 162 patients with 180 lesions were included and histologically correlated by operation (124 patients / 136 lesions) or corebiopsy (38 patients / 44 lesions) in our hospital. The evaluations were performed by 4 experienced radiologists in consensus.

RESULTS
180 evaluated lesions included 104 malignant lesions (93 invasive; 11 non-invasive cancers) and 76 benign lesions. The prepectoral edema sign was seen in 2.6 % of benign lesions (2/76), none of the DCIS-cases (0/11) and 25.8 % of malignant lesions (24/93).

Prepectoral edema were found significantly more frequently in poorly-differentiated cancers (33.9 %; 19/56 vs. 13.9 % (5/36)) as well as in presence of lymphangiosis (53.8 %; 14/26 vs. (9.8 %; 4/41)), positive lymphnodes (44.4 %; 12/27 vs. (19.4 %; 12/62)), size of tumor above 2 cm (47.1 %; 16/34 vs. (13.8 %; 8/58)), pectoralis infiltration (80.0 %; 4/5 vs. (22.7 %; 20/88)), presence of a hook sign (60.9 %; 14/23 vs. 14.5 %; 10/69).

The prepectoral edema sign was not statistically associated to tumor-type, presence or absence of additional DCIS, receptor status, number of lesions, margin, form, enhancement pattern and curve-type.

CONCLUSION
The Prepectoral Edema Sign seems to be a highly reliable indicator for tumors with malignant prognosis.

CLINICAL RELEVANCE/APPLICATION
Peripectoral edema is a very powerful sign towards malignancy in the differential diagnosis of breast lesions in MR-Mammography.

RESULTS
The sensitivity for DM was 87% and those of DBT and MRI were equivalent to 93.75%. The specificity for DM was 50%, that of DBT was 68.18% and that of MRI was 71.43%, whereas the NPV of DM was 91.7% and that of each of DBT and MRI was 97.4%. The efficacy of DM was 60%, that of DBT was 86.7% and that of MRI was 88.3%. Association between DM, DBT and MRI finding results and the final diagnoses revealed highly significant correlation, having p-values of 0.009 for DM and 0.001 for each of DBT and MRI. Association between the results of DM and those of DBT showed that DBT had a statistically significant higher diagnostic value for diagnosing breast lesions than DM, having a p-value of 0.005. However, the association between the results of DM and those of MRI showed that there is no statistically significant difference between DM and MRI, with a p-value of 0.422. The association between the results of DBT and those of MRI showed that there is a statistically significant difference between DBT and MRI for diagnosing breast lesions, with a p-value of 0.043.

CONCLUSION
Both MRI and DBT showed better performance than did DM. Both can add a lot to the information gained for better diagnosis and prompt management of breast lesions.

CLINICAL RELEVANCE/APPLICATION
Both DBT and MRI are better than DM in detecting or excluding breast cancer, specially in cases with dense breasts.

SSE02-02 • Comparative Study with Digital Mammography (DM) vs. DM Combined with Digital Breast Tomosynthesis (DBT) for the Detection of Invasive Lobular Carcinoma (ILC)

Giovanna Mariscotti ; Manuela Durando (Presenter) ; Laura Martinich MD * ; Enrica Caramia ; Pier Paolo Campanino ; Andrea Luparia ; Laura Bergamasco ; Paolo Fonio ; Giovanni Gandini MD
Tomosynthesis in Breast Cancer Visualization as a Function of Mammographic Density

Pragya A Dang MD (Presenter); Kathryn L Humphrey MD; Phoebe E Freer MD; Elkan F Halpern PhD *; Mansi A Saksena MD; Elizabeth A Rafferty MD *

PURPOSE
To compare tomosynthesis to conventional mammography for detection and characterization of biopsy proven invasive cancers.

METHOD AND MATERIALS
In this IRB approved, HIPAA compliant study, 172 biopsy proven invasive breast cancers (142 Invasive ductal carcinoma-IDC, 25 Invasive lobular carcinoma-ILC, and 5 invasive mammary carcinoma; age range: 35-91 years), consecutively accrued prior to biopsy between 3/2011 and 10/2012 and imaged with combined tomosynthesis-mammography were retrospectively reviewed. The visibility (rated on 5-point scale) and morphology (shape and margins) of each cancer on 2 view tomosynthesis and 2 view mammography images were recorded.

RESULTS
The visibility scores for IDC with tomosynthesis and mammography were 3.4+/−1.1 and 2.6+/−1.2, respectively, and for ILC were 3.2+/−0.9 and 2.3+/−1.2, respectively; significantly higher for tomosynthesis compared to conventional mammography (p<0.0001) for all cancers. 16% (28/172) cancers (20% ILC and 16% IDC) were occult on mammography, whereas 3% (5/172) cancers were occult on tomosynthesis. Common presentations of cancers on tomosynthesis were irregular spiculated masses (61%, 105/172), architectural distortion (12%, 20/172), and lobulated circumscribed masses (8%, 13/172). Of the cancers presenting as architectural distortion on tomosynthesis, 50% (10/20) were occult on conventional mammography and 20% (4/20) were characterized as asymmetry or focal asymmetry on conventional mammography. Cancers presenting as architectural distortion on tomosynthesis had a disproportionately higher percentage of ILCs (20%). Of the irregular spiculated masses on tomosynthesis, 10% (11/105) were occult, 33% (35/105) characterized as asymmetries or focal asymmetries, and only 32% (34/105) definitively characterized as irregular spiculated masses on conventional mammograms. No invasive cancers were characterized as round or oval circumscribed masses on tomosynthesis. Of the cancers occult on tomosynthesis, 1(20%) was visible as an asymmetry on mammography.

CONCLUSION
Tomosynthesis was significantly better than conventional mammography in detecting cancers particularly those presenting as architectural distortion as well as characterizing cancer morphology.

CLINICAL RELEVANCE/APPLICATION
Identification of mammographically occult cancers and more accurate depiction of tumor morphology with tomosynthesis may allow formulation of a better assessment of the lesion on initial imaging.

Tomosynthesis in Breast Cancer Visualization as a Function of Mammographic Density

Reni S Butler MD (Presenter); Reynolds Ostrover; Regina J Hooley MD *; Jaime L Geisel MD; Madhavi Raghu MD *; Liane E Philpotts MD *

PURPOSE
To evaluate the effectiveness of digital breast tomosynthesis in the visualization of non-calcification breast cancers as a function of breast density

METHOD AND MATERIALS
Upon IRB approval, all cancers diagnosed from 10/3/2011 through 1/16/2013 were reviewed. Of these, 186 cancers in 159 patients were imaged with tomosynthesis in combination with 2D mammography. Cancers presenting with calcifications as the only mammographic finding were excluded, leaving a total of 155 cases. Images were evaluated by 7 breast radiologists and classified into five categories: Only Seen on Tomosynthesis, Better Seen on Tomosynthesis, Equally Well Seen on Both, Better Seen on 2D, and Only Seen on 2D. The breast density, type of mammographic finding, clinical presentation, and cancer histology were recorded.

RESULTS
Patients with scattered and heterogeneously dense breasts had the highest percentage of cancers seen only with tomosynthesis, with 15.4%(10/65) and 14.0%(6/43), respectively, compared to only 5.9%(1/17) of patients with extremely dense breasts and 0%(0/30) of patients with fatty breasts. The scattered and heterogeneously dense breast categories also had the highest percentage of cancers seen better on tomosynthesis with 52.3%(34/65) and 55.8%(24/43) respectively, while the fatty breast category had the lowest percentage (13.3%, 3/20). The extremely dense category had 35.3%(6/17) of cancers seen better with tomosynthesis. Finally, patients with fatty breasts and extremely dense breasts had the highest percentage of cancers seen equally well on tomosynthesis and 2D mammography, with 86.7%(26/30) and 58.8%(10/17), respectively, in contrast to 32.3%(21/65) and 30.2%(13/43), respectively, in the scattered and heterogeneously dense categories.

CONCLUSION
Tomosynthesis imaging is particularly beneficial for visualizing non-calcification breast cancers in patients with scattered and heterogeneously dense breasts, with 67.7%(44/65) and 69.8%(30/43), respectively, of cancers in these categories seen only or better with tomosynthesis. Patients with fatty and extremely dense breasts are more likely to have cancers seen equally well on tomosynthesis
Quantification of Stenotic Mitral Valve Area by Dual-source Computed Tomography in Patients with Atrial Fibrillation


Giovanna Mariscotti ; Manuela Durando (Presenter) ; Mirella Fasciano ; Giulia Schivazappa ; Davide Bosco ; Elisa Regini ; Chiara Ruggieri ; Paolo Fonio ; Giovanni Gandini MD

PURPOSE
To review our institutional experience in using DBT as SL in the evaluation of additional enhancing lesions identified on preoperative breast MRI.

METHOD AND MATERIALS
From June 2009 to January 2013, 520 patients with breast cancers detected on DM and ultrasound (US) and confirmed by cytology/histology underwent preoperative MRI. In 114 patients, MRI detected 164 additional lesions: all the patients underwent SL US who identified 114/164 (69.5%) MRI additional lesions. 50/164 (30.5%) lesions not seen on US underwent SL DM+DBT (the patients, who signed an informed consent, had mammographic two standard views in Combo mode (DM and DBT acquisition within a single compression) on the interested breast). Subsequently to SL DM+DBT, re-targeted US evaluation was performed. Focusing on SL DM+DBT, we compared morphological features, size and BI-RADS-MRI classification of additional MRI findings and DBT lesions features. Suspicous additional lesions were confirmed by percutaneous biopsy or surgical excision. Imaging follow-up (range 6-12 months) was used for probably benign lesions, not biopsied.

RESULTS
SL DM+DBT identified 32/50 (64%) of MRI additional lesions (mean size 10.2±6.2 mm), of which 28/50 (56%) were classified as BI-RADS-MR4 and 22/50 (44%) as MR3.

CONCLUSION
Second-look DM+DBT was helpful in the clinical work-up of additional lesions detected on preoperative breast MRI, particularly for non-mass-like enhancement.

CLINICAL RELEVANCE/APPLICATION
In our preliminary experience, the clinical work-up of the additional enhancing lesions detected on preoperative breast MRI was implemented by second-look with Digital Breast Tomosynthesis.

SSE02-06 • Digital Breast Tomosynthesis in Diagnostic Mammography: Can Tomo Affect the Final Assessment Categories?

Madhavi Raghu MD (Presenter) * ; Regina J Hooley MD * ; Liane E Philpotts MD * ; Jaime L Geisel MD ; Melissa A Durand MD ; Liva Andrejeva-Wright MD ; Laura J Horvath MD ; Reni S Butler MD

PURPOSE
To evaluate the rates of BI-RADS final assessment categories, in diagnostic patients undergoing tomosynthesis versus those undergoing 2D mammography with particular attention to BI-RAD3.

METHOD AND MATERIALS
A retrospective review of all diagnostic patients over two six month intervals before (Jan-June 2011) and after (Aug 2012-Jan 2013) the implementation of tomosynthesis was performed. The percentage of mammograms categorized as BI-RADS 1-5 was determined.

RESULTS
In the first interval, 2850 diagnostic mammograms were performed. Of these patients, 914 patients were categorized as BI-RADS 3 (32%), 1670 patients as BI-RADS 1 or 2 (59%), 179 patients as BI-RADS 4 (6.3%) and 24 patients categorized as BI-RADS 5 (0.8%). The 914 patients in the BI-RADS 3 category had 977 findings: asymmetries 363 (37%), calcifications 398 (40%), masses 201 (21%) and architectural distortion 15 (2%). In the second interval, 2761 diagnostic mammograms were performed, of which 2036 patients underwent tomosynthesis. Of these patients, 533 patients were categorized as BI-RADS 3 (27.6%), 1315 patients as BI-RADS 1 or 2 (64.6%), 133 patients as BI-RADS 4 (5.8%) and 35 patients as BI-RADS 5 (1.7%). The 563 BI-RADS 3 patients had 602 findings: asymmetries 186 (31%), calcifications 245 (41%), masses 158 (26%) and architectural distortion 14 (2%). The BI-RADS 3 rate decreased from 35% in the pre-tomo group to 27% in the post-tomo group (p<0.001).

CONCLUSION
The use of tomosynthesis in diagnostic patients resulted in a significant decrease in the rate of BI-RADS 3, particularly for masses and asymmetries with a concomitant significant increase in the rate of BI-RADS 1/2 and 5.

CLINICAL RELEVANCE/APPLICATION
Tomoosynthesis use in diagnostic mammography can reduce the number of patients categorized as BI-RADS 3 requiring follow up.
Severe Aortic Stenosis

Differences of Cardiac Function and Characteristics of Aortic Valve according to Myocardial Fibrosis in Patients with

METHOD AND MATERIALS

We retrospectively enrolled 102 patients (77 women, 52.4 ± 10.9 years old) with AF and MS who underwent ECG-gated DSCT, TTE, and CMR prior to operation. The MVA were determined planimetrically by DSCT, CMR, TTE as well as assessed by Doppler TTE using the pressure half-time method (TTE-PHT) and they were compared among each other using linear regression and Bland-Altman analyses. Grade of MS (mild, moderate, and severe) was determined according to the results of TTE (TPP-planimetry, TTE-PHT, and TTE-overall) and diagnostic accuracy of DSCT for detecting severe MS was assessed using each TTE as reference.

RESULTS

The MVA on DSCT (mean, 1.27 ± 0.27 cm²) was significantly larger than those seen with TTE-planimetry and TTE-PHT (1.16 ± 0.28 cm² and 1.07 ± 0.30 cm², respectively; p=0.002). Planimetry of MVA measured by DSCT may offer a reliable, alternative method for the quantification of MS in patients with AF, even though systemically overestimated, as compared with MVA calculated by CMR and TTE.

CONCLUSION

In MS with AF patients, DSCT could be an alternative to TTE in patients with poor acoustic windows or whenever MVA using TTE is indeterminate severity of MS to clinicians.

SSE03-02 ● Initial Systolic Flow Displacement in Patients with Bicuspid Aortic Valve Predicts Ascending Aortic Enlargement

Nicholas S Burris MD (Presenter); Monica Sigovan PhD; Elaine Tseng MD; David A Saloner PhD; Michael D Hope MD

PURPOSE

Bicuspid aortic valve (BAV) is a common anomaly, which is associated with dilation of the ascending aorta (AsAo), causing significant morbidity and mortality. Prior retrospective cardiac MR (CMR) studies utilizing 4D flow techniques have shown that eccentric flow patterns caused by bicuspid valve anatomy are correlated with AsAo enlargement. However, 4D Flow methods require significant post-processing time and specialized training which limits its broad applicability. Peak systolic flow displacement, a previously described parameter, can quantify flow eccentricity in the AsAo and can be easily calculated from phase contrast (PC) data, a commonly obtained CMR sequence. We hypothesize that systolic flow displacement will positively correlate with AsAo growth rate.

METHOD AND MATERIALS

Cardiac MRI/MRA data were reviewed from 23 patients with BAV who had at least 2 CMR studies >1 year apart, age =16 years, with PC data acquired in the AsAo on initial study. Ascending aortic diameter measurements were made at standard levels, and growth rates of maximally enlarged segments were determined. Flow displacement measurements on initial study were compared with maximal aortic diameter growth rate in a prospective manner.

RESULTS

Average follow-up was 3.1±2.1 years and average patient age at first study was 33.7±11.9 years. Displacement at initial study was significantly correlated with AsAo growth rate by Pearson’s correlation (r=0.39, p=0.03). In a comparison of means, AsAo growth rate was 2.5 times greater in patients with high initial flow displacement of ≥0.2 (1.0±0.7 mm/y, n=11) vs. patients with low initial flow displacements (1.0±0.7 mm/y, n=12).

CONCLUSION

We demonstrate that high peak systolic flow displacement at initial study significantly correlates with greater subsequent AsAo enlargement, and that patients with high initial flow displacement values have 2.5 times greater growth rate compared with patients with low initial flow displacement values. Flow displacement measurement may be a simple way of risk stratifying patients with BAV.

CLINICAL RELEVANCE/APPLICATION

Cardiac MR systolic flow displacement measurement in the ascending aorta can predict interval enlargement in patients with bicuspid aortic valve and is recommended for risk stratification.

SSE03-03 ● Functional Classification of Aortic Regurgitation with Cardiac Computed Tomography: Comparison with Surgical Inspection and Transesophageal Echocardiography

Hyun Jung Koo MD (Presenter); Dong Hyun Yang MD; Joon-Won Kang MD; Joon Bum Kim; Tae-Hwan Lim MD, PhD

PURPOSE

To evaluate the diagnostic performance of cardiac computed tomography (CT) for assessing the mechanisms of aortic regurgitation (AR) using surgical inspection and transesophageal echocardiography (TEE) as reference standards.

METHOD AND MATERIALS

CT findings of 101 consecutive patients (62 males, mean age: 55.0±14.0 years) with AR who underwent aortic valve or root surgery were evaluated. As reference standards, surgical inspection and TEE were reviewed for determining repair-oriented functional classification of AR: type I, dilated aortic root with cusp tethering; type II, whole prolapse of cusp; type III, cusp retraction; and type IV, rheumatic or degenerative valves, infective endocarditis or aortic dissection. Multiphase CT images were analyzed by two readers in consensus. Aortic valve (AV) morphology, root dilatation, and aortic regurgitation orifice (ARO) were evaluated on CT, and cusp morphology was categorized as normal, partial prolapse (prolapse of the distal part of a cusp), whole prolapse (prolapse of the entire body of a cusp), and retraction. TEE data were reviewed using ventricular functional parameters and direction of AR flow. Classification of AR based on CT was compared to the reference standards, and cusp-by-cusp comparison was performed.

RESULTS

Agreement between CT and the reference standards was 96.7% for functional classification of AR, and the number of patients in each type were as follows: type I (n=36), type II (n=13), type III (n=12), and type IV (n=40). In cusp-by-cusp comparison for AV morphology, CT showed 82.5% of concordance. Whole prolapse was noted in 13 patients, and all of them represented eccentric AR. Among 41 patients with partial prolapse, 23 patients were found in type I, and 26% of them showed eccentric AR. In 12 patients with cusp retraction, 33.3% of eccentric AR was demonstrated. Although the percentage of eccentric AR in partial prolapse was larger than that in normal AV, there was no statistically significance (p=0.07). The ARO measuring on CT was significantly correlated with end-diastolic volume on echocardiography (p=0.002).

CONCLUSION

CT clearly defines the functional classification of AR with high concordance rate to the reference standards.

CLINICAL RELEVANCE/APPLICATION

By showing the detailed valve morphology, CT can help in decision making for the aortic valve repairability.

SSE03-04 ● Differences of Cardiac Function and Characteristics of Aortic Valve according to Myocardial Fibrosis in Patients with Severe Aortic Stenosis

Tae Hyung Kim (Presenter); Jin-Woo Choi; Hweung Kgon Hwang; Meong Gun Song; Sung Min Ko

PURPOSE

To investigate the differences of cardiac function and characteristics of aortic valve according to myocardial fibrosis (MF) in patients with severe aortic stenosis (AS).

METHOD AND MATERIALS

Eighty-one patients (48 male, mean age 59 years) with pure severe AS (n=33) or severe AS with mild aortic regurgitation (n=48) were...
RESULTS
MF was observed in 34 patients. There were no differences in valvular morphology and clinical characteristics between two groups, except mild aortic regurgitation being more prevalent patients with MF (n = 28) than without MF (n=20, p = 0.0008). Patients with MF had higher aortic valve calcium volume score (2941 ± 1960 mm3 vs 1660 ± 1092 mm3, p = .0003) and calcium grade by CCT (p=.008), more severe [aortic valve area by CMR (0.73 ± 0.15 cm² vs 0.82 ± 0.13 cm², p = .002), peak velocity (5.0 ± 0.7 m/sec vs 4.5 ± 0.7 m/sec, p = .005) and mean pressure gradient by TTE (60 ± 19 mmHg vs 51 ± 17 mmHg, p<.005)], higher indexed LV mass by CMR (90.2 ± 34.9/g/m² vs 63.3 ± 17.9 g/m², p<.0001), lower indexed LV ejection fraction by CMR (37.1 ± 9.5 vs 41.4 ± 8.9, p=.04), and larger indexed LV end-diastolic volume (93.2 ± 20.5 ml/m² vs 79.3 ± 19.4 ml/m², p=.016) by CMR compared with patients without MF.

CONCLUSION
MF is associated with more severe calcific AS, worse LV functional parameters, and higher LV mass index in patients with severe AS. Early detection of MF using CMR may increase the chances for early surgical treatment in severe AS.

CLINICAL RELEVANCE/APPLICATION
MF occurs in severe AS and is associated with long-term clinical outcome. MF is detected by delayed contrast-enhanced CMR.

SSE03-05 • Evaluation of Cardiac Reverse Remodeling after MitraClip Procedure Using MRI

Patrick Krumm (Presenter) ; Christine S Zuern ; Bernhard Klumpp MD ; Claus D Claussen MD ; Andreas E May ; Ulrich Kramer MD ; Thomas Wurster ; Stefanie Mangold MD ; Achim Seeger ; Christiane Bretschneider

PURPOSE
The MitraClip System (Abbott Vascular) is a novel percutaneous interventional method for mitral valve repair. It is predominantly applied on patients that are not eligible for surgical valve repair. The purpose of this study was to examine reverse remodelling by evaluating pre- and postinterventional cardiac function and atrial dilatation.

METHOD AND MATERIALS
33 patients (age 75.5±8.1 years; 11 female) were prospectively included in this study. Magnetic resonance imaging was performed before and 6 weeks after intervention in 20 patients. 13 patients had to be excluded due to implantable pacemakers. Cardiac function was measured using steady-state free precession (SSFP) cine sequences by assessment of enddiastolic volume (EDV), ejection fraction (EF), myocardial mass (MM) and myocardial mass index (MMI). Planimetry of the left atrium (LA) was performed in identical slices in four-chamber view.

RESULTS
EDV was preinterventional 179.2 ml; postinterventional 171.9 ml (p=0.01). EF was was preinterventional 39.7%; postinterventional 44.0% (p=0.001). MM was preinterventional 165.7 g; postinterventional 153.6 g (p=0.03). MMI was preinterventional 85.0 g/m²; postinterventional 84.3 g/m² (p=0.6). LA plane was preinterventional 41.1 cm²; postinterventional 38.6 cm² (p

CONCLUSION
The MitraClip procedure has a positive effect on cardiac morphology and function and induces reverse remodelling: Significant reduction of LA and LV dilatation has been considered as cardiac reverse remodelling in the literature. The quantifiable left atrial dilatation as well as the left ventricular dilatation decreased significantly as an indirect sign of reduced mitral regurgitation. Myocardial mass decreased significantly in the context of reduced dilatation. MMI has not decreased for less body weight at follow up due to cardiac recompensation.

CLINICAL RELEVANCE/APPLICATION
The clinical benefit of a successful MitraClip intervention can be monitored and validated using MRI in clinical follow-up examinations.

SSE03-06 • Assessment of Leaflet Closing Angles in Mechanical Prosthetic Heart Valves with Multidetector-row CT Compared to Cinefluoroscopy: An In Vitro Study

Dominika Sucha MD (Presenter) ; Petr Symersky MD ; Evert-Jan Vonken MD, PhD ; Esther Provoost MMEdSc ; Steven Chamuleau MD, PhD ; Ricardo P Budde MD, PhD

PURPOSE
Cinefluoroscopy is the gold standard for leaflet motion evaluation in mechanical prosthetic heart valves (PHV). In the past decade multidetector-row computed tomography (MDCT) has shown the ability to evaluate PHV leaflet motion in patients as well, however the actual accuracy of leaflet restriction assessment is unknown. In this study leaflet restriction measurements with MDCT were compared to cinefluoroscopy measurements in four common mechanical PHVs in optimal in vitro conditions.

METHOD AND MATERIALS
Three blinded observers independently measured leaflet closure angles on both cinefluoroscopy and retrospectively ECG-gated MDCT images and scored leaflets as normal or restricted. For this, three mechanical bileaflet and one monoleaflet PHVs (St. Jude, Carbomedics, ON-X and Medtronic Hall) were imaged in a pulsatile in vitro model. For each PHV four various grades of leaflet closure restriction were simulated in one of the leaflets. Hence, five image acquisitions were made of each PHV; one without and four with restriction. Data was analyzed using the intraclass correlation coefficient (ICC) and Bland-Altman plots.

RESULTS
MDCT and cinefluoroscopy agreement was high, with ICCs ≥0.899. Per observer analysis showed maximal differences between MDCT and cinefluoroscopy closure angle measurements of -2 to +3 degrees in both restricted and non-restricted leaflets. Overall, sensitivity and specificity for detection of leaflet restriction was 0.88-0.94 and 1.00, respectively for CT and 0.94 and 0.89-1.00, respectively for cinefluoroscopy. Interobserver agreement was high in restricted and non-restricted leaflets on both CT and cinefluoroscopy images (ICCs >0.995).

CONCLUSION
The maximal difference in optimal in vitro conditions between leaflet angles measured with MDCT and cinefluoroscopy is 3 degrees. MDCT and fluoroscopy both accurately detect incomplete leaflet closure.

CLINICAL RELEVANCE/APPLICATION
Multidetector-row CT allows accurate leaflet closure angle measurements in both restricted and non-restricted prosthetic heart valves.
SSE04-01 • Myocardial MR Spectroscopy (MRS) as Early Indicator of Athlete’s Heart and Hypertrophic Cardiomyopathy

Francesco Secchi MD (Presenter) ; Maddalena Belmonte ; Marcello Petrini ; Paola Maria Cannao ; Giovanni Di Leo ; Francesco Sardanelli MD *

PURPOSE
To evaluate myocardial energetic metabolism with 31P-MRS and 1H-MRS in healthy volunteer, athletes and patients affected with hypertrophic cardiomyopathy (HCM) in order to define early metabolic modifications.

METHOD AND MATERIALS
We prospectively performed a cardiac 1.5-T MR (Siemens, Sonata) in 24 subjects: 10 athletes (A), 7 patients affected with HCM (H) and 7 healthy volunteers (V). With subjects in supine position, ECG-triggered cine steady-state free precession (true-FISP) and 1H-MRS point resolved spectroscopy sequence (PRESS) were performed. For the 1H-MRS a single voxel was placed into the septum. With patients in prone position a 31P-MRS multivoxel chemical shift imaging sequence was acquired. Heart function was measured segmenting cine images with Syngo-Argus software. 1H-MRS spectra were processed using jMRUI software; 31P-MRS spectra using Spectroscopy-Argus (Siemens). Kruskal-Wallis and Jonckheere-Terpstra tests were used. Data were reported as median (interquartile interval).

RESULTS
Ejection fraction (%), indexed end-diastolic volume (ml/m2), end-systolic volume (ml/m2), mass (g/cm2) and septal thickness (mm) were 68, 95, 30, 72 and 10 for group A, respectively; 68, 73, 20, 81 and 18 for group H, respectively; 63 (P=.865), 78 (P=.011), 29 (P=.013), 45 (P=.008) and 6 (P 0.01), RA (56.6±7.0 vs 54.9±7.6 mm; P=.006), PVA (10.9±3.0 vs 9.7±3.0 cm2; P=.008), indexed RV mass (g/m2) 27.9±8.9 vs 30.7±9.7; P=.006) and indexed LV mass (g/m2) 50.3±12.5 vs 55.3±14.4; P=.002) were higher in athletes compared to patients and healthy volunteers.

CONCLUSION
Myocardial 1H- and 31P-MRS could help in detection of early HCM in particular in case of young asymptomatic athletes.

SSE04-02 • Cardiac Remodeling after Pulmonary Vein Isolation in Patients with Atrial Fibrillation Is Related to the Degree of Baseline Left Ventricular Diffuse Fibrosis

Murilo Foppa MD, DSc (Presenter) ; Reza Nezafat PhD ; Warren J Manning MD ; Mark E Josephson MChir ; Hussein Rayatzadeh ; Neville Gai PhD ; Jaime Shaw ; Sebastien Weingartner ; Harsh Parmar

PURPOSE
Pulmonary vein isolation (PVI) using radiofrequency (RF) ablation is becoming a reasonable therapy for the treatment of paroxysmal atrial fibrillation (AF). The impact of the PVI on short and long-term cardiac remodeling is not yet known. Recent data demonstrate higher level of left ventricular (LV) diffuse fibrosis as measured by T1 mapping in patients with AF. In this study, we sought to identify short-term cardiac remodeling after PVI and how they relate to baseline characteristics including left ventricular myocardial T1 time.

METHOD AND MATERIALS
All patients with AF who underwent RF ablation for PVI and had CMR prior and post-PVI procedure from 2006 to 2011 were identified. CMR parameters of LV, right ventricular (RV) sizes and function, left atrial axial length (LA), right atrial axial length (RA), pulmonary veins total cross sectional area (PVA), and LV diffuse fibrosis as measured by T1 relaxation time in the septum using a Look-Locker sequence were measured in all patients pre and post-PVI. T1 measurements were corrected for age, weight, contrast dose, eFGR, and time after injection. The two scans were compared using paired t test and multiple linear regression to account for covariates.

RESULTS
We studied 141 patients (58±10 years, 70% male, BMI 29.1±5.6 kg), 46% had high blood pressure and 11% had diabetes. Sixty-five percent of patients were in SR at the pre PVI scan and 90% at the post PVI scan, 38 [IQR 33-57] days after the PVI. The PVA was associated with SR at post PVI scan. Patients procedures showed statistically significant reduction in LA (59±7.8 vs 57.3±8.1 mm; P<0.01), RA (56.6±7.0 vs 54.9±7.6 mm; P=0.006), PVA (10.9±3.0 vs 9.7±3.0 cm2; P=0.008). PVI causes changes in atrial sizes and RV ejection fraction. LV T1 associations suggest that the severity of LV myocardial fibrosis at baseline may influence the degree of structural changes post PVI.

CLINICAL RELEVANCE/APPLICATION
PVI may affect cardiac structures other than LA and the magnitude of it may be related to baseline LV myocardial diffuse fibrosis severity.

SSE04-03 • Effect of 2010 Task Force Criteria on Reclassification of Cardiac MRI Criteria for ARVC

Ting Liu MD (Presenter) ; Amit Pursnani MD ; Umesh C Sharma MD, Dphil ; Yongkasem Voorasettakarnkij ; Daniel Verdini MD ; Ashley M Lee BS ; Peerawut Deepprasertkul ; Heidi Lumish ; Manavjot S Sidhu MD, MBBS ; Hector M Medina MD ; Suhny Abbara MD * ; Godfred Holmvang ; Udo Hoffmann MD ; Brian B Ghoshhajra MD

PURPOSE
We sought to evaluate the effect of the revised 2010 Task Force Criteria (TFC) on the prevalence of major and minor MRI criteria for Arrhythmogenic Right Ventricular Cardiomyopathy (ARVC) versus the original 1994 TFC. We also assessed the utility of CMR to identify alternative diagnoses for patients referred for ARVC evaluation.

METHOD AND MATERIALS
968 consecutive patients referred for cardiac magnetic resonance imaging (CMR) with clinical suspicion of ARVC from 1995 to 2010, were evaluated for the presence of major and minor CMR criteria per the 1994 and 2010 ARVC TFC. MRI criteria included right ventricle (RV) dilatation, reduced RV ejection fraction, RV aneurysm, or regional RV wall motion abnormality. Quantitative and qualitative RV measures of end diastolic volume (RVEDV) and RV ejection fraction (RVEF) were present in 45% and 85% of patients, respectively.

RESULTS
Of 968 patients, 220 (22.7%) fulfilled either a major or a minor 1994 TFC, and 25 (2.5%) fulfilled any of the 2010 TFC criteria. (See Figure) Among patients meeting 1994 criteria, only 25 (11.4%) met the 2010 criteria. All patients who fulfilled the 2010 criteria also satisfied 1994 criteria. Per the 2010 TFC, 21 (2.2%) patients met major criteria and 4 (0.4%) patients fulfilled minor criteria. 8 patients meeting 1994 minor criteria were reclassified as satisfying 2010 major criteria, and 4 patients fulfilling the 1994 major criteria reclassified to minor or no criteria. 89 (9.1%) patients had other cardiac diagnoses, including 43 (4.4%) with clinically important potential ARVC mimics. These included sarcoidosis, RV volume overload conditions (e.g ASD, PAPVR), and other cardiomyopathies.

CONCLUSION
Compared with the 1994 TFC, the 2010 TFC significantly reduced the overall MRI diagnosis of ARVC from 22.7% to 2.5%. CMR identified alternative cardiac diagnoses in 9.1% of patients.

CLINICAL RELEVANCE/APPLICATION
**SSE04-04 • Three-Dimensional Visualization of Hemodynamic Derangement in the Left Ventricular Outflow Tract and Ascending Aorta: A Novel Imaging Parameter in Hypertrophic Cardiomyopathy**

**Bradley D Allen** MD (Presenter) ;  **Lubna Choudhury** MD ;  **Pim Van Ooij**;  **Alex Barker**;  **Jeremy D Collins** MD *;  **Robert O Bonow** MD ;  **James C Carr** MD *;  **Michael Markl** PhD

**PURPOSE**
To study the left-ventricular outflow tract (LVOT) pressure gradient and 3D blood flow patterns in the ascending aorta (AAo) in hypertrophic cardiomyopathy (HCM) patients using 4D flow MRI.

**METHOD AND MATERIALS**
Patients with HCM (n = 14, age = 59.8 ± 11.2 yrs) and controls (n = 10, age = 54.8 ± 9.0) were included in this IRB approved study. Patients had echocardiography assessment within 60 days of MRI and met at least one of the following criteria: LVOT obstruction defined as pressure gradient >30 mmHg on echo (n = 5), MRI-measured septal thickness > 1.5 cm or septum /free wall thickness ratio > 1.3, or systolic anterior motion (SAM) of the mitral valve on MRI. 4D flow MRI was performed on patients during cardiac MRI for HCM assessment. Age-matched controls were selected from a volunteer database. Blood flow visualization and quantification were performed in dedicated software (EnSight, CEI, Apex, NC). Peak velocity was measured in a cylindrical analysis volume placed in the LVOT. Peak LVOT pressure gradient was calculated using the simplified Bernoulli equation $P = 4v^2$ (P = gradient, v = velocity). Time-resolved pathlines were generated to depict blood flow over one cardiac cycle. Flow pattern was graded for helical flow in the AAo (minimal = 0, moderate = 1, severe = 2). Data were analyzed using a Wilcoxon signed-rank test or t-test as appropriate. Linear regression was used to correlate continuous measurements.

**RESULTS**
Helical flow (1.4 ± 0.7 vs. 0.1 ± 0.3, p

**CONCLUSION**
Comprehensive outflow tract hemodynamic assessment with MRI may be useful in the diagnosis of HCM and LVOT obstruction.

**CLINICAL RELEVANCE/APPLICATION**
Hemodynamic derangement in obstructive HCM is known to impact patients symptoms and disease progression. 3D hemodynamic assessment can provide novel insight into the pathophysiology of this disease.

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**SSE04-05 • Incidence of Non-Task Force Criteria Findings by CMR in Subjects with Various Arrhythmogenic Right Ventricular Cardiomyopathy Scores**

**Neda Rastegar** MD (Presenter) ;  **Stefan L Zimmerman** MD ;  **Cynthia James** PhD ;  **Brittney Murray** MS ;  **Aneline S. J. M. Te Riele** MD ;  **Aditya Bhonsale** MD ;  **Crystal Tichnell** MSc ;  **Hugh Calkins** ;  **Harikrishna Tandri** ;  **David A Bluemke** MD, PhD *;  **Ihab R Kamel** MD, PhD *

**PURPOSE**
To determine the incidence of abnormal morphologic findings, in addition to the standard task force criteria (TFC), by cardiac MRI (CMR) in subjects with variable degrees of severity of arrhythmogenic right ventricular cardiomyopathy/dysplasia (ARVC/D).

**METHOD AND MATERIALS**

**RESULTS**
The incidence of definite ARVC (Group A), borderline ARVC (Group B), and those who did not meet TFC (Group C) was 58 (61.7%), 19 (20.2%) and 17 (18.1%), respectively. With respect to CMR-based criteria only, 30/94 (31.9%) fulfilled major, while 3/94 (3.2%) fulfilled minor CMR criteria, and the remaining 61 (64.9%) did not fulfill any CMR criteria. In the entire cohort, 47 subjects (50%) had one or more abnormality on CMR. 60% of subjects who met major CMR criteria had LV fat and/or delayed enhancement (DE). We stratified the subjects in Group A based on the TFC score into three subgroups (score 4 and 5, 6 and 7, 8-10). The percentage of LV fat and DE increased with increase in TFC score. RV ejection fraction was significantly lower (43.4% vs. 52%, p=0.001) and RV end-diastolic volume index was significantly higher (96 mL/m2 vs. 69 mL/m2, p=0.0006) in Group A compared with Group C.

**CONCLUSION**
In patients with definite ARVC LV fat infiltration and DE are increasingly seen with higher TFC scores.

**CLINICAL RELEVANCE/APPLICATION**
Ventricular fat infiltration and DE, although not considered diagnostic criteria for evaluation of ARVC, may help in suggesting more advanced ARVC/D.

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**SSE04-06 • Post-myocarditis Scars Underlying Ventricular Tachycardia: Correspondence between Delayed-enhanced CMR or MDCT Imaging and Electroanatomic Mapping**

**Anna Palmisano** (Presenter) ;  **Antonio Esposito** MD ;  **Francesco A De Cobelli** MD ;  **Giuseppe Maccabelli** ;  **Paolo Della Bella** ;  **Alessandro Del Maschio** MD

**PURPOSE**
Catheter ablation guided by electroanatomic mapping (EAM) is an effective treatment for patients with ventricular tachycardia (VT) recurrence also in patients suffering from nonischemic cardiomyopathy. Post-myocarditis scars are more challenging than post-ischemic scars because they are scarcely identified at EAM using a common approach with bipolar voltages. At this aim, unipolar mapping, including larger region of myocardial activity, may be more effective but it is less specific. Delayed enhancement imaging provide high accurate identification of myocardial scars. Aim of the study was to compare scars identified at delayed-enhanced imaging with different EAM approaches: bipolar-endocardial; unipolar-endocardial; bipolar-epicardial; unipolar-epicardial

**METHOD AND MATERIALS**
19 patients (pts) with post-myocarditis VT were enrolled. 4 pts with ICD underwent MDCT including a delayed low-energy (80 kV) scan for scars identification; the remaining 15 pts underwent CMR including IR T1w sequences acquired 10-15 min after gadolinium injection. Scars site, extension and transmural distribution (subendocardial, mid-wall, subepicardial, transmural) were evaluated at imaging and compared with bipolar and unipolar voltages at endocardial and epicardial EAMs.

**RESULTS**
All patients showed myocardial scars at imaging, with subepicardial distribution in 10/19 pts and epicardial to midwall distribution in the remaining 9 pts. EAMs found low voltages suggestive for scar in 18/19 pts. Imaging-revealed scars were more frequently identified by unipolar mapping (71,1% for epicardial map, 24,7% for endocardial map) rather than bipolar one (63,2% for epicardial map, 1% for endocardial maps). In particular, epicardial unipolar mapping identified 100% of epicardial scars vs 44% by bipolar map.

**CONCLUSION**
Unipolar electroanatomic mapping guided by pre-ablation CMR or MDCT late enhanced imaging increases the chances for the identification of postmyocarditis scars underlying recurrent ventricular tachycardia, amplifying the possibilities of a successful radio-frequency ablation treatment in these patients.

**CLINICAL RELEVANCE/APPLICATION**
Merged pre-ablation late enhanced imaging and unipolar mapping allow a better identification of VT-substrate in patients with postmyocarditis scars, increasing the chances of successful trans-cathe
Both radiologists scored correctly all 30 cases without pneumothorax, regardless of acquisition settings or reconstruction algorithm. Six cases were equivocal for pneumothorax: 2 (equivocal for pneumothorax) and 4 (certainly a pneumothorax). CT

### RESULTS

Statistical analyses were assessed by frequency and kappa statistics. No significant correlation for development of pneumothorax was detected in coaxial versus non-coaxial technique. The incidence of pulmonary hemorrhage was 5.8% (38 out of 650). Treatment was only conservative. Significant risk factors involved in the development of pulmonary hemorrhage including small central or basal lesions, long intrapulmonary needle track and traversing pulmonary vessels in the needle track. The management of such condition is only conservative.

### CLINICAL RELEVANCE/APPLICATION

Dual marking with radiotracer and hookwire under CT fluoroscopy is a safe and no time consuming procedure, and it has made needlescopy assisted lung resection for small nodules or GGO lesions easier, more convenient, and less hazard in relatively superficial lesions.

### CONCLUSION

Dual marking with radiotracer and hookwire under CT fluoroscopy is a safe and no time consuming procedure, and it has made needlescopy assisted lung resection for small nodules or GGO lesions easier, more convenient, and less hazard in relatively superficial lesions.
Both radiologists scored correctly all 30 cases without pneumothorax, regardless of acquisition settings or reconstruction algorithm. Six out of 90 (6.7%) pneumothoraces were called equivocal by reader 1 and 8 out of 90 (8.9%) by reader 2. Overall agreement between both readers was very good (κ=0.85). The two thinnest pneumothorax regions were called equivocal by either one radiologist or the other at the lowest radiation dose settings (80 kVp/10mAs and 80kVp/20mAs), regardless reconstruction kernel. The lowest acquisition parameters that none of the readers had equivocal interpretations were 100kVp/20mAs (0.89mGy).

CONCLUSION
Acquisition settings as low as 100kVp/20mAs (0.89mGy) may be suitable to confidently detect the presence of very small pneumothoraces after intervention, regardless of reconstruction algorithm.

CLINICAL RELEVANCE/APPLICATION
Evaluation of small pneumothorax with MDCT may be confidently performed with very low acquisition parameters. This may help reduce radiation dose for detecting pneumothorax after intervention.

SSE05-06 • Analysis of Risk Factors Influencing Local Tumor Control in Patients with Pulmonary Nodules after Microwave Ablation (MWA)

Thomas J Vogl MD, PhD (Presenter) ; Thomas Worst ; Nagy N Naguib MSc ; Nour-Eldin A Nour-Eldin MD, MSc

PURPOSE
To evaluate the risk factors predicting local tumor control after microwave ablation (MWA) of primary and secondary lung malignancies ≤3 cm in maximum diameter.

METHOD AND MATERIALS
In this retrospective study 91 index tumors (ITs) in 57 patients were treated with single antenna MWA. Time to local progression was monitored using CT over a median follow-up of 10.2 months ± 6.2 (range, 6.0 - 29.2). An overall estimated time to local tumor progression was performed via Cox regression model. Factors hypothesized to correlate with ablation response included tumor diameter (15.5mm), tumor shape (round/oval vs. irregular), clear vs. ill-defined tumor margin, adjacency to the pleura, adjacency to bronchi, vessels of > 3 mm in diameter located at a maximum of 5 mm from the IT, energy applied to IT (26.7 J/mm²) and occurrence of cavernous formations after ablation. A logistic regression model was used to correlate the data.

RESULTS
Local tumor progression occurred in 30/91 (33%) ITs, seen in 21/57 (36.8%) patients. Mean time to local tumor progression was 8.3 months (± 5.5; range, 2.1 - 25.2) (median, 22.6 months ± 12.4 months). Risk factors significantly correlating with local tumor progression were >15.5 mm (p

CONCLUSION
Independent predicting factors for local tumor progression in primary and secondary lung neoplasms ≤3cm in diameter are irregular IT shape and CLINICAL RELEVANCE/APPLICATION
Irregular IT shape and <3cm in diameter.

SSE05-06 • Percutaneous Computed Tomography (CT)-guided Transthoracic Needle Lung Biopsy (TTNLB) in Patients with Hematologic Malignancies: Diagnostic Yield, Safety and Clinical Outcomes

Ruth M Dunne MBCh (Presenter) ; Gowri Satyanarayana ; Driele Peixoto ; Francisco M Marty MD ; Ritu R Gill MBBS *

PURPOSE
To evaluate the diagnostic utility and safety of CT-guided TTNLB in patients with hematologic malignancies and impact on clinical outcomes.

METHOD AND MATERIALS
This IRB-approved HIPAA-compliant study included consecutive patients with hematological malignancies who underwent TTNLB procedures between July 1, 2007 and June 30, 2012. Demographic, clinical and pathological data were collected. Both cyto-pathologic and microbiologic results were also assessed. Complications and hospital admission stays were recorded. Primary outcome measures were diagnostic efficacy, defined by number of procedures, which provided a specific diagnosis of either malignancy or infection; and safety defined, by number and type of complications per procedure. Secondary outcome measure was change in therapy based on the diagnostic yield. Statistical analysis were performed to determine univariate and multivariate predictors of diagnostic efficacy and frequency and severity of complications.

RESULTS
108 patients underwent 114 TTNLB procedures, resulting in established specific diagnoses in 37.7% (43/114) of procedures: 26 (22.8%) lesions were consistent with malignancy and 17 (15%) were infective etiologies. The most common underlying malignancy was non-Hodgkin lymphoma in 39% (42/108) of patients. Biopsied lesion median diameter was 3.1cm (range, 0.7-14.2 cm; interquarttile range, 2.1-5.5cm); lesions were most frequently located in the left lower lobe (31/114 [27.2%]); were pleural-based in (73/114 [64%]); had surrounding ground glass opacification in (59/114 [51.8%]). Complications occurred in 31 (27%) of 114 procedures: small volume hemoptysis in 4 (3.5%) procedures and pneumothorax in 28 (24.5%) procedures, three requiring chest tube placement. Pneumothorax incidence was significantly associated with larger (18-G) biopsy needle use and longer lesion distance from pleura (p>0.05). The results of TTNLB led to changes in antimicrobial or oncological therapy in 46(44.7%) of the 103 patients with adequate follow-up.

CONCLUSION
TTNLB is a safe diagnostic procedure in patients with hematologic malignancies with the potential of making specific diagnoses with minimal morbidity and can positively affect patient management.

CLINICAL RELEVANCE/APPLICATION
TTNLB in patients with hematologic malignancies is useful as it may establish specific diagnoses for which targeted treatments are available and can be performed safely with minimal morbidity.
**SSE06-03 • Structured Physician Order Entry for Trauma CT Scans Improves Clinical Information Transfer and Billing Efficiency in the Emergency Department**

**Jeremy R Wortman MD (Presenter) ; Aaron D Sodickson MD, PhD ; Asha Goud MD ; Michael H Stella MD ; Ali Raja MD, MBA * ; Anna Poulos ; Dana Marchello**

**PURPOSE**
To measure the impact of a structured physician order entry system for trauma CT imaging on the clinical information provided to the radiologist, and on associated coding practices and reimbursement success.

**METHOD AND MATERIALS**
The study was conducted between April 1, 2011 and January 14, 2013 at a quaternary care institution with a Level 1 Trauma Center and 58000 ED visits annually. The intervention implemented in March of 2012 was a structured order entry system for trauma CT scans. The presence in the requisition of clinical signs and symptoms and mechanism of injury, the primary ICD-9-CM code category, the success of reimbursement, and the occurrence of initial reimbursement denials were compared before and after the intervention for head through pelvis trauma CT scans. Chi square statistics were used to compare examinations and patients before and after the intervention.

**RESULTS**
457 patients received CT pan-scans, including 2734 distinct exam accessions. After the intervention, there was a 62% increase in requisitions containing clinical signs, symptoms, or physical examination findings (from 1% to 63%, p < .0001), and a 99% increase in provided mechanism of injury (from 0.4% to 99%, p < .0001). There was a 19% increase in primary ICD-9-CM codes representing clinical signs or symptoms (from 3% to 22%, p < .0001), and a modest 4% increase in reimbursement success for examinations submitted to insurance carriers (from 91% to 95%, p = .003). Rate of initial reimbursement denials dropped 7% (from 24% to 17%, p = .04).

**CONCLUSION**
Implementation of structured physician order entry for trauma CT imaging was associated with a large increase in rate of clinical history provided to the radiologist. This was associated with a decrease in initial reimbursement denials and a modest increase in reimbursement success.

**CLINICAL RELEVANCE/APPLICATION**
Structured physician order entry for trauma CT imaging can increase the clinical information provided to the radiologist, improve coding practices, and increase reimbursement success and efficiency.

**SSE06-02 • Structured Physician Order Entry for Trauma CT Scans Improves Clinical Information Transfer and Billing Efficiency**

**Jonathan Opraseuth MD ; Ari C Sacks MD (Presenter) ; Alexander J Adduci MD, PhD**

**PURPOSE**
Evaluate the percentage of patients with incidental coronary artery calcifications on CT and determine if these patients are being appropriately managed according to the proposed new ACO quality measures for patients with ischemic vascular disease, specifically in regards to aspirin/antithrombotic treatment.

**METHOD AND MATERIALS**
IRB approved, retrospective review of all patients that underwent a Chest CT or CTA in the Emergency Department of a tertiary care, academic medical center between 9/1/2012 and 12/1/2012. The presence of coronary artery calcifications (CAC) was graded as mild, moderate, or severe. The electronic medical records of patients with CACs were evaluated to determine if there was a documented diagnosis of coronary artery disease (CAD) and if these patients were on an antithrombotic medication according to ACO guidelines.

**RESULTS**
568 consecutive patients had a Chest CT or CTA in the ED between 9/1/2012 and 12/1/2012. 45.4% patients (n=258), average age of 67.4 years (range 30 to 97 years), demonstrated presence of coronary artery calcifications graded as mild (n=125), moderate (n=74), or severe (n=59). Of the patients with CACs, 27.5% (n=71) had a documented diagnosis of CAD and 40.3% (n=104) were on aspirin. Of the patients who were not on aspirin (n=154), 6% (n=10) had a documented allergy or contraindication and 29% (n=44) were on another antithrombotic or anticoagulant. Of the patients with severe CACs, 73% (n=43) were on aspirin or another antithrombotic and 48% (n=28) had a documented diagnosis of CAD.

**CONCLUSION**
A large subset of patients with coronary artery calcifications incidentally noted on CT do not have documented CAD and are not being adequately treated with antithrombotic therapy according to the newest ACO guidelines. By acting upon this information, radiologists can facilitate early preventative care of coronary artery disease and improve adherence to the ACO guidelines regarding management of patients with ischemic vascular disease.

**CLINICAL RELEVANCE/APPLICATION**
Detection of incidental coronary artery calcifications identifies patients with undiagnosed coronary artery disease and who may benefit from aspirin/antithrombotic therapy according to ACO guidelines.
Coronary Artery Calcification Is Often Overlooked in CT Pulmonary Angiograms of Patients with Suspected Pulmonary Thromboembolism

Omid Khalilzadeh MD, MPH (Presenter); Patrick C Johnson BS; Robert A Novelline MD; Garry Choy MD, MS

PURPOSE
In patients with suspected pulmonary thromboembolism (PTE), coronary artery calcification (CAC) can be an incidental finding in CT pulmonary angiograms. We evaluated the frequency of under-reporting CAC and its association with acute coronary syndrome (ACS) diagnosis.

METHOD AND MATERIALS
Data of 469 consecutive patients suspected for PTE, who were referred to the emergency radiology department for CT pulmonary angiograms, were reviewed. Radiology reports were rechecked and positive CAC findings were recorded. All CT pulmonary angiograms were re-evaluated by one radiologist and CAC findings were recorded. The rate of ACS and PTE as final diagnosis for that hospital admission was calculated. The association between CAC and ACS diagnosis was assessed in different subgroups of patients.

RESULTS
About 11.1% of patients had PTE and 43.8% had CAC. CAC was significantly higher in patients with ACS diagnosis than those without (56.2% vs. 40.4%; OR=1.9). There was a strong positive association (OR=3.5) between CAC and ACS in younger patients (age=45 in men, age=55 in women); those without PTE (OR=2.15) and without cardiometabolic risk-factors (OR=3.8). CAC was unreported in 45% of patients with positive CAC (n=98). ACS was the final diagnosis in 31.6% of patients with unreported CAC. There was a significant association between CAC and patients in whom ACS was unreported (OR=2.18). This association was more prominent in the above subgroups.

CONCLUSION
CAC is often overlooked in emergency CT pulmonary angiograms. CAC is a significant predictor of ACS, particularly in younger patients, those without PTE and cardiometabolic risk-factors. Especially in these sub-groups, radiologists should assess CAC findings.

CLINICAL RELEVANCE/APPLICATION
This study encourages radiologists to more vigilantly look for CAC in emergency CT pulmonary angiograms. Particularly in younger patients, CAC is highly suggestive for ACS diagnosis.

Radiology Resident On Call Performance in the Diagnosis of Ectopic Pregnancy Compared to Examinations Performed by Board Certified Sonographers

Alan H Richman MD; Cynthia L Wallentin MD (Presenter); Ichiro Ikuta MD, MMedSc

PURPOSE
To evaluate the technical and interpretive skills of radiology residents in performing ultrasound exams for the emergent diagnosis of ectopic pregnancy.

METHOD AND MATERIALS
All emergency ultrasound exams ordered with a clinical suspicion of ectopic pregnancy were reviewed from 9/01/2011 to 12/31/2012. Out of 182 exams, 98 were performed by a resident with a resident preliminary report issued, and 84 were performed by an ultrasound technologist with a radiology attending final report. Sensitivity and specificity was calculated for radiology residents and ultrasound technologists with manual chart review as the gold standard. In a double-blind fashion, exams were graded for image quality with a 5-point Likert scale, and compared using a Cochran-Mantel-Haenszel test. Former residents were surveyed regarding whether the technical skills acquired in their training benefited them in their fellowship and attending positions.

RESULTS
A total of 22 ectopic pregnancies were found upon chart review. Ectopic pregnancy sensitivity was 69% for residents and 67% for technologist/attending; specificity was 100% for both residents and technologist/attending. Overall image quality demonstrated no statistically significant difference between residents and technologists (Figure). Resident survey reveals that ultrasound technical training is considered a valuable acquired skill.

CONCLUSION
Radiology residents can be trained to emergently perform and correctly diagnose ectopic pregnancy on par with ultrasound technologists and radiology attendings with a similar sensitivity and specificity to published data for the initial ultrasound exam. The comparable image quality ensures a technically adequate exam to ensure patient safety. A survey of former residents reveals that ultrasound technical training is a valuable acquired skill in fellowship and attending positions. Consideration should be given to making ultrasound technical skills an integral part of a diagnostic radiology residency curriculum.

CLINICAL RELEVANCE/APPLICATION
No published study has evaluated the technical skills of radiology residents in performing emergent ultrasound exams for the emergent diagnosis of ectopic pregnancy.

Impact of Resident Training on Imaging Utilization: A Ten Year Perspective at a Level I Trauma Center

Bahman Sayyar Roudsari MD, PhD (Presenter); Kevin Psoter; Jeffrey G Jarvik MD, MPH*

PURPOSE
Little is known regarding utilization of computed tomography (CT) over the course of resident’s training in a level I trauma center. In this study, we hypothesized that CT use is higher in early academic year (i.e. July-August) compared to the rest of the year, after adjustment for potential confounding variables, such as injury severity score, that could influence utilization rate.

METHOD AND MATERIALS
We linked Harborview Medical Center (HMC) trauma registry to the HMC billing department data from July 2000 to June 2010. Trauma registry included detailed information regarding patient demography, injury characteristics, trauma care and outcome. Billing data included detailed information on type and frequency of different body region CTs performed during hospitalization. Number of all CTs, CT thorax, abdomen and pelvis were the main outcomes evaluated. The primary exposure of interest was admission in July-August vs. the remainder of the year. Negative binomial regression was used to evaluate the association between month of the year and CT use, adjusting for age, gender, race/ethnicity, year of admission, mechanism and severity of injury, length of hospitalization, ICU admission, and final disposition.

RESULTS
From 2000-2010 a total of 57,544 trauma admissions were recorded. The mean age of the patients was 38 years and 71% were male. On average the patients were hospitalized for 7 days. On average patients underwent 2.9 CTs during hospitalization and the most commonly performed studies for these patients were head (1.1 CTs/person), pelvis (0.5 CTs/person), abdomen (0.4 CTs/person), and thorax (0.2 CTs/person). Patients admitted in July-August underwent slightly higher rate of abdomen (IRR: 1.06; 95% CI: 1.02-1.10), pelvis (IRR: 1.06; 95% CI: 1.02-1.10), and thorax (IRR: 1.06; 95% CI: 1.00-1.12) CTs. No differences were observed for head or extremity CTs.

CONCLUSION
We found that CT chest, abdomen and pelvis were slightly more common at the beginning of the academic year after adjusting for potential confounders. This could be partially due to the limited experience of new residents on trauma service. Our ongoing project further characterizes the factors associated with such observations.
Gastrointestinal (CT Dose Reduction II)

Monday, 03:00 PM - 04:00 PM • E353A

SSE07 • AMA PRA Category 1 Credit ™ • ARRT Category A+ Credit:1
Moderator
Meghan G Lubner, MD
Moderator
Rizwan Aslam, MBChb *

SSE07-01 • Factors Leading to High Dose CT Scans at a Tertiary Care Center: Can We Avoid Them?

Priyanka Prakash MD (Presenter); William W Boonn MD *; Tessa S Cook MD, PhD

PURPOSE
To identify patients scanned with above acceptable radiation levels for CT abdomen and pelvis examinations (CTAP) and assess the reasons for high-dose scans.

METHOD AND MATERIALS
CTAP examinations between July 2012 and March 2013 on 64-slice (Sensation 64, Siemens) scanners were reviewed. All scans were acquired using automatic tube current modulation. Remaining scan parameters were held constant at pitch 1, slice thickness 5mm, collimation 10 and kVp 120 except for very large patients. The acquisition details (mean mAs, kVp, scan length, effective patient diameter) and dose details including CTDIvol, effective dose, size specific dose estimate (SSDE), dose length product (DLP), organ specific effective doses for these scans were extracted using a commercial software (eXposure, Version 1). The above acceptable radiation dose was defined as \( \pm 2 \) standard deviations above the respective means. All patients who underwent the CT scan with \( \pm 2 \) standard deviations above the mean DLP, effective dose and SSDE were identified. These scans were reviewed on PACS to identify the reason for high doses.

RESULTS
1685 scans (995 females, 690 males) were included in the study. The mean DLP, effective dose and SSDE for these scans were 734.7±338.5mGy-cm, 13.2±6.4mGy-cm and 15.6±3.8mGy. The scans with doses greater than DLP of 1411.6 (35; 6M, 29F); effective dose of 42.5 (120; 12M, 78F); and SSDE of 23.1 (47; 7M, 40F) were identified. The reasons for high effective dose were patient size (17/35), 140 kVp for scans very large patients (5/35), longer scan length for coverage of perineum (2/35) and repeats because of patient motion, off centering, abdominal wall excluded from FOV (11/35). Similarly, patient size (9/29), 140 kVp (3/29), scan length (3/29) and repeats (12/29) accounted for high DLP. For high SSDE, patient size (19/47), 140 kVp (7/47) scanning with arms by side (24/47) and patient off centering (17/47) were the identifiable factors.

CONCLUSION
Patient size, 140 kVp, repeats, patient off centering and scanning with arms by side account for higher than acceptable radiation dose. Of these, patient off centering and repeats are avoidable factors. Scanning with arms by the side may be avoidable in certain circumstances.

CLINICAL RELEVANCE/APPLICATION
Technologists can be given feedback/ in-service training reiterating the role of proper patient positioning, avoiding repeats and scanning with arms above head to avoid unnecessary radiation exposure.

SSE07-02 • Half Contrast Agent Dose and Low Radiation Dose Protocol for Abdominal Dynamic CT: Clinical Impact of the Iterative Model Reconstruction (IMR) for Low kVp Imaging

Takeshi Nakaura MD (Presenter); Shinichi Tokuyasu RT *; Masafumi Kidoh; Ryo Itatani; Kazunori Harada; Yasuyuki Yamashita MD *; Shinichi Nakamura MD

PURPOSE
Low kilo-voltage (kVp) CT is well suited for low contrast and low radiation dose abdominal CT; however, increased image noise is a problem. The recent introduced iterative model reconstruction (IMR, Philips Healthcare) dramatically reduces the image noise and offers virtually noise free images. We evaluated the feasibility of a half contrast agent dose and low radiation dose protocol for abdominal dynamic CT using 80 kVp and the IMR technique.

METHOD AND MATERIALS
This prospective study received institutional review board approval; prior informed consent was obtained from all patients. We enrolled 30 patients who underwent abdominal dynamic CT using 80-kVp setting with a half contrast dose (300 mgI/kg) during 30 sec. We also enrolled 30 patients who were scanned with a standard 120-kVp protocol with filtered back projection (FBP) technique using the standard contrast dose of 600 mgI/kg during 30 sec as a control group. The 80-kVp images were reconstructed with FBP, hybrid-iterative reconstruction (iDose4) and IMR. We compared the effective dose (ED) of each protocol and evaluated image noise, CT numbers and the contrast to noise ratio (CNR) of 120 kVp and FBP-, iDose4-, IMR-reconstructed 80 kVp images at the abdominal aorta in hepatic arterial phase (HAP) and hepatic parenchyma in portal venous phase (PVP).

RESULTS
The total effective radiation dose was 42% lower with 80-kVp scan than with 120-kVp scan (9.0 mSv ± 1.3 vs 15.6 mSv ± 2.6). CT numbers with the half contrast dose 80-kVp protocol were significantly higher than with the 120-kVp protocol (abdominal aorta: 371.2 ± 65.1 vs 333.3 ± 46.9, \( p = 0.04 \); hepatic parenchyma: 121.1 ± 20.0 vs 107.7 ± 17.6, \( p < 0.01 \)). The CNR of 80-kVp with IMR were significantly higher than 120-kVp protocols (abdominal aorta: 87.9 ± 19.8 vs 42.5 ± 10.8, \( p < 0.01 \); hepatic parenchyma: 26.3 ± 4.5 vs 13.2 ± 3.2, \( p < 0.01 \)).

CONCLUSION
IMR is a promising technique to improve the image quality of the half contrast agent dose and low radiation dose protocol for abdominal dynamic CT with low kVp setting.

CLINICAL RELEVANCE/APPLICATION
The contrast dose for abdominal dynamic CT can be reduced by 50% by using a 80 kVp setting with IMR with improved image quality and reduced radiation dose.

SSE07-03 • How to Choose Spectral CT Imaging Protocol Individually: A Dose Study in Abdomen

Tan Guo MD (Presenter); Cheng Zhou MD; Wen Chen; Juan Chen MD, PhD

PURPOSE
Spectral CT scan is thought of high dose level, but different protocol combinations can ensure a relative low dose. The aim of this study is to discuss choosing spectral CT protocol individually for each patient in abdominal examinations.
METHOD AND MATERIALS
This was a retrospective study using the imaging data of another abdomen research. 44 patients underwent two phase enhancement abdomen scan. GSI mode scan with fixed tube current were used in artery phase and conventional 120 kVp scan with auto tube current were used in portal venous phase (GE discovery CT 750 HD, GE Healthcare). There were two protocol settings of GSI mode scan (protocol A with pitch 1.375 and protocol B with pitch 0.984), and 31 patients underwent protocol A while others underwent protocol B. The CTDI were fixed in protocol A (15.64 mGy) and protocol B (21.84 mGy) for fixed tube current. The 44 patients were divided into 3 groups according to BMI (low BMI: 26). The noises and CTDI were compared in different groups and protocols between GSI mode scan and conventional 120 kVp scan.

RESULTS
The CTDI of GSI mode scan with both protocol A or B were significant higher than conventional 120 kVp scan (7.95 mGy ) in low BMI group, the noises of GSI mode scans (6.3±0.8) were significant lower than conventional scan (11.36±2.1). In the medium BMI group, the CTDI of protocol A didn’t show significant difference compared with conventional scan (14.97 mGy), CTDI of protocol B was significant higher than conventional scan (16.88 mGy). The noises of protocol A (10.3±0.9) and B (8.9±0.8) didn’t show significant difference with conventional scan. In the large BMI group, the CTDI of protocol A were significant lower than conventional scan (24.46 mGy), CTDI of protocol B didn’t show significant difference compared with conventional scan (26.45 mGy). The noises of protocol A (8.6±1.3) were equal to the noises of conventional scan, and the noises of protocol B (7.7±1.0) were significant lower than conventional scan.

CONCLUSION
In low BMI group, spectral CT scan is not suggested for the relatively high dose level. In medium and large BMI group, protocol A is suggested for acquiring the same image quality without increasing dose.

CLINICAL RELEVANCE/APPLICATION
Spectral CT scan as a dual energy technique has been introduced in clinical applications and confirmed as useful in diagnosing. However, the dose of spectral CT imaging is still debated.

SSE07-04 • Radiation Dose Optimization in Abdominal Dual-source, Dual-energy CT: Assessment of Image Quality, Iodine Quantification and Low-contrast Detectability?

Matthias Benz (Presenter); Michele Pansini MD; Kovacs Bolazs; Robert Bolt; Dorothee Harder; Georg M Bongartz MD *; Zsolt Szucs-Farkas MD, PhD; Sebastian T Schindera MD *

PURPOSE
To assess the image quality, iodine quantification and low-contrast detectability in abdominal dual-source, dual-energy CT at different radiation dose levels in a phantom.

METHOD AND MATERIALS
A custom liver phantom with 43 hypodense tumors (diameters of 5, 10 and 15 mm; tumor-to-liver contrast of -10, -25, and -50 HU) and eight tubes containing solutions of varying iodine concentration (0-22 mg/ml) were placed in a cylindrical water container that mimicked an intermediate-sized patient. The phantoms were scanned with a dual-source CT scanner (Somatom Definition Flash, Siemens) using the abdominal dual-energy protocol recommended by the vendor (tube A, 100 kVp, 230 reference mAs; tube B, 140 kVp, 196 reference mAs) (protocol A). The phantoms were also scanned with three dose-optimized protocols in which the reference mAs setting of tube A was reduced by 40, 80, and 120% compared to protocol A (protocol B, C and D, respectively). The radiation dose was assessed with the volume CT dose index (CTDIvol). The image noise was measured, and the contrast-to-noise ratio (CNR) of the tumors was calculated. Tumor detection was independently performed by three radiologists. Software provided by the vendor was used for iodine quantification. Kruskal-Wallis test was used to compare iodine measurements between protocols.

RESULTS
The CTDIvol of protocol A, B, C and D measured 17.7, 14.6, 11.5 and 8.5 mGy, respectively. As the radiation dose decreased, the image noise increased (13.2, 14.4, 16.7 and 19.4 HU for protocol A, B, C and D, respectively) and the CNR decreased (4.4, 3.8, 3.1, and 2.7 for protocol A, B, C and D, respectively) (P < 0.05). The overall sensitivity for tumor detection measured 82.2%, 82.2%, 81.4% and 79.8% (P = 0.789). Quantitative iodine measurements showed no significant difference in the four protocols (P = 0.996).

CONCLUSION
The radiation dose of the abdominal dual-energy CT protocol that is provided by the vendor can be reduced by at least 50% while maintaining low-contrast detectability and accuracy in iodine quantification. Image noise and CNR is not an adequate surrogate for evaluating the potential for radiation dose reduction.

CLINICAL RELEVANCE/APPLICATION
The radiation dose-optimized abdominal dual-source, dual-energy CT protocol improves patient safety without degradation of diagnostic accuracy.

SSE07-05 • Reduction of Total Iodine Dose by Using Low Tube Voltage and High Tube Current Technique in Combination with Adaptive Statistical Iterative Reconstruction for Dynamic CT of the Liver

Yoshifumi Noda MD ; Satoshi Goshima MD, PhD ; Hiroshi Kawada MD ; Haruo Watanabe MD ; Hiroshi Kondo MD ; Masayuki Kanematsu MD ; Nobuyuki Kawai MD (Presenter) ; Yukichi Tanahashi MD ; Kyongtae T Bae MD, PhD *

PURPOSE
To prospectively compare a low tube voltage (80-kVp) with a conventional (120-kVp) CT protocol for contrast enhancement degree of vascular and liver parenchyma, image quality, and detectability of hepatocellular carcinomas (HCCs).

METHOD AND MATERIALS
Institutional review board approval and written informed consent was obtained. During a 9 months period, 170 patients (114 men, 56 women, age range 40-85 years, mean age 67.7 years) with suspicious having liver disease were randomized into three groups according to BMI (low BMI: 26). The 44 patients were divided into 3 groups according to BMI (low BMI: 26). The noises and CTDI were compared in different groups and protocols between GSI mode scan and conventional 120 kVp scan.

RESULTS
The CTDIvol of protocol A, B, C and D measured 17.7, 14.6, 11.5 and 8.5 mGy, respectively. As the radiation dose decreased, the image noise increased (13.2, 14.4, 16.7 and 19.4 HU for protocol A, B, C and D, respectively) and the CNR decreased (4.4, 3.8, 3.1, and 2.7 for protocol A, B, C and D, respectively) (P < 0.05). The overall sensitivity for tumor detection measured 82.2%, 82.2%, 81.4% and 79.8% (P = 0.789). Quantitative iodine measurements showed no significant difference in the four protocols (P = 0.996).

CONCLUSION
The radiation dose of the abdominal dual-energy CT protocol that is provided by the vendor can be reduced by at least 50% while maintaining low-contrast detectability and accuracy in iodine quantification. Image noise and CNR is not an adequate surrogate for evaluating the potential for radiation dose reduction.

CLINICAL RELEVANCE/APPLICATION
The radiation dose-optimized abdominal dual-source, dual-energy CT protocol improves patient safety without degradation of diagnostic accuracy.

SSE07-06 • Reduction of Total Iodine Dose by Using Low Tube Voltage and High Tube Current Technique in Combination with Adaptive Statistical Iterative Reconstruction for Dynamic CT of the Liver

36 hypervascular HCCs (mean size, 16.8 mm; range, 6.0-88.0 mm) were identified in 35 patients (27 men, 8 women, mean 69.5 years, age range 51-85 years). Compared with group 1 and 3, group 2 demonstrated significantly higher contrast enhancement and SNR of the aorta in hepatic arterial phase (P < .001), portal vein (P < .001) and hepatic vein (P < .001) in portal venous phase (PVP), and liver parenchyma in all phases (P < .001). In group 2, HLC (P = .004) and FOM (P = .001) obtained in equilibrium phase were significantly superior to those in other groups. Sensitivity, specificity, AUC for detection of HCC, and image quality were comparable among three groups. The effective dose during HAP was lower in group 1 (3.3 ± 1.2 mSv) than in group 2 (3.8 ± 1.6 mSv) and 3 (4.1 ± 1.5 mSv) (P = .025).

CONCLUSION
Use of 400 mgI/kg at 80-kVp tube voltage demonstrated comparable image quality and detectability of HCC to conventional protocol of 600 mgI/kg at 120-kVp, while the use of 500 mgI/kg at 80-kVp showed better enhancement degree and HLC.
CLINICAL RELEVANCE/APPLICATION
Our study demonstrated the possibility of the iodine-dose reduction in 80-kVp CT imaging of the liver. This information is useful for designing clinical protocols for hepatic CT imaging.

SSE07-06 • Liver CT with Low Tube Voltage and Model-based Iterative Reconstruction (MBIR) Algorithm for Hepatic Vessel Evaluation in Living Liver Donor Candidates
Bo Yun Hur (Presenter); Jeong-Min Lee MD *; Ijin Joo MD *; Joon Koo Han MD; Byung Ihn Choi MD, PhD *

PURPOSE
To investigate the image quality and diagnostic confidence of Model-based Iterative Reconstruction (MBIR) algorithm for evaluation of hepatic vessels on low-tube-voltage (100-kVp) liver donor CT.

METHOD AND MATERIALS
Fifty-one consecutive low-tube-voltage liver CT for liver donor work-up were reconstructed using FBP, adaptive statistical iterative reconstruction (ASIR), and MBIR and were compared with each other and thirty high-tube-voltage (120-kVp) liver donor CT scans reconstructed using FBP. Weighted volume CT dose index and dose-length product, mean image noise, and contrast-to-noise ratios (CNRs) were assessed. Two radiologists evaluated the image quality and diagnostic confidence on the different image sets.

RESULTS
In low-tube-voltage CT, a significant dose reduction was obtained compared with that in high-tube-voltage CT (p=0.001). The image noise on MBIR images was significantly lower and CNRs on MBIR images were higher compared with those on FBP and ASIR images of low-tube-voltage CT (p

CONCLUSION
Low-tube-voltage liver CT using MBIR algorithm may increase the image quality and improve the diagnostic confidence for hepatic vessel evaluation at a reduced radiation dose compared with high-tube-voltage CT with FBP.

CLINICAL RELEVANCE/APPLICATION
Low-tube-voltage CT using MBIR could be recommended to liver donors for preoperative hepatic vessel evaluation because of improved image quality and diagnostic confidence with reduced radiation dose.
Does PET/CT Derived Tumor Heterogeneity and Glucose Uptake Predict Survival in Primary Colorectal Cancer Patients?

Ming Young S Wan MBChir; Balaji Ganeshan PhD (Presenter) *; Alec Engledow; Daren Francis; Nick Reay-Jones; Manuel Rodriguez-Justo; Vicky J Goh MBCh *; Marie Meagher; Jacquie Pock; Kim Jaggs; Jackie Hayward; Helen Whiteway; Zia Saad; Faira Rizal; Jakub Nalepa *; Michael Hayball *; Robert Kozarski; Peter J Ell MD *; Stuart A Taylor MBBS; Steve Halligan MD; Kenneth Miles *; Ashley M Groves MBBS *

PURPOSE
To investigate the prognostic value of FDG PET and CT textural analysis (CTTA) in determining overall survival in primary colorectal cancer.

METHOD AND MATERIALS
3 patients were lost to follow up leaving 126 for analysis (79-males; 47-females; mean-age 62.6±10.6y). 39 (31.0%) patients died during follow-up. Univariate analysis revealed that textural heterogeneity (p=0.012) and tumor clinical stage (p=0.003) predicted survival but SUVmax or size did not. Using multivariable analysis, tumor computed tomography textural heterogeneity (p=0.026) and stage (p independent survival predictors).

CONCLUSION
Using a cross validation model, tumor heterogeneity as measured on CT is shown to be a survival factor for patients with primary colorectal cancer, independent of clinical stage.

CLINICAL RELEVANCE/APPLICATION
Given that performing textural analysis is simple and could be easily adopted into clinical workflow, it would have potential management implications for primary colorectal cancer patients.

Gastrointestinal (Cirrhosis and Portal Venous Hypertension)

Monday, 03:00 PM - 04:00 PM • E451A
To determine whether magnetic resonance (MR) relaxometry of T1 in the liver can differentiate normal liver parenchyma from liver cirrhosis stratified by the Child-Pugh (CP) score.

METHOD AND MATERIALS
This retrospective study was approved by institutional review board and informed consent was waived. One hundred eight patients (M:F=34:74, age range 26-76) underwent T1 relaxometry using modified Look-Locker inversion recovery (MoLLI) sequence before and 20 minutes after Gd-EOB-DTPA injection at 3T. T1 relaxometry was performed in a single breath-hold, and repeated three times at the different levels (upper than portal hilum, portal hilum and below portal hilum level). Signals were measured at the three levels, carefully avoiding vessels and focal lesions, and the mean values were taken. Patients were divided into three groups: normal liver function (n=30), liver cirrhosis (LC) with CP A (n=65), LC with CP B (n=11) and LC with CP C (n=1), except one patient with severe iron deposition (CP B, n=1). T1 relaxation times of precontrast and postcontrast relaxometries among the groups were compared with each other.

RESULTS
On postcontrast T1 relaxometry, CP B group showed significantly longer T1 relaxation time (509.27±128.7 msec) than CP A (339.4±103.7 msec) and normal liver function (291.6±73.0 msec) groups (p<0.05).

CONCLUSION
MR T1 relaxometry of the liver parenchyma on Gd-EOB-DTPA enhanced MR may have potential to estimate liver function.

CLINICAL RELEVANCE/APPLICATION
T1 relaxation times may assess liver function quantitatively, by objectively assessing Gd-EOB-DTPA uptake of the liver.

SSE09-02 • The Feasibility of Texture Analysis Using Susceptibility-weighted Magnetic Resonance Imaging in Detecting Patients with Liver Cirrhosis

Diana S Feier MD (Presenter) ; Thomas Knogler MD ; Marius E Mayerhoefer MD, PhD ; Csilla Balassy MD ; Ahmed Ba-Ssalamah MD

PURPOSE
To establish the feasibility of textural features of liver parenchyma obtained on susceptibility weighted magnetic resonance imaging (SWI MRI) which will enable the detection of liver cirrhosis in patients with diffuse chronic liver diseases (CLD).

METHOD AND MATERIALS
RESULTS
Six out of ten texture features selected on the basis of Fisher coefficients were derived from grey-level histogram. Of the 65 patients included, 62 (95.38%) were classified correctly by k-NN. Sensitivity was 96.3% and specificity was 94.7%.

CONCLUSION
Although it proved to be a feasible method, further studies are necessary to determine whether the SWI texture analysis features are able to differentiate between severity scores of liver cirrhosis.

SSE09-03 • Dynamic Gadoxetic Acid-enhanced MR Imaging of the Rat Liver: Correlation between Functional MR Parameters and Hepatocyte Organic Anion Transporter Function in Cirrhosis

Matthieu Lagadec MD ; Maxime Ronot MD (Presenter) ; Sabrina Dobias PhD ; Celine Girdeau PhD ; Jean-Luc Daire PhD ; Simon Lambert ; Magali Fasseu ; Valerie Paradis MD ; Richard Moreau PhD ; Bernard E Van Beers MD, PhD

PURPOSE
To assess the value of enhancement and pharmacokinetic parameters measured at dynamic gadoxetate-enhanced MR imaging in the determination of hepatic organic anion transport function in rat liver cirrhosis.

METHOD AND MATERIALS
RESULTS
In rats with cirrhosis, the maximal enhancement and time to peak decreased significantly relative to control rats, whereas the elimination half-life increased significantly. Similarly, the hepatic extraction fraction decreased and the mean residence time increased significantly. Several enhancement and pharmacokinetic parameters correlated significantly with the transporter expression at simple regression analysis (p < 0.05). At multiple regression analysis, only the hepatic extraction fraction correlated significantly with the expression of Oatp1a1 and Mrp2 with r values > 0.7, as did the mean residence time with Mrp4. The respective values were p < 0.001, r = 0.744; p < 0.001, r = 0.911, and p = 0.001, r = 0.921.

CONCLUSION
The pharmacokinetic parameters, hepatic extraction fraction and mean residence time, determined at dynamic gadoxetate-enhanced MR imaging, are markers of the changes of hepatic organic anion transporter expression in liver cirrhosis.

CLINICAL RELEVANCE/APPLICATION
DHCE-MRI has the potential to assess hepatocyte transporter function in liver cirrhosis.

SSE09-04 • Utility of Dynamic and Hepatobiliary Phase Gadoxetate-enhanced MRI for Characterization of T1-w Hyperintense Lesions in Cirrhosis. Do Challenges Exist?

Ka-Kei Ngan MD (Presenter) ; Jing Luo ; Michael Nalesnik MD * ; Keyanoosh Hosseinzadeh MD *

PURPOSE
To evaluate gadoxetate-enhanced DCE-MRI for detection of hepatocellular carcinoma (HCC) in cirrhotic patients with incidentally discovered T1-w hyperintense lesions.

METHOD AND MATERIALS
Chart review of cirrhotic patients with gadoxetate-enhanced MRI at 1.5T from 2008-2012 was performed. Patients with histologically confirmed hyperintense lesions on precontrast T1-w imaging were included. Lesion size, location, T1-w, T2-w, and dynamic and hepatobiliary (HB) phase signal intensity were recorded independently by two radiologists. A 4 point confidence scale classified the lesions: 1=definitely benign, 2=probably benign, 3=probably malignant, and 4=definitely malignant. Each lesion was scored based on precontrast and dynamic phase ("dynamic"), and then with the addition of the HB phase ("dynamic and HB"). Discrepancies were resolved by consensus.
Scores 1 and 2 were grouped into "benign" and 3 and 4 as "malignant", and diagnostic performance comparing "dynamic" and "dynamic and HB" phases was performed. Fisher’s exact test evaluated the correlation between HB phase and histopathology. Kappa coefficients were calculated to quantify inter-observer agreement for each imaging phase and the final diagnosis. Bootstrap resampling was used to compare benign and malignant lesion sizes.

RESULTS
There were 42 pathologically confirmed lesions (15 wd-HCC, 4 mod-diff HCC, 3 dysplastic nodules, 20 regenerative nodules) in 20 patients. Based on consensus data, combining dynamic and HB phase did not change diagnostic performance compared to dynamic phase only. Sensitivity and specificity of 0.74 and 0.78. Inter-observer agreement was only moderate for both dynamic (0.43) and combined dynamic and HB phases (0.5). HB phase did correlate with pathology (p<0.05).

CONCLUSION
Although, addition of HB phase did not improve diagnostic performance, hypointensity on HB phase correlates strongly with malignancy. No discriminatory threshold size was found.

CLINICAL RELEVANCE/APPLICATION
A hyperintense precontrast T1-w lesion that becomes hypointense on the HB phase raises high suspicion for malignancy.

SSE09-05 • Supersonic Shear Wave Elastography as a Non-invasive Tool for Determining Improvement of Portal Hypertension in Cirrhotic Patients

SSE09-06 • Assessment of Liver and Spleen Viscoelastic Properties Associated with Portal Hypertension Using Multifrequency Magnetic Resonance Elastography

METHOD AND MATERIALS
Twenty-three consecutive patients who were diagnosed with portal hypertension (≥6 mmHg of HVPG) on initial HVPG measurement and who underwent follow-up measurement to evaluate response to treatment were enrolled in this retrospective study. Liver stiffness measurement was performed in all of the subjects, followed by HVPG measurement through transjugular catheterization on the same day. Liver stiffness was obtained intercostally, which was repeated 5 times at the same location of the right liver. The relationship between the HVPG and liver stiffness on initial measurement was investigated by using Pearson’s correlation test. Furthermore, we evaluated whether a change in the HVPG (?HVPG) was correlated with a change in the liver stiffness (?LS). The subjects were subdivided into two groups: those in whom the HVPG at follow-up decreased by ≥20% compared to the initial measurement (clinical improvement), and those in whom the percentage of decrease was less than 20%. The performance to determine improvement of portal hypertension was investigated using the receiver operating characteristics (ROC) curve analysis.

RESULTS
Liver stiffness was significantly correlated with HVPG at initial and follow-up measurements (r=0.501 and 0.527, respectively). The mean rate and difference of ?LS were strongly correlated with ?HVPG (r=0.863 and 0.707, respectively). To determine the improvement of portal hypertension, the area under the ROC curve was 0.79 of rate of ?LS, and 0.78 of difference of ?LS.

CONCLUSION
Supersonic SWE is feasible method to determine improvement of portal hypertension in cirrhotic patients.

CLINICAL RELEVANCE/APPLICATION
Supersonic SWE is available for evaluation of improvement of portal hypertension, therefore can replace conventional invasive catheterization. Supersonic SWE is available for evaluation of improvement.
SSE10-01 • Feasibility Study of Prospective ECG-triggered Axial Scan Applied in Renal Artery Imaging

Ying Guo MD (Presenter) ; Dapeng Shi MD ; Minghua Sun ; Peigang Ning ; Hui Xu

PURPOSE
To investigate the feasibility of prospective ECG-triggered axial scan applied in renal artery imaging.

METHOD AND MATERIALS
72 patients referred to renal CT angiography were randomly divided into 2 groups. Group A (n=37) underwent prospective ECG-triggered axial scan. Group B (n=35) performed conventional 120 kVp CTA with Noise Index of 8, pitch of 1.375 and same contrast media protocol of group A. Images were reviewed by 2 experienced radiologists independently. ROIs were placed in psoas muscle, R/L renal artery. Signal-to-noise ratio (SNR) and contrast-to-noise ratio (CNR) was calculated with ROI measurements. Subjective score was rated on a 5-point-scale and artifact caused by spiral scan and axial scan were evaluated. Comparison of percentages of diagnostic images (score=3) were performed and image quality was statistically compared. DLP and Effective Dose was recorded and compared.

RESULTS

CONCLUSION
Renal artery imaging performed prospective ECG-triggered axial scan can get equivalent image quality compared with 120 kVp, while radiation dose and artifact caused by spiral scan greatly reduced.

CLINICAL RELEVANCE/APPLICATION
Prospective ECG-triggered axial scan can be applied in renal artery imaging and got excellent diagnostic images.

SSE10-02 • Comparison of Fixed to Weight-based Contrast Dose for CTA of the Chest, Abdomen, and Pelvis

Theodora A Potretzke MD (Presenter) ; Scott K Nagle MD, PhD *

PURPOSE
To determine whether a fixed or a weight-based contrast dose injection results in more uniform opacification of the aorta in patients undergoing combined CT angiography of the chest, abdomen, and pelvis.

METHOD AND MATERIALS
This IRB-approved retrospective study included 22 fixed dose (150 mL iohexol) exams (11 ECG-gated) and 22 weight-based dose (P3T protocol, Medrad, Pittsburgh, PA) exams (12 ECG-gated) obtained for clinical purposes between 12/8/2011 and 4/24/2012. All scans were performed on a GE 64-slice CT scanner. Age and body mass index (BMI) of each patient were recorded. The aortic attenuation gradients (AAG) and the percent aortic attenuation decrease (PAD) were calculated from mean Hounsfield Units in ROIs placed in the ascending aorta (AscAo) and at the aortic bifurcation (AoBif) using the equations: AAG = AscAo - AoBif, PAD = (AscAo \( \times \) AoBif) / AscAo. Kruskal-Wallis (Wilcoxon rank sum) and Fisher exact tests were used to test for differences in continuous and categorical variables, respectively. Criterion for statistical significance was p < 0.05 (two-sided).

RESULTS
There was no significant difference in age or BMI between the groups. When ECG-gating was used for the chest portion of the exam, the aortic opacification was more uniform with fixed dose than with weight-based dose (AAG -11 vs 91, p=0.027; PAD -49 vs 21%, p=0.014). The aortic opacification was also more uniform using a fixed dose injection on the non-gated exams; however, the difference was not statistically significant (AAG -14 vs 22, p=0.324; PAD -1% vs 5%, p=0.36). The mean weight-based contrast dose (126 ± 4 mL) was significantly lower than the fixed dose (150 mL).

CONCLUSION
A fixed contrast dose for ECG-gated CTA-chest/abdomen/pelvis provides more uniform aortic opacification than does weight-based contrast dosing. This may be due to a slight (1-2 s) delay between the chest and abdomen portions of the exam on the GE VCT scanner, related to switching between gated and non-gated modes. However, weight-based dosing using the Medrad P3T software can be used to decrease iodinated contrast load for non-gated CTA of the chest, abdomen, and pelvis without compromising aortic opacification.

CLINICAL RELEVANCE/APPLICATION
Since bolus arrival time varies considerably through the large volume covered by CTA chest/abdomen/pelvis, it is important to ensure that weight-based contrast dosing provides adequate opacification.

SSE10-03 • Utility of CT Spectral Imaging to Optimize the Image Quality of Pelvic CT Angiography

Xiaosong Du (Presenter) ; Yang Xiaotang ; Zhang Jianxin ; Wang y Yan ; Zhou Lifang ; Cheng Weiling

PURPOSE
To investigate the utility of CT spectral imaging to optimize the image quality of pelvic CT angiography in patients with cervical cancer: comparison with traditional polychromatic X-ray imaging (TPXI).

METHOD AND MATERIALS
60 patients with diagnosed cervical cancer underwent pelvic CT angiography either with CT spectral imaging mode (n=30, group A) or conventional scan mode (n=30, group B) with 120kVp. The contrast agent dose of 1 ml/kg, the flow rate was 3-5ml/s adaptive to the Body Mass Index. The optimal contrast-to-noise (CNR) for iliac artery was achieved by dedicated software for spectral imaging analysis (GI viewer). The selected optimal monochromatic image and TPXI image were post-processed by MIP and VR. Also, the bilateral iliac artery CT values, noise and CNR were measured on the selected optimal monochromatic image and TPXI image respectively. The image qualities were accessed by two experienced radiologists with 5-point scale. Dose-length-product (DLP) was recorded for both groups.

RESULTS
Data compared with student T-test and sum-rank test. Quality were accessed by two experienced radiologists with 5-point scale. Dose-length-product (DLP) was recorded for both groups. Image qualities were accessed by two experienced radiologists with 5-point scale. Noise and CNR were measured on the optimal monochromatic image and TPXI image respectively. The image qualities were assessed by two experienced radiologists with 5-point scale. Dose-length-product (DLP) was recorded for both groups.

CONCLUSION
Low-keV monochromatic images improve the visualization of the feeding artery and latered branches of the cervical cancer.

CLINICAL RELEVANCE/APPLICATION
Low-keV monochromatic images improve the visualization of the feeding artery and latered branches of the cervical cancer, which help its clinical diagnosis and treatment.

SSE10-04 • Comparing Diagnostic Accuracy of Contrast Enhanced CT Angiography and Contrast Enhanced MR Angiography for the Assessment of Hemodynamically Significant Transplant Renal Artery Stenosis

Santhosh Gaddikeri MD (Presenter) ; Lee M Mitsumori MD, MS * ; Sandeep Vaidya MD ; Daniel S Hippe MS * ; Puneet Bhargava MD ; Manjiri K Dighe MD

PURPOSE
To compare diagnostic accuracy of contrast enhanced CT angiography (CTA) and contrast enhanced MR angiography (MRA) for the assessment of hemodynamically significant transplant renal artery stenosis (TRAS).
METHOD AND MATERIALS
After institutional review board approval, records of 27 patients with TRAS confirmed on Digital Subtraction Angiography (DSA) were retrospectively reviewed. Thirteen patients had MRA and 14 had CTA prior to DSA. Two board-certified fellowship trained radiologists, one each from interventional radiology and body image were blinded to the DSA and CTA/MRA data respectively and classified the stenosis as either hemodynamically significant (=/> 50%) or non-hemodynamically significant.

RESULTS
Seven of 13 patients who had significant TRAS on MRA also had significant stenosis on DSA and 3 of 4 patients with non-hemodynamically significant stenosis on MRA had a significant stenosis on DSA (sensitivity 0.70, specificity 1). Two hemodynamically significant stenosis were not visualized on MRA due to susceptibility artifacts.

Ten of 14 patients who had significant TRAS on CTA also had significant stenosis on DSA and 1 of 3 patients with non-hemodynamically significant on CTA had a significant stenosis on DSA (sensitivity 0.90, specificity 0.66).

CONCLUSION
MRA is more specific but less sensitive than CTA to diagnose hemodynamically significant TRAS. Susceptibility artifact related to surgical clips is a significant limitation of MRA to accurately diagnose TRAS.

CLINICAL RELEVANCE/APPLICATION
Higher specificity and lack of radiation and nephrotoxic iodinated contrast makes MRA a better modality than CTA in the diagnosis of hemodynamically significant TRAS.

SSE10-05 • CT Renal Angiography: Comparison between Iodixanol (270 mg I/ml) with Monochromatic Imaging and Iohexol (350 mg I/ml) with Conventional Imaging

Kefeng Zhou (Presenter) ; Jian He MD, PhD ; Bin Zhu

PURPOSE
To compare the image quality of CT renal angiography using iso-osmolar Iodixanol (Visipaque, 270 mg I/ml) at monochromatic images with low-osmolar Iohexol (Omnipaque, 350 mg I/ml) at conventional 120kVp images

METHOD AND MATERIALS
Thirty patients received Iohexol (Omnipaque 350 mgI/ml) who underwent conventional CT scan (120kVp, NI=8,pitch 1.375, rotation time 0.8s) in CT renal artery angiography and forty-two patients received Iodixanol (Visipaque 270 mg I/ml) who underwent spectral CT imaging(40mm,0.6s,large) with the single-source fast kV switching dual energy acquisition (80 kVp and 140 kVp) during the arterial phase (bolus tracking, 1.0 ml/kg, 3.5ml/s). Five regions of interest (ROI) were drawn at the abdominal aorta, left and right renal artery and cortex respectively. CT attenuation value and contrast-noise ratio (CNR) of each ROI were obtained on both optimal monochromatic images and the conventional scan. Volume rendering images of renal artery were reconstructed by both of them( thickness 0.625mm) and the image quality and radiation dose were compared between the two groups.

RESULTS

CONCLUSION
Monochromatic images (usually around 53keV) by using Iodixanol (270 mg I/ml) with low radiation dose could provide better image quality than conventional images by using Iohexol (350 mg I/ml) in renal artery CT angiography

CLINICAL RELEVANCE/APPLICATION
Lower monochromatic imaging in renal artery angiography with low Iodine-consistency contrast medium, which is benefit to renal function, can achieve better quality images than conventional protocol.

SSE10-06 • Comparison of the Effect of Visipaque 270 and Visipaque 320 in CT Angiography

Haijian Fan (Presenter) ; Bin Zhu

PURPOSE
To compare the effect of Visipaque 270 and Visipaque 320 in CT angiography in the arterial phase.

METHOD AND MATERIALS
This prospective study was approved by local ethics committee and patient’s informed consent was obtained. One hundred and thirty one patients were recruited in this study. Forty two patients received Visipaque 270, 1 mL/kg, and 89 patients received Visipaque320, 1 mL/kg. All the patients were scanned on a 64-slice CT scanner (Discovery CT 750HD, GE) with gemstone spectral imaging in the arterial phase. GSI viewer was used to acquire the images, and the CT values of the two sets of images in the abdominal aorta, left, right renal artery were measured and calculated.

RESULTS
The t-test showed that the CT values of the abdominal aorta, left, right renal artery in the images of Visipaque 270 group (510.22±113.76, 454.48±111.32 and 454.01±106.39) and those in images of Visipaque 320 group (554.47±130.93, 480.52±117.11 and 480.37±115.20) showed no significant differences (all P value > 0.05).

CONCLUSION
As no significant difference, it will be a better choice for patients who received angiography in the arterial phase.

CLINICAL RELEVANCE/APPLICATION
Visipaque 270 is equal to Visipaque 320 in CT angiography.
**SSE11-03 • Long-term Results after Magnetic Resonance-guided Focused Ultrasound Surgery (MRgFUS) Treatment of Patients with Symptomatic Uterine Fibroids**

**Julia Kamp** MD (Presenter) ; **Vera Froeling** MD ; **Patrick Freyhardt** ; **Matthias David** PhD ; **Alexander N Beck** MD

**PURPOSE**

Long-term results after magnetic resonance-guided focused ultrasound surgery (MRgFUS) treatment of premenopausal women with symptomatic uterine fibroids. Outcome was measured by the Uterine fibroid Symptom and Quality of Life Questionnaire (UFS-QOL).

**METHOD AND MATERIALS**

Retrospective evaluation of 54 patients, who were initially included into a prospective short-time study. MRgFUS treatment had been performed between 2003 and 2008. Patients were readdressed to receive long-term results of this collective. Clinical outcome was assessed by the fibroid specific questionnaire UFS-QOL. Results at baseline, after 3, 12 and a mean time of 59 months are presented.

**RESULTS**

After MRgFUS-treatment of symptomatic uterine fibroids quality of life improved significantly. Symptom relief was seen after 3 and 12 months and especially at long-term follow-up after a median time of 59 months. The score of overall quality of life increased significantly from a median of 64.7 (QR: 28.1-56.3) to 77.6 (QR: 61.4-87.1) after 3 months (p < 0.05). The mean CT numbers between TNC and VNC were not significantly different (P> 0.05). The mean CNR from the two phases was rated as good. The mean effective doses for the three-phase protocol and blended versus IO images was not significantly different (P> 0.05). In the renal cortex-to-RFA site, the CNR between linearly blended and IO images was not significantly different (P> 0.05). The imaging quality of the VNC from the two phases was rated as good. The mean effective doses for the three-phase protocol and for TNC images were 11.2 and 2.1 mSv, respectively.

**CONCLUSION**

MRgFUS therapy of symptomatic uterine fibroids leads to long-term symptom relief (mean 59 months). The rate of reinterventions might be reduced by improved patient-screening. As in current studies suggested there seem to exist possible predictors of long-term success.

**CLINICAL RELEVANCE/APPLICATION**

Long-term results after MRgFUS treatment of uterine fibroids are still rare, they are essential to prove effectivity and to allow comparison with other methods (surgical and minimal invasive).
METHOD AND MATERIALS

From October 2011 to March 2013, 54 patients aged between 24 and 51 (mean age 37.5), with symptomatic adenomyosis and uterine fibroids were treated with MRgFUS, in our department. This study includes 18 patients affected only by adenomyosis. Symptomology was assessed through the symptoms severity score questionnaire. The technical plan was characterized by the use of a high-energy-grid-sonication. The mean energy delivered for each patient was of 3450 J (minimum value of 1300 J and maximum value of 5600 J). This allowed us to reach the therapeutic temperature also in more vascularized parts of the lesion. In order to treat the peripheral parts of the lesion, we used a shorter spot length (from 4 to 6 mm) and a shorter cooling time between the sonication. All patients were treated once and the longest treatment lasted about 120 minutes.

RESULTS

We evaluated "pre-treatment volume" measured in the T2-weighted sequences using an informatic method on single slice; "treated volume" obtained from the Exablate measurement system 2100; "Non Perfused Volume" (NPV), evaluated on the c.e. T1-weighted sequences made immediately after treatment. Results showed a "treated volume" mean value of 72.5% of the volume drawn by the operator. The NPV was meanly 14% greater than the "treated volume". Comparing the three different parameters we can demonstrate that we treated a mean of 86.5% of the lesion. After 12 weeks, the symptomatic score showed a reduction of about 90% if compared to the pre-treatment one.

CONCLUSION

MRgFUS is a mini-invasive treatment for adenomyosis. It permits to maintain the integrity of the uterus, a good extension of NPV, a shorter hospitalization with significant reduction of the symptoms. In conclusion, it is a valid and conservative treatment in a pathologic which so far had limited therapeutic perspectives.

CLINICAL RELEVANCE/APPLICATION

The study demonstrates the effectiveness of the technique in the uterine adenomyosis treatment, allowing complete resolution of symptomatology and mostly uterine saving, thus avoiding hysterectomy.

SSE11-06 • Entirely Endophytic Small Renal Masses: Outcomes of Percutaneous Biopsy with US or CT Guidance

Mi-Hyun Kim MD (Presenter); Jeong Kon Kim MD; Hyuck Jae Choi MD; Kyoung-Sik Cho MD

PURPOSE

Endophytic renal tumors have been related to higher surgical complexity and higher postoperative complication rate than exophytic lesions. To avoid unnecessary surgery, the number of biopsies in these endophytic lesions is increasing in our institution. The purpose of our study was to evaluate the diagnostic rate and safety of the percutaneous core needle biopsy in patients with entirely endophytic small renal masses (SRM).

METHOD AND MATERIALS

A total of 57 biopsies of the entirely endophytic SRM (= 4 cm) were performed with 18-gauge needle from July 2004 to January 2013. The diagnostic rate, histologic finding, complication rate, the type of image guidance (US or CT), and tumor location were assessed from the retrospective chart and image reviews. Tumor location was divided into two subgroups (central- vs. peripheral tumor). Central lesions were defined as tumors protruding to the renal sinus fat and in actual contact with the pelvicalyceal system and/or main renal vessels.

RESULTS

Biopsy was diagnostic in 53 (93.0%) renal masses and nondiagnostic in 4 (7%). Among the diagnostic biopsies, 60% (32 of 53) were malignant and 40% (21 of 53) were benign. No serious complication such as active bleeding was occurred. Of the 57 biopsies, 39 were done with CT guidance and 18 with US guidance. Of the entirely endophytic SRMs, 35% (20 of 57) were central tumors and 65% (37 of 57) were peripheral tumors. Central tumors had a higher rate of malignant pathology (90% in central tumors, 44% in peripheral tumors, P < .05). The diagnostic rate was not different between central tumors (95%) and peripheral tumors (92%) (P > .05).

CONCLUSION

Percutaneous biopsy of the completely endophytic SRMs is safe and diagnostic in most cases. Image-guided core needle biopsy can aid the clinician in the management and decision-making of the entirely endophytic SRMs.

CLINICAL RELEVANCE/APPLICATION

Image-guided biopsy can be helpful for the the management of the entirely endophytic small renal mass, and can decrease unnecessary surgery of benign tumors.

ISP: Health Service, Policy and Research (Practice and Medical Management)

Monday, 03:00 PM - 04:00 PM • S102D

SSE12 • AMA PRA Category 1 Credit™: 1 • ARRT Category A+ Credit: 1

Moderator
Aine M Kelly, MD

Moderator
Gelareh Sadigh, MD

SSE12-01 • Health Service, Policy and Research Keynote Speaker: Medical Management
Aine M Kelly MD (Presenter)

SSE12-02 • The Vancouver workload Utilization Evaluation (VALUE) Study of Radiologists
Del Dhanoa MD (Presenter); Savvas Nicolaou MD; Kirsteen R Burton MD, MBA

PURPOSE

The purpose of the study is to characterize the workload of on-site hospital radiologists. Our hypotheses are that during the course of a typical work day: 1) hospital radiologists perform a wide number of duties; and 2) radiologists experience a significant number of value based interactions which directly influence patient care.

METHOD AND MATERIALS

A multicenter, randomized prospective observational study was performed across 1 month of observation of 14 staff radiologists at 3 independent hospital facilities. The subjects were prospectively observed to characterize the workload activities performed during dayshifts. One of the hospitals is a tertiary care academic institution and the other two hospitals are community based hospitals within the Greater Vancouver area. Interruptions were defined as: 1) simple interruptions and 2) break in tasks. A simple interruption is an event that briefly takes the physician away from his current activity but does not cause the physician to switch to a new activity. A break in tasks as an event that lasts greater than 10 seconds and causes the physician to switch tasks. Interruption types and frequencies were also categorized during this study.

RESULTS

Radiologists spent 36.4% of their time on image interpretation. The proportion of non-interpretative tasks was 43.8% which includes activities such as protocolling requisitions, supervising and monitoring studies, image guided procedures, consulting with physicians and direct patient care. Total clinical productivity was 87.7% and radiologists experienced on average 6 interactions per hour with other...
CONCLUSION
Radiologists spend a considerable amount of time servicing referring physicians and patients by performing tasks beyond image interpretation. Almost half of the radiologist’s work day is spent on critical clinical activities separate from image interpretation which drive the medical imaging department. The radiologist’s total clinical productivity is 87.7%.

CLINICAL RELEVANCE/APPLICATION
The on-site added value radiologists deliver suggests that radiologists are central figures in the medical imaging department who are difficult to replace by off-site or non-radiologist image inter.

SSE12-03 • Protocol Driven Ultrasound: An Effective Method to Improve Efficiency in an Ultrasound Department

Rupan Sanyal MD (Presenter) * ; Aimen Ismail ; Benjamin R Kraft ; Mark E Lockhart MD ; Lauren F Alexander MD ; Timothy M Beasley PhD ; Michelle L Robbin MD *

PURPOSE
Ultrasound is operator dependent and although each department has guidelines, a wide variation in image acquisition between studies is often seen. Ultrasound protocols are preset pathways for each study in the machine which, when launched, guide the sonographer through the mandated views for the study. The purpose of this study is to evaluate the impact of implementation of protocol-driven ultrasound on the efficiency of performing carotid Doppler studies.

METHOD AND MATERIALS
IRB approved/HIPAA compliant retrospective study of consecutive patients evaluated carotid Doppler ultrasounds before and after incorporation of protocols into the ultrasound machines at the outpatient facility of a tertiary care hospital. Duration of examination and number of images obtained by five experienced sonographers for 219 consecutive carotid Doppler studies before and 218 studies after implementation of protocol-driven ultrasound were calculated and compared using ANOVA test.

RESULTS
After implementation of protocol driven ultrasound, there was a significant 12.5% reduction in duration of carotid Doppler studies (p < 0.0001).

CONCLUSION
Implementation of protocol driven ultrasound is an effective tool which streamlines image acquisition and significantly improves efficiency in an ultrasound department.

CLINICAL RELEVANCE/APPLICATION
Protocol driven ultrasound is an effective method of improving efficiency in an ultrasound department and its implementation is recommended.

SSE12-04 • Improving the Patient Experience: Communication Is Keystone for Optimizing the Outpatient Imaging Experience

Garry Choy MD, MS (Presenter) ; William Barron ; Sharon Gibson ; George Desko ; Barbara Hubley ; Jae Lee ; Efren J Flores MD ; Giles W Boland MD ; Gloria M Salazar MD ; David A Rosman MD *

PURPOSE
Obtaining patient feedback holds significant potential in improving the quality of care for patients in radiology. The goal of this study aims to better measure patient experience in our department. We set forth to better characterize factors that impact overall patient satisfaction levels and identify key opportunities for improvement.

METHOD AND MATERIALS
We deployed a 13-question multiple choice and free text survey to patients who visited three outpatient imaging centers in our practice to obtain feedback on our services. We accepted responses via an electronic survey or handout. Multiple choice and free text responses were both analyzed in detail.

RESULTS
We received 786 responses from patients in the outpatient setting over a 5 month time period. The three indicators in which our patients were the least satisfied were: (1) communication of wait times, (2) detailed explanation of exam, and (3) staff introductions of themselves. In contradiction, patients noted outstanding performance in: (1) convenience of imaging center location, (2) cleanliness of facilities, and (3) staff friendliness. Over 98% of respondents also indicated they would refer a family, friend, or colleague.

CONCLUSION
While quality of imaging interpretation and aesthetics of facilities are important to an imaging center’s success, a key issue identified by patients centers around communication issues. Specifically, this study provides evidence that there is a need for proper communication of wait times, explanation of exam, and staff introductions.

CLINICAL RELEVANCE/APPLICATION
Patient satisfaction in medical imaging setting can be improved through better communication with patients, particularly regarding staff introductions, explanation of examinations, and wait times.

SSE12-05 • Using a Safety Metric to Measure the Success of a Program to Manage the Utilization of Advanced Diagnostic Imaging

Mark D Hiatt MD,MBA (Presenter) * ; Timothy R Johnstad MBA * ; Brock A Oxford MPH *

PURPOSE
In the context of recent concerns about inappropriate utilization of advanced diagnostic imaging (ADI) and the associated deleterious effects of excessive radiation exposure, a radiology benefit management company (RBM) implemented a program to assist a state Medicaid plan manage the use of outpatient ADI, encouraging the withdrawal of inappropriate requests or change to a more appropriate modality (such as ultrasound or MRI in lieu of CT when indicated). This study investigated the feasibility of using an innovative means to frame the importance of this initiative in terms of its safety impact, measuring the performance of the program by how well it reduced ionizing radiation delivered, as opposed to reducing costs incurred.

METHOD AND MATERIALS
The RBM instituted a program to manage ADI for the New York State Medicaid program on April 11, 2011. The results were analyzed, using Consults per Thousand Members as a proxy for utilization from inception through February 28, 2013, comparing program performance to pre-implementation claims data from 2010. Managed modalities included CT, CTA, MRI, MRA, cardiac nuclear medicine (CMM), and PET. The radiation reduced was expressed in terms of net milliSieverts (mSv), chest x-ray equivalents (CXREs), and cigarettes smoked (cigs) spared using consistently applied conversion factors. (A CXRE is the radiation exposure from 1 chest radiograph in the posteroanterior dimension.)

RESULTS
Utilization management of 115,977 procedure requests for an average covered membership of 725,012 over the course of the study resulted in a 36% reduction in radiation exposure overall, with the radiation spared equivalent to the avoidance of approximately 135 thousand mSv, 6.75 million CXREs, or 2.74 billion cigs.

CONCLUSION
Using a safety metric, such as radiation exposure reduced expressed in various forms that may be meaningful to patients, is a feasible means of measuring the performance of a program to manage the utilization of ADI. The success of such an endeavor may be assessed.
Patients Prefer the Current Model of Results Delivery, though Many Would Like Access to Their Reports

**Miguel C Cabarrus MD (Presenter) ; David M Naeger MD ; Alexander Rybkin MD ; Aliya Qayyum MBBS *  
**

**PURPOSE**
To assess outpatients preferences for receiving imaging results and to assess their knowledge regarding the role of radiologists.

**METHOD AND MATERIALS**
This Institutional Review Board-approved study surveyed patients from an academic medical center and a county hospital over a four-week period. Voluntary, anonymous surveys were given to all English speaking, adult outpatients undergoing CT or MRI. The survey assessed 212 patients preferred delivery method for radiology results and their understanding of radiologist's education and role. Differences were assessed with Fisher's Exact or chi-squared tests with a significance level of 0.05.

**RESULTS**
573 completed surveys were received, representing a response rate of 24%. 360 (63%) of patients preferred the usual model of communication through their referring physician, though 155 (27%) of them also wanted a copy of their report. 212 (37.0%) patients preferred a model in which radiologists communicated the results in person or over the phone in a timely manner, including the possibility of receiving a copy of the report. There were no significant differences between county and academic medical center patients (p=0.57). If reports were made available, patients expressed an equal interest in email, mail and online portal options (38%, 31%, and 32%, respectively), though the county hospital patient subset preferred mail (60%, p

**CONCLUSION**
Most patients preferred the current model of result delivery in which ordering providers relay results, though many patients expressed an interest in directly receiving their reports as well. Our study also demonstrated limited awareness of our profession amongst patients.

**Patient interest in receiving copies of their reports may represent an opportunity for radiologists to increase our communication with patients and to raise awareness of our field.**

**Informatics (Workflow and Displays)**

**Monday, 03:00 PM - 04:00 PM • S402AB**

**SSE13 • AMA PRA Category 1 Credit™: 1 • ARRT Category A+ Credit:1  
**

**Moderator  
David S Hirschorn , MD  
**

**Moderator  
Sanjiv Bajaj , MD  
**

**SSE13-01 • RadPath: An Electronic Platform to Integrate Radiology and Pathology Consultations for Indeterminate Lesions  
**

**Corey W Arnold (Presenter) ; Dean Wallace MD ; Fereidoun G Abtin MD ; Benjamin M Ellingson MS, PhD * ; Alex A Bui MS, PhD ; Scott Binder ; Denise R Aberle MD ; Dieter R Enzmann MD  
**

**CONCLUSION**
The RadPath application allows radiologists and pathologists to efficiently communicate and integrate diagnostic findings, and provides treating clinicians with a succinct summary of results and conclusions.

**Background**
In general, current workflows for diagnosing indeterminate lesions include a radiologist and pathologist working separately to issue reports on the same patient, without a formal process for correlating findings and resolving possible discordance. Treating clinicians are then required to discover all reports pertaining to a patient and resolve any unclear findings and diagnoses.

**Evaluation**
We implemented an electronic platform to facilitate communication between radiologists and pathologists during indeterminate lesion diagnosis to enable the creation of a specialized interface for treating clinicians that provides a concise summary of salient diagnostic findings and conclusions. After a biopsy procedure, a RadPath report is typically initiated by the radiologist, who triggers the system to pull and correlate the various reports from various clinical databases. Using text processors and structured elements within the record, RadPath automatically presents a radiologist with a distilled view of diagnostic information, including report sections and key image slices. The radiologist confirms this view and then shares it with a pathologist, who triggers the system to retrieve and distill pathology reports and images. If after performing his/her analysis, the pathologist finds any conflicting information with the radiologic exam, the RadPath report may be shared back to the radiologist with attached comments from the pathologist. This asynchronous process provides a formal way to efficiently correlate findings.

**Discussion**
Preliminary findings indicate that creating a RadPath report requires approximately five minutes from the radiologist and pathologist. A pilot study is underway to determine impacts to the speed and accuracy of diagnoses. Additional software modules are under development that allow treating clinicians (e.g., oncologists and surgeons) to add information to RadPath, enabling a succinct temporal view of a patient's diagnostic, treatment, and outcome information.

**SSE13-02 • Just in Time Data: Accessing Relevant Clinical Information during Image Interpretation Using MPage Summaries  
**

**Norman B Thomson MD (Presenter) ; James V Rawson MD ; Kristopher N Lewis MD  
**

**CONCLUSION**
The Georgia Regents University Medical Center Imaging MPages went live April, 2011. The various uses of the MPages, feedback from Mpages users, and lessons learned will be described and discussed.

**Background**
Imaging providers require up to date clinical patient information to optimally protocol, review and interpret imaging examinations. A clear understanding of clinical context is needed to provide valuable, focused reports and offer effective conclusions and recommendations to improve patient care and outcomes. Paging thru multiple consult and progress notes, procedure descriptions, laboratory and pathology reports, problem lists, vital signs summaries, IandO charts, nursing notes, and other electronic health records to find key contextual information is laborious, inefficient and prone to error. At Georgia Regents University Medical Center, a multidisciplinary team designed, created and implemented a set of custom designed Cerner MPages to provide organized contextually focused patient information to a provider in a single display window, which could be incorporated within the Radiology Information System Desktop. The MPages were designed to assist and augment radiology workflow.
SSE13-03 • Optimized Hospital Radiologist Staffing in a Multisite Radiology Enterprise: A Data Driven Rational Approach to Efficiently Delivering Real Time Subspecialized Radiology

Lily Zou MD (Presenter) ; Murray D Becker MD, PhD ; Alberto F Goldszal PhD, MBA * ; Lisa Martinez

PURPOSE

The current environment requires subspecialization with rapid turnaround times to maximize diagnostic accuracy and time efficiency. These challenges are complicated by the demands of real time reading and the day to day variation in study volumes. Thus, radiologist staffing is a balance of having adequate staff/subspecialization to cope with peak demand, while not incurring waste due to overstaffing. We investigate: 1. study volumes by day/shift; 2. distribution of study types by skillset; 3. variation in volumes by day/shift; 4. impact of aggregation of studies from multiple sites on variations in volume. The results are used to show how to optimize radiologist staffing.

METHOD AND MATERIALS

Data was collected from 5 hospitals (1 academic/4 community) that use a common radiologist staff and unified multisite workstation/worklist. HL7 messages from 285,981 diagnostic radiology studies over 180 consecutive days were analyzed. Studies were sorted by: time (8hr shift: 1st, 2nd, 3rd); day of week; specialty (Neuro, Body, General); Stat flag, and Site. Parameters calculated: avg shift volume (by skillset, day, stat flag) and volume variability was characterized by the coefficient of variation.

RESULTS

All sites are similar : (50% of all studies and 60% stat studies occur between 4pm and 8am (2nd/3rd shifts). By narrow margins, the 1st shift has more total studies than the 2nd shift, but the 2nd shift has more Stat studies. The fraction of Stat studies is higher on weekdays than weekends. Smaller hospital sites tended to have larger variations in per shift volume, but all sites show variability (coefficient of variation=20-40%). Variation was least for General and higher for Body and Neuro. Variation was greatest on the 3rd shift. No site had adequate volume to have 1 FTE in each of General, Body, and Neuro on all shifts. But by aggregating sites, this goal could be attained, and the overall per shift study variation was significantly reduced.

CONCLUSION

Real time subspecialized reading requires adequate 2nd+3rd shift (4pm-8am) staff. Individual sites do not have adequate volumes to always support subspecialization. By aggregating studies from multiple sites, volumes reach a critical mass that supports subspecialization, with the added benefit of reducing day-to-day volume variations.

CLINICAL RELEVANCE/APPLICATION

The analysis of an enterprises study volumes provides a mechanism to optimize the use of radiologists through rational staffing models.

SSE13-04 • Angular Dependency of the Spatial Resolution in Handheld Display Devices

Aldo Badano PhD (Presenter) * ; Asumi Yamazaki MS

CONCLUSION

We found that handheld display devices have subtle viewing angle dependency corresponding to different display technologies. While the angular dependency is small, further investigations are needed to determine the effect on lesion detectability in radiological images.

Background

The increased use of handheld devices for medical image viewing is due in part to improved display image quality, portability, and internet access. A challenge in handheld display devices is that performance should be consistent under different ambient environments. The angular dependency of display luminance and contrast has been extensively investigated for workstation displays. In this study, we report on the spatial resolution as a function of viewing direction for various handheld display devices.

Evaluation

We characterized a liquid crystal-display (LCD) phone, two LCD tablets, and two light-emitting-diode (OLED) phones using a PenTile sub-pixel arrangement. Each screen displaying one pixel line pattern was captured using an imaging photometer camera directed at the screen center at various orientations with 1-degree steps from -8 to 8 degrees relative to the perpendicular viewing direction. The line luminance profiles were obtained and modulation transfer functions (MTF) were calculated.

Discussion

The resolution properties of LCD handhels are independent of viewing directions. As expected, the maximum luminance value on the line profile decreases at tilted angles. On the other hand, we observe the maximum luminance of the horizontal line profile in OLEDs at -8 degrees is the maximum luminance gradually decreased for angles up to 8 degrees. The MTF at 8 degrees decreased by a maximum of 3.4% at the Nyquist frequency from the highest MTF measured at 0 degrees. In the vertical direction, while the maximum luminance is almost constant except for the extreme tilt angle cases, the highest MTF at 0 degrees gradually decreased with off-normal angle resulting in the lowest MTF with 5.3% decrease at -8 degrees at the Nyquist frequency. Angle dependency of OLED displays can be attributed to the sub-pixel driving of PenTile designs with horizontally asymmetric sub-pixel layout.

SSE13-05 • Creation of an Interactive, Real-time Single Screen Depiction of Personal Imaging History in the Electronic Medical Record

H. B Harvey MD, JD (Presenter) ; Akshay Saini ; Pari Pandharipande MD, MPH ; Tarik K Alkasab MD, PhD

CONCLUSION

We have created and deployed an interactive imaging history in the EMR to facilitate utilization of this data by clinical providers and reduce unnecessary exposure to diagnosis.

Background

Patient imaging histories provide treating clinicians and radiologists with valuable information and help to avoid duplicative imaging and unnecessary exposure to diagnostic radiation. However, imaging histories in the electronic medical record (EMR) are often not structured with the needs of these providers in mind. We created and deployed an interactive, real-time, single screen depiction of an individual's imaging history in the EMR aimed at optimizing utility to clinical providers.

Evaluation

The interactive display is driven by a background service that retrieves a record of the imaging history from the enterprise clinical data repository through a medical record aggregation and search tool. This provides records of imaging exams at all sites across the nine component hospitals and the system, including outside exams that have been uploaded to the system. For each retrieved record, the exam date, description, and report impression are extracted. The system uses a lookup table to map each exam description to a body part and modality and attaches this information as well. This processed data set is then passed to the ordering physician or radiologist's web browser, where a JavaScript plugin integrated into an icon in the electronic EMR converts the dataset into an interactive display. For each combination of body part and modality, the tool displays an approximate time when a matching study was last obtained. When the user selects a study on the left, a right pane displays relevant patient information and report text, with the ability to navigate to other studies from a horizontal timeline. This displays the temporal relationship of imaging studies in a useful and efficient way.

Evaluation

The interactive display is driven by a background service that retrieves a record of the imaging history from the enterprise clinical data repository through a medical record aggregation and search tool. This provides records of imaging exams at all sites across the nine component hospitals and the system, including outside exams that have been uploaded to the system. For each retrieved record, the exam date, description, and report impression are extracted. The system uses a lookup table to map each exam description to a body part and modality and attaches this information as well. This processed data set is then passed to the ordering physician or radiologist's web browser, where a JavaScript plugin integrated into an icon in the electronic EMR converts the dataset into an interactive display. For each combination of body part and modality, the tool displays an approximate time when a matching study was last obtained. When the user selects a study on the left, a right pane displays relevant patient information and report text, with the ability to navigate to other studies from a horizontal timeline. This displays the temporal relationship of imaging studies in a useful and efficient way.
**CONCLUSION**
A novel web-based platform and workflow were developed for presenting mammography cases on a mobile device. Large mammogram fields were optimized to balance download times and image quality. Scollable MRI, tomosynthesis, and ultrasound images were also presented with PACS-like navigation using a mobile touchscreen.

**Evaluation**
An online database of radiology cases was developed and presented elsewhere. Ten breast cases with mammogram, tomosynthesis, MRI, and ultrasound images were collected, optimized, and uploaded to the database using a web browser. Mammography images obtained using a Hologic Selenia system were cropped and scaled from a maximum dimension of 4096 pixels (70 micron resolution) to 2250 pixels (130 micron resolution) to accommodate mobile screens. File sizes were reduced to 1 MB or less using JPEG compression with a quality factor of 80-100. As a result of these optimizations, download times for compressed digital mammography files were within 2 seconds for a WiFi-connected mobile device with a typical data rate of 4 Megabits per second. Despite JPEG compression, pathology under 1 mm could be adequately resolved for teaching purposes. Scollable stacks of breast MRI, tomosynthesis, and ultrasound images were also made available, and content could be navigated using a touchscreen.

**Discussion**
High resolution images and multimodality content make mobile presentation of breast cases challenging. However, when mammograms were cropped, scaled, and compressed to 1 MB or less, download speeds were reduced to within 2 seconds per image and image quality remained sufficient to represent subtle pathology. The web-based approach to this case file allowed users to upload image stacks of any modality with immediate online availability.
RESULTS
With both modalities and with imaging under leg traction 23 out of 26 type 2 and 5 out of 5 type 3 lesions were detected yielding a sensitivity of 88.5% and 100%. Sensitivity of imaging analysis without traction was 61.5% for type 2 and 60% for type 3 lesions. 7 type 2 (P = 27%) and 2 type 3 lesions (P = 40%) were only seen with traction.

CONCLUSION
Imaging with traction improved detection of lig. teres lesions. The authors suggest that application of traction during MRA enables visualization of the ligament more similarly to the arthroscopic point of view which reflects a more lax condition of stress and hence facilitates the evaluation of flaps, intrasubstantial fluid accumulation and hypertrophy.

CLINICAL RELEVANCE/APPLICATION
Accurate imaging of lig. teres lesions is challenging. According to recent research on the biomechanical function of the ligament these lesions are increasingly relevant for operative strategies.

SSE14-03 • Detection of Occult Hip Fractures Utilising a Dual Source CT Algorithm Targeted to Detection of Bone Marrow Edema: Initial Results at Vancouver General Hospital

Taryn L Reddy FRANZCR ; Patrick McLaughlin FFRRCSI (Presenter) ; Savvas Nicolaou MD ; Hugue A Ouellette MD

PURPOSE
The purpose of this study was to evaluate the performance of virtual subtracted non calcium images reconstructed from dual energy computed tomography (DECT) data sets for the detection of bone marrow (BM) edema in patients with suspected hip fractures following trauma.

METHOD AND MATERIALS
25 consecutive patients who presented to the Emergency department at Vancouver General Hospital between January 1 2011 and January 1 2013 with clinical suspicion of hip fracture but inconclusive radiographs formed the basis of this study. 7 patients were male and 18 were female, aged between 24 and 97. All CT scans were performed on a dual source CT scanner. Tube voltages were set at 100 kVp and 140 kVp with activated tin filter. The tube current was set at 160mAs with automated attenuation-based tube current modulation.

The postprocessing software algorithm used for the generation of the virtual subtracted non calcium images was originally developed for postprocessing of liver data but was adapted for bone imaging by setting the relative contrast ratio to 1.75, and the minimum and maximum values were set at 300 and 1500 with a range of 3. Two radiologists reviewed the findings on the multimodality workstation utilizing the modified VNC Liver Dual Energy algorithm.

RESULTS
7 of 25 cases did not demonstrate evidence of fracture or BM edema. 14 cases demonstrated evidence of fracture with BM edema (two of these 14 cases also demonstrated BM edema in a different region where fracture was not detected) 1 case demonstrated fracture without accompanying BM edema. 5 cases demonstrated BM edema where the fracture was only seen after review of bone marrow windows (1 case) and in the other four cases although no fracture was identified there was sufficient BM edema to warrant concern of an underlying fracture (two of these cases also demonstrated fractures in a different region with evidence of BM edema).

PPV=0.74,NPV=0.88,Sensitivity=0.93,Specificity=0.58.

CONCLUSION
Findings in this series suggest that DECT can be used to facilitate the diagnosis of hip fractures in patients, particularly in cases where fractures are difficult to visualise on CT, by using a dual energy algorithm which is targeted to the detection of bone marrow edema.

CLINICAL RELEVANCE/APPLICATION
By using an algorithm targeted to the detection of bone marrow edema, DECT can be used to facilitate the diagnosis of occult hip fractures in patients.

SSE14-04 • Reliability of CT Findings of the Sacroiliac Joint - How Many Carats Is This Gold Standard?

Zain K Rajabali (Presenter) ; Babak Mahgooodi BEng, MD ; Isabelle Drolet MD ; Vinmarsha G Swami BSC ; Jacob I Jaremko MD ; Robert G Lambert MBBCh *

PURPOSE
The sacroiliac (SI) joints are the primary site of spondyloarthopathy (SpA), but direct tissue evaluation of SI joint arthropathy from surgical specimens is impractical. The de facto imaging gold standard for bony features of SpA such as SI joint ankylosis is CT scan, but there is little study of the associated inter-observer variability. Therefore, we sought to test reliability of CT assessment of features of SI joint arthropathy. We hypothesized that identification of ankylosis and erosion would be highly reliable (kappa>0.8).

METHOD AND MATERIALS
In this ethics-approved retrospective study at a tertiary hospital, we obtained CT scans of SI joints performed from 2002-2012 for any indication. We had 60 patients aged 10-52 years (mean 33.8), 31 (52.5%) female, 6 (10%) aged 60-79, 15 (25%) aged 80 and over. The prevalence of the features assessed were: ankylosis (kappa 0.48, 20% prevalence), erosion (kappa 0.78-0.89, left-right SI joint), widening (kappa 0.65, prevalence 25%), intra-articular mineralization (kappa 0.69, prevalence 30%), sclerosis (kappa 0.54, prevalence 25%), and subchondral cysts (kappa 0.78, prevalence 30%). The most reliable feature was erosion, with kappa 0.65-0.78. Other features were: subchondral cysts (kappa 0.54, prevalence 25%), and sclerosis (kappa 0.54, prevalence 25%). The least reliable feature was ankylosis, with kappa 0.48-0.78.

CONCLUSION
Detection of SI joint erosion on CT scan was highly reliable between two experienced observers. However, reliability was poorer than expected for several other features of SI joint arthropathy, including notably ankylosis, for which CT is generally considered the gold-standard imaging test. Further study is needed to refine feature scoring to improve the reliability and accuracy of CT assessment of findings that may relate to spondyloarthropathy.

CLINICAL RELEVANCE/APPLICATION
Radiological findings on CT of the sacroiliac joints are highly variable, but with training, even subtle erosion can be reliably observed.

SSE14-05 • Ultrasound Guided Synovial Biopsy in Patients’ with Hip Arthroplasty

Anukul Panu MD, FRCP (Presenter) ; Theodore T Miller MD ; Gregory R Saboeiro MD * ; Giorgio Perino MD ; Geoffrey Westrich MD *

PURPOSE
To evaluate the efficacy of ultrasound guided synovial biopsy in patients with hip arthroplasty suspected of having an adverse local tissue reaction (ALTR).

METHOD AND MATERIALS
We retrospectively assessed 39 consecutive biopsies for suspected ALTR performed over a 2 year period that were sent for an ultrasound guided synovial biopsy. Ultrasound images were retrospectively reviewed to determine synovial thickness and whether an effusion could be distinguished from synovium. Tissue samples were assessed for diagnostic adequacy and the presence of ALTR. The relationships between synovial thickness, sample adequacy, and the presence of ALTR were analyzed as well as the sensitivity of biopsy. Final pathologic diagnosis at revision was used as the gold standard for ALTR.
RESULTS
Adequate samples containing synovial tissue were obtained in 36/39 biopsies (92%). 34/39 (87%) biopsies were taken from an anterior approach with 5/39 (13%) taken posteriorly with all samples directed at the site of maximal synovial thickness via the safest technically feasible approach. There were no post-procedural complications. Synovium could be distinguished from effusion in 38/39 cases (97%). There was no difference between synovial thickness (avg 1.6 cm) or the number of samples obtained (avg 4) between the diagnostic and non-diagnostic biopsy cohorts. Review of the failed biopsies revealed the needle falling short of the capsule in 2/3 of the cases; these cases were performed earlier in the series. Of the 36 adequate specimens, 28 underwent revision and were found to have ALTR with 6/28 (21%) having false negative biopsies. Using the final diagnosis of ALTR at revision as the gold standard, the sensitivity for US guided biopsy is 0.79 (95% CI 0.59-0.91); we are unable to calculate specificity as there have been no true negatives at revision.

CONCLUSION
Ultrasound guided biopsy is a safe procedure that can aid in the diagnosis of patients suspected of having ALTR. The false negatives are due to sampling error. There is no apparent difference between synovial thickness and the ability to obtain an adequate sample or with synovial thickness and ALTR seen at biopsy. Additionally, there is no association between the number of samples obtained and the adequacy of the specimen.

CLINICAL RELEVANCE/APPLICATION
Pre-operative histologic evaluation of the synovium for the presence of suspected ALTR has become critical in the surgical management of these patients.

SSE14-06 • Advanced Core Decompression of the Hip: 3T MRI Monitoring of Patients with Avascular Necrosis
Andrea Lazik MD (Presenter) ; Tim Clasen ; Stefan Landgraebler * ; Florian Grabellus ; Thomas C Lauenstein MD ; Jens M Theysohn MD

PURPOSE
Advanced Core Decompression (ACD) is a new treatment option for patients with avascular necrosis (AVN) of the hip which is still under clinical evaluation. In opposition to standard core decompression, ACD uses an expandable reamer that allows optimal debridement of necrosis after drilling a core to the femoral head. Afterwards the bone defect is filled with a bone graft substitute. We aimed to monitor structural changes and therapeutic success of ACD based on 3T MRI.

METHOD AND MATERIALS
Twenty-five patients (19 male, 6 female, mean age 48.7 years) underwent 3T MRI of the hip prior to and 30 days - 2 years after ACD. The extended clinical protocol included TIRM, PD/T2w TSE, high resolution T1w, DESS and contrast enhanced T1w VIBE sequences. Sequences were evaluated regarding delineation of necrosis, bone, graft and transformation zone in consensus by two radiologists using a 5-point scale (0 = poor contrast, 4 = very good contrast). The volume of necrosis was measured before and after ACD using a post processing tool. MRI images were compared to histological specimens in cooperation with a pathologist.

RESULTS
AVN prior to ACD as well as the defect filled with the graft after ACD and the residual necrosis could be imaged with reproducible high quality at 3T. T1w (mean 2.92) and PDw (mean 2.36) sequences provided best contrast to measure the volume of (residual) necrosis. Every patient showed a reduction of necrosis after ACD (by 16.5% to 90.3%, mean 41.3%, SD 22.5). The transformation zone around the graft could especially be visualized by T2w TIRM, ce T1 VIBE and PDw sequences (contrast granulation zone / bone: 3.11, 3.0 and 2.88). The arrangement of different layers within the transformation zone correlated with histological findings.

CONCLUSION
Structural changes and reduction of necrosis after ACD can be monitored by MRI. ACD can significantly reduce the volume of necrosis in AVN of the hip.

CLINICAL RELEVANCE/APPLICATION
3T MRI is a feasible instrument to quantify and monitor the success of ACD. Further long-time evaluation is needed to identify early MRI signs of healing response or breakdown of the femoral head.
Organ transplant recipients often suffer from severely impaired bone strength arising from a combination of pre-existing osteoporosis and bone disease aggravation due to immunosuppressive treatment after surgery. Lung transplant (LuTX) recipients, in particular, are under an intense post-transplant drug regimen and fracture rates are high. Despite, low bone mineral density and altered states of bone turnover have been reported, bone microarchitecture status has not been analyzed.

**METHOD AND MATERIALS**

After recovery from surgery, 46 patients (female: n=28, male: n=18; mean age: 43.9±13.7) and 46 healthy, age and gender-matched controls (Co) underwent high resolution peripheral quantitative computed tomography (HR-pQCT; SCANCO Medical AG) of the ultradistal radius. Volmetric bone mineral density (BMD) and bone microarchitecture were assessed by a software provided by the manufacturer. Paired t-tests were used to compare mean differences between LuTX patients and Co.

**RESULTS**

Female LuTX recipients had higher cortical porosity (+51.5%, p=0.034), cortical pore diameter (+10.9%, p=0.009), diameter heterogeneity (+18.3%, p=0.021), and lower trabecular BMD (21.1%, p=0.045) than healthy women. Male LuTX patients had lower cortical thickness (-18.9%, p=0.003), total BMD (-21.3%, p=0.001), trabecular BMD (-23.3%, p=0.001), trabecular thickness (-14.4%, p=0.003), and trabecular number (Tb.N: -13%, p=0.028) than healthy men.

**CONCLUSION**

Our results indicate that cortical integrity and trabecular bone microarchitecture are severely impaired in female but also male LuTX recipients. Thinning and porosity of cortical bone might be crucial factors leading to disproportionately high risk of fragility fractures in LuTX recipients.

**CLINICAL RELEVANCE/APPLICATION**

The use of HR-pQCT facilitates patient-oriented research in metabolic bone diseases leading to high risk of fragility fractures such as transplantation osteoporosis.

**SSE15-03 • Automatic Detection of Osteoporotic Vertebral Fractures in Routine Thoracic and Abdominal MDCT**

**Thomas Baum** MD (Presenter); **Jan S Bauer** MD; **Thomas Netsch** PhD; **Tobias Klinder** PhD*; **Martin Dobritz** MD; **Ernst J Rummeny** MD; **Peter B Noel** PhD; **Cristian Lorenz** PhD

**PURPOSE**

To develop an automatic spine segmentation algorithm for routine thoracic and abdominal MDCT and use this algorithm to automatically detect osteoporotic vertebral fractures.

**METHOD AND MATERIALS**

We retrospectively identified 85 patients (43 men, 42 women) older than 45 years of age, who underwent routine contrast-enhanced thoracic and abdominal MDCT. Sagittal reformations (SRs) with a slice thickness of 3mm were routinely reconstructed. The SRs were input for the automatic spine segmentation algorithm. To determine the reproducibility error of the algorithm, five patients were analyzed, who underwent two MDCT examinations within 8 weeks. The performance of the algorithm to detect fractures was investigated in (i) cross-sectional MDCT images of 71 patients including 8 men and 9 women with prevalent osteoporotic vertebral fractures and (ii) baseline and follow-up MDCT images of 9 patients with an incidental vertebral fracture in the follow-up MDCT. Our automatic algorithm firstly localized and identified the vertebrae from T5 to L5 in the MDCT images. Then, each vertebra was automatically segmented by using corresponding vertebra surface shape models that were adapted to the original images. Finally, anterior, anterior-middle, and posterior height of each vertebra was automatically determined, and anterior-posterior-ratio (APR) and middle-posterior-ratio (MPR) were computed. As gold standard, two radiologists graded vertebral fractures from T5 to L5 according to the Genant classification in consensus by using the SRs.

**RESULTS**

The reproducibility error of the algorithm expressed as root mean square coefficient of variation amounted 1.2% for APR as well as MPR. Using ROC analysis to differentiate vertebrae with prevalent versus without fracture, AUC values of 0.84 and 0.83 were obtained for APR and MPR, respectively (p<0.001). We presented a reproducible automatic spine segmentation algorithm that adequately detected osteoporotic vertebral fractures.

**CLINICAL RELEVANCE/APPLICATION**

Osteoporotic vertebral fractures are underdiagnosed in routine radiographs and MDCT. Our automatic spine segmentation algorithm may support radiologists to report osteoporotic fractures.

**SSE15-04 • Positive Effects of Brown Adipose Tissue on Bone Structure and Density**

**Miriam A Bredella** MD (Presenter); **Corey Gill**; **Clifford J Rosen**; **Anne Klibanski** MD; **Martin Torriani** MD

**PURPOSE**

Recent studies suggest a link between brown adipose tissue (BAT) and bone. The purpose of our study was to investigate the effect of BAT on femoral bone structure and density.

**METHOD AND MATERIALS**

The study group comprised 46 patients (10 m, 36 f; mean age of 46.2±17.2 y) who underwent FDG-PET/CT for benign etiologies (n=11) or follow-up of successfully treated malignancies (n=35; mean time between PET/CT and last form of treatment: 14.8±18.0 months). All subjects were BAT positive on PET/CT. BAT volume was quantified and the following measures of femoral bone structure were determined. Linear regression analysis between BAT volume and measures of femoral bone structure and body composition was performed. Forward stepwise regression modeling was also performed to determine the strongest predictor of femoral cortical CSA and femoral density.

**RESULTS**

There were positive correlations between BAT volume and femoral density (r=0.45, p=0.03), total femoral CSA (r=0.39 p=0.02), femoral cortical CSA (r=0.36, p=0.03), and marrow CSA (r=0.32, p=0.05). BAT volume correlated positively with thigh muscle area (r=0.41, p=0.01) and thigh SAT (r=0.35, p=0.04). When femoral cortical CSA was entered as a dependent variable and BAT volume, age and BMI as independent variables in a forward stepwise regression model, BAT volume was the only predictor of cortical CSA and explained 19% of cortical CSA variability. When femoral bone density was entered as a dependent variable and BAT volume, age and BMI as independent variables, BAT volume was the only predictor of femoral density and explained 20% of femoral density variability. The addition of muscle CSA as an independent variable significantly decreased the contribution of BAT.

**CONCLUSION**

BAT volume is a positive predictor of femoral bone structure and density. The relation between BAT and bone could be, in part, mediated by muscle.

**CLINICAL RELEVANCE/APPLICATION**

The identification of brown adipose tissue as a potential regulator in bone formation could lead to novel therapies to prevent bone loss.
Ectopic and Serum Lipids Are Positive Determinants of Bone Marrow Fat in Obesity

Miriam A Bredella MD (Presenter) ; Corey Gill ; Anu V Gerweck ; Melissa G Landa ; Vidhya Kumar ; Scott M Daley ; Martin Torriani MD ; Karen K Miller MD

PURPOSE
Recent studies have linked obesity to bone loss. However, the etiopathology of obesity-associated bone loss is incompletely understood. Serum lipids and ectopic lipid deposits are emerging as important regulators of skeletal physiology, but little is known about their effects on bone in obesity. In addition, both bone and fat cells arise from the same mesenchymal stem cell within bone marrow, capable of differentiation into osteoblasts and adipocytes and obesity has been found to cause a shift into the adipocyte lineage. The purpose of our study was to investigate the associations between ectopic lipids and serum lipids on bone marrow fat, as a marker of stem cell differentiation, in young obese men and women.

METHOD AND MATERIALS
The study group was comprised of 106 healthy young men and women (mean age: 33.7±6.8 years, mean BMI: 33.2±7.1 kg/m2), who underwent 1H-MRS using a PRESS sequence at 3 Tesla of 3D for bone marrow fat content, of soleus muscle for intramyocellular lipids (IMCL), and liver for intrahepatic lipids (IHL), serum cholesterol, triglycerides and an oral glucose tolerance test as a measures of insulin resistance (IR). Exercise status was assessed by the Paffenbarger activity questionnaire.

RESULTS
There was a positive association between bone marrow fat and IHL (r=0.21, p=0.048) independent of BMI, age, IR, and exercise status.

CONCLUSION
Our study suggests that ectopic and serum lipids are positive determinants of bone marrow fat in obese men and women. Because bone marrow fat is known to be inversely related to BMD, these results support the notion that ectopic and serum lipids may exert negative effects on bone. Further studies are needed to investigate this hypothesis and other potential mediators of the effects of obesity on bone.

CLINICAL RELEVANCE/APPLICATION
Elevated ectopic and serum lipids are not only risk factors for cardiovascular disease and type 2 diabetes but may be a risk factor for bone loss.

Analysis of the Microarchitecture of Cancellous Bone by Tomosynthesis - A Feasibility Study in Cows

Junya Yamamoto (Presenter) ; Kazuhiro Mori ; Kazuyoshi Nishino PhD ; Akinori Sakai MD, PhD ; Takatoshi Aoki MD, PhD

PURPOSE
To examine the correlations between total strut length (TSL) obtained by tomosynthesis (TS), microarchitectural parameters obtained by microfocus computed tomography (µCT), and the reproducibility of the TSL of TS.

METHOD AND MATERIALS
Cancellous bone images of 5 cow femurs were acquired using TS (74 projection images, 65 kV, 5 mAs, 0.15 mm pixel size), radiographs (70 kV, 1.8 mAs, 0.15 mm pixel size), and µCT (130 kV, 80 µA, 0.08 mm voxel size). TS tomograms were reconstructed with a 1 mm slice pitch and 0.15 mm pixel size. Five regions of interest (ROIs) were defined in the proximal femur: the femoral neck (FN), greater trochanter (GT), medial intertrochanter (MI), lateral intertrochanter (LI) and posterior intertrochanter (PI). For each ROI, TSLs were derived from TS images and radiographs, and microarchitectural parameters (bone volume per tissue volume, BV/TV; trabecular thickness, Tb.Th; trabecular number, Tb.N; trabecular spacing, Tb.Sp; TSL; and trabecular bone factor, TBPf) were derived from µCT images. Correlations between the TSLs of TS images/radiographs and the microarchitectural parameters of the µCT were evaluated. The coefficient of variance (CV) of the TSLs of TS were evaluated to assess the reproducibility of the TSL analysis and the effect of internal rotation with/without correction by oblique reslicing of the TS images.

RESULTS
The TSL of TS and microarchitectural parameters of µCT (BV/TV: r=0.91, p<0.001, Tb.Th: r=-0.54, p<0.01, Tb.N: r=0.93, p<0.001, Tb.Sp: r=-0.58, p<0.005, TSL: r=0.87, p<0.001, TBPf: r=-0.45, p<0.005) were more highly correlated than those obtained using radiographs (BV/TV: r=0.62, p<0.001, Tb.Th: r=-0.18, p=n.s., Tb.N: r=0.67, p<0.001, Tb.Sp: r=-0.18, p=n.s., TSL: r=0.52, p<0.01, TBPf: r=-0.46, p<0.05). At five ROIs, the CV of TSL of TS, repeated 10 times, ranged from 0.71% to 1.86% (FN: 0.71%, GT: 1.73%, MI: 1.86%, LI: 1.29%, and PI: 1.82%). During examinations in which the internal rotation was corrected by 0~10 degrees by reslicing the tomograms, the CV was significantly improved from 4.4% to 1.1% (p<0.05).

CONCLUSION
Cancellous bone microarchitectural parameters with tomosynthesis correlate well with those from µCT and have high reproducibility.

CLINICAL RELEVANCE/APPLICATION
Tomosynthesis is a potentially useful method to quantitatively analyze the microarchitecture of cancellous bone in vivo with a low radiation dose.
RESULTS
DTI results: the later maturing fiber connecting the temporal cortex with inferior frontal cortex (i.e., SLF) in the left hemisphere showed significant negative correlation with age at two positions: Ba6 (SLF-Prg) and Ba39/40 (SLF-TP). In the right hemisphere, there were significant negative correlations in the SLF/anterior corona radiata and anterior thalamic radiation close to the cingulate cortex (Ba32) (SLF-CC and ATR-CC). Cortical thickness results: two left brain areas correlated significantly with age. One was in the middle frontal cortex (MFC, Ba10), and the other was in the TP (Ba39). These two areas were roughly at the two ends of one of the dorsal pathways (the later maturing dorsal fiber of the SLF).

CONCLUSION
The results suggested that the neural structures which mature later may be affected more than those mature earlier, supporting the last in, first out principle of ageing.

CLINICAL RELEVANCE/APPLICATION
The current study extend the 'last in, first out' principle to a large-scale neural network corresponding to high-level cognitive network (i.e., language).

SSE16-02 • Voxel-based Morphometry at 3-T MR Imaging for Detection of Individuals with Mild Alzheimer Disease
Xiangzhu Zeng MD (Presenter) ; Huishu Yuan MD ; Ying Liu MD ; Zheng Wang MS ; Na Zhang MD

PURPOSE
Voxel-based morphometry (VBM) was used to investigate the patterns of cortical atrophy in mild Alzheimer's disease.

METHOD AND MATERIALS
13 mild Alzheimer's disease (AD, 5 men and 8 women, mean age 75.00±7.36 years) cases and 15 no cognitive impairment (NCI, 4 men and 11 women, mean age 71.20±7.89 years) cases were investigated. For all cases, high-resolution T1SPGR images were acquired on a GE750 3T scanner. The acquisition parameters were: TR/TE = 4.9/2 ms, voxel size = 1X1X1 mm3. After image acquisition, T1SPGR images were segmented, normalized and smoothed using VBM8 (http://dbm.neuro.uni-jena.de/vbm/). The statistical analyses were performed on SPM8 by two-sample t-test for comparing mild AD with NCI.

RESULTS
There were significant differences in Mini Mental Status Exam (MMSE) (mild AD: 21.3±4.97, HC: 28.75±0.93) and between the 2 groups (p < 0.001) but none in age (p = 0.061). Cortical volumes decreased significantly (p < 0.001, pFWE = 0.05, T = 5.33, corrected for multiple comparisons) in mild AD compared to NCI in the bilateral parahippocampal gyrus, bilateral middle temporal gyrus and inferior temporal gyrus, left inferior frontal gyrus and left insula.

CONCLUSION
Our results showed patterns of regional cortical atrophy of mild AD, suggesting underlying structure abnormality. As a potential biomarker, VBM could identify the structural changes of mild Alzheimer patients.

CLINICAL RELEVANCE/APPLICATION
VBM is a useful noninvasive tool to identify the cortical atrophy in mild Alzheimer disease.

SSE16-03 • Arterial Spin Labeling at 3-T MR Imaging for Detection of Individuals with Mild Alzheimer Disease
Xiangzhu Zeng MD (Presenter) ; Huishu Yuan MD ; Ying Liu MD ; Zheng Wang MS ; Na Zhang MD

PURPOSE
Arterial spin labeling (ASL) was used to investigate the role of vascular impairment in mild Alzheimer's disease.

METHOD AND MATERIALS
13 mild Alzheimer's disease (AD, 5 men and 8 women, mean age 75.00±7.36 years) cases and 15 no cognitive impairment (NCI, 4 men and 11 women, mean age 71.20±7.89 years) cases were investigated. For all cases, pseudo-continuous ASL scanning was conducted with 36 label/control images acquired on a GE750 3T scanner. The acquisition parameters were: post-labeling delay = 1500 ms, TR/TE = 462/10.5 ms, voxel size = 2X2X4 mm3. High-resolution T1SPGR images were acquired as well. After image acquisition, CBF maps were calculated using in-house software. T1SPGR was segmented using SPM8 and registered onto CBF maps. As partial volume effect (PVE) is strongly recommended in ASL due to its limited spatial resolution and the cortical atrophy in dementia, a PVE correction method was incorporated by using a software called fMRI Grocer (http://code.google.com/p/fmrigrocer/). Mean gray matter (GM) CBF was calculated for each case and preprocessing and statistical analyses were performed on SPM8.

RESULTS
There were significant differences in Mini Mental Status Exam (MMSE) (mild AD: 21.3±4.97, HC: 28.75±0.93) and between the 2 groups (p < 0.001) but none in age (p = 0.061). GM CBF decreased significantly (p < 0.001, T = 3.84, corrected for multiple comparisons) in mild AD compared to NCI in the bilateral precuneus and cuneus, bilateral parahippocampal gyrus, bilateral middle temporal gyrus and inferior temporal gyrus, left inferior frontal gyrus and left insula.

CONCLUSION
Our results revealed patterns of regional hemodynamic impairment typical of mild AD, suggesting underlying vascular abnormality. As a potential biomarker, ASL could differentiate the patients from the healthy.

CLINICAL RELEVANCE/APPLICATION
3D ASL is a useful noninvasive MRI sequence to identify the vascular impairment in mild Alzheimer's disease.

SSE16-04 • Changes of Functional Activation in the Prefrontal Lobe in Early Alzheimer’s Disease during Memory Tasks: An ASL-fMRI Study at 4.0T
Wei Chen MMedSc ; Xiaowei Song PhD ; Careesa Liu ; Ryan D’Arcy ; Steven D Beyea PhD (Presenter) * ; Kenneth Rockwood

PURPOSE
Perfusion-based functional MRI using arterial spin labeling (ASL) has been used to investigate brain activation based on cerebral circulation. While the so-called neurocompensatory response using perfusion fMRI has been proposed in early Alzheimer's disease (AD) based on BOLD fMRI data, few studies have evaluated such neurocompensatory response using perfusion fMRI. Here, we investigated brain functional changes under episodic memory encoding and retrieval tasks in subjects with early AD and those with cognitively healthy aging using high-field ASL.

METHOD AND MATERIALS
Twelve subjects diagnosed with early AD (mean age=72.3±7.9 yrs, females=5) and 12 age-matched cognitively normal subjects (CN, mean age=73.7±5.5yrs, females=9) were enrolled in this study. A 4T Varian-Oxford human MRI system with interleaved multi-slice flow-sensitive alternating inversion recovery (FAIR) was employed to investigate brain activation during both encoding and retrieval tasks. Data processing and analysis were performed using FSL, with the bilateral frontal lobes as the region of interest.

RESULTS
Brain activation was found in bilateral frontal cortex and the anterior cingulate cortex (ACC) in AD in response to both encoding and retrieval tasks. Increased activation was found during retrieval compared to encoding, which was primarily seen in the bilateral dorsolateral prefrontal cortex (DLPFC) and the ACC (Figure 1). Moreover, patients with early AD showed significantly greater activation than the normal controls in the bilateral prefrontal cortex including the DLPFC and the ventrolateral prefrontal cortex (VLPFC) (especially...
CONCLUSION
Hyperactivation, as measured using ASL perfusion fMRI, was found in bilateral prefrontal cortex in subjects with early AD during memory tasks, suggesting possible neurocompensatory response.

CLINICAL RELEVANCE/APPLICATION
Perfusion based functional changes may provide a sensitive measure to benefit early AD diagnosis.

SSE16-05 • Significance of Cerebellar Activity in the Attention Network in MCI
Zhizhang Qi (Presenter) ; Kuncheng Li MD

PURPOSE
Once cerebellum was a structure specialized for motor processing, while recently, it is also considered to be involved in cognition, here we want to investigate its meanings in the evaluation of mild cognitive impairment (MCI).

METHOD AND MATERIALS
Eighteen MCI and twenty normal elderly were recruited from a community investigation. Demographics of MCI patients and healthy elderly, including age, sex, and education years, were matched between the two groups. The age of participants was equally distributed between the two diagnostic groups (t=0.56, p=0.28 two-sample two-tailed t test) with similar medians and ranges. However, the groups were significantly different with regard to MMSE scores (t=2.18, pAll imaging was performed with a 3 T Siemens Trio system. Functional MR images were acquired while at rest.

Functional connectivity analysis: Taking left temporal parietal junction(TPJ) area and left inferior parietal lobule(IPL) as seed, functional connectivity was performed between the seed and whole brain with a voxel-wise manner.

RESULTS
Ventral attention network was verified with functional connectivity to left TPJ. And dorsal attention network was verified with functional connectivity to left IPL. The between-group differences were detected through two sample t-test. No significant difference was detected in ventral attention network between MCI and healthy elderly. While in dorsal attention network, significant difference was detected between MCI and healthy elderly. While taking comparison to healthy elderly, decreased functional connectivity to left IPL was observed in right cerebellar lobule VIIa Crus II, in addition to bilateral frontal cortex, right precuneus, right temporal cortex. And increased functional connectivity to left IPL was observed in right cerebellar vermis VI, right cerebellar lobule VI, right cerebellar VIIa Crus I, left cerebellar lobule VI, in addition to bilateral precuneus.

CONCLUSION
TPJ and IPL is the core of ventral and dorsal attention network. Changes of functional activity were observed in dorsal attention network in MCI. And cerebellum may play an important role in this process.

CLINICAL RELEVANCE/APPLICATION
(dealing with cerebellar activity) cerebellar activity was verified in the dorsal attention network and may be significant in evaluation of changes of cognitive function of mild cognitive impairment

SSE16-06 • Detecting Microstructural Abnormality in Gray and White Matter of Alzheimer’s Disease Using Diffusional Kurtosis Imaging
Nan-Jie Gong (Presenter) ; Chun-Chung Chan ; Lam-Ming Leung ; Chun-Sing Wong

PURPOSE
Newly introduced method of diffusional kurtosis imaging (DKI) is able to delineate non-Gaussian diffusion, which is beyond the scope of conventional diffusion tensor imaging (DTI). Clarifying whether the more accurate approach can improve imaging diagnosis of Alzheimer’s disease (AD) is of intense interests.

METHOD AND MATERIALS
DKI data were collected from a 3T scanner with 3 b values (0, 1000, 2000 s/mm²) and 32 diffusion directions. Using SPM, we conducted two sample t-test of DKI parametric maps voxel-by-voxel between two groups of 11 ADs, 20 normal controls (NCs). Statistical maps were thresholded at p < 0.001 and clusters with at least 500 edge-connected voxels were labeled.

RESULTS
In AD patients, compared with NC, significantly lower fractional anisotropy were observed in right frontal cortex and gyrus, right temporal cortex and gyrus. In addition, significantly higher mean diffusivity were observed in right temporal white matter, and significantly lower mean kurtosis in right inferior frontal gyrus, left and right temporal cortex, left and right inferior longitudinal fasciculus.

CONCLUSION
Adding to the traditional DTI metrics, DKI metric like mean kurtosis can provide new regional contrast between AD and NC.

CLINICAL RELEVANCE/APPLICATION
Therefore, DKI may potentially improve detection of early disease.
CVR averaged over the grey matter and white matter demonstrated a biphasic trend in both males and females, as illustrated in Figure 1. There is a definite increase in CVR up to the mid-teens, followed by a gradual downwards slope and plateau with increasing age. The observed effect is far more prominent in females.

CONCLUSION
The dependence of CVR can confound interpretation of results, especially during childhood and adolescence when significant cerebrovascular changes take place. Our study shows an apparent trend in the evolution of CVR with age in healthy subjects. Additional data will be collected to further substantiate this finding as well as extend the age range for a more comprehensive understanding of how CVR is affected.

CLINICAL RELEVANCE/APPLICATION
The effect of age is a major consideration in the interpretation of fMRI findings in children.

SSE17-02 • Quantitative Measurement of Cerebrovascular Reserve in Unilateral High Grade Carotid Steno-occlusion by Acetazolamide-challenged CT Perfusion: Correlation with Symptom and Type of Collateral Circulation

Doran Hong MD (Presenter) ; Younghen Lee MD ; Hyung Suk Seo ; Sang-II Suh ; Nam J Lee MD ; Hae Young Seol MD ; Jung Hyuk Kim

PURPOSE
CT perfusion with acetazolamide (CTP-ACZ) is introduced as a useful method to evaluate the cerebrovascular reserve (CVR). In patients with severe carotid stenosis, assessment of CVR and collateral circulation is essential for treatment strategy. However, the hemodynamic contribution of collateral circulation is uncertain. Therefore, we correlated CVR in adult patients with unilateral high grade intracranial steno-occlusion with their symptoms, angiographic findings by CTP-ACZ.

METHOD AND MATERIALS
A retrospective analysis of prospectively collected 35 patients (M:F=22:13, mean age, 51.9±14.5 years) with unilateral internal carotid artery(ICA) or middle cerebral artery(MCA) high grade steno-occlusion (severe stenosis> 70%; occlusion=7:28) were performed. They underwent CTP before and 20 minutes after intravenous administration of ACZ . We manually drew regions of interest in the cortical flow territory of the MCA at the level of basal ganglia and centrum semiovale in each hemisphere; recorded CTP parameters (cerebral blood flow (CBF), mean transit time (MTT). We compared the percentage change (PC) of CBF and MTT difference by calculating CBF and MTT measured before and after ACZ infusion, regarding to (1)symptomatic (n=17) VS. asymptomatic (n=18) (2)primary (n=8) VS secondary (n=20), by SPSS multivariate analysis. Degree of stenosis and presence of collateral circulation were assessed by cerebral angiography (n=22), CT- or MR- angiography (n=35).

RESULTS
Compared to the contralateral hemisphere supplied by non-stenotic ICA, PC of CBF and MTT difference obtained by CTP-ACZ were significantly lower in hemisphere ipsilateral to high grade stenosis (p

CONCLUSION
Because CTP parameters measured by CTP-ACZ might be variable in high grade carotid stenosis depending on the location of ROI, optimization of CTP-ACZ must be needed for clinical relevance.

CLINICAL RELEVANCE/APPLICATION
Because CTP parameters measured by CTP-ACZ might be variable in high grade carotid stenosis depending on the location of ROI, optimization of CTP-ACZ must be needed.

SSE17-03 • Correlation of Multi-echo Vessel-encoded Arterial Spin Labeling and Hypercarbic Blood-oxygenation Level Dependent Reactivity MRI for Quantification of Hemodynamic Compensation in 70 Patients with Cerebrovascular Disease

Daniel Arteaga BA (Presenter) ; Megan K Strother MD ; Travis R Ladner MD ; Robert Singer MD ; Carlos Faraco PhD ; Manus Donahue PhD

PURPOSE
The purpose of this work is to develop and clinically implement a MRI protocol for quantifying the relationship between hemodynamic compensation mechanisms including cerebrovascular reactivity (CVR), baseline cerebral blood flow (CBF), CBF reactivity, and CBF territory dynamics in patients with cerebrovascular disease. In many patients at risk for stroke with compromised cerebral perfusion pressure, the critical barrier to stratifying stroke risk based on this information rests with a lack of (i) methodology for measuring multiple hemodynamic parameters in a clinically relevant timeframe and (ii) knowledge of how changes in such parameters should be interpreted for prognosis.

METHOD AND MATERIALS
Methods: Changes in end-tidal CO2 (?EtCO2) were monitored and CVR was assessed using blood oxygenation level dependent (BOLD) MRI (TR/TE=2000/35 ms; spatial resolution = 3.5x3.5x3.5 mm3) in conjunction with 180s/180s off (room air) / on (5%/95% CO2/O2) breathing. Baseline CBF was assessed using a pseudo-continuous (pCASL) approach (TR/TI/TE=4000/1650/13 ms; spatial resolution = 3x3x7 mm3). Hemodynamic compromise was correlated with extent of vascular stenosis. For Moyamoya subjects, MRI hemodynamic data were compared with clinical disability scores and modified Suzuki Scores (mSS), calculated from angiography.

RESULTS
At TE2=35 ms, the spin labeling contributes minimally relative to BOLD weighting. This finding demonstrates that moderate temporal resolution (TR=4500 ms) may be achieved for BOLD sensitivity in a functional ME VE-ASL approach. Clinical findings varied with underlying etiology. In patients with Moyamoya disease, BOLD CVR was significantly (P=0.017) higher in low mSS hemispheres (z-statistic= 5.0±2.5) compared to high mSS hemispheres (z-statistic=3.7±1.7), implying that regions with less advanced stages of Moyamoya disease have higher reactivity. All study participants are monitored longitudinally to understand the relationship between hemodynamic imaging and stroke risk.

CONCLUSION
A clinical 3T head MR protocol was expanded and clinically implemented for simultaneous measurements of CVR, baseline CBF, CBF reactivity, and CBF territory mapping using a novel 15 min ME VE-ASL approach.

CLINICAL RELEVANCE/APPLICATION
Hemodynamic MRI can demonstrate cerebrovascular impairment noninvasively, and may be useful in the longitudinal evaluation of stroke risk in patients with intracranial stenosis.
DWI is the most accurate technique for delineating acute infarct core. Large DWI infarct volume (>70cc) is associated with poor outcome despite treatment, and has been used as a treatment exclusion criterion. CT is more widely available than MRI, but suffers from poor specificity for infarct detection. We sought to determine whether a combined approach using noncontrast CT (NCCT) and CT angiography (CTA) improves prediction of large DWI infarcts.

**METHOD AND MATERIALS**

In a single-center, retrospective study, we identified consecutive acute ischemic stroke patients with anterior circulation proximal artery occlusions who underwent both CT and MRI. Patients were categorized into two groups based on DWI lesion volume (≥ vs. >70 cc). Because patient exclusion from treatment requires high certainty for the presence of a large infarct, we utilized thresholds previously reported to have high (>95%) specificity for DWI infarct volume >70cc for NCCT ASPECTS (scores 0–4) and CTA collateral evaluation (malignant collateral profile: absent collaterals in >50% of MCA M2 division territory). We determined the test characteristics of these prespecified thresholds in this dataset, and evaluated whether these thresholds in combination would improve the diagnostic yield for identifying patients with large infarcts.

**RESULTS**

Fifty-five patients satisfied study criteria. Median NIHSS was 14 (IQR 6-18), and mean age was 66.9 ± 15.2 years. Fifteen (27.2%) patients had a DWI infarct core volume >70cc. NCCT ASPECTS 0-4 had 100% specificity but only 53.3% sensitivity for identifying a large infarct on DWI. Similarly, the CTA malignant collateral profile had 97.5% specificity but only 53.3% sensitivity. In a combined approach (i.e., satisfaction of either threshold), the sensitivity was improved to 73.3% while maintaining a high specificity (97.5%). Of the 15 patients with large infarcts, 7 were missed using each threshold alone, while only 4 were missed using the combined thresholds.

**CONCLUSION**

Combining NCCT and CTA collateral evaluation improves the sensitivity for identifying patients with large DWI infarcts while preserving the high specificity required for treatment exclusion.

**CLINICAL RELEVANCE/APPLICATION**

For identifying large infarcts predictive of poor treatment response, combining NCCT and CTA collateral evaluation improves sensitivity from 53% to 73%, while preserving high (>95%) specificity.

### SSE17-05 • Intracranial Intraplaque Hemorrhage: Prevalence and Association with Infarction in a Population-based Study

**Yuan Yuan Xie MD, BEng (Presenter); Ye Qiao; Nariman Nezami MD; Jarunee Intrapiromkul MD; Saeedeh Mirbagheri MD; Zeeeshan Anwar; Li Liu; Bruce A Wasserman MD**

**PURPOSE**

Carotid intraplaque hemorrhage (IPH) is a well-recognized risk marker for cerebrovascular ischemic events. It can be reliably identified on MRI using MPRAGE, a 3D T1-weighted sequence, due to the short T1 of blood products. Although it is an important target in imaging extracranial carotid plaque, little is known about its occurrence in intracranial plaque. Our aim was to determine the prevalence of IPH in middle cerebral artery (MCA) plaques, in a US community-representative population (the Atherosclerosis Risk in Communities Neurocognitive Study [ARIC-NCS]), and investigate its association with ischemic infarcts.

**METHOD AND MATERIALS**

1,141 ARIC-NCS participants (mean age, 76 (67 90); 42% male; 84% white, 15% black) underwent brain MRI scans that included 3D MPRAGE (resolution 1mm3, TR 2.3s, TE 3ms, TI 900ms, flip angle 9°), 3D time-of-flight (TOF) MRA, and 3D black blood [1] sequences. MCA plaques were identified on TOF MRA and confirmed on black blood MRI. Signal intensity (SI) was measured at the corresponding location on MPRAGE and IPH was considered present if this SI exceeded that measured in the pterygoid muscle. T1-, T2-, and T2* images were used to rule out recent hemorrhage. Pathology was used as the gold standard. Plaques and IPH were identified on 1.141 exams, 89 MCA plaques were identified in 71 (6.2%) participants (mean age 80). There were 18 (1.6%) cases with bilateral MCA plaques, 28 (2.5%) cases with right MCA plaques, and 24 (2.1%) cases with left MCA plaques. Out of 89 MCA plaques, there were 57 plaques (64%) in 45 (3.9%) participants with IPH. 13 plaques had infarcts in the territories of the plaques, and IPH was present in 12 (92%). 46 plaques showed IPH without corresponding infarcts, and 30 plaques showed neither IPH nor infarcts. IPH was associated with territorial infarcts (odds ratio, 7.83 [CI = 0.97-63.4, p = 0.05]; marginally significant).

**CONCLUSION**

Although the prevalence of IPH in this population is infrequent, its association with ischemic events suggests its identification might have important clinical relevance. 1. Qiao Y et al. JMRI. 2011

**CLINICAL RELEVANCE/APPLICATION**

Identifying intracranial IPH on T1 sequences might provide insight on risk of stroke.

### SSE17-06 • Stroke Rehabilitation Using Brain-computer-Interface Technology with Multi-modal Neurological Feedback: Brain Activation Changes Associated with this Interventional Therapy

**Brittany Young (Presenter); Jie Song MS; Leo Walton; Svyatoslav Vergun; Veena A Nair PhD; Mitch Tyler; Justin Sattin; Dorothy Farrar-Edwards; Justin Williams; Vivek Prabhakaran MD, PRD**

**PURPOSE**

Brain-computer interface (BCI) is an emerging technology for stroke rehabilitation, but little is known about neuroplastic changes associated with its use. We examine changes in brain activity during imagined (MI) and executed (ME) hand motor tasks associated with BCI-based interventional therapy.

**METHOD AND MATERIALS**

Anatomical and functional images were collected on 16 subjects (8 stroke patients; 8 healthy controls) on a GE 3T MR scanner. Functional images were acquired during MI and ME finger tapping or squeezing of each hand. Not all subjects completed all tasks. Patients had right upper extremity impairment and were given therapy of the affected hand up to three times weekly for up to six weeks. Patients were scanned pre-, mid- and post-therapy. Group-level analyses compared mid- and post-therapy activation to pre-therapy using AFNI.

**RESULTS**

Normal and Stroke subjects showed supplementary motor area (SMA) and precentral gyrus activity in both MI and ME tasks. Stroke subjects showed mid-therapy activation increases that persisted post-therapy in the left SMA, premotor cortex, and cingulate during ME affected hand tapping, bilaterally in the cerebellar tonsils during MI affected hand tapping, in the left medial and superior frontal gyr and the cingulate during ME unaffected hand tapping, and in the right precuneus during MI unaffected hand tapping. Mid-therapy activation increases in the left sensorimotor cortex and SMA during ME tasks of the affected hand. Post-therapy activation increased in the left inferior frontal gyrus and insula during MI squeezing of the unaffected hand. All fMRI activity are reported at p < 0.05.

**CONCLUSION**

The results suggest that interventional therapy of the affected hand using BCI is associated with brain activity changes in specific areas involving both affected and unaffected hands. Persistent activation increases associated with ME and MI tasks of the affected hand may represent neuroplastic recovery. These data also suggest that some sensorimotor cortex changes may develop earlier while other changes take longer to emerge with BCI therapy.
CLINICAL RELEVANCE/APPLICATION
Characterizing changes in brain activation after stroke rehabilitation using brain-computer interface technology will provide insight into mechanisms of neuroplasticity associated with this therapy.

Neuroradiology/Head and Neck (ENT Oncology)

Monday, 03:00 PM - 04:00 PM • N230

SSE18 • AMA PRA Category 1 Credit ™:1 • ARRT Category A+ Credit:1
Moderator
Julia Fruehwald-Pallamar, MD
Moderator
Barton F Branstetter, MD

SSE18-01 • Initial Clinical Experience of Core Needle Biopsy with BRAF V600E Mutation Analysis in Thyroid Nodules

Eun Ju Ha; Jung Hwan Baek; Hun Cho MD (Presenter); Jeong Hyun Lee MD, PhD

PURPOSE
To evaluate the role of core-needle biopsy (CNB) with BRAF V600E mutation combined analysis in thyroid nodules having non-diagnostic or atypia of undetermined significance (AUS) results on fine-needle aspiration (FNA).

METHOD AND MATERIALS
From January 2011 to March 2012, CNB +BRAFV600E mutation combined analysis was performed on thyroid nodules with previously non-diagnostic (n=32) or AUS (n=97) results. Direct DNA sequencing technique was used for BRAF V600E mutation analysis. The diagnostic value of CNB +BRAFV600E mutation analysis was evaluated.

RESULTS
The sensitivity and positive predictive value of BRAF V600E mutation in CNB specimens were 66.3% and 100%, respectively. Of 32 nodules with previously non-diagnostic results, CNB showed 81.3% (26/32) of conclusive results with 6 cases of AUS and no cases of non-diagnostic results. There was no additional value of CNB+BRAFV600E mutation analysis. Of 97 nodules with previously AUS results, CNB showed 93.8% (91/97) of conclusive results with 5 cases of AUS and 1 case of non-diagnostic results. There was 3.1% (3/97) additional value of CNB+BRAFV600E mutation analysis.

CONCLUSION
CNB of the thyroid nodule demonstrate high rates of conclusive diagnoses in patients for whom previous FNA results are non-diagnostic or AUS. The CNB +BRAFV600E mutation analysis may be helpful for patients with previously AUS results.

SSE18-02 • Bimodal Histogram Analysis of Apparent Diffusion Coefficient Values for Detection of Occult Tonsil Cancer in Patients Presenting with Neck Metastasis from an Unknown Primary

Young Jun Choi MD (Presenter); Jeong Hyun Lee MD, PhD; Jung Hwan Baek

PURPOSE
To explore the role of bimodal histogram analysis of apparent diffusion coefficient (ADC) values for detecting occult palatine tonsillar squamous cell carcinoma (PTSSC) in patients with neck metastasis from an unknown primary.

METHOD AND MATERIALS
This retrospective study was approved by the institutional review board, and informed consent was waived. We enrolled 19 patients with occult PTSSC presenting with neck metastasis from an unknown primary, 20 with overt PTSSC on physical examination, and 20 with normal neck. Diffusion-weighted imaging (DWI) was performed with b values of 0 and 800 sec/mm2. ADC values of the entire volume of palatine tonsil were measured by manual drawing of regions-of-interests. Bimodal histogram parameters of the ADC values were obtained using in-house code and statistically tested for difference (Kruskal-Wallis test, Mann-Whitney U test). Receiver operating characteristic (ROC) analysis was employed to determine the best differentiating parameter between occult PTSSCs and normal tonsils. We also analyzed added values of histogram analysis of ADC values to conventional MRI and 18F-FDG PET/CT.

RESULTS
The bimodal histogram analysis showed statistically significant differences in mean, 50th and 90th ADC values between overt PTSSCs and occult PTSSCs/normal palatine tonsils. Between occult PTSSCs and normal tonsils, standard deviation ([0.54±0.20]x10^-3 mm^2/sec vs [0.41±0.09] x 10^-3 mm^2/sec), skewness ([0.52±0.38] x 10^-3 mm^2/sec vs [0.30±0.25]x10^-3 mm^2/sec), and 90th value of ADC ([1.75±0.27] x 10^-3 mm^2/sec vs [1.52±0.25]x10^-3 mm^2/sec) were significant higher (P<0.05).

CONCLUSION
Adjunctive histogram analysis of ADC values detected five more occult PTSSCs (26.3%) than conventional MRI and 18F-FDG PET/CT, therefore, adjunctive histogram analysis can be helpful when conventional MRI and 18F-FDG PET/CT failed to detect occult PTSSCs.

CLINICAL RELEVANCE/APPLICATION
Adjunctive bimodal histogram analysis can be helpful when conventional MRI and 18F-FDG PET/CT failed to detect occult PTSSCs.

SSE18-03 • Role of ARFI in the Assessment of Thyroid Nodules

Bagyam Raghavan MBBS, DMRD (Presenter); Sounak Paul MBBS; Sathyasree Viswanathan MBBS; Atif Wasim Haneef Mohamed; Jayaraj Govindaraj MD; Saravanan Shanmugasundaram DMRD, MBBS

PURPOSE
The purpose of the study was aimed at improving diagnostic significance of thyroid sonography in predicting cytological type of thyroid nodules by additional use of ARFI.

METHOD AND MATERIALS
110 nodules were evaluated by B-mode imaging and color Doppler and ARFI. Shear wave elasticity measurements according to ARFI (Acoustic Radiation Force Impulse) imaging was performed for 110 nodules in 52 patients. Images obtained by Virtual Touch tissue imaging (VTI) were classified into three groups: Soft, Intermediate hardness, and Hard. Numerical values were also computed for the nodules Virtual touch tissue Quantification (VTQ ). The results of B-mode imaging, color Doppler and ARFI were compared with the cyto-pathological diagnosis and analyzed statistically using Chi square test, and Logistic regression analysis to find out the correlation between the sonographic variables and final cytological end result. The significant VTQ values of each subgroup of hardness were evaluated by ANNOVA (Analysis of Variants). SSPS for Windows, Version 17 was used for the statistical analysis.

RESULTS
Multi nodular goiter and Thyroiditis nodules can remain indeterminate after B-mode and Color . In our study we found that tissue hardness assessment obtained by ARFI helped in categorization of such nodules and reducing negative cytology rates. The concordance between
In this study however we obtained a significant statistical correlation of intermediate hardness in predicting thyroiditis, odds ratio of 9.22 (95% confidence interval from 3.09 to 27.45) (p value Multi nodular goiter and Thyroiditis nodules can remain indeterminate after B-mode and Color).

CONCLUSION
In our study we found that tissue hardness assessment obtained by ARFI helped in categorization of such nodules and reducing negative cytology rates.

In this study however we obtained a significant statistical correlation of intermediate hardness in predicting thyroiditis, odds ratio of 9.22 (95% confidence interval from 3.09 to 27.45) (p value

CLINICAL RELEVANCE/APPLICATION
ARFI with Virtual Touch Tissue Imaging Analysis is a quick additional parameter in the diagnosis of thyroid nodules

SSE18-04 • Preliminary Evaluation of MR Diffusion Kurtosis Imaging at 3-Tesla for Head and Neck Squamous Cell Carcinoma: A New Monitoring Tool for Early Treatment Response
Yukie Shimizu (Presenter) ; Noriuki Fujima MD ; Daisuke Yoshida ; Tomohiro Sakashita ; Akihiro Homma ; Kohsuke Kudo MD ; Hiroki Shirato MD, PhD

PURPOSE
The purpose of this study is to investigate the usefulness of 3-T MR diffusion kurtosis imaging (DKI) for the assessment of patients with head and neck squamous cell carcinoma (HNSCC).

METHOD AND MATERIALS
Eighteen patients who were histopathologically diagnosed as HNSCC were included in this study. All patients were treated with super-selective arterial infusion of cisplatin with concomitant radiotherapy. TDKhey underwent magnetic resonance imaging (MRI) using DKI sequence before the treatment and at the early treatment period (at time point of 15-25 Gy in total 65 Gy radiotherapy). All MR scanning was performed by using a 3-T unit (Achieve TX; Philips Medical Systems, Best, The Netherlands) with a 16-channel neurovascular coil. DKI was obtained by using single-shot echo planar diffusion weighted imaging with 4 different b values of 0, 800, 1000, 2000s/mm². Three orthogonal motion probing gradient was used. The quantitative DK value of the tumor in each of the 18 patients was calculated using DKI datasets. The change ratio of DK value between pre-treatment and early treatment period was also calculated.

RESULTS
After the treatment, thirteen patients were classified into complete remission (CR) group and the other five were into non-CR group judging from multi-modality assessment and clinical follow-up. Mean of value in pre-treatment, early treatment period, and its change ratio were compared between CR and non-CR groups using non-paired T-test.

CONCLUSION
The change ratio of DK value in CR group was significantly lower than non-CR group (0.78±0.13 vs 0.93±0.05, P<0.05).

SSE18-05 • Treatment of Metastatic Lymph Nodes in the Neck from Papillary Thyroid Carcinoma by Percutaneous US-guided Interstitial Laser Ablation: Three Years Experience
Giovanni Mauri MD (Presenter) ; Luca Cova MD ; Tania Tondolo ; Tiziana Ierace MD ; Enzo Di Mauro ; Claudio M Pacella MD ; S. Nahum Goldberg MD * ; Luigi Solbiati MD

PURPOSE
We report our three year experience with percutaneous US-guided interstitial laser ablation for metachronous cervical nodal metastases from papillary thyroid carcinoma.

METHOD AND MATERIALS
Laser ablation was technically feasible and well tolerated in all patients, with no either immediate or late complications. In 5 cases a second PLA was performed to treat recurrent disease (3 pt) or new lymph node metastases (2 pt). At a mean follow up time of 19 months local control was achieved in 19/26 (73%) patients, with 11 (42%) having serum Tg/TgAb normalized. Complete ablation (lack of enhancement at CEUS, no uptake at 18F-FDG PET) was achieved in 38/46 (83%) 4 patients developed distant disease progression.

CONCLUSION
Percutaneous US-guided interstitial laser ablation seems to be an effective, low cost and safe therapeutic tool for the treatment of metachronous nodal metastases from papillary thyroid carcinoma in the neck which would otherwise require often challenging further resections.

SSE18-06 • Intravoxel Incoherent Motion MR Imaging: Emerging Applications for Nasopharyngeal Carcinoma at the Primary Site
Shui Xing Zhang MD (Presenter) ; Qianjun Jia MD ; Zhong-Ping Zhang ; Chang Hong Liang MD ; Wen-Bo Chen BArch ; Qian-Hui Qiu

PURPOSE
To compare pure molecular diffusion, $D$, perfusion-related diffusion, $D^*$ and perfusion fraction, $f$, determined from diffusion-weighted (DW) magnetic resonance (MR) imaging on the basis of the intravoxel incoherent motion (IVIM) theory in patients with nasopharyngeal carcinoma (NPC) at the primary site.

METHOD AND MATERIALS
This prospective study was approved by the appropriate ethics committee, and written informed consent was obtained from all patients. Between December 2011 and October 2012, 35 consecutive patients (22 men, 13 women; mean age, 49 years; age range 16–69 years) with suspected of having NPC were examined on a 3.0T MR scanner. DW imaging was performed by using a single-shot echo-planar sequence with 13 b-values (0, 10, 20, 30, 50, 80, 100, 150, 200, 300, 400, 600, 800 sec/mm²). MR imaging was compared with endoscopy and biopsy for the detection of NPC. Mean interval between MR imaging examination and subsequent nasopharyngeal biopsy was 3 days (range, 0–11 days). The initial study population comprised of 21 patients with newly diagnosed NPC (13 men, 8 women; mean age, 55 years) and 14 patients with adenoids enlarge (9 men, 5 women; mean age, 35 years). The lesion $D$, $D^*$ and $f$ were measured and compared in patients with primary NPC and benign hyperplasia.

RESULTS
CONCLUSION
IVIM DWI is a feasible technique for investigating primary NPC although limited in 11.4% patients due to susceptibility artifacts around the skull base. D is significantly decreased in primary NPC. The elevation of D* reflects increased blood vessel generation and parenchymal perfusion in primary NPC, indicating that D* can provide insight into the physiological activities related to the disease.

CLINICAL RELEVANCE/APPLICATION
Intravoxel incoherent motion (IVIM) can differentiate benign and malignant head and neck disease, and differentiating certain histological types of malignancy.

Nuclear Medicine (Quantitative Imaging)
Monday, 03:00 PM - 04:00 PM • S504CD

SSE19-01 • Integration of Automated Quality Control Using Image Classification into a CAD System for Bone Scan Lesion Detection

Keith W Henkel MS, BEng (Presenter) *; Matthew S Brown PhD *; Jonathan G Goldin MBChB, PhD; Grace Kim MD; Katherine Yang *; Bharath Ramakrishna; Greg Chu; Richard Pais

PURPOSE
The aim of this research is to develop an automated bone scan image classifier for quality control as a pre-processing step prior to application of a CAD lesion detection system. As quantitative image analysis of bone scans becomes increasingly useful in clinical trials, so does the need to define quality bone scans in such a way that it predicts images’ usability for an automated lesion detection system.

RESULTS
Based on review of the CAD segmentation, 35.5% of the 833 images were usable. In the test data set, images were split by those performed on ADAC machines (n=30), and those performed on other machines (n=803). To confirm the algorithm identified in the training set, its sensitivity and specificity were compared against the usability predictive power of the individual parameters. Overall, the manufacturer identified parameter, not ADAC, appeared to have a low classification accuracy, but there was not enough data in the ADAC dataset reach a firm conclusion. In the other machine group, pixel spacing also showed a low classification accuracy (sensitivity of 0.889, specificity of 0.702). The image type most commonly associated with usable images (ORIGINAL / PRIMARY / WHOLE BODY / EMISSION) had a very high classification accuracy with a sensitivity of 0.918 and a perfect specificity (no false negatives) of 1.000. Image Type is defined in DICOM Part 3: Information Object Definitions, and had a perfect specificity. Image size (256 by 1024 pixels as usable, others as requiring manual review) had a sensitivity of 0.968 and specificity of 0.985 in predicting image usability, the largest individual parameter sensitivity.

The combination of manufacturer, image type, and image size provide the best criteria for identifying quality bone scans: a sensitivity of 0.973 and a perfect specificity of 1.000. Further classification of images by pixel spacing (the last step of the algorithm identified in the training data set) actually had no further effect on the sensitivity and specificity. Images incorrectly identified as usable (n=7) were not usable due to extravasation hindering anatomic segmentation or due to missing anatomy with two notable exceptions: a pair of blood pool NM images. Including all images performed on ADAC scanners, for which the sample size was too small to identify an association, 56 of 833 images (6.7%) would require review via a non-automated process to determine usability of an image.

CONCLUSION
The question of how to approach quality control of medical images for use in automated systems appears to have an answer in traditional image classification. Close regulation of consistent scanner use, delay times from injection of radiotracer to acquisition of image, and varying doses received across time points, though not completely irrelevant, are not as significant factors in identifying quality images as simple DICOM header values like image type, image size, and manufacturer. Based on the inefficacy of including pixel spacing as a step in classifying the images of the test set, further evidence will be sought to determine if including the parameter is redundant or not.

METHODS
Acceptable bone scan image quality was defined in terms of usability for processing by an CAD lesion detection system currently in use in clinical trials (see Brown et al. Computer-aided quantitative bone scan assessment of prostate cancer treatment response. Nuclear Medicine Communications. 33(4):384-394, April 2012.). The CAD system atlas-based segmentation of anatomic landmarks and normal bone has been observed to fail when non-standard and/or non whole-body DICOM images are acquired, i.e., for secondary screen captures, spot views, tomos, key images, etc. Such images are unusable by CAD processing required in clinical trials and are thus considered of unacceptable quality.

From a training set of over 3,000 images (Phase 2 multi-center clinical trial of VEGFR-2 inhibitor in prostate cancer), four technical imaging parameters from the DICOM header were identified as features to classify image quality as acceptable or not: (1) image size, (2) image type, (3) pixel spacing, and (4) manufacturer. In the training data set, the best correlations with usability were found by differentiating by manufacturer first, then by a combination of image type, image size, and pixel spacing. While additional factors such as radiotracer dosage and timing may affect the quality of a bone scan, they are not consistently available within the DICOM header and are prone to manual entry error, and therefore have been excluded from analysis.

To test the imaging parameter features, 833 images from 25 patients across 23 sites were analyzed from a different multi-center Phase 2 prostate cancer clinical trial. Each of the images was processed by the CAD lesion detection system, and usability was determined as defined above. Statistically, sensitivity and specificity are reported to test the association between classified image quality and CAD usability.

SSE19-02 • QIBA2 FDG PET Reading Study: Variability of Liver FDG Uptake Measurements across Different Sites

Joo Hyun O MD (Presenter) ; Edward A Eikman MD ; Jaime L Montilla-Soler, ; Paul E Kinahan PhD *; James M Mountz MD, PhD ; Eric Perelman ; John Sunderland PhD ; Heather Jacene MD ; Nathan C Hall MD, PhD *; Michael V Knopp MD, PhD; Abdel K Tahari MD, PhD ; Ronald Boellaard PhD ; Otto S Hoekstra MD ; Li Huo ; Hye Ok Kim ; Sun Young Chae ; Sae Jung Na ; Sung Hoon Kim ; Mike Sathekge ; Moses Modiassie ; Sally Barrington ; Andrew M Scott ; Sam Berlangieri ; Andrew Quon MD ; Jeffrey P Leal BA ; Muhammad A Chaudhry MD,MBBS ; Richard L Wahl MD *

PURPOSE
To determine the variability in measurement of FDG uptake in normal liver background in identical human PET studies analyzed by differing readers, software and performance sites.

METHOD AND MATERIALS
Baseline and post-therapy FDG PET/CT images of a single patient were distributed digitally to 15 sites in North America, Europe, Africa, Asia and Australia in an IRB approved study. Readers at each site measured the background activity by placing a 3 cm diameter spherical volume of interest (VOI) in right side of the liver. Workstation software from 8 different vendors were used for the quantification. The standard uptake value (SUV) and SUV corrected for lean body mass (SUL) were measured using local standard approaches.

RESULTS
The liver background SUV ranged from 1.47 to 2.19 at baseline with standard deviation (SD) of 0.16; and ranged from 1.80 to 2.96 (SD...
CONCLUSION
SUV and SUL measurements of the normal liver derived from the same set of FDG PET/CT images showed generally similar, but not consistently the same, values. The cause of the variance of liver measurements is likely due to both human VOI selection methods and software differences.

CLINICAL RELEVANCE/APPLICATION
These results indicate that varying quantitative results can be extracted from identical PET/CT images and suggest the need to more fully standardize the PET analytic process.

SSE19-03 • Impact of 4D PET-CT on SUV Quantification in Lung Tumors: How Many Phase-bins?

Carlo Cavedon  DPhil (Presenter); Emanuele Zivelonghi; Stefania Guariglia; Maria Grazia Giri; Daniela Grigolato; Michele Zuffante; Marina Cucca; Marco Ferdigehini MD

PURPOSE
To find the optimal number of phase bins in respiratory-gated PET-CT (4D PET-CT) in order to improve SUV quantification in lung tumors while preserving signal-to-noise ratio.

METHOD AND MATERIALS
28 patients with lung tumors were studied with 18F-FDG 4D PET-CT. Only patients that showed respiratory-induced tumor motion greater than 5 mm were enrolled. 4D PET-CT was performed by means of a Philips Gemini BigBore TOF scanner and the Varian RPM respiratory gating system. 3.0 MBq/kg, 2 min/bed and retrospective-mode for both PET and CT modalities were used. Images were reconstructed using 1 (no sorting) up to 10 phase bins. SUVmax values within the lesion were studied as a function of the number of phase-bins. The lower number of phase bins that allowed SUV quantification no smaller than 90% compared to the gold standard (10 phases) was considered as optimal. Lesion volumes were estimated by three different segmentation methods: fixed SUV=2.2 threshold, 40% of SUVmax isocontour and gradient-based method. These volumes were also studied as a function of the number of phase bins.

RESULTS
SUVmax measured at max exp was on average 63.2% higher in the gated acquisition (10 phases) compared to the non-gated case (range 11.5%-328.3%). The underestimation of SUV in non-gate-PET-CT was strongly dependent on lesion volume and location, small lesions in the lower lung region being the most affected. When comparing 4D PET-CT in 4 and 10 phases, the underestimation reduced to 12.3% (range 2.0%-37.7%). The corresponding value for 6 and 10 phase bins was 6.9% (range 0.0%-23.3%). Volumes estimated by the fixed-threshold method increased with the number of phase bins, SUVmax percentage-based volumes decreased and gradient-based volumes did not show a unique trend.

CONCLUSION
4D PET-CT offers an advantage in 18F-FDG SUV quantification for tumors that move with respiration. The balance between acquisition/reconstruction time, SNR and accuracy of SUV estimation seems to be achievable using 4 to 6 phase bins, depending on lesion volume and location. SUV-based volume quantification obtained by multiple segmentation methods is less prone to inconsistent results when respiratory gating is used.

CLINICAL RELEVANCE/APPLICATION
4D PET-CT can improve SUV quantification in tumors that move with respiration. This might be especially useful when metabolic data are used to help delineate reference volumes in Radiation Oncology.

SSE19-04 • Impact of a New Respiratory Amplitude-based Gating Technique (HD-Chest) in Evaluation of Subdiaphragmatic PET Lesions

Axel Van Der Gucht (Presenter); Benjamin Serrano; Florent Hugonnet; Benoit Paulmier; Nicolas Garnier; Marc Faraggi * MD

PURPOSE
PET acquisition requires several minutes which can lead to respiratory motion blurring, partial volume effect and SUV under-estimation. To avoid these artifacts, conventional 10-minute Phase-Based Respiratory Gating (PBRG) can be performed but is time-consuming and difficult with a non-compliant patient. HD-Chest is an amplitude-based gating method which keeps 35% of the counts at the end of expiration to minimize respiratory motion. We estimated the impact of HD-Chest on subdiaphragmatic lesion detectability and quantification.

METHOD AND MATERIALS
Our study consisted of 30 patients for a total of 76 hepatic and 26 perihepatic lesions. Each patient underwent 3 acquisitions on a Siemens Biograph mCT (4 rings and time-of-flight); a Standard free breathing Whole Body (SWB, 5 to 7 steps / 2.5 min per step, 3.3 ± 0.4 MBq/kg of 18F-FDG), a 10-min PBRG with six bins and a 5-min HD-Chest. All gated acquisitions were performed with an ANZAI respiratory gating system. 3.0 MBq/kg, 2 min/bed and retrospective-mode for both PET and CT modalities were used. Images were reconstructed using 1 (no sorting) up to 10 phase bins. SUVmax values within the lesion were studied as a function of the number of phase-bins. The lower number of phase bins that allowed SUV quantification no smaller than 90% compared to the gold standard (10 phases) was considered as optimal. Lesion volumes in SWB images were detected in the gated images. PBRG and HD-Chest respectively revealed 5 and 9 new lesions and relocated 7 and 8 lesions. Localization remained uncertain for 2 lesions in both gated methods. Four lesions revealed by HD-Chest were missed by PBRG in 3 non-compliant patients. Compared to SWB, TBR but not SUVmax increased significantly with PBRG (respectively 40 ± 62%, p).

CONCLUSION
A better detection rate, a better coregistration, a higher contrast, a reduction of the acquisition time by up to 50% compared to PBRG make of HD-Chest the first choice respiratory-gated PET protocol in the evaluation of subdiaphragmatic lesions.

CLINICAL RELEVANCE/APPLICATION
4D PET-CT in 4 and 10 phases, the underestimation reduced to 12.3% (range 2.0%-37.7%). The corresponding value for 6 and 10 phase bins was 6.9% (range 0.0%-23.3%). Volumes estimated by the fixed-threshold method increased with the number of phase bins, SUVmax percentage-based volumes decreased and gradient-based volumes did not show a unique trend.

CLINICAL RELEVANCE/APPLICATION
4D PET-CT in 4 and 10 phases, the underestimation reduced to 12.3% (range 2.0%-37.7%). The corresponding value for 6 and 10 phase bins was 6.9% (range 0.0%-23.3%). Volumes estimated by the fixed-threshold method increased with the number of phase bins, SUVmax percentage-based volumes decreased and gradient-based volumes did not show a unique trend.

CLINICAL RELEVANCE/APPLICATION
4D PET-CT in 4 and 10 phases, the underestimation reduced to 12.3% (range 2.0%-37.7%). The corresponding value for 6 and 10 phase bins was 6.9% (range 0.0%-23.3%). Volumes estimated by the fixed-threshold method increased with the number of phase bins, SUVmax percentage-based volumes decreased and gradient-based volumes did not show a unique trend.
CONCLUSION

Treated liver volumes can be quantified easily on the post-interventional Y-90 SPECT/CT using a threshold based semi-automatic approach. Functional and morphologic pre-therapeutic target volume estimation correlates well with the treated volumes, with a slight advantage of the functional technique, most probably due to patients presenting with perfusion patterns differing from the expected vascular anatomy.

CLINICAL RELEVANCE/APPLICATION

Functional target volume estimation correlates slightly better with treated liver volumes in SIRT than the morphologic approach and is an important adjunct to depict unexpected liver perfusion patterns.

SSE19-06 • Integrated PET/CT Color Scale Response Assessment Workflow

Joseph Coala BS (Presenter) ; Alin Chirindel MD ; Joo Hyun O MD ; Steve Cho MD *

PURPOSE

Assessment of tumor response to therapy by FDG PET/CT image sets from various time points can be often tedious and time consuming, especially in complex patients with multiple lesions or subtle changes. We developed and applied an integrated color-coded PET/CT image visualization workflow incorporating the tumor uptake at two time points to allow the reader to efficiently and accurately assess the relative PET tumor response to therapy.

METHOD AND MATERIALS

Using MIM 5 imaging software (MIM Software TM), we analyzed FDG PET/CT image sets from two time points for 6 melanoma and 6 lymphoma cases. With technical support from MIM, we created a workflow that deformed the baseline PET and CT to the follow-up images. The SUV in each voxel of the deformed baseline PET was subtracted from each voxel’s SUV in the follow-up PET. Each PET voxel was assigned a color based on its subtraction value, and the colored images were fused with the follow-up CT image set to create an anatomical view of the relative SUV changes. The colors corresponding to each subtraction value were based on a 20-color scale for positive and negative absolute and percent SUV change from baseline to follow-up. Two readers with third reader adjudication reviewed all 12 cases to determine if the response of the lesions with the greatest SUV values from baseline (max of 2 per organ) were accurately depicted by the color scale by comparing it to traditional gray-scale PET/CT visualization and ROI SUV values.

RESULTS

The number of lesions analyzed per patient ranged from 1 to 5 for each based on the state of the patient’s disease. The readers found that integrated PET/CT color scale images accurately depicted the approximate SUV changes for 26 of the 28 index lesions. The less clear color scale representations occurred because of small errors in the deformable registration in a lung nodule and with development of tumor necrosis.

CONCLUSION

The integrated color scale PET/CT tumor response image sets provides an efficient and reliable method of determining the approximate tumor SUV changes associated with disease progression or treatment response for the major index lesions in our pilot study of metastatic melanoma or lymphoma patients.

CLINICAL RELEVANCE/APPLICATION

Integrated color scale PET/CT representation can be a helpful aid to quickly judge and approximately quantify tumor response to therapy, especially in cases difficult to assess by current methods.

Nuclear Medicine (SPECT/CT)

Monday, 03:00 PM - 04:00 PM • SS05SAB
CONCLUSION
SPECT/CT is superior to conventional planar lymphoscintigraphy in the detection of both sentinel lymph nodes and downstream lymph nodes in vulvar cancer.

CLINICAL RELEVANCE/APPLICATION
SPECT/CT may contribute to a more comprehensive lymph node mapping in vulvar cancer and might facilitate surgical exploration in difficult cases.

**SSEE20-02 • SPECT/CT and Freehand-SPECT 3D-imaging Can Localize Sentinel Nodes in the Operating Room Using Mixed-reality Navigation**

Gjis Kleinjan MD ; Nynke S Van Den Berg MSc ; Oscar Brouwer ; Simon Horenblas MD, PhD ; Henk G Van Der Poel ; Omgo Nieweg ; Thomas Wendler ; Fjjs Van Leeuwen (Presenter) ; Renato Valdes Olmos

**PURPOSE**
By providing anatomical landmarks, SPECT/CT has improved the sentinel node (SN) localization in different types of cancer. The introduction of mixed-reality protocols makes it possible to incorporate the SPECT/CT information into the patient environment during the operation. The Declipse§ SPECT-system (SurgiEye, Munich, Germany) uses 3D SPECT/CT mixed-reality for intraoperative navigation. The device is also equipped with a Freehand-SPECT (FHS) probe that generates 3D imaging to be real-time merged with the patient environment (augmented-reality). The aim of the study was to determine the feasibility of the navigation system to localize SNs.

**METHOD AND MATERIALS**
The hybrid tracer Indocyanine green (ICG)-99mTc-nanocolloid is fluorescent and radioactive. For inguinal SNs the tracer was injected around the primary lesion in 10 penile cancer patients and 5 patients with melanoma of the leg. A reference tracker (ReT) was placed on the patient during preoperative SPECT/CT to upload SPECT/CT images into the Declipse§ system. In the operating room, a sterile ReT allowed incorporation of SPECT/CT images onto the patient. A gamma probe with a second sterile ReT was used to navigate towards the SN. The fluorescence of the hybrid tracer confirmed the SN location. FHS was evaluated for pelvic SNs in 4 prostate cancer patients. Based on pre-operative SPECT/CT, the area of interest was scanned with a laparoscopic probe. A Sterile ReT was placed on the patient and on the laparoscopic probe, to match the information of FHS-scanning of the radioactive signal in the SN. SN imaging was generated and used in an augmented-reality-based 3D navigation protocol.

**RESULTS**
In the groin SN location indicated by mixed-reality based navigation deviated on average 4.5mm (range 0-10 mm) from the actual location; this was confirmed by its fluorescence signal. FHS-based augmented-reality navigation allowed the identification of 4 pelvic SNs in 4 patients.

**CONCLUSION**
The 3D SPECT/CT-mixed-reality based SN navigation is feasible for groin and pelvis, and has the potential to guide SN localization in areas of complex anatomy. FHS real-time generated 3D imaging may complement navigation.

**CLINICAL RELEVANCE/APPLICATION**
An accurate localization of the SNs could be of clinical relevance by lowering the false negative rate in SN detection in different types of cancer with lymphatic drainage to complex anatomical areas.

**SSEE20-03 • Impact of SPECT/CT on Interpretation of Bone Scans in a Supra-regional Oncology Centre**

Umme Sara Zishan MBBS (Presenter) ; Hamish Richardson MSc ; Zubair Khan MBBS, FRCS

**PURPOSE**
To evaluate impact of single photon emission computed tomography/computed tomography (SPECT/CT) in assessment of indeterminate uptake on planar bone scans compared with prior practice.

**METHOD AND MATERIALS**
Retrospective comparative study. Data was collected from reports available on radiology information system. First data set included bone scans from June 2009–June 2010 when planar whole-body images were referenced to other available structural imaging. After installing hybrid scanners in late 2010, SPECT/CT was used as a problem solving tool in patients with indeterminate/ suspicious lesions on planar imaging. The second set of data included bone scans (with added SPECT/CT if required) from June 2011–June 2012. The reports were analysed and categorised into these six categories: Normal, bony metastatic disease, degenerative changes, fractures/trauma, incidental findings, inconclusive requiring further investigation.

**RESULTS**
First data set from 2009/10 included 1422 reports, while 1617 reports were included in the second data set. The latter also included 737 reports with added SPECT/CT. In 2009/10, 16.5% (234/1422) of the scans showed bony metastatic disease, 8.8% (125/1422) were indeterminate requiring further investigations and 1.8% (26/1422) showed incidental findings. In 2011/12, 23% (372/1617) of overall bone scans showed bony metastatic disease. There was reduction in the number of referrals for further investigations to 7.8% (126/1617). There was increased pick up of incidental findings both benign and malignant conditions to 13.3% (219/1617). Specifically looking at bone scans with added SPECT/CT for indeterminate lesion/s (i.e. not clearly malignant and no recent structural imaging for that lesion) the sensitivity for diagnosis of metastatic disease was 30.1% (222/737). Pick up of incidental findings was 27.13% (200/737), there were 207 benign and 67 malignant lesions. 10.2% patients (75/737) were referred for further investigations, most of them to assess the incidental findings.

**CONCLUSION**
SPECT/CT had a significant impact with improved detection of bony metastatic disease, better characterisation and reduction in onward referrals. There was increased detection of incidental pathology (benign and malignant), some of these required further investigation.

**CLINICAL RELEVANCE/APPLICATION**
SPECT/CT is a powerful cost effective tool providing accurate diagnosis of indeterminate uptake on planar bone scan.

**SSEE20-04 • Feasibility of 90Y Bremstrahlung Scan to Determine SIRT Patient Dose**

Chor-Yi S Ng PhD (Presenter) ; Martin W Law PhD ; Victor H Lee MD, MBBS ; W. H. Ma MBCh ; T. W. Leung MD, MBBS

**PURPOSE**
We reported the use of 90Y PET/CT imaging for patient dose computation of the SIRT procedure. Other than 90Y PET/CT, 90Y Bremstrahlung SPECT/CT scan can also be used to evaluate the distribution of 90Y microspheres after SIRT. This work aimed to evaluate the feasibility of using 90Y SPECT/CT scan as a tool for patient dose evaluation. We compared and contrasted its performance for dose determination with 90Y PET/CT scan.

**METHOD AND MATERIALS**
PET/CT and SPECT/CT were done for a rectangular phantom with 4 spherical inserts containing 90Y solution in a cold background. The volume of the inserts ranged from 0.38 to 57.79 cm³. To determine the absorbed dose, the PET and SPECT images were convolved with the 90Y voxel dose kernel and the results presented as DICOM-RT dose files. Dose volume histogram was computed for each insert and compared with the actual dose based on total energy deposited by 90Y. A patient’s 90Y Bremstrahlung SPECT/CT image was used to compute the 3D dose distribution from SIRT. The computed physical dose was converted to biologically effective dose then to dose.
RESULTS
All 4 inserts were visible on the PET images while the 0.38 cm³ sphere was not detected on the SPECT images. The SPECT images showed significant scatter, with average background to target ratio equal to 5.4% compared to 0.2% for PET. The SPECT scatter was partially corrected by deducting a constant value from the pixel counts on the images, then absorbed dose was computed. For the SPECT images, the computed dose volume extended beyond the inserts' boundary into the cold background. This could result from inadequate scatter correction. The partial volume effect was also more marked for SPECT with a large reduction in observed count rate as the volume of the object decreased. For the insert of volume 4.06 cm³, the dose dropped to 23% of the actual value for SPECT compared to 57% for PET. Based on the SPECT images, the patient's 2 Gy/fraction equivalent dose to tumor, liver and lung were 106.5 Gy, 24.8 Gy and 1.5 Gy respectively.

CONCLUSION
Improved correction methods for partial volume effect and scatter are needed for accurate dose calculation for SIRT based on SPECT/CT imaging.

CLINICAL RELEVANCE/APPLICATION
SPECT/CT could be a tool for in vivo dose determination for the SIRT procedure which will help to assess treatment efficacy and toxicity of SIRT.

SSE20-05 • Localization of Parathyroid Adenomas by Tc99m Sestamibi SPECT-CT, Contrast-enhanced Multi-phase CT (4D-CT) and Combination of SPECT-CT and 4D-CT

Franklin C Wong MD, PhD (Presenter); Thinh H Vu MD; Stephen T Wong PhD; Dawid Schellingerhout MD; Hubert H Chuang MD, PhD; Nandita Guha-Thakurta MD; Edmund E Kim MD; Srinivas C Kappadath PhD *; Nancy Perrier MD; Eric M Rohren MD, PhD

PURPOSE
This study is designed to compare the abilities of Tc99m Sestamibi (MIBI) SPECT-CT, dynamic contrast enhanced CT (4D CT) and combination of both modalities to identify parathyroid adenomas

METHOD AND MATERIALS
A retrospective study was conducted under IRB-approved chart review for patients undergoing parathyroid adenoma resection in Jan 2010-June 2010. Parathyroid SPECT-CT was conducted after the patient received 20 mCi of Tc99m MIBI, 4D CT was conducted within 2 days from MIBI. All images were display in planar digital displays. Three teams of nuclear physicians and radiologist were assigned to interpret anonymized imaging studies without clinical or pathologic information. The surgical pathology is used as the gold standard. An A-F type location scheme was applied to identify the location of the lesions.

RESULTS
A total of 41 evaluable patients were collected. Histopathology reported 46 lesions with 21 in the left and 25 in the right size. SPECT-CT correctly lateralized 36 lesions but correctly identify 18 lesion types while combination of both correctly lateralized 37 lesions and identified 24 lesion types.

CONCLUSION
The combination of 4D CT and MIBI SPECT CT may have additional diagnostic values for identification of parathyroid adenomas.

CLINICAL RELEVANCE/APPLICATION
The use of combination of 4D CT and MIBI SPECT-CT may enhance the accuracy of pre-surgical identification of lesions for treatment planning

SSE20-06 • The Value of Routinely Post Radioiodine Therapy Sestamibi SPECT with SPECT CT Imaging Diagnosis in Clinic

Yu Wen Chen MD, MA (Presenter); Pi Jung Hsio MD; Yung Chang Lai

PURPOSE
The fusion imaging of SPECTCT will improve diagnostic quality. In here, we collect thyroid cancer patients with high dose radioiodine therapy and post therapy scintigraphy with SPECTCT diagnosis during prior one year. The value of SPECTCT in imaging diagnosis will be disclosed in this article.

METHOD AND MATERIALS
During prior one year (Aug, 2011 to Aug 2012), we collect sixty-five patients received high dose radioiodine therapy and post radioiodine scintigraphy with SPECTCT imaging. Forty patients who were newly diagnosed as advanced differentiated thyroid cancer (DTC) and received bilateral total thyroidectomy with central nodal dissection. The other twenty five patients were diagnosed as recurrence during follow-up. The mean age of patients is 51.2 year-old (19 to 76) and ratio of female to male is 5:11. After high dose radioiodine administration, the imaging was performed at the following 5th and 8th day respectively. The imaging protocols were including whole body scintigraphy (WBS) and SPECTCT (Philips, Bright view XCT). The acquisition of SPECTCT was including SPECT protocol with 32 frames/30 sec per frame and cone-beam CT with 30mA/120 kV parameters. The field of view included hard palate to diaphragm, as three beds routinely. The imaging reconstruction was based on iterative algorithm. The interpretation of imaging was performed by two nuclear medicine physicians.

RESULTS
Among newly diagnosed forty DTC patients, almost remnants are detectable, except one patient. Based on SPECTCT localization, pyramid and contralateral tubercle are the most common sites of remnant exist. Twelve patients (30%) are demonstrated as N1b after post radioiodine therapy SPECTCT diagnosis. There is no detectable distal lung or bone metastasis among this group of patients. The SPECTCT imaging provides differential diagnosis for low grade of radioiodine avid pulmonary nodule in an old lady with tuberculosis history. For the twenty five patients with recurrent thyroid cancer, remnants are near not detectable, except two young age females (8%). Five patients (25%) are demonstrated as N1b nodal involvement on SPECTCT. Three patients are diagnosed as lung metastasis on WBS and SPECTCT imaging. The SPECTCT provides pulmonary nodular pattern in the two patients.

CONCLUSION
Routinely post radioiodine therapy scintigraphy with SPECTCT imaging provides exact nodal stage and remnant distribution.

CLINICAL RELEVANCE/APPLICATION
none
Association of Magnetic Resonance Imaging (MRI) Findings and Initial Presenting Symptoms in Infants with Non-accidental Mild Traumatic Brain Injury

Paggie Kim MD (Presenter) ; Mona Tafti MD ; Barbara A Holshouser PhD

PURPOSE
To investigate association between a child’s initial presenting symptom and subsequent additional MRI findings after non-accidental mTBI.

METHOD AND MATERIALS
A retrospective single-center review of the emergency room and radiology records of 151 infants, who presented to the Loma Linda University Medical Center Pediatric Emergency Department for evaluation of suspected NAT from 2001 to 2008, was conducted. Inclusion criteria included infants less than 3 years of age with an initial GCS score of 13-15 (i.e., mTBI) who had both a CT and a MRI brain examination available for review. Records were examined for the occurrence of initial symptoms and the presence on imaging of intracranial abnormalities. Association between initial presenting symptoms and additional MRI findings were calculated using odds ratio with 95% confidence interval.

RESULTS
Of the 151, 67 met our inclusion criteria. The mean age was 6.8 months (+/- 7.4 months) and the mean initial GCS score was 14.6 (+/- 0.6). The most common initial presenting symptoms and findings were retinal hemorrhage (39%) and vomiting (33%). The most frequent additional MRI findings not seen on CT were subdural hemorrhage (39%), ischemia/infarction (27%), subarachnoid hemorrhage (29%) and atrophy (27%). Statistically significant associations were found between the initial presenting symptoms of seizure, and additional MRI findings of ischemia/infarct and SDH.

CONCLUSION
Compared to CT, MRI provides clinically useful data in children less than 3 years of age with NAT/mTBI, particularly with evidence of ischemia/infarction and atrophy. Although children in our study presented with mild symptoms and GCS scores of 13-15, the association between the additional MRI findings and the initial presenting symptoms may help in creating an algorithm to determine when a child must have an additional MRI examination. This will, in turn, help in reducing or even preventing long term risk of neurodevelopmental disabilities following mTBI/NAT.

CLINICAL RELEVANCE/APPLICATION
Association between the initial presenting symptoms and subsequent additional MRI findings can help predicting if a child must have an MRI prior to discharge from the hospital.

MRI Features of Cortical Venous Injury in Abusive Head Trauma (AHT)

Arabinda K Choudhary MBBS (Presenter) * ; Krishnamoorthy Thamburai MD ; Mark Dias MD ; Danielle K Boal MD

PURPOSE
1. To assess evidence of direct intracranial venous injury in AHT
2. To assess evidence of indirect features of intracranial venous injury in AHT
3. To assess for thrombosis of cortical veins and sinuses in AHT

METHOD AND MATERIALS
We identified patients between 0-3 years with AHT managed at our institute from 2001-2012. MRI and MRV were evaluated by two experienced neuroradiologists to assess for subdural hemorrhage, parenchymal abnormalities and thrombosis. Detailed evaluation of veins and sinuses included evidence of direct venous injury with blood clot adherent to the bridging cortical veins (Lollipop sign) terminating in the region of subdural hemorrhage, secondary features of venous injury with compression (compression sign) of cortical veins by the subdural hemorrhage.

RESULTS
A total of 45 studies were reviewed. The median age was 3 months with 62% males. 41/45 children (91%) had SDH. On MRV, 14/45 cases (31%) had no evidence of venous compression, including 10 with, and 4 without SDH. The remaining 31/45 cases (69%) had imaging evidence of cortical vein and/or sinus compression. Venous compression was most commonly bilateral in 45%. In 17/31 cases (54.8%) only the cortical veins were compressed whereas in 11/31 cases (35.5%) both cortical veins and sinuses were compressed. In 3/31 cases (9.7%) only the sinus was compressed.

Evidence of direct trauma to the bridging vein (lollipop sign) was seen in 44.5% of cases. All veins having a lollipop sign also had evidence of venous compression from an overlying SDH. Among 22/41 children with a small volume SDH, 15/22 (68.2%) had evidence of venous compression and 10/22 (45.4%) had a lollipop sign. Among 19 cases of moderate or large SDH, 16/19 (84.2%) had evidence of venous compression and 10/19 (52.6%) had a lollipop sign (table 1). The four remaining children without SDH had neither venous compression nor a lollipop sign. Thrombosis was found in 2/45 cases of AHT.

CONCLUSION
1. Evidence of displacement and/or compression of cortical veins and sinuses from subdural hemorrhage is present in 69% of cases of AHT.
2. Evidence of direct trauma to the veins can be identified in 44.5% of cases. There were no cases of cortical vein compression or lollipop sign in absence of subdural hemorrhage.

CLINICAL RELEVANCE/APPLICATION
Our study will increase awareness and subsequently improve detection of MRV findings of compression and evidence of direct trauma to the bridging veins.

SSE21-04 • A Diffusion Tensor Imaging (DTI) Study of Brain White Matter and Neuropsychiatric Abnormalities in Attention Deficit/Hyperactivity Disorder (ADHD) Children

Lizhou Chen (Presenter) ; Xinyu Hu ; Yi Liao ; Lanting Guo ; Qiyong Gong ; Xiaoi Huang MD ; Ning He ; Fei Li MD

PURPOSE
ADHD is highly prevalent in school-age children with impaired cognitive functions. Diffusion tensor imaging (DTI) owns a unique advantage of detecting microstructural changes in cerebral white matter and might be useful to detect cognitive abnormalities in ADHD. In present study, we aim to examine the whole-brain fractional anisotropy (FA) difference between drug-naïve ADHD children and healthy controls (HC) in a relatively large sample size and also to explore the correlation of FA value with neuropsychiatric measurements.

METHOD AND MATERIALS
47 ADHD children (mean age=10.1, male=41) and 48 HC (mean age=10.9, male=35) were recruited. All participants underwent a set of neuropsychological tests including Stroop test (ST), visual memory test (VMT), verbal fluency test (VFT) and Wisconsin Card Sorting test (WCST)). The DTI measures were acquired via 3-T MR system using EPI sequence with 20 directions. FA map was generated by FSL after eddy current and brain extraction, and put into SPM8 for normalizing and smoothing. Voxel-wise comparison was done by two sample t-test with age and sex as covariates, threshold at P<0.05.

RESULTS
Comparing with HC, the ADHD group demonstrated increased FA in the body of corpus callosum extending to bilateral middle cingulum (peak coordinates [-12,2,38], T=4.27) (see Figure), while no decreasing cluster was detected. The cluster displayed a positive correlation with VMT scores for 30-minutes delay intervals (r=0.32, p=0.029), VFT scores for total numbers (r=0.46, p=0.001) and right numbers (r=0.43, p=0.001), ST scores for right numbers (r=0.31, p=0.032), while negatively correlated with ST scores for wrong numbers (r=-0.32, p=0.028) and total time (r=-0.37, p=0.01).

CONCLUSION
Our study found elevated FA value in the group of ADHD children which correlated with multiple cognitive functions. We postulated there might be a compensatory mechanism for increased information translation between hemispheres in ADHD children.

CLINICAL RELEVANCE/APPLICATION
Diffusion tensor imaging (DTI) may be a useful technique to help with the evaluation of cognitive abnormalities in ADHD children.

SSE21-05 • 1H Magnetic Resonance Spectroscopy Assessment of Metabolic Brain Maturation in Attention Deficit Hyperactivity Disorder

Arturo R Alvarado MD (Presenter)

PURPOSE
To evaluate aged-related biochemical changes in Frontal Lobe White Matter (FLWM) using 1H Magnetic Resonance Spectroscopy (MRS) in children diagnosed as Predominantly Inattentive Type Attention Deficit Hyperactivity Disorder (ADHD).

METHOD AND MATERIALS
Forty right-handed male children (5 years old) diagnosed as ADHD according to the Diagnostic and Statistical Manual of Mental Disorders IV (DSM-IV) criteria participated in the study after their parents’ consent and the Local Ethics Committee authorization was obtained. Psychological/behavioral treatment was performed during the course of the investigation avoiding medications use. MRS studies were performed on a 3.0 Tesla scanner (Signa Excite®, GE) with a standard head coil using Point-Resolved Spectroscopy (PRESS) localization with automated shim and water suppression. Parameters were fixed at TR = 1500 ms, TE = 35 ms and 256 FID. T1, T2 and T2 FLAIR MR images in axial, coronal and sagittal views were acquired before MRS examination and single voxel of 4.00 cm³ (2.0 cm x 1.0 cm x 2.0 cm) was placed in each FLWM and Occipital WM used as internal reference pattern. All children were examined every 12 months in a date close to the birthday during 4 consecutive years. Metabolic signals of N-Acetylaspartate (NAA), Creatine (Cr), Choline (Cho), Glutamine-Glutamate complex (Glx) and myo-Inositol (mI) were detected and NAA/Cr, Cho/Cr, Glx/Cr and mI/Cr ratios were calculated.

RESULTS
Significant age-dependent decreases in Glx/Cr ratio was observed in FLWM at both sides as well as in Cho/Cr ratio in right FLWM (p<0.01). These findings suggest that Glx/Cr and Cho/Cr ratios are increased in FLWM of children with ADHD and the age-dependent reduction might constitute a brain maturation marker in ADHD.

CONCLUSION
These findings suggest that Glx/Cr and Cho/Cr ratios might be a useful marker of neuropsychiatric abnormalities in ADHD children.

CLINICAL RELEVANCE/APPLICATION
The Glx/Cr and Cho/Cr age-dependent decrease evaluated through MRS might be useful as a complement of routine ADHD examinations. Therefore; we recommend its use on ADHD evaluation.

SSE21-06 • Medication Naïve Attention-deficit/Hyperactivity Disorder Subjects Have Low Brain Iron Levels as Detected by Magnetic Field Correlation Imaging

Vitria Adisetiyono PhD (Presenter) ; Rachael Deardorff MS ; Ali Tabesh PhD ; Els Fieremans PhD ; Kevin M Gray MD ; Adriana Di Martino ; F. Xavier Castellanos MD ; Jens H Jensen PhD ; Joseph A Helpern MD *

PURPOSE
Stimulant medication reduces symptoms in attention-deficit/hyperactivity disorder (ADHD) through indirectly increasing dopamine (DA) levels in the striatum. Hence, it is suspected that reduced DA levels are part of ADHD pathology. However, both increased and decreased DA markers have been detected in ADHD. Interestingly, reduced DA markers have been consistently found in medication naïve patients while increased markers have been found in patients with a history of medication use, suggesting increased DA markers may reflect an adaptive response to medication. Here we assess the relationship between medication history and brain iron levels in children and adolescents with ADHD compared to typically developing controls (TDC). As brain iron is required for DA synthesis, assessing iron levels with MRI may provide non-invasive indirect measures of DA.

METHOD AND MATERIALS
27 TDC, 12 ADHD-naïve and 10 ADHD-medication were recruited. As indices of brain iron, magnetic field correlation (MFC) and relaxation rates (R2, R2* and R2') were used. All are affected by tissue iron but differ in their sensitivities and specificities. MFC was estimated with MFC imaging, R2 with a multiple spin echo sequence and R2* with a multiple gradient echo sequence. R2* = R2 - R2. The globus pallidus (GP), caudate nucleus (CN), putamen (PUT) and thalamus (THL) were chosen as regions of interest because of their suspected role in ADHD in addition to having high iron content. Serum iron measures were also collected.
RESULTS
The ADHD-naïve subgroup had significantly lower MFC than either TDC or the ADHD-medication subgroup in 3 of the 4 brain regions studied (FDR corrected). ADHD-naïve vs. TDC: PUT (p = 0.005, d = 1.0), CN (p = 0.003, d = 1.1) and THL (p = 0.012, r = 0.4); ADHD-naïve vs. ADHD-medication: PUT (p = 0.002, d = 1.5), CN (p = 0.004, d = 1.4) and THL (p = 0.021, r = 0.5). TDC and the ADHD-medication subgroup did not significantly differ in MFC. In contrast, no significant group differences were detected using the R2, R2*, R2' or serum measures.

CONCLUSION
Similar to other DA marker measures, lower brain iron levels (indexed only by MFC) are observed in medication naïve ADHD and appear to normalize with medication.

CLINICAL RELEVANCE/APPLICATION
Reduced brain iron in medication naïve ADHD is a promising biomarker. MFC imaging’s ability to non-invasively detect these aberrant levels may help improve ADHD diagnosis and guide optimal treatment.

Physics (CAD II)

SSE22-02 • Digital Breast Tomosynthesis (DBT): Computerized Detection of Clustered Microcalcifications in Planar Projection from Multiscale Bilateral Regularized Simultaneous Algebraic Reconstruction

Ravi K Samala PhD (Presenter); Heang-Ping Chan PhD; Yao Lu PhD; Lubomir M Hadijliski PhD; Jun Wei PhD; Mark A Helvie MD *

PURPOSE
To develop computer-aided detection (CADe) methods for microcalcification clusters (MCs) in DBT.

METHOD AND MATERIALS
With IRB approval and informed consent, DBTs were acquired from human subjects using a GE prototype DBT system. The data set was divided into a training set (127 views from 64 breasts with MCs) and an independent test set (104 views from 52 breasts with MCs and 76 views from 38 breasts without MCs). The biopsy-proven cluster location was marked by an MQSA radiologist. DBT volume is reconstructed using our recently developed simultaneous algebraic reconstruction technique (SART) with multiscale bilateral regularization that reduces noise, enhances MCs, and preserves the sharpness of tissue structures. A planar projection (PPJ) image is generated by selectively extracting the high-frequency information including potential MCs from the 3D volume and projecting it to a plane. Cluster centroid objects and individual seed points are then detected from the PPJ image using iterative adaptive thresholding in combination with segmentation guided by the local contrast-to-noise ratio (CNR). The cluster centroid objects are further screened using a neural network trained for recognizing true signals and false positives (FPs). Dynamic clustering embedded with machine learning rules based on CNR, size and number of signals is used to detect MCs. FP clusters are further reduced using the size, skewness and kurtosis properties of the CNR histogram of the cluster. The detection on PPJ images was compared with that in the 3D volumes using jackknife free-response receiver operating characteristic (JAFROC) analysis.

RESULTS
For the test set, the FP rate decreased by 50% at 85% sensitivity for both the view-based and case-based performance (0.61 and 0.54 FPs/view, respectively) on the PPJ images compared to that in the 3D volumes (1.92 and 1.01 FPs/view). The case-based sensitivity reached 95% at 0.82 FPs/view in the PPJ images. JAFROC analysis showed a significant improvement with a figure-of-merit of 0.65 and 0.58 for PPJ and 3D, respectively (p-value=0.006).

CONCLUSION
Computerized MC detection on PPJ images outperforms that in 3D reconstructed volumes. Further study is underway to improve the PPJ method.

CLINICAL RELEVANCE/APPLICATION
CADe can be an adjunct to radiologist reading and has the potential to improve detection of subtle microcalcification clusters and increase the workflow in DBT interpretation.

SSE22-01 • Digital Breast Tomosynthesis (DBT): Computerized Detection of Clustered Microcalcifications in Planar Projection from Multiscale Bilateral Regularized Simultaneous Algebraic Reconstruction

SSE22-01 • Digital Breast Tomosynthesis (DBT): Computerized Detection of Clustered Microcalcifications in Planar Projection from Multiscale Bilateral Regularized Simultaneous Algebraic Reconstruction

SSE22-02 • Benchmarking Computer-aided Detection of Pulmonary Nodules on the Recently Completed Publicly Available LIDC/IDRI Database

Colin Jacobs MSc *; Bram Van Ginneken PhD (Presenter); Stephan Fromme *; Mathias Prokop MD, PhD *; Eva M Van Rikxoort PhD

PURPOSE
The recently completed LIDC/IDRI database provides by far the largest public resource to assess the performance of algorithms for the detection of pulmonary nodules in thoracic CT scans. We report the performance of two detection systems, and address the issue of completeness of the reference standard.

METHOD AND MATERIALS
The LIDC/IDRI database contains 890 thoracic CT scans with section thickness of 2.5mm or lower, one per patient, from 7 centers acquired with 17 different scanner models from 4 manufacturers. Cases have been annotated in an extensive reading process comprising a blinded and an unblinded review by four radiologists who indicated all nodules 3mm effective diameter. We define nodules >3mm indicated by all four observers as positive findings. We applied two pulmonary nodule detection systems: Herakles, an industry research prototype (MeVis Medical Solutions, Bremen, Germany) and ISICAD (Image Sciences Institute, Utrecht, The Netherlands), a system trained with data from the Dutch-Belgian NELSON lung cancer screening trial. We report sensitivity at 1, 2, and 4 false positive (FP) detections per scan and analyze the FPs.

RESULTS
The 890 scans contained 775 positive findings. At 1, 2, and 4 FP/scan, Herakles had a sensitivity of 69%, 75%, and 79%, respectively. For ISICAD this was 51%, 63%, 72%. We analyzed the FPs of Herakles at an operating point of 2 FP/scan. Of these, 31% were annotated by at least one radiologist as a nodule >3mm. An additional 17% were indicated by at least one radiologist as a nodule

CONCLUSION
The LIDC/IDRI data set is an excellent benchmarking tool for nodule detection algorithms. Automated detection can identify pulmonary nodules that have not been annotated in an extensive reading process with blinded and unblinded review by four human observers.

CLINICAL RELEVANCE/APPLICATION
Algorithms for automatic detection of pulmonary nodules can be compared and improved through the availability of a common database for benchmarking.
SSE22-03 • Independent Combination of Multiple Readers for the Detection of Lung Nodules in Chest Radiographs: Setting a Benchmark for Computer-aided Detection

Steven Schalekamp MD (Presenter) * ; Nico Karssemmeijer PhD * ; Cornelia M Schaefer-Prokop MD * ; Bram Van Ginneken PhD

PURPOSE
The detection performance for lung nodules in chest radiographs shows a large interreader variability. High miss rates of lung cancer have been reported though judged as being visible in retrospect. History has proven that computer intelligence is able to surpass human performance also for complex tasks (e.g., Watson). Purpose of our study was to explore the potential gain in performance by independent combination of multiple observers. That way we aimed to define the upper boundary of visual detectability that ideally should be achieved by a computer aided detection (CAD) system.

METHOD AND MATERIALS
111 digital chest radiographs (CXR) containing a single small nodule (average diameter 16mm.) and 189 normal controls served as study group. Nodules had to be visible on the frontal radiograph with 42% of them judged as being of low and very low conspicuity. Twelve observers were asked to localize the lung nodules in the CXRs with help of bone suppressed images. Location based ROC was used for analysis. Mean sensitivity in a false positive fraction range between 0 and 0.2 was used to measure nodule localization performance. This was done for all observers separately and subsequently for the combination of multiple observers (up to 12). Observer findings were averaged when findings were located within 1.5 cm of each other. When no finding was present at the location of another observers finding a zero-score was assigned in the averaging calculation.

RESULTS
The mean sensitivity at a false positive fraction range between 0 and 0.2 was 64.0% for single reading (range 45.5% - 78.2%). Combining the readings of two observers improved lung nodule detection on average to a mean sensitivity of 73.1%. Adding more observers lead to a further performance increase up to a mean sensitivity for 12 observers of 82.3%. On average, 26 nodules were missed by single observers, 15 nodules by a combination of 2 observers, and only 5 nodules were missed when combining 12 observers.

CONCLUSION
The variable and partially low baseline performance underlines the limitation of the single observer. If CAD is able to reach the combined performance of multiple readers, a dramatic increase of nodule localization performance can be expected with drastic reduction of missed rates.

CLINICAL RELEVANCE/APPLICATION
An independent combination of multiple readers for the detection of lung nodules in chest radiographs should be used as measure for achievable CAD performance.

SSE22-04 • Computer-aided Detection of Epidural Masses in Computed Tomography Using a Constrained Gaussian Mixture Model

Sanket Pattanaik BS ; Jiamin Liu PhD ; Jianhua Yao PhD * ; Weidong Zhang PhD ; Evrim B Turkbey MD ; Ronald M Summers MD, PhD (Presenter) *

PURPOSE
Although epidural masses detection is often accomplished using MRI, the more routine use of CT imaging makes early detection in this modality advantageous. Our preliminary Computer-Aided Detection (CAD) framework addresses the dearth of work focusing explicitly on the detection of epidural masses. We supply a spatially-constrained Gaussian Mixture Model (CGMM), using tissue classes informed by the spinal canal composition, to localize candidate detections and reduce false positives.

METHOD AND MATERIALS
40 patients with chest-abdomen-pelvis CT scans were examined. 23 patients were selected with MRI reports confirming an epidural mass. 17 patients without epidural masses were randomly selected to serve as controls. Two radiologists manually demarcated the centroids of each epidural mass identified in the CT scans to serve as ground truth. The CAD system segments the whole spine using a watershed algorithm and directed graph search. It isolates the spinal canal using a four-part vertebra medial model, boundary dilation, and intensity thresholding. Four tissue classes were generated using K-means clustering to represent normal intradural tissue, fat/vasculature, the epidural mass, and a partial volume region between the bone and soft tissue. CGMM was employed to refine classification, taking advantage of both spatial and intensity parameters. Detections were limited to masses extending from the canal boundary. These detections were then submitted for feature extraction and support vector machine classification (SVM).

RESULTS
Before classification with SVM, our CAD system detected 44 out of 47 detections. Missed detections resulted from undersegmentation of the canal in the L5-S1 regions. A sensitivity of 80% with 7.2 false positives per patient was attained following classification and ten-fold cross-validation, which compared favorably with the sensitivity of 76% with 7.4 false positives per patient attained by restricting CAD to intensity based K-Means clustering.

CONCLUSION
Our CAD system lays the groundwork for detection of epidural masses in CT scans and points to the importance of using a combination of spatial and intensity based parameters to localize masses in the canal.

CLINICAL RELEVANCE/APPLICATION
Epidural masses in the spinal canal can cause pain or paralysis and can indicate metastasis. Alerting radiologists of the presence of these masses in CT can speed response to underlying pathologies.

SSE22-05 • A Fully Automatic Registration Algorithm for Multiparametric Prostate MRI

Valentina Giannini (Presenter) ; Anna Vignati ; Simone Mazzetti ; Filippo Russo MD ; Christian Bracco PhD * ; Michele Stasi ; Daniele Regge MD

PURPOSE
Multiparametric (mp) MRI has been proposed as a potential alternative screening method for prostate cancer (PCA) diagnosis. One of the most challenging problems is to correctly align different types of images so that features coming from different sequences can be extracted from the same group of pixels. The aim of this study is to present a fully automatic registration system capable of correcting for movements generated during the dynamic acquisition (DCE) and for DW image distortion.

METHOD AND MATERIALS
The dataset includes 21 men with histologically proven PCa (age 65 [7], mean[SD]) that underwent endorectal 1.5T MRI with the following scanning protocol: axial T2-w, DW imaging (b-values 0, 600, 1000 and 1400 s/mm^2) and a 13-s time resolution DCE sequence. All patients underwent radical prostatectomy within 3 months from MRI. A radiologist manually outlined regions of interest on the T2-w images in areas corresponding to the tumoral foci at histology and in a non-tumoural region located in the contralateral peripheral zone (PZ).

First a multi-resolution rigid registration algorithm, based on the mutual information similarity measurement, corrected misalignment between T2-w and DCE images. Afterward, a linear deformation field decoding along the vertical axis was applied on the DW images. Parameters and ADC parameters coming from registered and non-registered images were fed into a Bayes classifier, and the area under the receiver operating characteristic curve (AUC) was computed before and after registration. The one-tailed paired t-test was used to evaluate differences between AUC, sensitivity and specificity obtained by the classifier before and after registration.

RESULTS
CONCLUSION
This study demonstrated the feasibility of a fully automatic registration framework on a MRI prostate CAD system. The proposed method seeks to have all the MRI dataset registered to the T2-w image, thus allowing a more reliable multiparametric analysis.

CLINICAL RELEVANCE/APPLICATION
An automatic registration algorithm, integrated in a CAD for PCa, can reduce observer variability and reading time, and can be used to guide targeted prostate biopsy directly on the suspected region.

SSE22-06 • Computer-aided Detection of Prostate Cancer Based on Automatic Multi-parametric Magnetic Resonance Image Analysis
Simone Mazzetti (Presenter) ; Valentina Giannini ; Anna Vagnati ; Filippo Russo MD ; Michele Stasi ; Daniele Regge MD

CONCLUSION
The application of a CAD system based on mp-MRI information that automatically highlight cancer suspicious regions will improve the diagnostic accuracy of the radiologist, reducing reader variability and speeding up the reading time.

Background
Prostate cancer (PCa) is the most common malignancy affecting men in the world and represents the third cause of cancer death in industrialized countries. Diagnosing PCAs using multi-parametric (mp) magnetic resonance imaging (MRI) is increasingly being used in the diagnostic pathway, also in combination with computer-aided diagnosis (CAD) systems, in order to automatically detect and localize the disease.

Aim of this study is to present a CAD system based on T2-w imaging, diffusion (DW) and dynamic contrast-enhanced (DCE) acquisitions to produce a pixel-wise malignancy probability map of the prostate gland.

Evaluation
The dataset included 20 men, with PSA > 4 ng/ml and confirmed PCa by transrectal ultrasonography guided biopsy. Patients underwent MRI at 1.5T using an endorectal coil and radical prostatectomy within 3 months of imaging. The pathologist contoured foc of cancer on prostate sections, to create the standard of reference. Then a radiologist compared imaging with histopathology and reported both malignant and benign regions of interest (ROI) on the T2-w images. The first step for the CAD system was the registration between T2-w, DW and DCE-MRI. Then each pixel belonging a ROI was represented as a vector containing values of T2-w signal intensity, of the apparent diffusion coefficient and of quantitative physiological parameters (e.g. $K_{trans}$) from DCE. Selected features were fed into a support vector machine classifier in order to provide a classification that maximized the detection of true positives, minimizing the false positive cases.

Discussion
The CAD performed automatic mp-MRI analysis, supported by a preliminary registration step between the three MRI datasets. The results are objective and reproducible, providing a unique information for clinicians summarized in a malignancy probability map.

SSE23-01 • Design and Evaluation of an Interactive MPR Viewer for Real-time Filtering of Large High-resolution Breast CT Data
Ronny Hendrych * ; Marcel Beister (Presenter) * ; Willi A Kalender PhD *

PURPOSE
In clinical breast CT it is of interest to calculate low-noise CT volumes for soft-tissue lesion (STL) detection from noisy high-resolution (HR) images for micro-calcification diagnosis to avoid multiple reconstructions. A viewer for multi planar reformatting (MPR) was developed and evaluated to offer a continuous adjustment of spatial resolution, to reduce the time necessary for the diagnostic procedure and to improve the workflow.

METHOD AND MATERIALS
Simulations of mathematical breast phantoms were performed (ImpactSim, CT Imaging GmbH, Erlangen, Germany) with average glandular dose levels varied from 1.5 up to 6 mGy. Furthermore, a breast CT prototype (CT Imaging GmbH, Erlangen, Germany) was used to scan an ACR Phantom (CIRS, Norfolk, VA, USA). Volumetric images were reconstructed in HR mode and subsequently 3D filtered using the following techniques: Gaussian, median and box filters and an iterative impulse detector using a weighted median filter. The visibility of lesions was assessed by calculating the effective contrast-to-noise ratio (CNReff), combining the usual CNR with the diameter of the lesion in question.

RESULTS
The MPR viewer allowed for continuous interactive real-time filtering of large HR volumes in an interactive fashion. In the simulated breast CT volumes the applied filters improved the CNReff for lesions of 2 mm from 1.4 unfiltered in the HR volumes up to 39.2, 23.7, 40.5 and 8.5 for box filter, median, Gaussian and impulse detector. For the ACR phantom the Gaussian filter achieved the best results with an increased CNReff from 7.6 to 51.4 for the smallest lesion. Thereby all filters help to surpass the Rose criterion which states that values of 5 or higher are necessary to distinguish objects from the surrounding area.

CONCLUSION
The MPR viewer eliminates the need for multiple reconstructions in breast CT. It allows adjusting interactively the spatial resolution and thereby changing the effective CNR continuously.

CLINICAL RELEVANCE/APPLICATION
MPR viewers may help to avoid multiple image reconstructions, increase the effective CNR of lesions and improve the workflow for breast CT exams.

SSE23-02 • Evaluation of Sinogram Affirmed Iterative Reconstruction Using the XCAT Phantom in a Model Observer Study
Fatma Elzahraa A Elshahaby (Presenter) ; Benjamin Tsui PhD * ; Matthew K Fuld PhD * ; Pamela T Johnson MD * ; Elliot K Fishman MD * ; Jingyan Xu PhD

PURPOSE
The study was designed to compare the performance of Siemens Sinogram Affirmed Iterative Reconstruction (SAFIRE) and the Weighted Filtered BackProjection (WFBP) reconstruction methods using realistically simulated CT images from the 3D Extended
METHOD AND MATERIALS
Five simulated spheres (dia.=5mm, attenuation ratio of sphere:background= 1%) were placed at 5 locations in the liver of the XCAT phantom. Noisy CT projection data, 50 sets of lesion-present and 50 lesion-absent, at 11.5 ms/rotation were generated using the DRASIM/XCAT simulation software. They were reconstructed on a Siemens Definition Flash scanner using WFBP with kernels B31F, B41F, B50F, B70F, and SAFIRE at strengths 1, 3, 5, and each with kernels I31F, I41F, I50F, I70F. A total of 250 lesion-present and 250 lesion-absent images were generated for each reconstruction + kernel combination. The central 64x64 pixels centered on the lesion was extracted and processed using 5 octave-wide rotationally symmetric frequency channels. 125 CT images were used for CHO training and 125 images for CHO testing. The receiver operating characteristic (ROC) curve and the area under the curve (AUC) from each reconstruction + kernel combination, and the statistical significance of the AUC difference were analyzed by LABROC4 and CLABROC programs.

RESULTS
The mean AUC did not change much for different kernels of WFBP, but it varied for SAFIRE especially at strengths 3 and 5. Using the sharp kernel 170F, the AUC decreased as the images became noisier which reduced the lesion detectability. For this detection task, the kernels I31F and I41F had the highest AUCs in WFBP for WFBP and I41F for SAFIRE. At these kernels, SAFIRE-3 outperformed WFBP and SAFIRE-1 and the AUC differences were statistically significant. The AUC difference between SAFIRE-3 and SAFIRE-5 was statistically insignificant indicating similar performance in lesion detection.

CONCLUSION
By appropriate choices of the filter strength and kernels, SAFIRE outperformed the WFBP method in a lesion detection task using realistically simulated CT images. The results remain to be confirmed using clinical data.

CLINICAL RELEVANCE/APPLICATION
The advanced Sinogram Affirmed Iterative CT reconstruction (SAFIRE) method has the potential to improve lesion detectability in the clinical setting.

SSE23-03 • Quantitative Assessment of Metal Artifact Reduction in C-arm Cone-beam CT Guidance of Neurovascular Interventions

Carolina Cay (Presenter) ; Marta Wells ; Adam S Wang PhD * ; Jeffrey H Siewerdsen PhD * ; Tina Ehtiyat PhD * ; Christopher Rohkohl * ; Bernhard G Scholz MD * ; Martin G Radvany MD *

PURPOSE
To evaluate the performance of a metal artifact reduction (MAR) algorithm in C-arm cone-beam CT guidance of neurovascular interventions.

METHOD AND MATERIALS
Preclinical studies were conducted using a robotic C-arm (Artis Zeego; Siemens AG) for 3D imaging and MAR prototype developed by the manufacturer. The MAR algorithm involves semi-automatic segmentation of metal components, sinogram correction, and 3D image reconstruction. A head phantom was developed involving a natural skull in tissue-equivalent plastic and the intracranial space filled with brain-equivalent gelatin. Plastics representing low-contrast brain, vessels, and CSF were incorporated along with a 3D prototype vascular tree and aneurysm (~9 mm diameter). Metal components were successively introduced: steel, titanium, and tungsten spheres (3.2, 6.4, and 12.8 mm diameter); an intravascular stent (Enterprise; DePuy); and coils (Deltamax; DePuy) in the last two with and without iodine contrast in the vascular tree. 3D images were reconstructed with and without MAR, and artifact magnitude was quantified in terms of the voxel value standard deviation from streaks in a region about the metal component.

RESULTS
The MAR algorithm demonstrated strong reduction in artifact in each scenario and reduced image artifact to a level sufficient for visualization of the metal component and surrounding structures. Artifact magnitude without and with MAR was, respectively: 427 vs 35 HU (3.2 mm steel); 506 vs 44 HU (6.4 mm steel); 384 vs 49 HU (12.8 mm steel); 451 vs 35 HU (coil only); and 455 vs 50 HU (stent + coil). Similar improvement (~8-13x reduction in artifact magnitude) was evident in Ti and W spheres (3.2-12.8 mm). Even under the most severe scenario examined, MAR restored visualization of the component and did not visibly degrade the fidelity of surrounding structures.

CONCLUSION
The MAR algorithm provided excellent reduction of artifact magnitude even under challenging scenarios of large and multiple metal components. This quantitative performance assessment indicates that the method warrants investigation in clinical studies. Ongoing work includes streamlining the semi-automatic segmentation step and analysis of tolerance to MAR parameters.

CLINICAL RELEVANCE/APPLICATION
3D imaging in neurovascular intervention is challenged by artifacts arising from stents, coils, and clips. The MAR algorithm diminishes such artifacts for improved guidance and verification.

SSE23-04 • Diagnostic Performance Assessment of an Iterative Reconstruction Algorithm Using a Model Observer: Correlation with Human Observers for a Low Contrast Detection Task with Unknown Lesion Locations

Shuai Leng PhD (Presenter) ; Lifeng Yu PhD ; Yi Zhang ; Michael R Bruesewitz ; Thomas J Vrieze RT ; Cynthia H McCollough PhD *

PURPOSE
To investigate the ability of a Channelized Hotelling Observer (CHO) to predict human observer performance for the task of low contrast lesion detection for unknown lesion locations, where CT images were reconstructed using an iterative reconstruction (IR) algorithm.

METHOD AND MATERIALS
Two cylindrical rods (3 mm and 5 mm diameters) were placed in a 35 x 26 cm torso-shaped water phantom to simulate lesions with -15HU contrast at 120 kV. The phantom was scanned 100 times on a 128-slice CT scanner at each of 4 dose levels (CTDIvol = 22.8, 17.1, 11.4, and 5.7 mGy). Images were reconstructed with the system's IR algorithm (SAFIRE, Siemens). A total of 100 signal-present images were generated by placing regions of interest (ROIs) around each lesion and 50 background images were generated from images without lesions, with each ROI containing 128x128 pixels. The location of the lesion (rod) in each ROI was randomly distributed by moving ROIs around each lesion. Three trained observers identified the presence or absence of lesions, indicated the lesion location in each image, and scored their confidence for the detection/localization task on a 6-point scale, from which localization ROC (LROC) curves were generated. The same images were analyzed using a CHO with Gabor channels. Internal noise was added to the decision variables for each image, and scored their confidence for the detection/localization task on a 6-point scale, from which LROC curves were generated. The product-moment correlation coefficients of 0.994 and 0.994 for 3mm and 5mm diameter lesions, respectively.

CONCLUSION
The performance of CHO with Gabor channels was highly correlated with human observer performance for the detection and localization of low contrast lesions with uncertain locations in CT images reconstructed with the SAFIRE IR algorithm.

CLINICAL RELEVANCE/APPLICATION
The ability of a CHO to objectively assess the performance of iterative reconstruction algorithms for detection tasks may provide an
A Novel Iterative-reconstruction Algorithm for Metal Artifact Reduction: Comparison with Filtered Back Projection and Linear-interpolation

Siva P Raman MD (Presenter); Pamela T Johnson MD *; Matthew K Fuld PhD *; Elliot K Fishman MD *

PURPOSE
Iterative reconstruction algorithms offer a new option for the reconstruction of images with decreased metal-related artifacts. The goal of this study is to quantitatively and qualitatively compare CT scans performed in patients with metallic hardware when reconstructed with three different reconstruction algorithms: (1) Traditional weighted filtered back-projection (WFBP), (2) a novel iterative reconstruction algorithm (IR-MAR) designed for metal artifact reduction (Siemens, Germany), and (3) a linear interpolation metal artifact reduction algorithm (LI-MAR).

METHOD AND MATERIALS
20 different consecutive pelvic CT scans in patients with unilateral or bilateral metallic hip arthroplasties were identified. These data sets were reconstructed in the axial plane using the three different reconstruction algorithms (WFBP, IR-MAR, and LI-MAR). An abdominal radiologist with 2 years of experience evaluated the images (on a scale of 1-10) with regards to image quality, providing separate scores for the overall image and individual appearances of the bladder, prostate/uterus, and pelvic side walls. ROI analysis was performed of the bladder lumen and subcutaneous fat (ipsilateral to hardware) with mean Hounsfield attenuation values and standard deviation (as a surrogate for noise) recorded.

RESULTS
Subjective quality ratings for the overall image and individual appearances were compared between the three reconstruction algorithms. ROI analysis was performed for the overall image and individual appearances of the bladder, prostate/uterus, and pelvic side walls. ROI analysis was performed of the bladder lumen and subcutaneous fat (ipsilateral to hardware) with mean Hounsfield attenuation values and standard deviation (as a surrogate for noise) recorded.

CONCLUSION
A novel metal artifact reduction algorithm based on iterative reconstruction offers significant improvements in subjective image quality compared to both traditional filtered back projection and older linear interpolation algorithms. Moreover, quantitative decreases in image noise are at least equivalent to linear interpolation MAR algorithms.

CLINICAL RELEVANCE/APPLICATION
A novel iterative reconstruction algorithm (IR-MAR) offers considerable qualitative and quantitative advantages over older reconstruction techniques when dealing with metal artifacts on CT.
prescription dose (Rx), and 2) a plan where the HR-CTV D90 received Rx and the PET-GTV D90 was boosted to 1.5Rx. In both cases the EQD2 D2cc dose to the bladder and rectum were kept below the GEC-ESTRO guidelines of 90 and 75 Gy, including the contribution from external beam therapy. Dose-volume parameters calculated for the all volumes.

RESULTS

Significant differences were seen between the MRI-GTV and PET-GTV contours (average size difference 21.8cc, average overlap 50%, see Figure 2). The PET-GTV boost to 150% was possible in four out of five cases, with the last case reaching 127% before reaching the rectal D2cc limit (Table 1). In 3 of the test cases, the PET-GTV also received about 150% of the Rx dose in the MRI-only plans, but were within tolerance for P2cc in the presence of a magnetic field. MRI-IGRT system. Correction factors were determined using techniques outlined in the AAPM Task Group 51 report and various other publications. Correction factors were determined as a function of ion chamber orientation in the magnetic field and compared to readings taken on a linear accelerator in the absence of a magnetic field.

RESULTS

The various ionization chambers with a central anode were within prescribed tolerance limits for P100 and P90 in the presence of a magnetic field. Parallel plate ionization chambers exceeded tolerance limits for P100, but were within tolerance for P90 in the presence of a magnetic field. There are no established tolerance limits for a stem correction factor, but several ionization chamber of both design types showed significantly different stem correction factors in the presence of a magnetic field compared to when not in a magnetic field. All ionization chambers showed a directional dependency in the stem correction factor in the presence of a magnetic field.

CONCLUSION

The ability of central anode ionization chambers to satisfy TG-51 correction factor tolerance limits seems uninhibited by the presence of a magnetic field, however parallel plate chambers were strongly affected by the presence of a magnetic field. Chambers of all design types may require bi-directional commissioning due to variations in the stem correction factor when in the presence of a magnetic field.

CLINICAL RELEVANCE/APPLICATION

Certain designs of ionization chambers seem unaffected by a magnetic field and are suitable for use with the first MRI-IGRT machine.

SSE24-05 • Analysis of Predictive Maintenance of Linear Accelerator Beam Uniformity Using Statistical Process Control

Charles M Able MS (Presenter) * ; Alan Baydush PhD * ; Michael T Munley PhD *

CONCLUSION

PDm monitoring of beam uniformity using a new method for determining SPC control limits is more effective than using traditional control limits. SPC false alarms are reduced thereby eliminating unwarranted service intervention. We are working to develop code that will provide an SPC evaluation using the new formula.

Background

The focus of this study is to determine the effectiveness of revisions to statistical process control (SPC) chart limits for linear accelerator steering coil current (beam uniformity) predictive maintenance (PdM) monitoring.

Evaluation

We have re-evaluated calculation of the limits for steering coil current (SCC) SPC charts based on our observations that the changes in
Stereotactic Body Radiation Therapy (SBRT) is a treatment option for inoperable early stage lung cancer patients. SBRT uses tightly conformed megavoltage (MV) x-ray beams to ablate the tumour in only a few treatment sessions. Small MV x-ray fields may cause lateral electron disequilibrium (LED) to occur within lung tissue, which can reduce the dose to the tumour to a variable extent. These dose effects may be challenging to predict using commercially-available dose calculation algorithms. Thus, to avoid LED, previous authors suggested using low energy photons and larger fields for lung cancer patients. We propose a new form of SBRT, named LED-optimized SBRT (LED-SBRT), which utilizes RT parameters designed to exploit LED to advantage. It will be shown that LED-SBRT can be used to reduce the dose within healthy lung tissue while enabling escalation of tumour dose levels.

**METHOD AND MATERIALS**

The DOSXYZnrc Monte Carlo software was used to calculate dose within a typical SBRT patient. To mimic a 360° SBRT arc, 36 equally weighted fields were focused onto the small tumour (~1 cm). 6 or 18 MV x-ray energies were used to simulate different plans of various field sizes. The LED-optimized plan, 18MV(3x1cm²), was compared to a clinical standard arc using 6MV(3x3cm²) beam parameters. A planning target volume (PTV) was generated by considering the extent of tumour motion over the patient’s breathing cycle. All dose results were normalized such that at least 95% of the PTV received at least 54 Gy (i.e. D95).

**RESULTS**

The LED-optimized plan produced a hot spot at the tumour center equal to 169Gy, which was approximately twice as large as the maximal dose found within the conventional plan. Despite escalated tumour dose levels, normal lung dose was still decreased. For example, the mean lung dose and V20 decreased by ~ 0.5 Gy and 1%, respectively, comparing the LED-optimized plan to the clinical standard.

**CONCLUSION**

This article introduces a novel SBRT technique, LED-SBRT, which exploits the LED phenomenon to reduce normal lung dose levels and permit tumour dose escalation.

**CLINICAL RELEVANCE/APPLICATION**

These results are significant as tumour dose escalation correlates well with tumour control (and overall survival), while lower lung dose metrics reduce the risk of lung toxicities (e.g. pneumonitis).
PURPOSE
Dynamic contrast enhancement MR imaging (DCE-MRI) offers noninvasive characterization of the vascular microenvironment and hemodynamics. In this study, we hypothesize that DCE-MRI can be used to evaluate treatment response and predict tumor recurrence in patients with spinal metastases undergoing hypofractionated SRS (24 Gy). We conducted a retrospective study of 30 patients with spinal metastases who underwent DCE-MRI before and after RT. 20 patients received single-fraction SRS (24 Gy), while 10 received hypofractionated SRS (27-30 Gy total). Kaplan-Meier analysis was used to estimate the actuarial local recurrence rates, which were compared using a log-rank test. Two compartment model-based perfusion parameters ($K_{trans}$: vascular permeability and $V_p$: plasma volume) were measured for each metastasis, relative to normal-appearing bone marrow. Percent change in parameter values from pre- to post-treatment were calculated and statistically compared.

RESULTS
At 20-month median follow-up, 5/30 (17%) patients had pathological evidence of local recurrence (LR). 3/10 (30%) patients treated with hypofractionated SRS had LR, while 2/20 (10%) patients with single-fraction SRS had LR. 1- and 3-year actuarial local recurrence rates were 24% and 44% for the hypofractionated SRS group vs. 5% and 16% for the single-fraction SRS group (p=0.20). The average change in $K_{trans}$ for patients without LR vs. those with LR was -76% (range, -99% to -12%) and -66% (range, -99% to -9%) vs. +28% (range, -19% to +102%) and -14% (range, -50% to +84%) ($p$).

CONCLUSION
We demonstrated that changes in perfusion, particularly $V_p$, reflect tumor responses to high dose RT in spinal bone metastases. Additionally, these changes predicted local tumor recurrence on average >6 months earlier than standard imaging did.

CLINICAL RELEVANCE/APPLICATION
The ability of DCE-MRI to detect early treatment response and predict local recurrence has the potential to improve patient care and outcome.

SSE25-04 • Dosimetric Implications of Setup Error in Craniospinal Irradiation with Volumetric Modulated Arc Therapy
Ben Durkee MD, PhD (Presenter) ; Braie Hargens MS ; Fred Van Den Haak ; Jennifer L Shah MD ; Sarah S Donaldson MD

PURPOSE
1. To demonstrate the dosimetric advantages and drawbacks of volumetric modulated arc therapy (VMAT) planning for craniospinal irradiation (CSI).
2. To demonstrate that small errors in setup are dosimetrically acceptable for CSI with VMAT.

METHOD AND MATERIALS
A single pediatric patient was simulated in the supine position on a Styrofoam board. The head was immobilized by a custom headrest and thermoplastic mask. No specific measures were taken to immobilize the spine or pelvis. Craniospinal therapy was prescribed to a dose of 23.4 Gy using 3D conformal radiotherapy (3D CRT) and VMAT. The two plans were compared with attention to coverage of the target volume and dose to normal tissues. Normal tissues examined included thyroid, heart, lungs, kidneys, bowel and whole body. The small setup error was simulated by applying 3 mm and 5 mm lateral shifts to the dosimetric map. The plan was re-analyzed by the same methodologist. Percent change in parameter values from pre-treatment to post-treatment were calculated and statistically compared.

RESULTS
Both plans resulted in good coverage of the target and met our pre-defined constraints for normal tissue. VMAT was superior to 3D CRT in minimizing dose to normal tissues near the midline, including thyroid (mean 11.4 Gy versus 22.2 Gy) and small bowel (V15).

CONCLUSION
Dosimetric implications of resultant setup errors must be considered when using highly conformal techniques such as VMAT. VMAT for CSI can spare dose to normal tissues near the midline, but at the expense of low-dose spill to large volume structures such as lung and whole body. Long-term implications, including risk for secondary malignancies, should be considered in patients selected for VMAT craniospinal irradiation. Planning with VMAT appears to be relatively resistant to small errors in setup, making it an appropriate modality for use in carefully selected children.

CLINICAL RELEVANCE/APPLICATION
Craniospinal irradiation with highly conformal techniques such as VMAT is relatively resistant to small errors in setup, and is appropriate for thoughtfully selected pediatric cases.
### ABSTRACT

**Purpose/Objectives:**
A recent multi-institution study demonstrated that radiotherapy dose >10 Gy to the pancreatic tail (PT) predicted an 11-fold increased risk of DM in childhood cancer survivors. These findings highlight the potential radiosensitivity of pancreatic islet cells responsible for insulin secretion. Cadaveric human studies have shown that up to 65% islet cells are located outside PT. These data suggest the importance of including the whole pancreas (P) as an organ-at-risk (OAR) during radiotherapy planning for pediatric tumors, such as CSI for medulloblastoma given its relatively favorable prognosis. This study compares CSI techniques of proton beam therapy (PBT), conventional photon fields (3DCRT), and helical tomotherapy (HT) to investigate their differential capacity for pancreatic sparing.

**Materials/Methods:**
5 average-risk medulloblastoma patients who received CSI to 23.4 CGE using PBT at a single institution were identified. P and PT had not been considered OARs during PBT planning. 3DCRT plans using opposed lateral cranial fields and posterior spinal fields were generated. P and PT were delineated as OARs on the PBT planning CT scan, and multiple HT plans were developed for each patient. HT plans delivering the lowest dose to P and PT without compromising target coverage were selected. Endpoints included mean dose (Dmean), maximum dose (Dmax), and volume receiving 10 Gy (V10). Comparisons were made using T-test; statistical significance was assigned to p values < 0.05.

**Results:**
All three modalities covered the PTV with the 95% isodose line.

<table>
<thead>
<tr>
<th>Endpoint</th>
<th>3DCRT</th>
<th>PBT</th>
<th>HT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Whole Pancreas (P)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dmean (Gy)</td>
<td>11.97</td>
<td>0.172</td>
<td>0.145</td>
</tr>
<tr>
<td>Dmax (Gy)</td>
<td>21.36</td>
<td>11.91</td>
<td>13.47</td>
</tr>
<tr>
<td>V10 (%)</td>
<td>59.05</td>
<td>0.61</td>
<td>4.48</td>
</tr>
</tbody>
</table>

| Pancreatic Tail (PT)     |       |      |      |
| Dmean (Gy)               | 8.2   | 0.09 | 0.01 |
| Dmax (Gy)                | 20.86 | 6.89 | 1.71 |
| V10 (%)                  | 39.28 | 0.41 | 0.92 |

Dmax to P and PT and V10 to PT were higher with 3DCRT as compared to PBT or HT (p=0.01 for 3DCRT vs. PBT for Dmax to P; p<0.05).

**Conclusions:**
PBT and HT provided significantly lower Dmax and V10 to PT than 3DCRT. However, PBT provided even better pancreatic sparing compared to HT, reducing Dmax to mean to P and PT and V10 to P. Thus, PBT for CSI may be associated with the lowest risk of long-term DM in pediatric medulloblastoma survivors.

### SSE25-06 • Feasibility of Simultaneous Integrated Boost Gamma Knife Planning For Malignant Gliomas and Brain Metastases

**Nevine M Hanna MD (Presenter)**

**ABSTRACT**

**Purpose:** Simultaneous Integrated Boost (SIB) in Gamma Knife planning defines and prescribes differential doses to the gross target volume (GTV) and the surrounding region of peritumoral infiltration or edema. The purpose of this is to report our preliminary assessment of the concept of the simultaneous integrated boost (SIB) applied to Gamma Knife radiosurgery in the treatment of recurrent gliomas and brain metastases.

**Methods:** 8 lesions in 6 patients underwent SIB Gamma Knife planning for recurrent glioma or resected brain metastases with a residual tumor nodule (2 lesions). SIB Gamma Knife planning was performed using Gamma Plan 8.2 according to a technique developed by the authors to differentially treat nested target volumes. The gross target volume (GTV) was defined by the contrast enhancing tumor nidus on T1 magnetic resonance imaging (MRI) sequences and the planning target volume-margin (PTV-m) was defined by the abnormal region on the T2 or FLAIR sequences. A higher dose was delivered to the gross target volume (GTV) defined by the contrast enhancing lesion as seen on the T1 contrast-enhanced SPGR sequences and a lower, volume-appropriate dose to the typically larger planning target region on the T2 or FLAIR sequences. A higher dose was delivered to the gross target volume (GTV) defined by the contrast enhancing lesion as seen on the T1 contrast-enhanced SPGR sequences and a lower, volume-appropriate dose to the typically larger planning target region on the T2 or FLAIR sequences. A higher dose was delivered to the gross target volume (GTV) defined by the contrast enhancing lesion as seen on the T1 contrast-enhanced SPGR sequences and a lower, volume-appropriate dose to the typically larger planning target region on the T2 or FLAIR sequences.

**Results:**
Average age was 53 years (46-71). Brain lesions treated included malignant gliomas as well as metastases secondary to melanoma and squamous cell carcinoma. Mean prescribed dose was 17.1 Gy (12-27) at 78% (65-84). Mean coverage at prescription was 85% (70-100) and mean treatment volume was 5.1 cc (0.3-10.1). Mean PTV-m volume = 24.5 cc (7.2-57.9). Prescribed dose was 8 Gy for re-irradiation and 16-17 Gy for non-re-irradiation treatment. Mean PTV-m coverage was 98% (95-100) and mean PTV-m treatment volume was 40 cc (4.2-86). Mean number of shots was 29 (5-54) and mean on-beam time was 76 minutes (23.7-158.6). Median post-treatment follow up after treatments is 22 weeks (4-59) with 3 patients deceased and 3 patients alive without evidence of complications at last follow up. Further radiological response is being analyzed.

**Conclusions:** We conclude from this preliminary study that SIB Gamma Knife plans with target and treatment volume adjusted GTV and PTV-m doses are feasible for implementation for Gamma Knife radiosurgery. The lack of toxicity and the preliminary clinical outcomes suggest the potential future utility of the SIB concept for Gamma Knife radiosurgical treatment planning.
To evaluate the efficacy of siRNA targeting MMP-9 in suppressing granulation tissue formation caused by bare metallic stent placement in a rat urethral model.

METHOD AND MATERIALS
All experiments were approved by the committee of animal research. In 20 Sprague-Dawley male rats (weight range, 300–350 g), a self-expanding metallic bare stent was inserted in the urethra under fluoroscopic guidance. One group of 10 rats (group A) was treated with MMP-9 siRNA/BPEI-ICG, while the other group of 10 rats (group B) received control siRNA/BPEI-ICG treatment. All rats were sacrificed at 4 weeks. The therapeutic efficacy of the MMP-9 siRNA/BPEI-ICG complex was assessed by comparing the two results of retrograde urethrography, histological examination, and quantification of MMP-9 by zymography and western blot analysis between the two groups.

RESULTS
Stent placement was successful in all rats without a single case of migration on follow up. Retrograde urethrography performed four weeks after stent placement demonstrated significantly larger luminal diameters of the urethra within the stents in group A compared to those in group B (P = .011). Histologic analysis revealed that the average percentage of granulation tissue area (P < .001), average number of epithelial layers (P < .001), and average thickness of submucosal fibrosis (P < .001) were significantly decreased in group A compared to group B. Meanwhile, the average density of inflammatory cell infiltration did not significantly differ among the two groups (P = .184). Quantitative analysis disclosed MMP-9 levels to be lower in group A relative to group B indicating positive inhibition of MMP-9 by MMP-9 siRNA/BPEI-ICG.

CONCLUSION
MMP-9 siRNA/BPEI-ICG is effective for inhibiting granulation tissue formation after bare metallic stent placement in a rat urethral model.

CLINICAL RELEVANCE/APPLICATION
Local therapy using MMP-9 siRNA/BPEI-ICG could be utilized to decrease stent-related tissue hyperplasia.

SSE26-03 • Biliary Intraductal Metastasis from Advanced Gastric Cancer: Radiologic and Histologic Features, and Clinical Outcomes of Percutaneous Metallic Stent Placement

Joo Yeon Lee (Presenter); Dong Il Gwon; Gi-Young Ko; Kyu-Bo Sung; Hyun-Ki Yoon

PURPOSE
The purpose of this study is to investigate radiologic and histologic features of biliary intraductal metastasis from advanced gastric cancer in 24 patients with biliary obstruction and clinical outcomes after metallic stent placement.

METHOD AND MATERIALS
Patient population: This retrospective study was approved by Institutional Review Board of our institution and written informed consent was waived. Between August 2003 and August 2012, 24 consecutive patients with obstructive jaundice related to biliary intraductal metastasis from advanced gastric cancers were enrolled. Imaging Methods and Diagnosis PTBD, Biliary Biopsy, and Pathologic Analysis Metallic Stent Placement Endpoints of stent placement and Statistical analysis

RESULTS
Imaging and pathologic Characteristics: uniform concentric linear (n=17) or band-like (n=7) enhanced wall thickening. 20 (83.3%) had cystic ductal lesions in contrast with the intraductal lesions. The level of biliary obstruction was hilar in 13 (54.2%) patients and non-hilar in 11 (45.8%). Ninety (79.2%) patients had lymph node metastasis around the biliary system. The submucosal fibrosis was universal feature in all biopsied cases (n=6), regardless of the malignant or atypical cells, and none of the cases shows biliary mucosa disruption by the malignant cells.

Outcomes of Metallic Stent Placement: Stent occlusion was observed in four (17%) patients treated with PTBD, in three owing to sludge incrustation and in one owing to tumor overgrowth, 49±278 days (mean, 168 days) after stent placement. Mean stent patency time was 341 days (95% CI 272±410 days) and cumulative stent patency rates at 3, 6, 9, and 12 months were 95%, 88%, 78%, and 62%, respectively

CONCLUSION
In conclusion, imaging and pathologic characteristics of biliary intraductal metastasis from advanced gastric cancer are uniform enhanced biliary wall thickening, and submucosal malignant cells and fibrosis without any disruption of biliary epithelial layer. Moreover, uncovered metallic stent placement was safe and effective methods for palliative treatment in patients with biliary intraductal metastasis caused by advanced gastric cancer.

CLINICAL RELEVANCE/APPLICATION
The clinical outcomes after uncovered stent placement and pathologic proof may give an explanation.

SSE26-04 • Intrabiliary Radiofrequency Heat-enhanced Local Chemotherapy of Cholangiocarcinomas Monitored by Dual-modality Imaging

Xia Wu (Presenter); Feng Zhang MD, PhD; Thomas X Le MD; Han Wang MD; Tong Zhang MD; Yanfeng Meng MD; Baojie
Single-centre Experience on 1292 Patients

PURPOSE
Patients with biliary malignancies have a poor prognosis. We developed a new technology, named intrabiliary radiofrequency heat (RFH)-enhanced chemotherapy, for efficient management of biliary malignancies.

METHOD AND MATERIALS
To establish proof-of-principle, serial in-vitro studies with GFP-labeled human cholangiocarcinoma cells and serial in-vivo studies with GFP-positive cholangiocarcinomas on mice were performed. The cells and tumors were treated by: (a) combination therapy with chemotherapies (gemcitabine and 5-fluorouracil (5-FU)) plus RFH; (b) chemotherapies-only; (c) RFH-only; and (d) phosphate-buffered saline. Cells proliferation was quantified by MTS assay, and tumor changes on mice monitored by 14.0 Tesla MR imaging and optical imaging overtime. To further validate the feasibility of this new technology, intrabiliary local delivery of gemcitabine and 5-FU were performed with RFH (8 pigs) or without RFH (8 pigs). Chemotherapies were delivered in bile duct walls were quantified by high-pressure liquid chromatography.

RESULTS
Combination therapy induced significantly lower cell proliferation than chemotherapies-only and RFH-only treatments (0.29±0.13 vs 0.87±0.10 and 0.73±0.35 vs 1.31, p=0.0009 and 0.001, respectively). Combination therapy resulted in smaller tumor volume than chemotherapies-only and RFH-only treatments (0.65±0.03mm³ vs 1.37±0.05mm³ and 1.30±0.21mm³, p=0.003). Only in the combination therapy group, both MRI and optical imaging demonstrated remarkable decreases of diffusion coefficients and fluorescent signals on tumor masses immediately after the treatments. Chemotherapies quantification showed higher average drug deposit dose in pig bile duct walls with intrabiliary RFH than that without RFH. (Gemcitabine: 0.32±0.033mg vs 0.260±0.030mg and 5-FU: 0.664±0.060mg vs 0.52±0.050mg, p

CONCLUSION
Intrabiliary RFH can enhance the chemotherapeutic effect on cholangiocarcinomas, which can be accurately monitored by diffusion-weighted MRI and optical imaging.

CLINICAL RELEVANCE/APPLICATION
This technical development may open new avenues to efficiently manage biliary malignancies using intrabiliary MRI and RFH-integrated therapies.

SSE26-05 • Clinical Relevance and Interventional-radiological Management of Complications after Pancreatic Surgery: A 10-year Single-centre Experience on 1292 Patients

Massimo Venturini MD (Presenter); Giulia Agostini; Gianpaolo Balzano; Francesco A De Cobelli MD; Stefano Cappio MD; Alessandro Del Maschio MD

PURPOSE
Despite the improvement in technique/expertise, pancreatic surgery remains burdened with a high complication rate. Our aim was to report our 10-year single-centre experience about the clinical relevance and the interventional-radiological management of the postoperative complications (treatment/prevention) on 1292 patients submitted to pancreatic surgery.

METHOD AND MATERIALS
In 2000-2012, 1292 patients were submitted to pancreatic surgery (total pancreatectomy, duodeno-cephalo-pancreatectomy, distal pancreatectomy). Patients were classified on the basis of the complication severity in 5 classes (Clavien-Dindo classification): 0=none, class 1=conservative treatment, 2=endoscopic/radiological interventional, 3=surgery, 4=intensive care, 5=death.

Interventional-radiological management consisted of: PTC/biliary drainage in case of biliary fistula ( bile in surgical drainage, normal bilirubin levels/undilated biliary ducts at US) under US/fluoroscopic guidance (right approach, puncturing along the course of the sixth-segment portal branch (Chiba needle 21G), or left approach if aerobilia/adequate volume of left hepatic lobe); embolization (microcoils/PVA-embolization) or covered-stenting (Viabahn-Gore) in case of bleeding; percutaneous drainage (US/CT-guidance) in case of liquid/infected collection. Percutaneous intra-portal islet auto-transplantation (PIPIAT) was performed in case of total pancreatectomy to prevent diabetes.

RESULTS
Patients were classified as follows: 524/1292 (40%) class 0; 210/1292 (16%) class 1; 361/1292 (28%) class 2; 79/1292 (6%) class 3a; 55/1292 (4%) class 3b; 24/1292 (2%) class 4; 39/1292 (3%) class 5. Among the 79 class-3a-patients, 74/79 required radiological-interventional management, 5/79 endoscopic management. The 74 interventions procedures were the following: 32 drainages of liquid/fluid infected collections, 30 biliary drainages, 12 bleeding management (9/12 embolization; 3/12 covered-stenting). 25/1292 underwent PIPIAT.

CONCLUSION
In centres of excellence pancreatic surgery has a low rate of complications, usually successfully managed and prevented by interventional-radiological procedures. In particular PIPIAT is an advanced, non invasive technique in the prevention of postoperative complications.

CLINICAL RELEVANCE/APPLICATION
In centres of excellence, interventionnal-radiological procedures take part in the management/prevention of the complications of pancreatic surgery, reducing the morbidity/mortality.

SSE26-06 • Percutaneous Cholecystostomy: New Route for Percutaneous CBD Stone Removal

Younggyung Shin (Presenter); Gyoo Sik Jung MD; Yong Joo Kim; Hee Kang MD

PURPOSE
To evaluate the technical feasibility and clinical efficacy of percutaneous choledocholithotomy through the percutaneous cholecystostomy tract in patients with common bile duct (CBD) stones.

METHOD AND MATERIALS
From September 2009 to February 2013, 73 consecutive patients (43 men, 30 women; age range, 30-95 years; mean age, 74 years) with CBD stone underwent percutaneous stone removal via cholecystostomy tract and cystic duct cannulation. Thirty seven patients had acute cholecystitis and thirty six patients had cholangitis. All patients could not tolerate immediate surgery due to cardiac problem (n = 8), previous cancer operation (n = 14), or poor medical condition including sepsis (n = 6), pulmonary dysfunction (n = 4), diabetes mellitus (n = 13), or liver cirrhosis (n = 1). The stones were extracted through the 12-Fr sheath using a Wittich nitinol stone basket under fluoroscopic guidance. Large or hard stones were fragmented using the basket fragmentation technique. The technical and clinical success rates, as well as complications were evaluated during follow-up period.

RESULTS
CBD stones were successfully removed in 50 of 73 patients (68%). Complete stone removal was obtained with one session in 41 patients. In 9 patients, second session was required due to multiple stones (n = 8) or migration of the fragmented stone to the CHD level (n = 1). In 23 patients, stone removal via cholecystostomy tract was failed due to failure of cystic duct cannulation (n = 14), multiple CBD stones (n = 4), proximal migration of CBD stone (n = 4), and low insertion of cystic duct (n = 1). Twenty two patients required additional PTBD for successful stone removal, and the remaining one refused further procedure. Stone removal was performed in the same session or within a maximum of 12 days (mean 3 days) after the percutaneous cholecystostomy procedure under conscious sedation. The mean time for removal of cholecystostomy catheter after successful stone extractions was 4.6 days. During the mean follow-up of 131 days, no procedure related complications were seen and no symptomatic or radiologic recurrences occurred.

CONCLUSION
Fluoroscopy-guided percutaneous CBD stone removal through the percutaneous cholecystostomy route seems to be technically feasible.
Correlation between Quantitative 18F-FDG Uptake on PET/CT with Prognostic Factors in Triple-negative Breast Cancers

Hye Ryoung Koo MD ; Woo Kyung Moon ; Nariya Cho MD ; Jung Min Chang MD ; Mirinae Seo MD ; Hye Mi Gweon MD (Presenter) ; Keon Wook Kang

PURPOSE
We aimed to investigate whether a correlation exists between quantitative 18F-FDG uptake on PET/CT and prognostic factors in triple-negative breast cancer

METHOD AND MATERIALS
Between January 2009 and December 2012, 1109 patients with newly diagnosed breast cancer underwent 18F-FDG PET/CT for initial staging followed by surgical treatment. This retrospective study involved 112 triple-negative invasive ductal cancers (mean tumor size 2.64cm, range 1 to 6.5cm) in 112 patients (mean age, 50.04 years; range, 28-77 years). Correlations between quantitative 18F-FDG uptake and various clinical and pathological features were analyzed.
SSG01-06 • Molecular Breast Imaging: The Sensitivity of Breast-specific Gamma Imaging (BSGI) as a Diagnostic Adjunct to Mammography and Ultrasound in a Triple Assessment Protocol

Jean M Weigert MD (Presenter) *; Douglas A Kieper BS *; Marcela Bohm-Velez MD

PURPOSE
BSGI is a diagnostic breast imaging procedure becoming more common in clinical breast practice. The goal of this work is to quantify its performance as an addition to mammography and ultrasound in detection of breast carcinoma when used in the community breast center setting.

METHOD AND MATERIALS
A multi-center patient registry was maintained for all patients routinely sent to BSGI as part of their diagnostic work up. From the registry data, patients who had a mammogram followed by ultrasound and BSGI were selected for evaluation. The BIRADS rating schematic was used for mammography and sonography and a similar category system was used for the BSGI images. For each modality, the reports were classified as positive (categories 4 - 6) or Negative (categories 0 - 3). Needle and/or surgical biopsy were conducted as deemed clinically necessary and all patients who had a malignant diagnosis by pathology were entered into this analysis.

RESULTS
731 patients had all three imaging modalities as part of their diagnostic work up resulting in 180 malignancies confirmed by pathology: 29 ductal carcinoma in-situ, 110 infiltrating ductal carcinoma, 11 infiltrating lobular carcinoma, 9 papillary carcinoma and 21 mixed component malignancies. Mammography was positive in 130 (sensitivity = 72%) while ultrasound was positive in 114 (sensitivity = 63%) and BSGI was positive in 147 (sensitivity = 82%). Mammography and ultrasound were positive in 163 cases (sensitivity = 90%), BSGI provided positive findings for 177 malignancies resulting in a sensitivity of 98%. A breast MRI detected one lesion missed by the three modalities while two lesions were found by pathology alone.

CONCLUSION
Of the three imaging modalities, BSGI provided the highest independent sensitivity and when added to the diagnostic workup, BSGI detected an additional 14 malignancies, increasing the sensitivity from 90% to 98%. Although it is beyond the scope of this work, it is interesting to note that the cost of the BSGI procedure is relatively low, about $320, and that in this population the BSGI specificity was 74%. In summary, when added to the diagnostic work up of patients in the community breast cancer, BSGI can improve the detection of breast malignancy when compared to mammography and ultrasound alone.

CLINICAL RELEVANCE/APPLICATION
BSGI can improve the detection of breast malignancy when compared to mammography and ultrasound alone.

SSG01-07 • False Positive Findings on Adjunct Screening Molecular Breast Imaging with Tc-99m Sestamibi

Carrie B Hruska PhD (Presenter) *; Amy L Conners MD; Katie N Jones MD; Michael K O’Connor PhD *; Deborah J Rhodes MD

PURPOSE
To determine the rates and histopathologic subtypes of false positive imaging findings and benign biopsies generated from adjunct screening with molecular breast imaging (MBI).

METHOD AND MATERIALS
Screening MBI was performed in asymptomatic women presenting for screening mammography who had dense breasts (>50% fibroglandular) on past prior mammogram. Intravenous injection of 8 mCi Tc-99m sestamibi was administered; bilateral 2-view MBI was performed using a dual-head CZT-based gamma camera. MBI studies were interpreted with access to the current screening mammogram and assigned an assessment of 1-5 that parallels BI-RADS. Assessment of 3 or higher was considered test positive. Participants with negative reference standard (benign biopsy result or negative/benign imaging at one year) were analyzed.

RESULTS
Of 1638 eligible participants, 1578 (96%) had complete reference standard, of which 1557 had no diagnosis of cancer. In 1557 participants with negative reference standard, 105 (6.7%) had test positive screening MBI and were recalled for diagnostic workup. Of these 105, 70 (67%) were resolved with benign findings on immediate diagnostic mammogram/ultrasound and follow-up MBI at 6 months. Final impressions included: stable background uptake (24) or resolved focal uptake (16); appearance of fibrocystic change (14), fibroadenoma (5), lymph node (3), post-operative change (4), or stable mass (2); and previously biopsied papilloma (2). The remaining 35 of 105 (33%) underwent biopsy: ultrasound-guided in 26, magnetic resonance imaging-guided in 7, and stereotactic in 2. Pathologic findings included fibroadenoma (11), benign breast parenchyma (6), fibrocystic change (5), papilloma (4), radial scar (3), stromal fibrosis (2), pseudoangiomatous stromal hyperplasia (2), atypical ductal hyperplasia (2).

CONCLUSION
For non-cancer cases, adjunct MBI had a recall rate of 6.7% and benign biopsy rate of 2.3%. The most common false positive imaging finding was background uptake of Tc-99m sestamibi in fibroglandular tissue; the most common biopsied benign lesion was fibroadenoma.

CLINICAL RELEVANCE/APPLICATION
MBI demonstrated a relatively low additional false positive rate compared to that reported for other modalities under consideration for supplemental screening in the dense breast.

SSG01-08 • Improved Diagnostic Yield in Dense Breasts with Supplemental Screening Molecular Breast Imaging

Deborah J Rhodes MD (Presenter); Carrie B Hruska PhD *; Amy L Conners MD; Katie N Jones MD; Michael K O’Connor PhD *

PURPOSE
We previously demonstrated that addition of Molecular Breast Imaging (MBI) using 20 mCi Tc-99m sestamibi to screening mammography (SM) increased diagnostic yield for breast cancer in dense breasts (Supplemental yield of 7.5/1000 screened). After implementing radiation dose reduction techniques, we are comparing performance of incident SM and prevalent screen MBI in women with dense
METHOD AND MATERIALS
Women presenting for SM with heterogeneously or extremely dense breasts on past prior SM were enrolled and underwent digital SM and MBI. MBI was performed with 8 mCi Tc-99m sestamibi and dual-head cadmium zinc telluride detectors. SMs were read independently; MBIs were read in comparison with SM. MBIs were assigned an assessment score of 1-5 which parallels BI-RADS; scores of 3-5 on MBI were considered positive.

RESULTS
In 1651 women enrolled, 1578 (96%) completed imaging and had reference standard of pathology findings within 365 days or negative imaging at >300 days. In 1578 analyzable participants, 21 had breast cancer diagnosed. Sensitivity was 5/21 (24%) for SM alone and 19/21 (91%) for the combination of SM and MBI. Diagnostic yield was 3.2 for SM and 12.0 for the combination (p = 0.0001). Diagnostic evaluation was prompted by SM alone in 174 (11%) patients and by the combination in 280 (18%). Biopsy was prompted by SM in 21 (1.3%) patients and by the combination in 67 (4.3%). The number of breast cancers diagnosed per number of biopsies (PPV) was 24% for SM and 28% for combination. Specificity was 88% for SM alone and 82% for the combination (p = 0.0001). Fourteen patients had cancer detected only on MBI: 4 ductal carcinoma in situ (DCIS); 8 invasive ductal carcinoma (IDC); and 2 invasive lobular carcinoma (ILC); median pathologic tumor size was 12 mm; range 4-62 mm. Three of 14 were node positive. The 4 MBI occult cancers were node negative and included 1 DCIS, 1 IDC, and 2 ILC; median pathologic tumor size was 6 mm, range 3-7 mm. Two patients had cancers detected on neither modality, including a 6 mm ILC detected on MRI and a 7 mm ILC detected on prophylactic mastectomy.

CONCLUSION
Low dose MBI as an adjunct to SM in women with dense breasts provided a supplemental yield of 8.8 per 1000 with a modest decline in specificity.

CLINICAL RELEVANCE/APPLICATION
The supplemental yield of adding screening MBI to SM in women with dense breasts is preserved at a lower administered dose of 8 mCi Tc-99m sestamibi.

S504AB • Submillisievert Radiation Dose Coronary CT Angiography: Clinical Impact of the Iterative Model Reconstruction (IMR) with Low kVp Scan

Takeshi Nakaura MD (Presenter) ; Shinichi Tokuyasu RT * ; Masafumi Kidoh ; Shinichi Nakamura MD ; Kazunori Harada ; Yasuyuki Yamashita MD * ; Ryo Itatani

PURPOSE
Recently, the submillisievert radiation dose coronary CT angiography becomes clinically available by the techniques such as the iterative reconstruction technique, prospective ECG gating and low kVp setting. However, increased image noise is a problem except the extremely small body size patients. The purpose of this study was to evaluate the usefulness of the recent introduced iterative model reconstruction (IMR, Philips Healthcare) in ultra-low dose cardiac CT.

METHODOLOGY AND MATERIALS
This prospective study received institutional review board approval; prior informed consent to participate was obtained from all patients. We performed submillisievert radiation dose coronary CT angiography (CTA) to 25 patients who had suspicious or past history of the ischemic heart disease. We also performed phantom study to evaluate the influence of object size with AEC phantom (CT-AEC Cone Phantom, Kyoto Kagaku). We reconstructed clinical and phantom studies with filtered back projection (FBP), hybrid-iterative reconstruction (iDose4) and IMR. We compared CT number, image noise and contrast noise ratio (CNR) in ascending order of each reconstruction technique. We compared relationship between image noise and body mass index (BMI) for clinical study, and object size for phantom study.

RESULTS
Calculated effective dose of patients was 0.98 mSv. The image noise of IMR reconstructed images is significantly lower than that of FBP and iDose4 reconstructed images (IMR: 16.7±2.8; FBP: 67.5±14.5; iDose4: 28.3±5.9, respectively) (p4 (r = 0.42, p < 0.01); however,
Correlation of Left Bifurcation Angulation with Plaque Formation

SSG03-02 • Impact of 100-kV on Image Quality, Noise and Radiation Dose of Coronary Angiography with 320-row CT in Patients with Different Body Mass Index

Liu H Yan (Presenter); Yang Dongliang; Xing Chen; Haibo Zhou; Qingqian Zeng; Huang Junyi

PURPOSE

METHOD AND MATERIALS

RESULTS

CONCLUSION

The 100kV setting is feasible for patients with BMI

CLINICAL RELEVANCE/APPLICATION

This method of 320-row CTA has been used in daily clinic works.

SSG03-03 • Is Coronary Artery Imaging Feasible with Non-ECG-Triggered CT? Comparison of Image Quality and Radiation Dose of Non-ECG-Triggered High-Pitch Dual-source CT Angiography Versus Non-ECG-Triggered Standard-Pitch CT Angiography of Thoracoabdominal Aorta

Sung Mok Kim MD (Presenter); Hee Young Lee MD; Eun Young Kim MD; Sohee Song; Yeon Hyeon Choe MD, PhD

PURPOSE

The purpose of this study was to compare image quality of coronary arteries and radiation dose in patients undergoing non-ECG-triggered high-pitch helical CT or non-ECG-triggered helical CT of thoracoabdominal aorta. To evaluate average heart rate (HR) required for diagnostic imaging of coronary arteries with high-pitch dual-source CT angiography (CTA) of thoracoabdominal aorta, we also compared image quality of coronary arteries in patients undergoing high-pitch helical CT based on the HR.

METHOD AND MATERIALS

We retrospectively assessed data from 137 patients (77 men, 60 women; mean age, 59 ± 15 [SD] years) undergoing CTA of thoracoabdominal aorta on 128-slice dual-source scanner using either non-ECG-triggered high-pitch helical mode (group1, n=92) or non-ECG-triggered standard-pitch helical mode (group2, n=45). Group1 was divided into two subgroups according to HR. Group1A was defined as patients with HR ≤ 60 beats/min and group1B as patients with HR > 60 beats/min.

RESULTS

Interobserver agreement on grade of image quality for 1,507 coronary segments evaluated by both observers was good (κ = 0.68). In group1, diagnostic image quality was found for 963 of 1,012 segments (95.2%). In group2, diagnostic image quality was found for 891 of 1,001 segments (89%). In group1, average HR was 57 ± 10 beats/min and in group2, average HR was 73 ± 11 beats/min. Within group1, average, HR was not significantly higher in patients with at least one nondiagnostic coronary segment compared with those without. All patients with average HR less than 60 beats/min had diagnostic image quality in all coronary segments. Group 2 scans displayed higher image noise at the level of aortic valve. Effective radiation dose was lower in group1 (mean ± SD, 4.3 ± 0.7 mSv) than group2 (5.4 ± 1.2 mSv).

CONCLUSION

Coronary artery imaging is feasible with non-ECG-triggered high-pitch CTA, especially in patients with lower HR. Thoracoabdominal aorta CTA with non-ECG-triggered high-pitch mode provides higher quality images of aortic valves and coronary arteries with lower effective radiation doses compared with non-ECG-triggered standard-pitch helical CT.

CLINICAL RELEVANCE/APPLICATION

Coronary artery imaging is feasible with non-ECG-triggered high-pitch CTA, especially in patients with lower HR.

SSG03-04 • Application of a Novel Motion Correction Algorithm in Prospective ECG-gated Coronary CTA of Patients with Relative High Heart Rates: Preliminary Study

Peng-Yu Li (Presenter); Qianwen Li; Zhuangzhi Su; Xinyu Yao; Xiangying Du MD; Kuncheng Li MD

PURPOSE

Prospective ECG-gated CT coronary CTA was usually carried out under low heart rates because of limited temporal resolution. Our study is to evaluate the effect of a novel motion correction algorithm (SnapShot Freeze, SSF) in improving the image quality of patients with relative high regular heart rates using the prospective ECG-gated scan mode.

METHOD AND MATERIALS

Patients with heart rates ranged from 65 to 75 bpm underwent prospective ECG-gated CTA using a 64-slice high definition CT system (GE, Discovery HD750). The X-ray exposure covered both the end-systole and middle-diastole of cardiac cycle. All image datasets were reconstructed at the optimal phase for each coronary artery with (group B) or without SSF (group A). Two experienced readers independently analyzed the image datasets according to a standard 15-segment model and a 5-score method (based on the interpretability of vessels in axial images): very poor (1), poor (2), adequate (3), good (4), and excellent (5). The coronary vessels with diameter no less than 1.5 mm were accessed. Scoring discordance was assigned by the third reader for consensus. X2 test of paired comparison of enumeration data was used to test the difference in image quality between groups A and B on per-segment level. Values of P < 0.05 were considered to reveal statistically significant differences.

RESULTS

CONCLUSION

Motion correction algorithm is useful in improving the image quality of patients with relative high heart rates in prospective ECG-gated coronary imaging.

CLINICAL RELEVANCE/APPLICATION

As a new method to reduce the motion artifact of coronary artery, SSF will expand the use of prospective ECG-gated coronary CTA to higher heart rates and subsequently reduce patients radiation dose.

SSG03-05 • Coronary CT Angiography Visualization of Coronary Plaques: An Investigation of Intraluminal Appearances and Correlation of Left Bifurcation Angulation with Plaque Formation

Zhonghua Sun PhD (Presenter)
SSG03-06 • Effect of a Novel Motion-correction Algorithm in the Improvement of Image Quality of Coronary CTA with Higher Heart Rates

Xiangying Du MD (Presenter) ; Kuncheng Li MD

PURPOSE
To verify the motion correction effect of a novel algorithm in coronary CTA of patients with higher heart rates

METHOD AND MATERIALS
15 patients with high heart rate (67bpm-85bpm, 73.7±5.5bpm) underwent retrospective ECG-gated coronary CTA using a GE CT scanner (GE Discovery CT750HD) with a speed of 0.35s/rotation. Images at 30%-80% R-R interval were reconstructed with single sector reconstruction at 5% intervals to select the best phase at end-systole and middle-diastole. Based on the best phasing, a motion correction algorithm (Snap shot freezing, SSF) was carried out to reconstruct the SSF images at the corresponding phases. In accordance with AHA staging, the right coronary artery was divided into three sections for evaluation. All images were independently assessed by 2 experienced radiologists who were blinded to each other. Image quality was graded with a 5-point scale and the images from the two reconstruction methods were compared accordingly.

RESULTS
A higher score of image quality was achieved at the SSF group. In end-systole, the application of SSF algorithm, the rate of qualified images increased from 86.7% to 94.4%, with 58.3% of the images of 2 points increased to 3 points or more. While in middle-diastole, the rate of qualified images increased from 48.9% to 67.8%, with 50% of the images of 2 points increased to 3 points or more.

CONCLUSION
SSF can be used to improve the image quality of coronary CTA in higher heart rates

CLINICAL RELEVANCE/APPLICATION
The SSF algorithm is an effective way to improve image quality of coronary CTA in higher heart rates.

SSG03-07 • What Is the Clinical Utility of Computed Tomography Angiography in Patients with a Previous Functional Test?

Maria C Ziadi MD (Presenter) ; Juan Manuel Montero ; Juliana Fiorenza ; Roberto L Villavicencio MD

PURPOSE
Computed tomography angiography (CTA) represents an excellent imaging modality to exclude obstructive coronary artery disease (CAD) noninvasively. We sought to assess the utility of CTA in patients (pts) without overt CAD and a previous functional test.

METHOD AND MATERIALS
Among 133 consecutive adult pts who underwent CTA, 78 pts (58.6%) had a previous functional study (99mTc SPECT, an exercise treadmill test (ETT) or a stress Echo) = 6 months. Test conclusions were categorized as follows: normal; abnormal due to ischemic ECG response; equivocal o inconclusive; myocardial ischemia; and/or necrosis. Coronary artery lumen on CTA was considered: normal=0%, mild= 1-49%, moderate= 50-69% and severe =70% stenosis. Obstructive CAD was defined as a =50% stenosis in any major vessel. Pre-test likelihood of CAD was considered : low, intermediate or high according to Diamond and Forrester classification.

RESULTS
Mean age was 56 ±14 years old, 42 pts were males. Most pts had a low (n=42) and intermediate (n=31) pre-test likelihood of CAD. A total of 56 pts (74%) had a previous SPECT, 17 pts (22%) an ETT and 3 pts (4%) a stress Echo. The prevalence of obstructive CAD was 19% (n=15). In 4 out of 15 pts (27%) with a normal test, CTA uncovered obstructive CAD. In 10 out of 14 pts (72%) with an ischemic ECG response, CTA showed 0% coronary stenosis, in 3 pts (21%) mild CAD and in 1 pt (7%) moderate CAD. Most pts with an equivocal or inconclusive test (n=26/29, 90%) presented not hemodynamically significant CAD. Among pts with myocardial ischemia (n=17), 6 pts (35%) had 0% stenosis, 5 pts mild CAD (29%) and 6 pts (36%) obstructive CAD. One out of 3 pts (34%) with a previous SPECT suggestive of necrosis had non-obstructive CAD on CTA.

CONCLUSION
CTA is clinically useful in pts with a previous false negative functional test. An ischemic ECG response may be associated with non-obstructive CAD, subject to secondary prevention. CTA is valuable to rule out significant CAD in pts with attenuation artifacts on SPECT, often mislabelled as necrosis or ischemia, and particularly in pts with a previous equivocal test.

CLINICAL RELEVANCE/APPLICATION
CTA yields high negative predictive value to exclude obstructive CAD, specially in intermediate risk pts and in those with previous equivocal tests. CTA provides additional data to functional imaging.
RESULTS
Mean HR during scan was 59.7 ± 9.8 bpm (range 38-98 bpm), and mean HRV 7.2 ± 1.6 bpm. Prescan beta-blockers were used in 37 patients (47.4%). Mean CT coverage was 251.9 ± 28.7 mm. Graft image quality was judged as diagnostic (scores 5 (excellent), 4 (good) and 3 (moderate)) in 96.6% of the 762 segments, with excellent interobserver agreement (kappa values = 0.90). Low quality scores were significantly associated with HRV = 1 bpm, with an odds ratio (OR) of 4.31 (95% confidence interval (CI) 1.10 - 16.84; p = 0.036). Association between low scores and body-mass index was near significance level (p = 0.053), with an OR of 1.15 (95% CI 1.00 ± 1.32). There was no significant association between quality score and HR, age, prescan nitroglycerine, NYHA class and LV ejection fraction. Quality scores were in the diagnostic range (scores 3-5) in 99.4% of proximal graft segments, as well as in 97.2% and 93.2% of middle and distal graft segments, respectively. Scores were significantly lower in distal segments, more susceptible to cardiac motion (p = 0.02).

CONCLUSION
CABG imaging with 270-msec rotation 256-slice MDCT and prospective ECG-gating showed an adequate image quality in 96.6% of graft segments and an excellent interobserver agreement. Graft image quality was not influenced by HR level. Image quality scores were however significantly decreased in patients with high HRV, as well as in distal graft segments.

CLINICAL RELEVANCE/APPLICATION
With 270-msec rotation 256-slice CT, CABG image quality is significantly decreased with high HRV and in distal segments near to the heart. Beta-blockers should still be considered for CABI imaging.

SSG03-09 • Prospective ECG-gated Coronary CT Angiography: Clinical Value of Noise-based Tube Current Reduction Method with Iterative Reconstruction
Junlin Shen (Presenter) ; Kuncheng Li MD ; Xiangying Du MD ; Daode Guo ; Yan Gao MD ; Lizhen Cao ; Jiabin Liu
PURPOSE
We developed the noise-based tube current reduction method, which was used to calculate the required tube current to obtain the desired noise according to the test bolus image noise measurement. The aim of this study was to evaluate the clinical value of noise-based tube current reduction method with iterative reconstruction for obtaining consistent image quality with dose optimization in prospective electrocardiogram (ECG)-gated coronary CT angiography (CCTA).

METHOD AND MATERIALS
We performed a prospective randomized study evaluating 338 patients undergoing CCTA with prospective ECG-gating. Patients were randomly assigned to fixed tube current with filtered back projection (Group 1, n=113), noise-based tube current with filtered back projection (Group 2, n=109) or with iterative reconstruction (Group 3, n=116). Tube voltage was fixed at 120 kV. Qualitative image quality was rated on a 5-point scale (1= impaired, to 5= excellent, with 3-5 defined as diagnostic). Image noise and signal intensity were measured; signal-to-noise ratio was calculated; radiation dose parameters were recorded. Statistical analysis included one-way analysis of variance, chi-square test, Kruskal-Wallis test and multivariable linear regression.

RESULTS
Image noise was maintained at the target value of 35 HU with small interquartile range for Group 2 (35.00-35.03 HU) and Group 3 (34.99-35.02 HU), while from 28.73 to 37.87 HU for Group 1. All images in the three groups were acceptable for diagnosis. A relative 20% and 51% reduction in effective dose for Group 2 (2.9 mSv) and Group 3 (1.8 mSv) were achieved compared with Group 1 (3.7 mSv). After adjustment for scan characteristics, iterative reconstruction was associated with 26% reduction in effective dose.

CONCLUSION
Noise-based tube current reduction method with iterative reconstruction maintains image noise precisely at the desired level and achieves consistent image quality. Meanwhile, effective dose can be reduced by more than 50%.

CLINICAL RELEVANCE/APPLICATION
Noise-based tube current reduction method with iterative reconstruction can further reduce radiation dose while maintaining consistent image quality in coronary CT angiography.

SSG04-01 • CT-PRM: A Novel Imaging Biomarker of Small Airways Disease in Asthma
Ruth Hartley MBChB, MRCS (Presenter) ; Sherif Gomen ; Jennifer Boes ; Maria Bule ; Sumit Gupta MRCP, PhD ; Christopher Brighting MRCP, PhD ; Brian D Ross PhD * ; Craig J Galban PhD * ; Salman Siddiqui MRCP
PURPOSE
Asthma is a chronic inflammatory airway disease that is characterised by variable airflow obstruction. The parametric response map (PRM) imaging analysis technique has recently been utilised to differentiate functional small airway disease (fSAD) from emphysema (using image registration techniques) in patients with chronic obstructive pulmonary disease (COPD) [Galban et al, Nature Med 2012]. It is not known whether fSAD or emphysema are features of asthma, or whether they correlate with the degree of airflow obstruction.

METHOD AND MATERIALS
Fifty-two patients with asthma were recruited and underwent inspiratory and expiratory computed tomography (CT). Images were analysed using the PRM algorithm, and the relative lung volumes exhibiting fSAD and emphysema were determined, as well as the centre of mass of the voxel distribution. Lung function was measured using spirometry, and multiple breath inert gas washout (MBW), a technique for measuring ventilation heterogeneity (VH) in the conductive (Scond) and intra acinar (Sacin) small airways. Data is presented as the mean ± standard deviation.

RESULTS
The relative volume of fSAD in patients with asthma was 14.3 [10.7], whereas significant emphysema was not observed in patients with asthma (2.9 [3.0]). The ratio of forced expiratory volume in one second to forced vital capacity correlated negatively with fSAD (R = -0.295, p

CONCLUSION
Functional small airway disease, but not emphysema, occurs commonly in patients with asthma, and correlates significantly with spirometric airflow obstruction. Further studies are required to determine if fSAD as measured by PRM on CT may be used to predict prognosis or response to treatment in patients with asthma.
SSG04-02 • Respiratory Muscle Movement in Pompe Disease Using Cine Magnetic Resonance Imaging

Pierluigi Clet MD (Presenter); Stephan C Wens MD; Adria Perez-Rovira PhD; Karla M Logie BSc; Piotr A Wielopolski PhD; Marleen De Bruijne PhD *; Ans T Van Der Ploeg MD; Pieter A Van Doorn PhD; Harm A Tiddens MD

PURPOSE
Late-onset Pompe's disease is a slowly progressive proximal myopathy. Respiratory problems are the major cause of death. Up-to-date respiratory muscles in Pompe patients have never been investigated using cine-Magnetic Resonance Imaging (cine-MRI). Cine-MRI allows us to assess the contribution of each respiratory muscle during the breathing cycle. We aimed to assess the performance of respiratory muscles in a group of Pompe patients and healthy volunteers. We compared diaphragmatic displacement between the groups and correlated displacement with spirometry parameters, such as forced expiratory maneuver in one second (FEV1).

METHOD AND MATERIALS
Each subject was trained to perform specific breathing maneuvers, such as FEV1 using an MRI-compatible spirometer, which was used for volume control during scans. Cine-MRI settings: 2 static scans (13sec) covering the entire thorax were acquired at end-inspiration and end-expiration using a 3D spoiled gradient echo (SPGR) sequence (TR/TE/FA=1.3/0.5/20; sagittal acquisition) in 31 3D SPGR slices per series. Mean displacement for volunteers 15.37±7.88 mm and 58.96±12.36 mm for patients; mean difference 43.58±7.02 mm; p=0.001; C1.26.40-50.77. FEV1 recorded during scans highly correlated with diaphragmatic displacement r=0.9; p=0.037.

CONCLUSION
Diaphragmatic function is significantly impaired in Pompe patients. In fact, in these patients movement of the anterior chest wall is the main contributor to breathing. Cine-MRI can be a useful tool for patient's characterization and to monitor treatment response in Pompe's disease

CLINICAL RELEVANCE/APPLICATION
Cine-MRI is a safe and feasible technique that can provide a new insight in Pompe disease

SSG04-03 • MRI Perfusion-weighted Fourier Decomposition (FD) Values Correlate with Pulmonary Blood Flow (PBF) Derived by Quantitative Dynamic Perfusion (DCE) MRI of the Lung in Patients with Chronic Thromboembolic Pulmonary Hypertension (CTEPH)

Christian Schoenfeld (Presenter); Marcel Gutterlet DiplPhys; Jan Hinrichs; Julius Renne MD; Katja Hueper; Steven Sourbron PhD; Tobias Weite MD; Marius Hoeper; Frank K Wacker MD *; Jens Vogel-Claussen MD

PURPOSE
Quantification of regional lung perfusion is crucial for diagnosis and treatment response monitoring in patients with CTEPH. The hypothesis of our study is that pulmonary parenchymal blood flow can be quantified using a novel non-contrast perfusion-weighted FD method and correlates with pulmonary blood flow (PBF) derived from the clinically established DCE MRI method in patients with CTEPH.

METHOD AND MATERIALS
23 patients with suspected CTEPH underwent lung MRI at 1.5T. FD MRI: Free breathing dynamic images were acquired in serial coronal planes covering the whole lung with a 2D Fast Low Angle Shot (FLASH) sequence with a temporal resolution of 3 frames/s for one minute. After non-rigid registration FD perfusion maps were calculated. DCE MRI: After bolus administration of 0.04 mmol/kg Gd-DOTA at 5cc/sec iv the first-pass of the contrast bolus was imaged using a dynamic 3D FLASH sequence. PBF maps were calculated on a pixel by pixel basis using model-independent deconvolution. Both lungs and corresponding normal and hypo-perfused lung areas were segmented on FD perfusion-maps and on DCE PBF-maps. Also phase contrast MRI measurements were performed in the right and left pulmonary arteries (PA) with a temporal resolution of 20ms.

RESULTS
A total of 192 corresponding lung areas were evaluated. There was a significant correlation between the perfusion-weighted values of the FD method and corresponding PBF derived by DCE MRI (r=0.65, p<0.05). Our results show that regional perfusion of lung parenchyma can be assessed using the perfusion-weighted FD method in CTEPH patients. Perfusion-weighted FD values correlate well with regional PBF calculated by DCE MRI.

CLINICAL RELEVANCE/APPLICATION
Clinical relevance statement: Perfusion of lung parenchyma can be assessed visually and quantitatively with perfusion-weighted FD in patients with CTEPH

SSG04-04 • 3D Non-contrast-Enhanced Perfusion MRI vs. 3D Contrast-enhanced Perfusion MRI vs. Perfusion Scan: Capability for Postoperative Lung Function Prediction in Non-small Cell Lung Cancer Patients

Yoshiharu Ohno MD, PhD (Presenter) *; Shinichiro Seki; Mizuho Nishio MD *; Hisanobu Koyama MD; Mako Tsubakimoto MD; Takeshi Yoshikawa MD *; Sumiaki Matsumoto MD, PhD *; Katsusuke Kyotani RT; Nobukazu Aoyama RT; Akiko Kusako RT; Saori Satou RT *; Yoshimori Kassai MS *; Satoshi Sugiyama *; Kazuhiro Sugimura MD, PhD *

PURPOSE
To directly assess the capability for postoperative lung function prediction among 3D non-contrast-enhanced perfusion MRI (non-CE-perfusion MRI), 3D contrast-enhanced perfusion MRI (CE-perfusion MRI) and perfusion scan (Q scan) in non-small cell lung cancer (NSCLC) patients.

METHOD AND MATERIALS
Seventeen NSCLC patients (10 men and 7 women) underwent non-CE-perfusion MRI, CE-perfusion MRI, Q scan, surgical treatment and pre- and postoperative FEV1% measurements. All non-CE-perfusion MRIs were acquired with a 3D fresh blood imaging obtained with an ECG-gated 3D half-Fourier fast SE sequence using a 3T scanner. On non-CE- and CE-perfusion MRIs and Q scan, each regional perfusion ratio in each lung was calculated as a ratio of the contrast uptake ratio between resected lobe and total lung. Then, each postoperative FEV1% (poFEV1%) was predicted from preoperative FEV1% and regional perfusion ratio in the resected lobe. To determine the capability of non-CE-perfusion MRI and Q scan for regional perfusion assessment, regional perfusion rate of non-CE-perfusion MRI was statistically correlated with that of CE-perfusion MRI and Q scan. To determine the capability for prediction of postoperative lung function among three methods, each predicted poFEV1% was correlated with actual poFEV1%. Finally, the limits of agreement (mean difference±1.96standard deviation) between actual and each predicted poFEV1% was also evaluated by Bland-Altman analysis.

RESULTS
Regional perfusion rate of non-CE-perfusion MRI had significant and excellent correlations with that of CE-perfusion MRI (r=0.92, p<0.01 and poFEV1% predicted by non-CE-perfusion MRI (r=0.91, p<0.01).
CONCLUSION
Non-CE-perfusion MRI has better capability for postoperative lung function prediction than perfusion scan, and is considered at least as valuable as CE-perfusion MRI in NSCLC patients.

CLINICAL RELEVANCE/APPLICATION
Non-CE-perfusion MRI has better capability for postoperative lung function prediction than perfusion scan, and is considered at least as valuable as CE-perfusion MRI in NSCLC patients.

SSG04-05 • Fluorine-19 MRI: A New Functional Pulmonary Imaging Modality

Marcus J Couch MSc, BSc; Iain K Ball; Tao Li; Matthew S Fox; Birubi Biman; Mitchell S Albert PhD (Presenter)

PURPOSE
Fluorine-19 (19F) magnetic resonance imaging (MRI) of the lungs using inhaled inert fluorinated gases can provide images that are similar in quality to hyperpolarized (HP) noble gas MRI. Inert fluorinated gases are nontoxic, abundant, inexpensive, and have short longitudinal relaxation times. As a result, there is sufficient thermally polarized signal for imaging, and the gases do not need to be hyperpolarized prior to their use in MRI. The purpose of this study was to optimize image acquisition strategies and breathing protocols for imaging of human lungs with inert fluorinated gas MRI.

METHOD AND MATERIALS
Imaging was performed using a 3.0T Philips Achieva scanner and a flexible wrap-around quadrature transmit/receive coil (Clinical MR Solutions). Eleven healthy volunteers were enrolled in this study with no history of lung diseases. Breathing protocols were optimized for imaging with an inhaled gas mixture of 79% perfluoropropane (PFP) and 21% O2. 3D 19F images were acquired using ultra-short echo time (UTE) and gradient echo techniques.

RESULTS
In one representative subject, the signal-to-noise ratio (SNR) in the center slices was 37 ± 4 for UTE, and 29 ± 6 for gradient echo images. In both cases, the SNR was more than a factor of 2 larger than the SNR reported by Soher et al. (Proc. ISMRM, 2010). Overall, the SNR from UTE images was significantly different from gradient echo images (p = 0.02). UTE images had a superior SNR; however, they suffered from poor edge detail due to the nature of the data acquisition.

CONCLUSION
Overall, 19F MRI using inert fluorinated gases is a new pulmonary imaging modality that can provide valuable spatially localized and functional information without the need for scarce noble gas isotopes, an expensive polarizer, or ionizing radiation. This preliminary study demonstrates the potential of 19F MRI for visualizing the distribution of ventilation in human lungs, and this may be a viable clinical imaging modality that can provide useful information for the diagnosis of chronic respiratory diseases.

CLINICAL RELEVANCE/APPLICATION
Inert fluorinated gas MRI can cheaply and efficiently obtain high quality images of the lungs, and it can potentially be performed on patients with chronic respiratory diseases.

SSG04-06 • Crus Atrophy: Accuracy of CT in Diagnosis of Diaphragmatic Paralysis

Wassawu Sukkasem MD (Presenter); Sherine G Moftah MD; Joshua O Benditt MD; Sudhakar N Pipavath MD *; J. D Godwin MD; Eric J Stern MD

PURPOSE
To evaluate ability of CT measurement of diaphragmatic crus thickness to distinguish a paralyzed from a non-paralyzed hemidiaphragm in patients with suspected diaphragmatic dysfunction.

METHOD AND MATERIALS
We performed a retrospective review of patients with suspected diaphragmatic dysfunction between January, 1997, and February, 2013. We identified 5,402 patients, 90 (1.7%) of whom underwent chest fluoroscopy; 72 patients (1.3%) had concurrent CT scans available for measurement of diaphragmatic crus thickness at the level of celiac and superior mesenteric arteries and the L1 vertebra. ROC analysis was performed to determine an optimal threshold for discriminating between paralyzed hemidiaphragm and non-paralyzed hemidiaphragm.

RESULTS
Of 72 patients, 11 (15.3%) had diaphragmatic paralysis by chest fluoroscopy. There was a significant difference in thickness of the crus for patients with and without diaphragmatic paralysis at the level of the celiac artery (mean±SD 1.7±0.6 mm vs. 3.6±1.3 mm, p = 0.017 on right; 1.1±0.4 mm vs. 0.0±0.1 mm, p = 0.001 on left) and the level of the L1 vertebra (mean±SD 1.5±0.7 mm vs. 4.4±1.6 mm, p = 0.018 on right; 1.5±0.6 mm vs. 3.6±1.7 mm, p = 0.017 on left). A threshold crus thickness of 2.5 mm at the celiac artery level and the level of the L1 vertebra permitted optimal distinction and provided a sensitivity of 100% and a specificity of 86% in identifying diaphragmatic paralysis for the right hemidiaphragm, and a sensitivity of 100% and a specificity of 64% for the left. A threshold crus thickness of 2.5 mm at the L1 vertebra level on coronal CT permitted optimal distinction and provided a sensitivity of 100% and a specificity of 86% in identifying diaphragmatic paralysis for the right hemidiaphragm, and a sensitivity of 100% and a specificity of 77% for the left. There was no statistical difference between axial and coronal measurements (AUC 0.93 vs. 0.94, p = 1.000 on the right; 0.82 vs. 0.89, p = 0.570 on the left).

CONCLUSION
Diaphragmatic crus atrophy assessed by CT is a good discriminator of paralyzed vs. non-paralyzed hemidiaphragm in patients with clinically suspected diaphragmatic dysfunction.

CLINICAL RELEVANCE/APPLICATION
In patients with suspected hemidiaphragm paralysis, CT measurement of diaphragmatic crus thickness of nerves.
RESULTS
The ICC for both measured quantitative parameters was lower during BH than in FB technique (PPF: 0.37 vs. 0.69; PPV: 0.69 vs. 0.84). Additionally, the R values of the BH measurements were higher than the corresponding R values of the FB measurements (PPF 0.32 vs. 0.16; PPV: 0.18 vs. 0.10). Overall, CV is significantly lower for the BH measurements both for PPF (p=0.008) and PPV (p=0.03). ICC values of PPF and PPV are higher for FB than for BH measurements and test-retest reproducibility is significantly better (p

CONCLUSION
A free-breathing measurement of pulmonary perfusion is suitable for the quantification of pulmonary perfusion and leads to parameter estimates with a better reproducibility than the conventionally used measurements during breath hold.

CLINICAL RELEVANCE/APPLICATION
Regarding the reproducibility, this study demonstrates that the desirable quantitative assessment of pulmonary perfusion during free breathing might be superior to the common breath hold technique.

SSG04-08 • Hyperpolarized ³He Magnetic Resonance Imaging Temporal-spatial Maps of Asthma to Guide Endobronchial Thermo-ablation

Sarah Svenningsen BSc (Presenter) ; Miranda Kirby PhD ; Stephen Choy MD ; Andrew Wheatley ; David McCormack MD ; Grace Parraga PhD

PURPOSE
Pulmonary functional imaging using hyperpolarized ³He magnetic resonance imaging (MRI) provides a way to map heterogeneous ventilation abnormalities that are regionally and temporally persistent in asthma. Bronchial thermoplasty is a novel asthma treatment that aims to reduce smooth muscle mass in the lobar and segmental bronchi, with the goal being improved symptoms and asthma control. Currently, treatment is not guided by imaging to specific airway abnormalities. The purpose of this study was to exploit the image-guidance potential of ³He MRI by developing lung function maps that spatially identify airway abnormalities in asthma.

METHOD AND MATERIALS
For a severe asthmatic, temporally persistent ventilation defects were observed on two visits 8 months apart after thermo-ablation therapy was completed. To improve the efficacy of thermoablation and decrease treatment time and cost, we investigated the potential for temporal-spatial lung function maps to guide therapy in asthmatics (n=7, 28±9 yr) who were evaluated using hyperpolarized ³He MRI three times, 7±2 days apart. Temporal maps were generated from ventilation images acquired on three occasions by co-registering ³He MRI after segmenting ³He voxel intensities using a modified k-means cluster algorithm. Corresponding, co-registered voxels were classified as 1) persistent defect, 2) intermittent defect, 3) partial ventilation, and, 4) persistent ventilation. The temporal map was registered to thoracic CT to enable structure-function comparisons and help guide therapy to specific ventilation defects.

RESULTS
We present a ³He MRI temporal-spatial lung function map co-registered to a CT-derived airway tree for a single asthmatic. Regions-of-interest (ROI) were identified with persistent and intermittent defects as appropriate targets for treatment, whereas ROI with partial or full ventilation were also identified as regions that should be avoided.

CONCLUSION
Personalized temporal-spatial lung function maps of asthma can be generated to display functional abnormalities observed over time and to guide localized therapy.

CLINICAL RELEVANCE/APPLICATION
Temporal-spatial lung function maps identified spatially and temporally persistent ventilation defects and the airways that lead to them as potential targets for thermo-ablation.

SSG04-09 • Impact of Scanning Conditions in the Evaluation of Pulmonary Blood Volume with Dual-energy CT: Results in 42 Subjects

Francesco Molinari MD (Presenter) ; Paul Felloni MD ; Francois Pontana MD ; Nunzia Tacelli MD ; Teresa Santangelo ; Martine J Remy-Jardin MD, PhD *

PURPOSE
To evaluate the characteristics of pulmonary blood volume (PBV) on dual-source, dual-energy chest CT examinations.

METHOD AND MATERIALS
Eligibility to this study required (a) the absence of respiratory disease after a diagnostic work-up including a dual-source, dual-energy chest CT angiographic examination; (b) rated with an excellent image quality (i.e., excellent quality of vascular opacification; no respiratory motion artifacts); and (c) obtained on the same CT unit (Definition Flash, Siemens Healthcare). Over a 2 year-period, 42 patients (mean age: 43.05 yr) fulfilled these criteria, enabling analysis of PBV in the following conditions: (a) collimation: 32x2x0.6 mm; (b) administration of 80 mL of a 40% contrast agent followed by 40 mL of a diluted contrast agent (70% NaCl; 30% iodine) at a flow rate of 4mL/s,. Qualitative analysis was based on visual assessment. Quantitative analysis measured the (a) iodine concentration per lung (IPipe software; Siemens) and (b) contrast agent followed by 40 mL of a diluted contrast agent (70% NaCl; 30% iodine) at a flow rate of 4mL/s,. Qualitative analysis was based on visual assessment. Quantitative analysis measured the (a) iodine concentration per lung (IPipe software; Siemens) and (b)

RESULTS

CONCLUSION
Distribution of PBV is influenced by physiological gradients and scanning conditions.

CLINICAL RELEVANCE/APPLICATION
This study provides quantitative information on lung perfusion in the conditions of standard evaluation of normal subjects.

SSG05-01 • Subcentimeter Lung Nodules Initially Stable for Two Years at Screening Low-dose CT: Long-term Follow-up Using Nodule Volumetry

Kyung S Lee MD, PhD ; Kyung Eun Shin MD (Presenter) ; Chin A Yi MD, PhD ; Myung Jin Chung MD * ; Myung-Hee Shin

PURPOSE
To retrospectively investigate long-term follow-up results for 2-year-stable subcentimeter nodules seen at screening low-dose CT (LDCT).
A total of 635 subjects, who had follow-up low-dose CT (LDCT) for the initial two-year screening period and for additional three years thereafter and who had noncalcified subcentimeter nodules, were included. By using nodule volumetry software, we measured interval change of nodule volume. Positive growth was defined as an increase in volume of at least 25% between two volume measurements.

RESULTS
A total of 1107 nodules (1037 solid, 70 ground-glass opacity nodules [GGNs]) were detected at baseline CT. Of 1037 solid nodules, 1032 (99.5%) showed no growth at initial two-year follow-up CT, while of 70 GGNs, 59 (84.3%) showed no growth. Of 1032 solid subcentimeter nodules showing no growth for initial two-year follow-up period, none showed further growth during additional three-year follow-up CT, whereas of 59 GGNs stable for initial two years, two (3.4%) showed growth to be proved as adenocarcinomas. Of five solid nodules depicting growth at initial two-year follow-up CT, one (20%) proved to be adenocarcinoma, whereas of 11 GGNs demonstrating growth for the initial two-year follow-up CT, four (36.4%) showed growth and proved to be lung cancers.

CONCLUSION
All solid subcentimeter nodules having initial two-year stability at screening LDCT can be considered benign, because none shows growth at further follow-up CT. On the other hand, subcentimeter GGNs have a more chance of growth than solid nodules and need further follow-up CT for more than two years.

CLINICAL RELEVANCE/APPLICATION
This study demonstrates the two-year stability rule for subcentimeter solid nodules in LDCT using volumetry and CT follow up for more than two years seems to be mandatory for subcentimeter GGNs.

SSG05-02 ● Inter-reader Variability in the Application of the 2013 Fleischner Society Recommendations on the Management of Solitary Subsolid Pulmonary Nodules

Alex C Penn MD (Presenter) ; Mingming Ma MD ; Benjamin B Chou MD ; Jeffrey Tseng MD ; Peter Phan MD

PURPOSE
To evaluate inter-reader variability in applying the 2013 Fleischner Society recommendations when presented with a potential solitary subsolid nodule identified on CT.

METHOD AND MATERIALS
Potential subsolid lung nodules were identified through a systematic retrospective review of CT studies that reported a clinical subsolid nodule over a one-year period. Three radiologists decided whether the potential subsolid nodules met Fleischner Society guidelines. They then determined if a solid component was present, measured each component in two dimensions, and issued management. Inter-reader variability for management was determined based on comparing all possible reader pairs and Fleiss Kappa was used to determine significance. Fisher's exact determined whether management was contingent on each decision. A Bland-Altman plot determined the limits of agreement for measurement within a 95% confidence interval.

RESULTS
Forty-four nodules with mean diameter 9.4 mm were evaluated by three radiologists with a measurement variability of 2.5 to +2.7 mm (95% C.I.). Management recommendations between two readers were in agreement for 85 out of 132 cases (64.4%, kappa = 0.43) (Figure 1). The remaining 47 cases of inter-reader variability in management recommendation were contingent on disagreement over whether a potential subsolid nodule met Fleischner criteria for 24 cases (51.1%, p 0.05), and greater than one of these factors for four cases (8.9%).

CONCLUSION
Our data shows moderate inter-reader variability in applying the 2013 Fleischner Society recommendations. Significant contributors of variability include determining whether the potential subsolid nodules fit criteria and whether there was a solid component. Although measurement variability was present, it did not significantly affect the final management decisions.

CLINICAL RELEVANCE/APPLICATION
Moderate interreader variability when applying the 2013 Fleischner recommendations for subsolid nodules was largely due to differences in categorization rather than in measurement.

SSG05-03 ● Solitary Pure Ground-glass Nodules ≤5 mm: Incidence of Growth

Ryutaro Kakinuma MD, PhD (Presenter) ; Yukio Muramatsu MD ; Masahiko Kusumoto MD ; Akiko Maeshima ; Hisao Asamura ; Noriyuki Moriyama MD, PhD

PURPOSE
A statement from the Fleischner Society suggests that solitary pure ground-glass nodules (SGGNs) have a high likelihood of malignancy. However, these nodules are often indolent with slow growth and a low propensity for distant spread. To evaluate the current analysis, we performed a retrospective study to determine the incidence of growth in solitary pure ground-glass nodules ≤5 mm.

METHOD AND MATERIALS
Potential subcentimeter nodules were identified through a systematic retrospective review of CT studies that reported a clinical subsolid nodule over a one-year period. Three radiologists decided whether the potential subsolid nodules fit Fleischner Society guidelines. They then determined if a solid component was present and measured each component in two dimensions, and issued management. Inter-reader variability for management was determined based on comparing all possible reader pairs and Fleiss Kappa was used to determine significance. Fisher's exact determined whether management was contingent on each decision. A Bland-Altman plot determined the limits of agreement for measurement within a 95% confidence interval.

RESULTS
A total of 354 SGGNs were included in this analysis. From the initial post-screening CT, 112 nodules had growth declared. The remaining nodules were considered stable for a mean follow-up period of 2.7 years. Significant growth was observed in 13 nodules (11%). The majority of these nodules (10) were resected, and 3 were followed with additional imaging. All nodules that showed significant change were referred to a pulmonologist.

CONCLUSION
Solitary pure ground-glass nodules ≤5 mm have a high likelihood of malignancy, but they are often indolent with slow growth and a low propensity for distant spread. A statement from the Fleischner Society suggests that solitary pure ground-glass nodules (SGGNs) have a high likelihood of malignancy. However, these nodules are often indolent with slow growth and a low propensity for distant spread. To evaluate the current analysis, we performed a retrospective study to determine the incidence of growth in solitary pure ground-glass nodules ≤5 mm.

SSG05-04 ● Subsolid Pulmonary Nodules Detected during Lung Cancer Screening: Results of a Close Follow-up Approach

Hester Gietema MD (Presenter) ; Ernst T Scholten MD ; Rozemarijn Vliegenthart MD, PhD ; Harry De Koning * ; Willem P Mali MD, PhD ; Matthys Oudkerk MD, PhD ; Rob Van Klaveren ; Mathias Prokop MD, PhD * ; Pim A De Jong MD, PhD

PURPOSE
Pulmonary Subsolid nodules (SSNs) have a high likelihood of malignancy, but they are often indolent with slow growth and a low propensity for distant spread. Aim of the current analysis was to show that close follow-up of SSNs is safe and that only growing SSNs and noncalcified subcentimeter nodules need further evaluation and treatment.

METHOD AND MATERIALS
The study population consisted of participants of the Dutch-Belgian lung cancer screening trial (NELSON). All detected SSNs were included in this analysis. Retrospectively, all persistent SSNs (visible on at least two computed tomography (CT) exams) and SSNs that were resected after first detection were segmented with dedicated software and maximum diameter, volume and mass were assessed. Volume doubling time (VDT) and mass doubling time (MDT) was calculated. SSNs that showed significant change were referred to a pulmonologist.

RESULTS
In total 7156 volunteers received up to four rounds of CT-screening. Two hundred sixty-four SSNs in 234 (3.3%) participants were detected during the trial. Hundred forty-seven (63%) SSNs in 126 participants disappeared at follow-up, leaving 117 persistent SSNs found in 108 (1.5%) participants available for analysis. Median follow-up duration was 1094 days (range 38 - 2380). Thirty-three (28%) SSNs were resected, and 28 SSNs were (minimally) invasive. None of the 84 (72%) non-resected SSNs developed into a clinical relevant malignancy.

CONCLUSION
Persistent SSNs have a high malignancy rate according to pathological analysis, but they rarely develop into clinical manifest...
malignancies unexpectedly. Our data suggest that long-term follow-up with CT may be a safe option to monitor changes in persistent SSNs. Resection should be considered only in SSNs that show rapid growth or appearance or growth of a solid component.

CLINICAL RELEVANCE/APPLICATION
Follow-up with CT may be a safe option to monitor changes in persistent SSNs, while resection should be considered only in SSNs that show rapid growth or appearance or growth of a solid component.

SSG05-05 • Pulmonary Pure Ground-glass Opacity Nodules: Added Value of Quantitative Dual Energy CT Analysis for Distinguishing Invasive Adenocarcinoma from Non- or Minimally Invasive Adenocarcinoma

Ji Ye Son (Presenter); Ho Yun Lee MD; Jae-Hun Kim PhD; Joung Ho Han; Ji Yun Jeong; Kyung S Lee MD, PhD; O. Jung Kwon; Young Mog Shim MD

PURPOSE
To determine whether quantitative analysis of iodine-enhanced Images generated from Dual-energy CT (DECT) have added value in distinguishing invasive adenocarcinoma from non- or minimally invasive adenocarcinoma (MIA), showing pure ground-glass nodule (GGN).

METHOD AND MATERIALS
RESULTS
CONCLUSION

quantitative evaluation using iodine-enhanced imaging metrics was more accurate for distinguishing IA from AIS or MIA than that of nonenhanced imaging metrics.

CLINICAL RELEVANCE/APPLICATION
Quantitative analysis of DECT imaging can help predict pathologic classification of pure GGN, which can better assist in surgical planning to select the candidate for limited resection.

SSG05-06 • Impact of Section Thickness on Classification of Pulmonary Nodules into Solid, Part-solid, and Non-solid: An Observer Study

Sarah J Van Riel MD (Presenter); Cornelia M Schaefer-Prokop MD *; Eva M Van Rikxoort MD; Bram Van Ginneken PhD; Mathias Prokop MD, PhD *; Steven Schalekamp MD *; Colin Jacobs MSc *; Pim A De Jong MD, PhD; Hester Gietema MD; Ernst T Scholten MD

PURPOSE
Recently published recommendations by the Fleischner Society differentiate between solid, part-solid, and non-solid nodules. A section thickness of 1mm is recommended for evaluation. It is, however, common practice to reconstruct thicker (3mm or 5mm) sections to reduce the number of sections to evaluate. Purpose of this study was to evaluate the impact of section thickness on nodule classification agreement.

METHOD AND MATERIALS
RESULTS
CONCLUSION

Mean agreement rate with the reference standard decreased from 85% (range 78-95%) to 77% (range 68-84%) and 75% (range 68-84%), for 1mm, 3mm, and 5mm section thickness, respectively. Readers were affected differently by increasing section thickness. The most experienced reader was influenced the least (agreement = 84-82-80%). Two readers demonstrated a major decrease in agreement.

It is, however, common practice to reconstruct thicker (3mm or 5mm) sections to reduce the number of sections to evaluate. Purpose of this study was to evaluate the impact of section thickness on nodule classification agreement.

CLINICAL RELEVANCE/APPLICATION
Nodule classification is affected by section thickness. The degree of loss of accuracy appears to be reader dependent.

SSG05-07 • Newly Developed Early Lung Cancer during Follow-up of Idiopathic Interstitial Pneumonia: Serial HRCT Observations

Mi Young Kim (Presenter); Ji-Eun Kim MD; Sang Young Oh MD; Chang-Min Choi; Tae Sun Shim; Dong Soon Kim MD

PURPOSE
To describe HRCT findings of newly developed peripheral T1 lung cancer in idiopathic interstitial pneumonia (IIP) during IIP follow-up

METHOD AND MATERIALS
RESULTS
CONCLUSION

Visual classification therefore requires acquisition and storage of 1mm sections.

CLINICAL RELEVANCE/APPLICATION
Nodule classification is impaired by increasing section thickness which may have consequences for patient management. Visual classification therefore requires acquisition and storage of 1mm sections.
SSG05-08 • Quantitative Measurement of Part-solid Nodule Size on CT in a Chest Phantom: Effect of Dose on Accuracy

**Ann L Scherzinger** PhD (Presenter) *, **Kavita Garg** MD; **Grace Kim** MD; **Nayana U Patel** MD; **Samuel Chang** MD; **Paul R Garrett** MD; **Luduan Zhang** PhD; **Nicholas Petrick** PhD; **Michael F McNitt-Gray** PhD *

**PURPOSE**
To assess the effect of dose on the accuracy of part-solid compared to solid nodule size measurements obtained from CT images of the chest.

**METHOD AND MATERIALS**
Twelve synthetic nodules, four solid (spherical) and eight part solid (spherical and lobular) (CIRS, Norfolk, VA) were imbedded in the lungs of an anthropomorphic torso phantom (LUNGMAN, Kyoto Kagaku Co., Ltd., Kyoto, Japan). The thorax phantom was imaged on a Sensation 64 (Siemens Medical Solutions USA, Malvern, PA) CT using a modified version of the QIBA recommended solid nodule protocol to include imaging at 40mAs (CTDVol = 3.06mGy) and 200mAs (15.32mGy). Images were independently segmented by four experienced radiologists at two sittings, using the INTIO ClearStart® SVMTM Segmentation and Volumetric Measurement System (Lung research version; INTIO, Inc, Broomfield, CO). Nodule diameter and volume measurements were obtained from these segmentations (n=256 part-solid, n=128 solid).

**RESULTS**
The relative bias estimates for part-solid nodules were 13.8% (16.1) for the longest diameter (1D) measure and 15.5% (20.4) for the volume (3D) measure with the 200mAs acquisition, and 13.6% (16.9) for 1D and 14.6% (23.7) for 3D at 40mAs. For solid nodules the relative bias estimates were 1.4% (5.4) for 1D and 31.6% (17.2) for 3D at 200mAs and 3.6% (6.5) for 1D and 36.6% (33.7) for 3D at 40mAs. Although the relative bias of solid nodule 3D volume measurements were significantly higher (p<0.05) interaction between solidity and dose.

**CONCLUSION**
Although the segmentation utilizing this semi-automatic technique consistently over estimated the size of both solid and part-solid nodules, this study showed that the bias in any of the morphometric measures, regardless of lesion solidity, was not influenced by changes in CT dose.

**CLINICAL RELEVANCE/APPLICATION**
The accurate measurement of part-solid lung nodule size change while minimizing cumulative radiation dose is important for the management of patients with suspected or proven lung cancer.

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**Gastrointestinal (Hepatic Steatosis Imaging)**

**Tuesday, 10:30 AM - 12:00 PM • E350**

**SSG05-09 • Stratification of Early Stage Lung Adenocarcinoma by Using Quantitative Analysis of Dual Energy CT Imaging**

**Jungmin Bae** (Presenter); **Ho Yun Lee** MD; **Ji Yun Jeong**; **Jae-Hun Kim** PhD; **Kyung S Lee** MD, PhD; **Joungho Han**; **Ji Ye Son**; **O. Jung Kwon**; **Byung-Tae Kim** MD; **Young Mog Shim** MD

**PURPOSE**
To evaluate the usefulness of quantitative analysis of dual energy CT (DECT) imaging metrics as predictors of histopathologic tumor grade and invasiveness in early stage lung adenocarcinoma in an attempt for treatment stratification.

**METHOD AND MATERIALS**
Patients in stage 1 or 2 with lung adenocarcinoma were prospectively included. All patients underwent DECT and PET/CT followed by complete tumor resection. Quantitative imaging parameters were assessed both from iodine map and non-contrast image of DECT datasets. Histologic tumor grades and subtypes of adenocarcinoma in situ (AIS), minimally invasive adenocarcinoma (MIA), and invasive adenocarcinoma (IA) were also evaluated. Clinico-demographic, DECT, and PET data were investigated by univariate and multivariate analyses to identify features that helped distinguish high-grade adenocarcinoma or invasive tumor.

**RESULTS**
Enrolled 60 patients included 48 in 1A stage (80%), 10 in 1B (17%), and 2 in 2A (3%). Of 71 tumors of 60 patients, 6 were AIS (8%), 11 were MIA (16%), and 54 (76%) were IA. In terms of tumor grade, 20 were low-grade (28%), 43 were intermediate grade (61%), and 8 were high-grade (11%). Multivariate analysis showed that presence of solid component, uniformity on iodine map (=0.01), and tumor density (=0.55 g) and the 75th percentile CT attenuation value (= -400 HU) on non-contrast image were statistically significant independent predictors of pathologic invasiveness. Independent predictors of high-grade adenocarcinoma consisted of tumor density on iodine map (=0.73 g), and the 75th percentile CT attenuation values on non-contrast image (= -400 HU). Using these characteristic features, the performance of the logistic regression model showed excellent differentiating accuracy (AUC, 0.973 for invasiveness, 0.972 for high-grade).

**CONCLUSION**
Quantitative using preoperative DECT imaging metrics can help to predict pathologic aggressiveness and invasiveness, which may help select the candidate for limited resection or adjuvant therapy.

**CLINICAL RELEVANCE/APPLICATION**
Quantitative analysis of DECT imaging metrics can help predict pathologic classification of lung adenocarcinoma and help establish treatment strategy.

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**SSG06-01 • Slower Hepatic Metabolic Rates in NASH Patients Revealed by the Fast and Localized 31P Saturation Transfer at 7T**

**Siegfried Trattning** MD (Presenter); **Ladislav Valkovic** PhD; **Martin Gajdosik** MSc; **Stefan A Traussnigg**; **Marek Chmelik** MSc; **Ivan Frollo**; **Michael Trauner**; **Martin Krssak** PhD

**PURPOSE**
Invasive liver biopsy is the only method currently used to distinguish between relatively benign non-alcoholic fatty liver (NAFL) and potentially progressive steatohepatitis (NASH). Phosphorus magnetic resonance spectroscopy (31P-MRS) combined with saturation transfer (ST) enables non-invasive measurement of metabolic activity at rest in vivo, which is indicative for inflammatory liver diseases. Therefore the aim of this study was to test the feasibility of ST at 7T for non-invasive distinction of NAFL and NASH.
RESULTS
The patient group was resolved by the histological diagnosis into fatty liver (NAFL; n=4) and steatohepatitis (NASH; n=6) subgroups. The NAFL patients had significantly lower k and F values when compared to NAFL (p=0.001) and also to healthy volunteers (p=0.002), with no overlap between the NAFL and NASH subgroups. Furthermore, the forward rate constant of the chemical exchange between Pi and ATP as determined by the ST experiment correlated well with the histologically assessed steatosis degree.

CLINICAL RELEVANCE/APPLICATION
Distinguish between pure steatosis and NASH in patients with NAFLD, if combined with a suitable MR fat quantification method.

a Multi-parametric Approach Combining T2-corrected IVIM, MR-DCE Imaging and Fat Volume Fraction Quantification to Evaluate Chronic Liver Diseases at 3.0T

Benjamin Leporq MS (Presenter); Frank Pilleul MD; Jerome Dumortier; Pierre-Jean Valette MD; Olivier Guillaud; Thibaud Lefort; Olivier Beuf PhD

PURPOSE
To evaluate a multi-parametric approach combining T2-corrected IVIM, MR-DCE imaging and fat content quantification method for chronic liver diseases assessment at 3.0T.

METHODOLOGY AND MATERIALS
3 algorithms were developed: (i) A Fat Volume Fraction (FVF) quantification algorithm correcting for relaxation time effects using a disjointed estimation of T1 and T2* of fat and water and accounting for the NMR spectrum of fat; (ii) an algorithm to quantify perfusion parameters including a rigid image registration procedure, an auto-calibrated tracer concentration quantification method based on a T1 precontrast mapping and a modeling step using a non-linear least square fit on a dual-input one compartment model; (iii) an algorithm to quantify IVIM parameters including a rigid image registration procedure, an auto-calibrated tracer concentration quantification method based on a T1 precontrast mapping and a modeling step using a non-linear least square fit on a modified IVIM model including liver and blood T2 decays. Validations were performed on a prospective study including 14 patients with chronic liver diseases.

RESULTS
Based on Wilcoxon’s test: FVF allowed to distinguish between all histological grade of steatosis. DSF significantly decrease in patients with steatosis without fibrosis. Hepatic perfusion index allowed to distinguish between non fibrosis, non-advanced fibrosis and advanced fibrosis, Portal and total perfusion, Dfast, and mean transit time allowed to distinguish between non-advanced and advanced fibrosis. A significant correlation was found between Dfast and portal perfusion or total perfusion (r = 0.86 and 0.81 respectively; p < 0.001).

CONCLUSION
Perfusion parameters given by MR-DCE imaging alone are relevant to evaluate fibrosis severity whereas fat overload constitute a confounding factor for fibrosis evaluation using IVIM when NAFLD and chronic hepatitis are mixed. The combination of IVIM and MR-DCE imaging do not bring additional information for fibrosis assessment in a wide spectra of etiologies. Since IVIM can give information about both hemodynamic changes and molecular diffusion restriction associated to liver fibrosis, IVIM could be a useful injection-free method to distinguish between pure steatosis and NASH in patients with NAFLD, if combined with a suitable MR fat quantification method.

Non-invasive chronic liver disease assessment using a MR multi-parametric approach.

Correlation of Quantitative Ultrasound Backscatter with 3T MRI-estimated Proton Density Fat Fraction (PDFF) for Assessment of Hepatic Steatosis

Abdullah T Alturki MD, MBBS (Presenter); Aiguo Han MS; Jessica Lam BS; Jonathan C Hooker BS; Amol Shah BS; Kevin A Zandes MD; Michael A Middleton MD, PhD *; William D. D O’Brien PhD; Rohit Loomba MD, MSc; Claude B Sirlin MD *; Michael P Andre MD

PURPOSE
To correlate quantitative ultrasound backscatter with 3T MRI-estimated proton density fat fraction (PDFF) for assessment of hepatic steatosis.

METHODOLOGY AND MATERIALS
In addition to routine MR examination of the liver with dynamic contrast enhancement (Gadoterate meglumine; Dotarem, Guerbet, France) 31P-MRS ST measurements of ten suspected NAFL/NASH patients (6m/4f; a=49.5±13.2y) were performed one day prior the liver biopsy. Additionally four healthy males (a=25.3±2.9y) were measured as controls. Examinations were performed in morning sessions after over-night fasting on a 3T MR system (Siemens Healthcare, Erlangen, Germany) using 1H/31P surface coil. The relaxation rate between inorganic phosphate (Pi) and adenosine-tri-phosphate (ATP) was calculated from liver spectra acquired w/o saturation of G-ATP and the apparent longitudinal relaxation (T1app) was measured with inversion-recovery sequence with G-ATP saturation. The forward rate constant (k) and metabolic flux (F) were correlated with histology, regarding disease status and steatosis degree.

RESULTS
A single breath-hold GRE multi-echo sequence allows simultaneous quantification of LIC and FF. A combined evaluation is essential to avoid calculation errors. Similarly to 1.5T, an algorithm for calculating liver iron concentration at 3T has been developed.

CONCLUSION
This technique may replace invasive liver biopsy.
To correlate quantitative ultrasound (QUS) backscatter coefficient (BSC) with 3T MRI proton density fat fraction (PDFF) as indicators of hepatic steatosis in a cohort of adults with known or suspected non-alcoholic fatty liver disease (NAFLD).

METHOD AND MATERIALS
This single site, cross-sectional, pilot study was IRB approved and HIPAA-compliant. In this study, T1-independent, T2* corrected breath-hold MRI was performed on a 3T GE Signa MR scanner to assess hepatic steatosis. Immediately before or after MRI, QUS measurements were made in the deep portion of liver segments VII-VIII using a right intercostal approach with the subject in a dorsal decubitus position and the subject's right arm at maximum abduction. Ultrasound imaging was performed during shallow breath-hold inspiration using a mechanical index of ~1.7. A Siemens S2000 scanner with 4C1 transducer was used to record raw full-bandwidth RF signals via the research interface for offline post-processing analysis. QUS procedure time was five minutes or less. The frequency range 2.2 - 2.6 MHz was selected to compute BSC for each patient.

RESULTS
CONCLUSION
These early results are encouraging for QUS BSC potentially being able to detect early NAFLD and to monitor its progression using a simple, inexpensive ultrasound technique. Additional recruitment of subjects is anticipated to increase sample size and explore further this interesting preliminary result.

CLINICAL RELEVANCE/APPLICATION
Non-invasive ultrasound that is sensitive to early stage NAFLD and capable of staging progression would be an invaluable tool for clinical care, clinical trials and drug development.

SSG06-05 • Accuracy of Spectrally-corrected MRI 2-echo and 6-echo Proton Density Fat Fraction (PDFF) in Measuring Longitudinal Hepatic PDFF Change Using MRS PDFF as Reference
Abdullah T Alturki MD, MBBS (Presenter); Tanya Wolfson MS; Jessica Lam BS; Gavin Hamilton PhD; Claude B Sirlin MD *; Michael S Middleton MD, PhD *

PURPOSE
To measure accuracy of longitudinal differences in 2-TE and 6-TE spectrally corrected MRI hepatic PDFF using MRS differences as reference.

METHOD AND MATERIALS
RESULTS
CONCLUSION
Cross-sectional and longitudinal accuracy were high for both MRI methods with MRS as reference, and PDFF differences between time points for 2-TE, 6-TE, and MRS were comparable.

CLINICAL RELEVANCE/APPLICATION
Since longitudinal 2-TE and 6-TE PDFF differences were comparable, spectrally corrected 2-TE MRI may suffice in some clinical and research settings to assess hepatic steatosis.

SSG06-06 • Quantification of Liver Fat at 3 Tesla: Intraindividual Comparison of Two Modified Dixon Techniques with MR Spectroscopic T2 Relaxometry and Histopathology
Guido M Kukuk MD (Presenter) *; Frank Traeber; Alois Martin Sprinkart MSc; Wolfgang Block; Holger Eggers PhD *; Winfried A Willinek MD *; Verena Sailer MD; Hans H Schild MD

PURPOSE
To assess the accuracy of dual-echo and multi-echo modified Dixon techniques for the in-vivo quantification of liver fat in comparison with MR spectroscopic and histopathologic determination of the fat fraction.

METHOD AND MATERIALS
RESULTS
21/43 patients had a hepatic fat fraction of more than 5% as determined by MRS, with a maximum of 47% and a mean value of 18%. Bland-Altman analysis revealed good agreement between 6-point mDixon and MRS, with a mean difference of only 1.6% and a Pearson correlation of r=0.982 (p
CONCLUSION
2-point mDixon slightly underestimates hepatic fat fraction in comparison to 6-point mDixon, which excellently matches the results from MR spectroscopy and histopathology.

CLINICAL RELEVANCE/APPLICATION
The 6-point mDixon method allows accurate in-vivo determination of liver fat contents at 3 Tesla.

SSG06-07 • Comparison of Single Slice Low-dose and Full-dose Nonenhanced CT Protocols for Evaluation of Pathology Proven Hepatic Steatosis
Michael Y Park MD (Presenter); Joon-II Choi; Seung Hwan Lee; Young Joon Lee MD; Seung Eun Jung MD; Jae Young Byun MD

PURPOSE
To determine the effects and adequacy of using a single slice low-dose nonenhanced CT protocol for evaluation of hepatic steatosis.

METHOD AND MATERIALS
The hepatic attenuation (HAT) and hepatic attenuation minus splenic attenuation difference (CTL-S) values were measured in 283 liver donor patients with liver biopsy performed during surgery. Full-dose nonenhanced CT was performed in 139 patients. Low-dose CT protocol with only a single slice including the superior segments of the liver and spleen was performed in 144 patients. Patients were divided in normal and fatty liver groups according to whether there was greater than or equal to 30% (moderate to severe) hepatic steatosis on pathological examination. The HAT and CTL-S were compared between the two protocols. Cutoff values with high sensitivity for screening the fatty liver patients were determined.

RESULTS
The median (IQR; interquartile range) of HAT was 59 (57.00~62.50) HU in the low-dose normal group and 51.33 (48.33~54.84) HU in the full-dose normal group, showing a statistically increased value (P < 0.0001) in the low-dose group. The median (IQR) of CTL-S was 7.75 (3.00~11.25) HU in the low-dose normal group and 7.63 (4.50~11.02) HU in the full-dose normal group, and did not show a statistical difference. Using a CTL-S cutoff value of less than or equal to 1 HU resulted in a 100% sensitivity, 86.03% specificity, 24% PV, and 100% NPV for screening fatty liver patients using low-dose protocols. Using a CTL-S cutoff value of less than or equal to 1.83 HU resulted in a 100% sensitivity, 86.67% specificity, 18.2% PV, and 100% NPV for screening fatty liver patients using full-dose protocols.

CONCLUSION
CTLS is a more stable value than HAT for evaluation of hepatic steatosis when using differing CT dose protocols. The threshold value and efficiency for CTLS to evaluate moderate to severe hepatic steatosis when using single slice low-dose protocols is similar to that of full-dose protocols.

**CLINICAL RELEVANCE/APPLICATION**

This study shows that using single slice low-dose nonenhanced CT protocols for screening of moderate to severe hepatic steatosis is feasible and can drastically reduce patient dose exposure.

**SSG06-08 • Non Invasive Quantification of Hepatic Steatosis in Living, Related Liver Donors Using Dual Echo Dixon Imaging and Single Voxel Proton Spectroscopy**

Sonal Krishan MD (Presenter) ; Yogesh Bathina

**PURPOSE**

To evaluate the diagnostic implications of hepatic fat fraction calculated using dual echo Dixon imaging and 1-H MR spectroscopy technique to detect hepatic steatosis in potential liver donors using histopathology as the reference standard.

**METHOD AND MATERIALS**

106 potential liver donors were included. MRI was performed on a 1.5-T scanner using a three-dimensional dual echo MRI sequence with automated reconstruction of in-phase (IP), out-of-phase (OP), fat-signal-only and water-signal-only images. Hepatic fat fraction was calculated by drawing 15 regions of interest on the IP, OP, fat only and water only images. Single voxel MR spectroscopy was performed at TE of 30 and 20 in right as well as the left lobe of liver. Liver fat fraction was calculated from water and fat peaks. 106 biopsies were prospectively evaluated for steatosis by a pathologist using traditional determination of the cell-count fraction. MRI and pathology values of steatosis were correlated using the Pearson correlation coefficient. Sensitivity and specificity of each of these methods was calculated using histopathology as gold standard.

**RESULTS**

Combination of dual echo Dixon imaging and proton spectroscopy is a useful tool for the preoperative diagnosis of hepatic steatosis in potential living liver donors. This can help avoid unnecessary biopsies in these patients.

**CLINICAL RELEVANCE/APPLICATION**

This study provides evidence for the use of noninvasive MRI based methods to assess hepatic steatosis in evaluation of potential liver donors and further avoiding unnecessary liver biopsies.

**SSG06-09 • Combined Use of Magnetic Resonance Fat Quantification and Magnetic Resonance Elastography in Liver Living Donors: Can It Reduce Need for Preoperative Liver Biopsy?**

Jeong Hee Yoon MD (Presenter) ; Jeong-Min Lee MD * ; Inpyeong Hwang MD ; Joon Koo Han MD ; Byung Ihn Choi MD, PhD *

**PURPOSE**

To determine whether combination of magnetic resonance (MR) fat quantification tools and MR elastography (MRE) can reduce the necessity of preoperative liver biopsy (LB) in living liver donor candidates.

**METHOD AND MATERIALS**

This retrospective study was approved by institutional review board and informed consent was waived. From January to December 2012, 124 living liver donor candidates (M:F=80:44, age range 16-61 years) underwent MRE at 1.5T and MR fat quantification tools such as 3 point Dixon method and spectroscopy (MRS) at 3T. Among them, 115 patients underwent operations and the others did not for following reasons: deceased donor (n=3); revocation of donation (n=2); death of potential recipient (n=1); detection of other diseases during work-up (n=3). Sensitivity, specificity, positive predicted value (PPV) and negative predicted value (NPV) were obtained for detecting significant fibrosis (=F2) or significant hepatic steatosis (>10%). On MRE, cut-off values were set as 2.5kPa, according to the previous study of nonalcoholic steatohepatitis. On liver fat quantification map or MRS, cut-off values were 9% due to known underestimation of fat quantification on MR.

**RESULTS**

Combination of MR fat quantification and MRE is a good surveillance tool for determining necessity of LB in living donor candidates.

**CLINICAL RELEVANCE/APPLICATION**

Combined use of MR fat quantification and MRE could select liver biopsy cases among liver donor candidates, and therefore, can reduce the necessity of biopsy which has potential of morbidity and morta

**ISP: Health Service, Policy and Research (Economic Analyses and Utilities)**

**Tuesday, 10:30 AM - 12:00 PM • S102D**

**SSG07 • AMA PRA Category 1 Credit ™.1.5 • ARRT Category A+ Credit:1.5**

Moderator

Pari Pandharipande, MD, MPH

Moderator

Janie M Lee, MD *

**SSG07-01 • Health Service, Policy and Research Keynote Speaker: Metrics of Value in Imaging**

Pari Pandharipande MD, MPH (Presenter)

**SSG07-02 • Who Is Medicare Paying for Medical Imaging: An Analysis of Great Regional Variation in Payments to Radiologists vs. Non-Radiologists**

David A Rosman MD (Presenter) * ; Eugene Nsiah ; Danny Hughes PhD ; Richard Duszak MD

**PURPOSE**

An understanding of who is performing and interpreting imaging examinations will be critical to healthcare reform: 1) for aligning incentives to maximize value in payment policy development and 2) for appropriately approaching risk from a group and health system perspective. We sought to study regional variation in Medicare Physician Fee Schedule (MPFS) payments on diagnostic imaging services to radiologists vs. non-radiologists.

**METHOD AND MATERIALS**

Using a 5% random sample of all approximately 32 million Medicare Part B beneficiaries in 2011, total spending was calculated on a state-by-state and US Census Bureau regional basis for all MPFS-covered diagnostic imaging services. Regional variation was analyzed.

**RESULTS**

Mean national diagnostic imaging per beneficiary spending was $220.37, with an average $95.43 (43.3%) to radiologists and $124.95 (56.7%) to non-radiologists. State-by-state and US Census Bureau regional variation was analyzed.
Mean national diagnostic imaging per beneficiary spending was $220.37, with an average $95.43 (43.3%) to radiologists and $124.95 (56.7%) to non-radiologists. The percentage of spending on non-radiologists ranged from 35.5% (North Dakota) to 71.0% (South Carolina). The percentage of total MPFS payments for diagnostic imaging to non-radiologists exceeded those to radiologists in 71% of states and in every Census Bureau region. Relative percentage of total MPFS payments to non-radiologists were highest in the South (61.2%) and lowest in the Northeast (50.8%). Overall payments to non-radiologists were less than 40% in only 2 states, but greater than 60% in 11 states.

CONCLUSION
Nationally, 56.7% (range 35.5% to 71.0% by state) of MPFS payments for diagnostic imaging services are made to non-radiologists.

Although this varies substantially by region, non-radiologists claim a majority of MPFS payments for diagnostic imaging in every Census Bureau region and in 71% of all states. Payment policy directed toward medical imaging needs to consider all provider groups and their roles in the imaging chain. Majority spending on non-radiologists may have significant implications in developing bundled and capitated payment models.

CLINICAL RELEVANCE/APPLICATION
MPFS payments for diagnostic imaging to non-radiologists exceed those to radiologists in 71% of states. Payment policies and at risk contracts must integrate this fact to accurately align incentives.

SSG07-03 • Medicare Spending on Medical Imaging Varies Greatly between States

David A Rosman MD (Presenter) *; Eugene Nsiah; Danny Hughes PhD; Richard Duszak MD

PURPOSE
To study regional variation in per beneficiary Medicare Physician Fee Schedule (MPFS) spending on diagnostic imaging services in relation to that for all healthcare services.

METHOD AND MATERIALS
Using a 5% random sample of all approximately 32 million Medicare Part B beneficiaries in 2011, total spending was calculated on a state-by-state and US Census Bureau regional basis for all MPFS-covered diagnostic imaging services. Regional variation was analyzed.

RESULTS
Mean diagnostic imaging per beneficiary spending was $197.08 (+62.96, range $98.79 in Hawaii to $368.83 in New Jersey), with 13 states $200. Mean total MPFS per beneficiary spending was $2,102.29 (+486.76, range $1,175.76 in Hawaii to $3,536 in New Jersey) with 4 states $2,500. Mean total and diagnostic imaging spending were both higher in the South and Northeast ($236.21 and $2,412.84 and $201.37 and $2,191.11, respectively) than the Midwest and West ($168.75 and $1,979.44 and $169.10 and $1,748.10). Overall, diagnostic imaging comprised 9.8% of total MPFS spending (+1.2%, range 6.8% in Vermont to 12.3% in Nevada), with 7 states 11.0%.

CONCLUSION
MPFS spending on diagnostic imaging services per beneficiary varies 3.7-fold between states. Spending on all healthcare services varies 3.0-fold. The percentage of spending on diagnostic imaging to total spend varies 1.8-fold. Regional variation in total healthcare and diagnostic imaging utilization is large, creating opportunities for improved utilization management, particularly in the context of emerging shared risk and savings payment models.

CLINICAL RELEVANCE/APPLICATION
Marked variation in MPFS spending on diagnostic imaging and total health services creates opportunities for utilization management and empowers shared risk and savings payment models.

SSG07-04 • Nationwide Medicare Data Show the End of Growth in Utilization Rates of Advanced Imaging

David C Levin MD (Presenter) *; Vijay M Rao MD; Laurence Parker PhD; Andrea J Frangos MPH

PURPOSE
Anecdotal reports from various sources have suggested that advanced imaging is no longer growing. Our purpose was to determine the correctness of this perception by studying recent trends in utilization rates of CT, MRI, and nuclear medicine, using a nationwide database.

METHOD AND MATERIALS
The Medicare Physician/Supplier Procedure Summary Master Files for 2000-2011 were used. These files cover all Medicare beneficiaries in traditional fee-for-service Medicare (36.3 million in 2011). All CPT codes for CT, MRI, and nuclear medicine (including PET) were selected except those for guidance for invasive procedures and for radiation therapy planning. Procedure volumes in the 3 modalities were determined by tabulating global and professional component claims. Utilization rates per 1000 beneficiaries were calculated and tracked from 2000 through 2011.

RESULTS
The CT utilization rate per 1000 rose from 325 in 2000 to a peak of 637 in 2009 (+96%). In 2010, for the first time, a small drop in the rate was seen, to 626. In 2011 a large drop to 500 occurred. This was mostly attributable to bundling of the codes for CT of the abdomen and pelvis. The nuclear medicine rate per 1000 rose from 193 in 2000 to a peak of 320 in 2006 (+66%). There was a gradual and slight decline over the next 3 years, to 303 in 2009. In 2010, there was a sharp decline to 135, which was primarily due to bundling of the codes for primary myocardial perfusion imaging and its 2 add-on codes for left ventricular wall motion and ejection fraction. A further decline to 128 occurred in 2011. The MRI rate rose from 95 in 2000 to 185 in 2006 (+95%). The rate thereafter remained essentially flat, and was 184 in 2011. No code bundling occurred in MRI.

CONCLUSION
The rapid growth that was seen in use of advanced imaging in the early part of the last decade has stopped. Sharp declines were seen in CT in 2011 and nuclear medicine in 2010, due primarily to code bundling. However, even before then, growth in those 2 modalities had halted. In MRI, where no bundling occurred, growth stopped after 2006. The cause of the cessation of growth is multifactorial.

CLINICAL RELEVANCE/APPLICATION
Not applicable.

SSG07-05 • Cost Implications for Following Nationally Recommended Best-practice Follow-up Guidelines for Adrenal Lesion Characterization Detected by CT

David A Rosman MD (Presenter) *; Tarik K Alkasab MD, PhD; Anand M Prabhakar MD; Daniel I Rosenthal MD; Keith J Dreyer DO, PhD *; Debra A Gervais MD *; Giles W Boland MD

PURPOSE
In an attempt to reduce variation and improve outcomes, the ACR developed consensus best-practice guidelines for evaluating adrenal lesions detected at CT. However the cost implications of implementing these guidelines has not been evaluated. We have also separately presented poor compliance with these guidelines, which can substantially improve using a point-of-care clinical decision support tool (CDS) built upon the ACR recommendations. We evaluated the financial cost implications when radiologists adhered to these guidelines using a CDS tool when compared to recommendations without use of the tool.

METHOD AND MATERIALS
33,352 consecutive abdominal CT examinations were performed January 1 through October 23, 2012. Those

RESULTS
510 adrenal lesions (209 adenosmas, 230 Indeterminate lesions and 71 other) were identified. Without the CDS tool, overall imaging recommendation rates for further workup were 29% (147/510) compared to 66% (339/510) when using the CDS tool. Our clinical
SSG07-06 • The Value of Imaging: The Primary Care Physician Perspective

Christine Hughes (Presenter) *

PURPOSE
Measure the extent to which PCPs value advanced imaging (AI) modalities (MRI, CT, PET/CT) and to identify what the PCPs believe to be the benefits and drawbacks of AI.

METHOD AND MATERIALS
We worked with Harris Interactive, an independent polling firm to conduct 42 qualitative interviews with PCPs in April and May of 2011, to begin the process of defining the value of imaging and assigning metrics. A quantitative Internet survey of 500 PCPs was administered in July and August of 2012. To qualify as respondents PCPs were required to meet the following criteria: practice in the US, duly licensed in the state where practicing, General Practice, Family Practice or Internal Medicine as specialty, practice in mostly office or clinic-based setting, spend at least 75% of time in direct patient care, and see at least 1 patient for whom an advanced imaging study is appropriate in a typical month. Final results were weighted to be representative of the AMA universe based on gender, years in practice, region and specialty.

RESULTS
Primary Care Physicians believe imaging provides value. Ninety percent (90%) of the survey respondents agreed that AI allows them to be more confident in their diagnoses, and AI provides unique data that is otherwise not available, 89% believe AI allows them to make better clinical decisions and increases their confidence in treatment choices. Statistically significant differences occurred between age groups. More experienced physicians who were likely to have practiced without ready access to AI placed a higher value on AI than younger physicians. Whereas, younger physicians were more likely to view AI in as a tool in practice efficiency than older physicians.

CONCLUSION
There is no question of perceived value of advanced imaging: PCPs agree AI allows them to be more confident in diagnoses, provides unique data, and assists with clinical decision making and treatment choices.

CLINICAL RELEVANCE/APPLICATION
The partnership between PCPs and Radiologists will be bolstered with a deeper understanding of the perceived benefits and drawbacks of advanced imaging.

SSG07-07 • Emergency Radiology Utilization at a Level 1 Trauma Center from 1996-2012

Vignesh A Arasu MD (Presenter) ; Garry Choy MD, MS ; Hani H Abujudeh MD, MBA * ; Elkan F Halpern PhD * ; James H Thrall MD * ; Robert A Novelline MD ; Paul D Biddinger MD

PURPOSE
To retrospectively review growth rate in emergency radiology volume at an academic level 1 trauma center in a major urban city from 1996-2012.

METHOD AND MATERIALS
We reviewed our institution's computer database on aggregated diagnostic radiology examination volume ordered for patients visiting our emergency department (ED) from January 1, 1996 to December 31, 2012. Changes in exam coding were manually reviewed and corrected to ensure accuracy. The growth rate in volume was calculated as the average annual percent change in imaging examinations per 1000 ED visits. We statistically compared the growth rate to zero annual growth during 1996-2003 and 2003-2012 using z-test.

RESULTS
Both ED visits and imaging volume grew continuously throughout 1996-2012. When adjusting for ED visits, statistically significant growth of total imaging was observed from 1996-2003 at 8% per year (SD 6%, p < 0.01), while no significant growth was seen from 2003-2012 at 2% per year (SD 3%, p = 0.96). By modality, statistically significant growth was observed in CT and MRI from 1996-2003, and no significant growth from 2003-2012. X-ray showed no growth throughout 1996-2012. Ultrasound grew significantly during 1996-2003 at 12% per year (SD 10%, p < 0.01), and during 2003-2012 at 4% per year (SD 7%, p < 0.05). By anatomic region, no significant growth was observed from 2003-2012 for head and neck, abdomen and pelvis, chest, and extremity.

CONCLUSION
We observed a stable period of practice patterns for utilization of overall ED imaging, and specifically of CT and MRI, during the last 9 years of our institution. This is likely due to slowing of new imaging protocols during this time period, introduction of decision support systems, and increased awareness of practice guidelines and radiation risk among ED physicians. While the national health care discussion focuses on continual imaging growth, we demonstrate long-term stability in utilization of ED imaging is achievable.

CLINICAL RELEVANCE/APPLICATION
During the last 9 years at our institution, we have observed no significant growth in the overall utilization of imaging in the ED when adjusting for increasing ED visits.

SSG07-08 • Developing and Maintaining Imaging Volumes in Outpatient Radiology: The Impact of Direct Radiologist Interaction

Joseph Vavricek MD (Presenter) ; Laurent Grignon MD * ; William W Horsley MD ; Raymond A Murphy MD, PhD ; Mark D Keiper MD

PURPOSE
Direct sales and marketing efforts to referring clinicians may have a profound effect on referral patterns. This study was performed to assess the relative effect of direct radiologist participation in marketing and sales efforts on the development and maintenance of referral volumes in outpatient imaging.

METHOD AND MATERIALS
Monthly referral volumes of CT and MRI scans ordered by 19 referring clinicians to an outpatient imaging practice were collected over a 6 month period (January-June) in three sequential years. Data was collected in these months to control for seasonal variation. During the first 6 month period, a radiology sales representative visited the referring clinicians twice a month to provide basic support, substantive educational material and personal interaction with the clinicians. During the second 6 month period, the same sales representative visited referring clinicians every two weeks but accompanied by a radiologist as a team once a month. The radiologist and sales representative provided educational lectures, technical expertise and substantive personal interactions. During the final 6 month period,
the sales representative visited the referring clinicians twice a month without a radiologist. No significant changes in radiology practice service parameters occurred during the time periods studied.

RESULTS
The presence of a radiologist during the marketing and sales visits to referring clinicians had a positive statistically significant effect on overall scan volumes. During the time period in which the radiologist and sales representative visited clinicians, the number of CT and MRI volumes increased as much as 2.5 times when compared with baseline. However, the referral volumes began to decrease for all providers approximately 1.5 months after the radiologist stopped visiting the clinicians. Additionally, the referral volumes returned to baseline levels approximately 5 months after the radiologist terminated visits.

CONCLUSION
Direct radiologist participation in marketing and sales efforts to referring clinicians is a robust tool for creating and maintaining scan volumes in outpatient radiology.

CLINICAL RELEVANCE/APPLICATION
Direct radiologist interaction with clinicians profoundly affects referral patterns and is recommended to help develop, maintain, and optimize outpatient radiology scan volumes.

SSG07-09 • Relationship of Ordering Physician MRI Equipment Ownership to the Frequency of Negative Cervical Spine MRI

Timothy J Amrhein MD (Presenter); Ben E Paxton MD; Matthew P Lungren MD; Heather R Collins PhD; Ramsey K Kilani MD*

PURPOSE
To determine if ownership of MRI equipment by ordering physicians influences the frequency of negative cervical spine MRIs, and to evaluate cervical spine MRI pathology rates as a metric for comparison of utilization.

METHOD AND MATERIALS
A retrospective review was performed of 500 consecutive cervical spine MRIs ordered by two separate referring physician groups serving the same geographic community. The first group (FI) owned the scanners used and received technical fees for their use. The second group (NFI) did not have financial interest in the scanners used. All exams were performed with identical protocols and interpreted by a single musculoskeletal radiology group without financial interest in the imaging equipment. Final reports were reviewed and exams with moderate or severe spinal canal stenosis, neuroforaminal narrowing, facet degeneration, or disk bulges were considered positive. The percentage of negative studies in each group was calculated and the number of concomitant shoulder MRIs was recorded. Among positive scans, the frequency of severe lesions per scan was calculated for each group. Chi-square tests were used for categorical data and t-tests (2-tailed) and ANCOVAs (covarying for age) were used on continuous data.

RESULTS
A total of 500 consecutive cervical spine MRIs that met inclusion criteria were reviewed (250 FI, 250 NFI). 164 were negative (109 FI, 55 NFI); there were 98% more negative scans in the FI group (p

CONCLUSION
Cervical spine MRIs referred by physicians with a financial interest in the imaging equipment used were significantly more likely to be negative than those referred by physicians with no financial incentive. Among the positive studies, there was no statistically significant difference in the number of severe lesions per scan suggesting a highly similar distribution and severity of disease between the two patient samples. Further, patients in the FI group were more likely to undergo concomitant shoulder MRI.

CLINICAL RELEVANCE/APPLICATION
MRI referral patterns may be affected by the presence of an ordering physician’s financial interest in the imaging equipment used.

SSG08-01 • Gray-matter Volumetry Predicts Decline of Intelligence Quotient in Children with Sickle Cell Disease

Rong Chen PhD (Presenter); Michal Arkuszewski; Jaroslaw Krejza MD; Edward H Herskovits MD, PhD; Elias R Melhem MD, PhD

PURPOSE
For children with sickle cell disease (SCD), we aim to differentiate those with decline of intelligence-quotient (IQ) from counterparts without decline, based on structural magnetic-resonance (MR) imaging volumetry

METHOD AND MATERIALS
This prospective cohort study included 25 children with SCD, homozygous for hemoglobin S, with no history of stroke. We administered the Kaufman Brief Intelligence Test (K-BIT) to each child at yearly intervals for 2-4 years. Each child underwent MR examination within 30 days of the baseline K-BIT evaluation date. We calculated K-BIT change rates, and used rate of change in K-BIT to classify children into two groups: a decline group and a non-decline group. We then generated predictive models to predict the group-membership variable (K-BIT decline / non-decline) based on regional gray-matter volumes computed from structural MR images.

RESULTS
We identified six gray-matter structures (the left median cinulate gyrus, the right middle occipital gyrus, the left inferior occipital gyrus, the right fusiform gyrus, the right middle temporal gyrus, the right inferior temporal gyrus) that, when assessed for volume at baseline, are jointly predictive of whether or not a child would suffer subsequent K-BIT decline. Based on these six regional GM volumes, maternal education, and the baseline K-BIT, we built a prognostic model using the K* algorithm. The accuracy, sensitivity and specificity were 0.84, 0.75 and 1.0, respectively.

CONCLUSION
Structural MR imaging predicts subsequent IQ decline for children with SCD.

CLINICAL RELEVANCE/APPLICATION
Structural MR derived features can be used as a biomarker to predict subsequent IQ decline for children with SCD.

SSG08-02 • Heterogeneity as Biomarker in Tumour Imaging

Lejla Alic; Jifke F Veenland PhD (Presenter)

PURPOSE
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Tumour heterogeneity could be a valuable biomarker for differentiation, grading, response monitoring and outcome prediction. Many quantification techniques have been described, however in clinical practice these methods are scarcely used. The aim of this study is to evaluate the performance of the described methods and to identify the bottlenecks in the implementation in clinical practice.

METHOD AND MATERIALS
We searched OVID, EMBASE, and Cochrane CENTRAL up to 24 March 2013. Heterogeneity analysis methods were classified into four categories, i.e., non-spatial methods (NSM), spatial grey level methods (SGLM), fractal analysis (FA) methods, and filters and transforms (FandT).

RESULTS
From 6908 potentially relevant publications, 183 studies were included. The number of studies has been increasing steadily since 2009. Generally, 60 % studies use NSM, 49% use SGLM, 11 % use FA, and 28% use FandT. Differential diagnosis, grading or outcome prediction, the goal of features estimated per tumour, which is presumably caused by overfitting in small datasets. In only 53.4% of the classification studies, the use of cross-validation was reported. None of the publications report the use of an external validation set to test their findings. Retrospective analyses were conducted in 60% of the studies without a clear description of the inclusion criteria. Only 12% of the studies had a prospective study design. Almost none of the papers evaluated the incremental value of the heterogeneity biomarker on top of clinical established markers.

CONCLUSION
To enable the translation of imaging biomarkers from the research stage to clinical practice, research should focus more on prospective studies, use external datasets for validation, and focus on the added value of the proposed heterogeneity biomarker on top of the clinical established markers.

CLINICAL RELEVANCE/APPLICATION
Heterogeneity has the potential of a valuable biomarker.

SSG08-03 • Effective Staging of Fibrosis by the Selected Texture Features of Liver: Which One Is Better, CT or MR Imaging?
Xuejun Zhang PhD (Presenter) ; Yufan Zeng ; Hiroshi Fujita PhD; Yan Wen ; Liling Long MD ; Yu Huang MMed

PURPOSE
Different types of datasets acquired from CT and MR images are investigated to select the optimal parameters for the classification of texture patterns of hepatic fibrosis using Computer-aided Diagnosis.

METHODOLOGY AND MATERIALS
149 patients were scanned by MDCT and 218 patients were performed abdominal examination using 1.5T and 3T superconducting MR scanners. All the cases are verified by needle biopsies as the gold standard of our experiment, ranging from 0(no fibrosis) to 5(cirrhosis). For each case, at least four sequenced phase images are acquired: pre-contrast, arterial, portal venous and delayed phase. 15 texture features calculated from gray level co-occurrence matrix (GLCM) are extracted within an ROI in liver as one set of input vectors. Each combination of these input subsets is checked by using support vector machine (SVM) with leave-one-case-out method to differentiate fibrosis into two groups: normal or abnormal.10 ROIs in liver are manually picked up dispersedly by experienced radiologist from each sequenced image and each item in 15 features is averaged by 10 ROIs in each case to reduce the validation time. The number of input items n is selected from the combinations of 15 features exhaustively. (2^15-1 different combinations obtained, where n?[1,15])

RESULTS
According to the accuracy rate (AR) calculated from each combination, the optimal number of texture features to classify liver fibrosis degree is from 4 to 7, no matter what modalities are used. The overall performance calculated by the average sum of maximum AR value of all 15 types number of features is 66.83% in CT images, while 68.14%, and 71.98% in MR images (Fig.1a), respectively; among 15 texture features, mean gray value and entropy are in most common used in 3 datasets. Correlation has the lowest AR value and is abandoned to be used in all datasets. AR value tends to increase with the injection of contrast agency, and both CT and MR images reach highest performance in equilibrium phase as shown in Fig.1b.

CONCLUSION
Comparing the accuracy of classification on two modalities, we should reveal that MR images have an advantage over CT images, while 3T MRI is better than 1.5T MRI to detect liver fibrosis. The texture analysis is effective in equilibrium phase than in other phased images.

CLINICAL RELEVANCE/APPLICATION
MR can demonstrate fibrotic texture efficiently and equilibrium phase image is recommended as a main tool for interpretation of cirrhosis.

SSG08-04 • The Development of a Methodology to Simulate 3D Models of Benign and Malignant Breast Masses
Eman Shaheed (Presenter) ; Chantal Van Ongeval MD ; Frederik De Keyzer ; Kenneth C Young PhD ; David Dance PhD ; Hilde Bosmans PhD *

PURPOSE
Breast cancer remains a major health concern and a leading cause of cancer mortality among women. The commonly used screening mammography has limited sensitivity for small lesions detection due to anatomical noise. Therefore, new breast imaging modalities with proven superiority for lesion detection may remedy this shortcoming in breast cancer screening and diagnosis. Clinical trials are very expensive, giving rise to alternative dedicated simulation studies for the investigation of new modalities in terms of lesion detectability. Here, we present a new method to create more clinically-relevant 3D models of benign and malignant breast masses for use in simulation studies.

METHODOLOGY AND MATERIALS
Breast MRI cases with histologically-proven malignant masses, imaged with a 3D contrast enhanced acquisition, were collected. Each mass was manually segmented in three reconstructed orthogonal planes (sagittal, transversal, coronal), and then combined with logical OR, resulting in to get isotropic volume sizes in 3D space, then meshed. Due to the low resolution of MRI images, most of these masses had well defined borders. In order to create spiculated masses, suspicious for malignancy, the segmented model was used as nucleus with branches grown on the surface. The branches had different lengths, bifurcations, orientations and thicknesses. The clinical appearance of these models was assessed by inserting each mass model into 2D digital mammography and breast tomosynthesis (BT) images using a previously-validated simulation framework. Each 2D and BT was shown to an expert radiologist who scored the BI-RADS (scale 1-5) and the realism of the simulated mass (scale 1-10, 10=definitely real).

RESULTS
Preliminary results for the benign category (well defined borders) with 7 simulated masses showed a BI-RADS score between 2 and 3, and an average realism score of 8.1 (range 8-9) for 2D and 7.9 (7-9) for BT. For the malignant category with 8 spiculated masses, the BI-RADS score was between 4 and 5, and the average realism score was 8.3 (8-9) in 2D and 7.6 (7-9) in BT.

CONCLUSION
A new method to simulate 3D models, based on an atlas of real lesions, with variety of shapes and degree of malignancies was presented with promising results.

CLINICAL RELEVANCE/APPLICATION
The proposed 3D mass models are promising candidates to create enriched databases for virtual clinical trials and observer detectability.
1.960±0.073, 1.958±0.085 and 1.960±0.093 mm at the surfaces, respectively. Among those, the diameters of only arteries of 29 patients’ lungs are 1.513±0.159, 1.840±0.105, 1.929±0.076, 1.823±0.093, 1.934±0.079, 1.968±0.073, 1.977±0.082, and 1.994±0.092 mm (mean±SD) from distal to proximal surfaces with 5 mm intervals, respectively. The diameters of vessels are 1.544±0.158, 1.780±0.112, 1.863±0.094, 1.944±0.086, and 1.981±0.092 mm (mean±SD) from distal to proximal surfaces with 5 mm intervals, respectively.

RESULTS
We demonstrate that histogram features mean, standard deviation, skewness and kurtosis are robust to changes in resolution, with P>0.4 for analysis of variance (ANOVA) comparisons between resolutions for the single feature. Entropy however decreases with decreasing resolution (P<0.05).

CONCLUSION
The Shannon entropy within tumors decreases with decreasing image resolution, whereas basic distribution information like mean and standard deviation remain relatively stable. Uniformity behaves inversely to entropy.

CLINICAL RELEVANCE/APPLICATION
When interpreting studies about diagnostic performance of histogram analysis, one should consider the imaging protocol used in the respective study. Image resolution affects entropy estimates.

SSG08-06 • Differential Diagnosis of Benign and Malignant Brain Tumors by Use of Texture Analysis on FDG-PET Images
Shojo Kido MD, PhD (Presenter) ; Akiko Katamoto BS ; Rui Xu ; Yasushi Hirano

PURPOSE
To develop the computer-aided diagnosis (CAD) method by use of texture analysis and pattern classification technique to analyze F-18-fluorodeoxyglucose (FDG) uptake distribution of brain tumors for differential diagnosis of malignancy and benignancy on FDG-PET images.

METHOD AND MATERIALS
We used consecutive 24 patients with brain tumors (10 benign and 14 malignant cases). Each patient underwent MRI and PET scans continuously. In the PET images, it is difficult to determine the contours of tumors in many cases. So, MR images were used for determination for tumor regions on PET images. In the first step, each patient of MR image data was superimposed to PET image data by use of a three-dimensional registration algorithm. After manual segmentation of tumor regions on MR images, tumor regions on PET images were segmented based on those on MR images. Texture features representing FDG uptake distributions were obtained from these tumor regions on PET images. From these texture features, four optimal parameters to distinguish malignancy from benignancy were selected. For pattern classification technique, we used a support vector machine (SVM) as a classifier. We classified 24 tumors into benign and malignant cases with the SVM by a leave-one-out method. The performance of our CAD method was compared with a maximum standard uptake value (SUmax) based method that was generally used in clinical diagnosis.

RESULTS
The accuracy rate of our CAD method for all cases was 91.7% (22/24 cases). The accuracy rate for benign cases was 80.0% (8/10 cases), and that for malignant cases was 100.0% (14/14 cases). On the other hand, the accuracy rate of SUVmax based method for all cases was 62.5% (15/24 cases). The accuracy rate for benign cases was 20.0% (2/10 cases), and that for malignant cases was 92.9% (13/14 cases). The performance of our CAD method was superior to that of the SUVmax based method (P<0.05).

CONCLUSION
The CAD method for differential diagnosis of brain tumors on FDG-PET images by use of texture analysis and the SVM classifier indicated high performance compared with the SUVmax based method. This method is feasible for assisting radiologists in the differential diagnosis of brain tumors on FDG-PET images.

CLINICAL RELEVANCE/APPLICATION
The CAD method by use of texture analysis and the SVM classifier on FDG-PET images improves the abilities of radiologists for differential diagnosis of malignant and benign tumors on FDG-PET images.

SSG08-07 • Quantification of the Distribution and Extent of Automatically Classified Small Pulmonary Arteries and Veins on Volumetric Chest CT
Seyoun Park ; Sang Min Lee MD ; Namkug Kim PhD (Presenter) ; Joon Beom Seo MD, PhD ; Joon Ho Choi MD

CONCLUSION
Our automatic vessel classification-based quantification approach may be useful for assessing the status of many pulmonary disease, considering the spatial distribution and extents of automatically classified, small pulmonary arteries and veins.

Background
As one of meaningful indicators for assessing the status of pulmonary circulation in various pulmonary diseases, analysis of the distribution and extent of small pulmonary vessels is necessary. We developed a quantitative analysis method for determining the total vascular structure in 3D from volumetric chest CT.

Evaluation
Non-contrast volumetric chest CT scans with sub-millimeter thickness of 29 patients with chronic obstructive pulmonary disease (COPD) were used for this study. We extracted vessels as 3D points from volumetric CT images. A minimum spanning tree of pulmonary arteries and veins were then generated by construction energy minimization from extracted points. This tree was divided into smaller branches by cutting the mediastinal region. The arteries and veins were then separately collected to observe distributions. From the distal to proximal surfaces, we extracted 6 offset surfaces at 5 mm intervals and detected intersecting points with vascular trees. At each point, vascular direction was estimated using neighbor vessel points. Finally, vascular radii were computed by fitting cylinders at each center. Quantitative measures were computed such as the number of vessels and the mean diameters. We collected several quantitative measures, such as mean diameter, minimum and maximum diameters, cross-sectional areas of the inner pulmonary surface, the diameters of vessels are 1.544±0.158, 1.823±0.093, 1.934±0.079, 1.968±0.073, 1.977±0.082, and 1.994±0.092 mm (mean±SD) from distal to proximal surfaces with 5 mm intervals, respectively. Among those, the diameters of only arteries of 29 patients’ lungs are 1.513±0.159, 1.840±0.105, 1.929±0.076, 1.960±0.073, 1.958±0.085 and 1.960±0.093 mm at the surfaces, respectively.

Discussion
SSG08-08 • Quantitative Analysis of Infectious Lung Disease from Serial PET-CT Scans in Small Animal Models

Brent Foster (Presenter) ; Ulas Bagci PhD, Msc ; Ziyue Xu PhD ; Awais Mansoor PhD ; Brian Luna ; Bappaditya Dey ; Colleen Jonsson ; William Bishai ; Sanjay K Jain MD ; Daniel J Mollura MD

PURPOSE
To develop a complete image analysis and quantification framework that accurately determines disease severity and its progression in pulmonary infections using three small animal models: rabbit, ferret, and mouse.

METHOD AND MATERIALS
We designed a fast and robust automated image analysis platform with a quantification tool that facilitates accurate quantification of pulmonary lesions, and an image registration pipeline that supports a volumetric comparison of all serial scans using PET and CT images. The proposed method for analysis contained three steps: (i) the lung was segmented via an interactive region growing method; (ii) mathematical morphology was then applied to this binary mask to remove all non-lung regions from the images; and (iii) then the affinity propagation based clustering algorithm was used on all PET images to precisely segment the high uptake regions. The proposed framework was tested using sequentially acquired CT and PET images. The rabbits were infected with Mycobacterium tuberculosis (TB) (92 PET-CT scans). The ferrets were injected with the H1N1 influenza virus (44 PET-CT scans), and the mice were infected with an aerosolized respiratory pathogen (24 PET-CT scans). Segmentations were evaluated by expert radiologists and compared with ground truth segmentations.

RESULTS
Each small animal model was evaluated within the same animal type and the Dice Similarity Coefficient (DSC), and the Hausdorff distance (HD) were used for evaluation of the proposed method. The estimated lesion volume sizes from CT and PET images, estimated from the proposed method and the ground truth (R2=0.8922, p<0.05), showed excellent agreement. The proposed computational framework can increase the efficiency and quality of pre-clinical findings relative to clinical standards and decrease the inter-observer variation from manual quantification methods that can obscure findings.

CLINICAL RELEVANCE/APPLICATION
This framework can be applied clinically for accurate, efficient, and robust quantification of infectious diseases using longitudinal PET-CT images.

SSG08-09 • Computerized Differentiation of Regional Patterns of Diffuse Infiltrative Lung Disease for Iodine Quantification in Dual-energy CT Using SVM Classifier and a Hybrid Segmentation Method

Jangpyo Bae MS (Presenter) ; Yongjun Chang ; Jung Won Moon ; Ho Yun Lee MD ; Namkug Kim PhD

PURPOSE
To construct the computerized differentiation framework to quantify the iodine concentration according to the regional patterns of diffuse infiltrative lung disease (DILD) in dual-energy CT.

METHOD AND MATERIALS
Volumetric CT scans of thirty patients with diffuse interstitial lung disease (DILD) were performed by a 64-multi detector row dual energy CT scanner (Siemens Definition Flash) with in 0.75mm collimation at dept. of radiology, Samsung Medical Center. Two hundred seventy one rectangular regions of interest (ROIs) with 20x20 pixels, consisting of each 57 ROIs representing three regional disease patterns (ground-glass opacity; GGO; reticular opacity; RO; and consolidation; CONS) and 100 ROIs for normal region were marked at dual-energy CT images of various DILD by two experienced radiologists with consensus. Twenty eight density, textural and shape features (histogram, gradient, run-length, co-occurrence matrix, cluster, and top-hat) were calculated and employed to characterize the ROIs by a SVM classifier with sequential forward selection method which differentiate the ROI into each class. The lung segmentation was performed with a hybrid method using rib information and an inverse level set of which parameters were adjusted with the density histogram of lung region. In addition, five folding cross validation with twenty repetitions were performed for average ROI based accuracy. To validate the region based accuracy, 40 slices were randomly selected from 20 patients and drawn by two radiologists with consensus, which was compared with the computerized method.

RESULTS
The accuracies of the classification of ROIs and whole lung region were 87.61±0.76 and 74.20±4.62, respectively. The region based accuracies of normal, RO, GGO and CONS were 77.04±4.50, 37.69±12.20, 62.38±9.53 and 45.03±13.18. The region based accuracies of the classification of ROIs and whole lung region were 87.61±0.76 and 74.20±4.62, respectively. The region based accuracies of normal, RO, GGO and CONS were 77.04±4.50, 37.69±12.20, 62.38±9.53 and 45.03±13.18.

CONCLUSION
The proposed classification methods showed clinically applicable accuracy. In addition, the proposed segmentation method was effective in the lung with DILD in dual energy CT.

CLINICAL RELEVANCE/APPLICATION
This method is useful in computer aided differentiation and quantification of regional disease patterns of diffuse infiltrative lung disease in dual energy CT images.
Ultrasound Molecular Imaging

SSG09-03 • Black Blood 3D DCE-MR to Examine Permeability and Predict Nanoparticle Targeting in Experimental Atherosclerosis

Mark E Lobatto MD (Presenter); Claudia Calcagno PhD; Antoine Millon; Max Senders; Francois Fay PhD; Phil Robson PhD; Sarayu Ramachandran MS; Erik Stroes MD, PhD; Zahi A Fayad PhD*; Willem J Mulder MS, PhD

PURPOSE
Atherosclerotic disease is a major cause of global morbidity and mortality that might benefit from targeted therapy to the vessel wall. Recent studies have shown efficient and local drug delivery with nanoparticles, though the targeting method in atherosclerosis has not been clarified. In the current study we used in and ex vivo imaging methods to investigate nanoparticle targeting and the role of endothelial permeability in a rabbit model of atherosclerosis.

METHOD AND MATERIALS
To achieve this we developed a novel black-blood 3D Dynamic Contrast Enhanced (DCE)-MRI technique that allows the assessment of endothelial permeability over a large vascular region, e.g. the infra-renal aorta of an atherosclerotic rabbit. Atherosclerotic rabbits (n=8) were subjected to a DCE-MRI scan on a 3T clinical scanner and injected with nanoparticles labeled with the fluorescent dye Cy7 (Cy7-LN) that we allowed to circulate different time points (½-hour, 6 hours and 24 hours). Next, we injected a fluorescent dye (Evans Blue) that extravasates at sites with enhanced permeability, after which rabbits were sacrificed. Near infrared fluorescence imaging was then used to quantify both Cy7-LN and EB in excised aortas.

RESULTS
Excellent correlation was observed between the accumulation of Cy7-LN at a ½-hour and permeability determined with EB ($r^2=0.8, p=0.007$); DCE: $r^2=0.53, p=0.003$), but became insignificant after 24 hours (EB: $r^2=0.08, p=0.33$; DCE: $r^2=0.08, p=0.33$). With fluorescence microscopy we found Cy7-LN confined to the vasculature when circulated for a ½-hour, while gradual extravasation from the lumen and neovessels was seen at 24 hours. At 24 hours NW was found diffusely throughout the plaque, clarifying the aforementioned decrease in correlation between LN accumulation and endothelial permeability.

CONCLUSION
3D DCE-MRI allowed the visualization of permeability within atherosclerotic plaques, which similarly correlated with nanoparticle uptake.

CLINICAL RELEVANCE/APPLICATION
As nanoparticles may be employed for local drug delivery to atherosclerotic plaques, 3D DCE-MRI might be a valuable in vivo tool to predict if a subject is amenable to nanoparticle therapy.

SSG09-03 • Cardiac PET/MRI with 18F-FDG: Feasibility and Initial Results in Patients with Acute Myocardial Infarction

Felix Nensa MD (Presenter); Thorsten D Poeppel; Karsten J Beiderwellen MD; Juliane Schelhorn MD; Amir A Mahabadi MD; Philipp Heusch MD; Kai Nassenstein; Michael Forsting MD; Thomas W Schlosser MD

PURPOSE
To assess the feasibility of hybrid imaging of the heart with 18F-fluorodeoxyglucose (18F-FDG) on an integrated 3 Tesla PET/MRI system and to discuss its potential clinical impact.

METHOD AND MATERIALS
Twenty patients with confirmed acute myocardial infarction underwent 18F-FDG PET/MRI with oral glucose loading within 2-7 days after interventional revascularization. Tracer accumulation in each myocardial segment was compared to regional wall motion abnormalities and to signal intensity in late gadolinium-enhanced (LGE) images with Cohen's $\beta$ statistics. The size of the infarction zone was measured on LGE and PET images. In 10 patients additional PET/CT imaging was performed and PET data was visually and semi-quantitatively (SUVRmax) compared between PET/CT and PET/MR.

RESULTS
Absolute parallelized scan time was 71±3 min. Categorical inter-method agreement between PET and LGE over all patients and segments was $\gamma=0.83$, and $\gamma=0.81$ between PET and cine imaging. On average 20±17% of the entire left ventricular myocardium was classified as infarcted in both PET and LGE images and 19±19% in LGE images ($p=0.65$). Bland-Altman analysis of tracer uptake in PET/MR and PET/CT yielded limits of agreement of $-0.34$ to $3.65$ (SUVRmax: $6.51\pm4.32$ vs. $6.82\pm4.16$; $p=0.21$), the coefficient of variation was 0.18.

CONCLUSION
Cardiac PET/MRI in patients with acute myocardial infarction is feasible on an integrated PET/MR scanner. Comparison of PET images from PET/CT and PET/MRI showed good concordance. A close match between PET and MRI regarding myocardial viability and infarct quantification was demonstrated. Further study will show, if hybrid PET/MRI with 18F-FDG yields added value in patients with ischemic cardiac disease.

CLINICAL RELEVANCE/APPLICATION
Cardiac PET/MRI provides quantitative information on metabolic processes that might be incorporated into cardiac MRI protocols to improve risk stratification in acute myocardial infarction.

SSG09-04 • Non-invasive Assessment of Inflammation in a Murine Model of Chronic Inflammatory Bowel Disease Using Ultrasound Molecular Imaging

Ferdinand Knieling (Presenter); Steven B Machtaler PhD; Thierry Bettinger*; Richard Luong; Hualjun Wang MD, PhD; Juergen K Willmann MD*

PURPOSE
Ultrasound (US) molecular imaging has shown promising results in imaging inflammation in murine models of acute inflammatory bowel disease (IBD). The purpose of this study was to evaluate the feasibility of US molecular imaging using a clinically translatable microbubble (MB) targeted to the inflammation markers P- and E-selectin (MBselectin) for monitoring inflammation in a chronic and a chronic flare model of murine colitis.

METHOD AND MATERIALS
Acute colitis was established by rectal 2,4,6-trinitrobenzene sulfonic acid (TNBS) administration in 23 mice. Chronic colitis was established by 3 repetitive cycles of oral dextran sodium sulfate (DSS) administration in an additional 23 mice; an acute inflammatory flare in the chronic colitis model was simulated by rectal TNBS injection. All mice were imaged in contrast mode following i.v. injection of 5x107 MBselectin and control microbubbles (MBover) using a 21 MHz transducer (VisualSonics). In vivo imaging results were correlated with ex vivo immunofluorescence and histology.

RESULTS
Selectin-targeted US molecular imaging allows inflammation assessment in acute inflammation and chronic flare models of IBD in mice, which may simulate different disease states seen in patients with IBD.
SSG09-05 ● Inflammation Imaging Using Molecular Ultrasound in an Acute Terminal Ileitis Model in Swine

Haujun Wang MD, PhD (Presenter); Stephen A Felt DVM, MPH; Ismayil Guracar *; Steven B Machtaler PhD; Thierry Bettinger *; Juergen K Willmann MD *

PURPOSE
To translate ultrasound (US) molecular imaging using a clinical grade contrast microbubble targeted at the inflammation markers P- and E-selectin (MBselectin) to a large animal model of acute terminal ileitis.

METHOD AND MATERIALS
An acute terminal ileitis porcine model was established in 9 female pigs using intraluminal 2,4,6-trinitrobenzene sulfonic acid (TNBS) installation. All pigs were imaged before (control), and 48 hours after induction of ileitis. US molecular imaging was performed after i.v. injection of either MBselectin or non-targeted MBControl at a dose of 5×10^8/kg b.w. each using a clinical US machine (Acuson Sequoia 512; Siemens) and a clinical transducer (15L8BW; 7MHz). Four minutes after MB injection, images were acquired for 10 sec, followed by a 3-sec high power destruction pulse; this was followed by another 10-sec acquisition. Linearized imaging signal was expressed as intensity ratio, defined as average pre-destruction signal intensity divided by average post-destruction signal intensity. After imaging, pigs were sacrificed and the terminal ileum was analyzed for inflammation grade on Haematoxylin and Eosin staining and for expression of P- and E-selectin using immunofluorescence.

RESULTS
US molecular imaging of the terminal ileum was feasible in all 9 pigs. Imaging signal intensity ratio using MBselectin was significantly higher (increased by 106%; p=0.005) in acute ileitis compared to normal control ileum. Also, imaging signal in acute ileitis using MBselectin was significantly higher (increased by 103%; p=0.002) compared to MBControl. US imaging signal was not significantly different (p=0.06) when using MBselectin or MBControl in normal control ileum. Ex vivo analysis on Haematoxylin stained tissue samples confirmed strong inflammation in the terminal ileum. Immunofluorescence showed overexpression of selectins on the vasculature of inflamed bowel.

CONCLUSION
US molecular imaging with MBselectin can be translated to large animal imaging in an acute terminal ileitis porcine model and molecular US imaging signal correlates well with extent of inflammation on histology.

CLINICAL RELEVANCE/APPLICATION
The feasibility of US molecular imaging in large animals with ileitis paves the way towards clinical translation of US molecular imaging for the accurate quantification of inflammation in the abdomen.

SSG09-06 ● Optical Imaging for Real-time Detection of Cartilage Matrix Degeneration in Experimental Osteoarthritis Models

Shadi A Esfahani MD, MPH (Presenter); Andrea Foote; Averi A Leahy; Li Zeng; Umar Mahmood MD, PhD

PURPOSE
Osteoarthritis (OA) is a degenerative disease due to part to permanent destruction of cartilage matrix, causing patients pain and immobility. This destruction occurs by highly activated proteases in the matrix, predominantly matrix metalloproteinase (MMP). We used an optical probe, cleaved and activated by MMP enzymes in the cartilage and assessed the ability of this probe for early detection and monitoring of OA progression in animal models.

METHOD AND MATERIALS

RESULTS
Our imaging and histopathology results showed that targeting MMP is a promising non-invasive method for early detection and monitoring of cartilage matrix degeneration in a wear-and-tear model of OA. The method is readily translatable to humans.

CLINICAL RELEVANCE/APPLICATION
Optical imaging of matrix metalloproteinase could aid in non-invasive detection of cartilage destruction in early stages of disease and in evaluation of treatment response in osteoarthritic patients.

SSG09-07 ● Arterial Spin Labeling and T1-mapping for Evaluation of Renal Perfusion Impairment and Tissue Edema following Acute Kidney Injury in Mice—Comparison with Histopathology

Katja Hueper (Presenter); Marcel Gutberlet DiplPhys; Song Rong MD; Dagmar Hartung MD; Matti Peperhove MD; Amelie Barrmeyer; Michael Mengel; Hermann Haller MD; Frank K Wacker MD *; Martin Meier PhD; Faikah Gueler MD

PURPOSE
Acute kidney injury (AKI) leads to inflammation, decrease of renal perfusion, and loss of renal function. The purpose was to investigate whether arterial spin labeling (ASL) and T1-mapping allow monitoring renal perfusion impairment and acute tissue edema in a mouse model of ischemia induced AKI.

METHOD AND MATERIALS
AKI was induced in C57Bl/6 mice by transient unilateral clamping of the right renal pedicle for 35 min (n=10, moderate AKI) or 45 min (n=7, severe AKI). Animals underwent MRI prior to surgery and at different time points thereafter (d1, d7, d14, d21, d28) using a 7 Tesla magnet. Flow sensitive alternating inversion recovery (FAIR) EPI ASL sequences (13 inversion times) were acquired, and maps of renal perfusion and T1 relaxation time were calculated. Kidney volume was determined by segmentation of axial T2-weighted images. Renal pathology in the same animals after 4 weeks was assessed by histology. Statistical analysis comprised ANOVA for repeated measurements followed by multiple comparison with the Sidak method, unpaired t-tests and correlation analysis between MRI parameters, histology and kidney volume loss.

RESULTS
Renal perfusion at d7 was significantly reduced to 56±8% after moderate (p < 0.05) or severe (p < 0.001) AKI. ASL and T1-mapping allow non-invasive monitoring of renal perfusion impairment and tissue edema after AKI in mice. Changes of renal perfusion and T1 relaxation time are associated with the severity of renal pathology and kidney volume loss.

CLINICAL RELEVANCE/APPLICATION
Renal perfusion and T1 relaxation time measured by arterial spin labeling and T1-mapping may serve as non-invasive biomarkers to characterize renal pathology after acute kidney injury.

SSG09-08 ● Visceral Obesity Assessed by 1H-MRS Predicts Cardiovascular Events in Chronic Kidney Disease Patients

Francesca Bolacchi (Presenter); Ettore Squillaci MD; Fabrizio Chegai MD; Marco Nezzo MD; Giovanni Simonetti MD

PURPOSE
Cardiovascular disease is the leading cause of death among patients with chronic kidney disease (CKD). Although there is emerging
evidence that excess visceral fat is associated with a cluster of cardiometabolic abnormalities in these patients, the impact of visceral obesity evaluated by a gold-standard method on future outcomes has not been studied. We aimed to investigate whether visceral obesity assessed by 1H-MRS was able to predict cardiovascular events in CKD patients.

METHOD AND MATERIALS
We studied 48 nondialyzed CKD patients [58% men; 29% diabetics; age 52.4 ± 9 years; body mass index (BMI) 26 ± 4.2 kg/m²; estimated glomerular filtration rate (GFR) 32.7 ± 11.5 ml/min/1.72 m²]. Visceral and subcutaneous abdominal fat were analysed by single voxel magnetic resonance spectroscopy (MRS). The MRS lipid spectrum was analysed and a lipid polyunsaturation index (PUI) was calculated. Fifteen healthy subjects were enrolled as controls. Cardiovascular events including acute myocardial infarction, angina, arrhythmia, uncontrolled blood pressure, stroke and cardiac failure were recorded during 24 months.

RESULTS
Cardiovascular events were 3-fold higher in patients with higher PUI index. The Kaplan-Meier analysis indicated that patients with a high PUI index had shorter cardiovascular event-free time than those a normal PUI values (P = 0.031). In the univariate Cox analysis, PUI was associated with higher risk of cardiovascular events (hazard ratio = 3.4; 95% confidence interval = 1.1-10.5; P = 0.03). The prognostic power of PUI for cardiovascular events remained significant after adjustments for sex, age, diabetes, previous cardiovascular disease, smoking, sedentary lifestyle, BMI, GFR, hypertension, dyslipidemia and inflammation.

CONCLUSION
Visceral and subcutaneous fat as analysed by 1H-MRS is a valuable tool in predicting cardiovascular events in CKD patients.

CLINICAL RELEVANCE/APPLICATION
PUI index assessed by 1-H R MRS was a predictor of cardiovascular events in CKD patients.

SSG09-09 • C5b-9 Targeted Molecular MR Imaging in Rats with Heymann Nephritis: A New Approach in Evaluation of Nephrotic Syndrome

Wenbo Xiao MD ; Qiang Huang (Presenter) ; Song Wen ; Chuangen Guo ; Qidong Wang ; Rui Zhang

PURPOSE
To determine the feasibility of magnetic resonance imaging in rats with Heymann nephritis (HN) by using membrane attack complex C5b-9 targeted ultrasmall superparamagnetic iron oxide (USPIO)

METHOD AND MATERIALS

RESULTS
Anti-C5b-9-USPIO, as targeted molecular probe in MRI, could be used in specific imaging of rats with HN. Such a new molecular imaging method would be promising in the study of nephrotic syndrome diagnosis and treatment. [This study was supported by grants from the National Natural Science Foundation of P.R. China (81171388) to W.X. and partly from the Ministry of Health Research Foundation of P. R. China (WKJ2011-2-004) to W.X ]

CLINICAL RELEVANCE/APPLICATION
C5b-9 targeted molecular MR imaging can be a promising noninvasive approach in study of glomerulonephritis.

Musculoskeletal (Interventional II)

Tuesday, 10:30 AM - 12:00 PM • E450B

SSG10 • AMA PRA Category 1 Credit ™:1.5 • ARRT Category A+ Credit:1.5

Moderator
Daniel E Wessell , MD, PhD *

Moderator
Joseph S Yu , MD

SSG10-01 • Percutaneous CT-guided Biopsy of the Musculo-skeletal System: Results of 3146 Cases Carried Out in the Last 22 Years

Eugenio Rimondi MD (Presenter) ; Alberto Bazzocchi MD ; Paolo Spinnato MD ; Giancarlo Facchini ; Teresa Calabro ; Fabio Ferrari ; Davide Donati ; Pietro Ruggieri ; Ugo Alabisinni MD

PURPOSE
This is a retrospective review of a single institution experience with percutaneous CT-guided biopsy of musculo-skeletal lesions to evaluate results, to define indications and to emphasize the role of this procedure in the diagnosis and staging of inflammatory and neoplastic lesions of the musculo-skeletal system.

METHOD AND MATERIALS
From January 1990 until the end of January 2013, 3146 core needle CT-biopsy were performed. All histologic diagnoses and imaging studies were reviewed. Site of procedure included spine in 1103 (35.1%), thoracic cage in 141 (4.5%), upper limb in 255 (8.1%), pelvis in 703 (22.3%) and lower limb in 944 (30.0%) patients.

RESULTS
In 2495 (79.3%) CT-guided biopsies the procedure was diagnostic: at histology 664 (26.6%) lesions were malignant bone tumours, 587 (23.5%) benign tumours, 53 (2.1%) pseudo-tumours and 480 (19.2%) metastases. In 372 (14.9%) patients an acute or chronic inflammatory disease was found, 339 (13.6%) had other diagnoses (stress fractures, metabolic diseases, chronic degenerative arthropathies, Paget etc.). On the other hand, in 651 (20.7%) cases the CT-guided procedure was not successful: 63 patients underwent incisional biopsies and 588 a second CT-biopsy, diagnostic in 503 patients. This gives an overall rate of non-diagnostic exams of 148/3146 (4.7%). Major difficulties in obtaining a diagnostic sample were related with site, histotypes (small cells, myelomas and lymphomas are more difficult for adequate sampling), insufficient pre-biopsy evaluation or insufficient cooperation from the patient.

CONCLUSION
CT-guided biopsy is a useful and low-cost technique that should be recommended for most of the bony lesions, with or without soft tissues involvement, even deeply located and spinal lesions. Failures of this procedure can be reduced in experienced hands with a careful evaluation of the case before the procedure, and with a team approach from the radiologist, the orthopaedic surgeon and the pathologist.

CLINICAL RELEVANCE/APPLICATION
Percutaneous CT-guided biopsy is crucial in the management of musculo-skeletal lesions. This revisited presentation highlights potentials and limitations of the technique and a few clues for users.

SSG10-02 • Percutaneous Bone Biopsies: Comparison between CT-scan and Flat-Panel Cone Beam CT Guidance

Lambros C Tselikas MD (Presenter) ; Julien Joskin ; Geoffroy Farouil ; Florian Roquet ; Serge Dreuil PhD ; Anne Auperin MD
SSG10-03 • Vertebral Biopsy in Patients with Suspected Osteomyelitis: Does It Change Management?
Minzhi Xing MD (Presenter); Elizabeth I Parker MD; Michael R Terk MD

PURPOSE
To determine if vertebral biopsy affects clinical decision-making in patients with suspected osteomyelitis and diskitis

METHOD AND MATERIALS
Forty-seven (n=47) consecutive patients (mean age 67.4 years, 41.7% male) with suspected vertebral osteomyelitis and diskitis who underwent CT-guided vertebral biopsy over a 5-year period (2008-2012) at a single institution were included. A retrospective chart review was performed to determine biopsy results, immune status, antibiotic status at time of biopsy, blood culture positivity (defined as ≥2 cultures positive) and results of other fluid cultures (abscess drainage, urine). A change in management was defined as commencement of an antibiotic regimen or a change from pre-biopsy antibiotic regimen following biopsy results.

RESULTS
The cohort comprised patients with suspected osteomyelitis and diskitis who underwent biopsy of the lumbar (33, 70.2%), thoracic (13, 27.7%) and cervical (1, 0.02%) vertebrae. 23 patients (48.9%) were receiving empiric treatment or antibiotics for co-morbid disease (HIV, TB) at the time of biopsy. Adequate pre-biopsy blood cultures were obtained for 37 patients (78.7%), of which 4 were culture positive and would not have required biopsy for diagnosis. Vertebral biopsy was positive in 13 (27.2%) and negative in 34 (72.3%) patients. A change in management based on overall biopsy results occurred in 7 patients (14.8%). Of the patients with positive biopsy results, there was no change in management in 7 patients, who were continued on pre-biopsy antibiotic regimens. Of the patients with negative biopsy results, there was no change in management in 33 patients: 16 continued on the same pre-biopsy antibiotic regimen with a clinical diagnosis of osteomyelitis, and in 17 patients the decision to stop antibiotics, or an alternative diagnosis, was made before biopsy results were obtained and thus not influenced by biopsy results.

CONCLUSION
In this study, only 14.8% of vertebral biopsies provided positive histological confirmation of osteomyelitis and changed management. In the majority of patients with suspected osteomyelitis undergoing vertebral biopsy, there was little evidence that clinical decision-making with respect to antibiotic regimen was influenced by biopsy results.

CLINICAL RELEVANCE/APPLICATION
Vertebral biopsy in the setting of suspected osteomyelitis does not lead to a change in antibiotic management in the majority of patients.

SSG10-04 • CT-based Finite Element Modeling and Microstructural Analysis Detect Reduced Bone Mineral Content and Bone Strength in the Spine after CT Fluoroscopy-guided Interventional Procedures
Miyuki Takasu MD (Presenter); Yuko Nakamura MD; Daisuke Komoto MD; Masaki Ishikawa MD; Masao Kiguchi RT; Kazuo Awai MD *; Shuji Date; Chihiro Tani MD

PURPOSE
The long-term bone toxicity associated with CT fluoroscopy-guided interventional angiography has received little attention. The purpose of this study was to determine the prevalence of secondary osteoporosis (SO) and trabecular microstructural changes after CT fluoroscopy-guided transarterial chemoembolization (TACE) for hepatocellular carcinoma.

METHOD AND MATERIALS
Spinal microarchitecture was examined by 64-detector CT in 53 patients who underwent TACE and 85 sex- and age-matched controls. Each patient's cumulative radiation exposure due to CT fluoroscopy was determined by summing the skin dose recorded by dosimeters placed on the examination table. Patients who had received medications that contribute to the risk of osteoporosis were excluded. Using a 3D imaging analysis system and finite element modeling (FEM), the bone mineral content per tissue volume (BMC/TV), trabecular parameters, and mechanical properties of the third lumbar vertebrae were calculated. Using BMC/TV with a reported cutoff value 58 mg/cm3, the prevalence of SO was analyzed with the chi square test. A multivariate regression model of patients' characteristics including age, sex, cumulative radiation dose, and dose per procedure was constructed to identify predictors for SO. The trabecular parameters were compared among three groups, including controls, patients with SO, and patients without SO, by Scheffé's post hoc test.

RESULTS
The prevalences of SO were 42.5% in males and 50.0% in females; it was higher in males than in the controls (P=0.04). By multivariate regression analysis, age was a significant contributor to SO (P=0.004). The microstructural and mechanical properties were significantly lower in patients with SO than in the controls and the elastic modulus obtained by CT/FEM was significantly lower in patients without SO than the controls (P=0.03).

CONCLUSION
The prevalence of SO was significantly higher in male patients than the controls. The bone quality and failure load were significantly reduced in patients with SO and the elastic modulus was significantly lower in patients without SO than in the controls.

CLINICAL RELEVANCE/APPLICATION
Multidetector CT detected an increased risk of SO after CT fluoroscopy-guided TACE. CT/FEM can alert to trabecular changes before the clinical manifestation of SO.
SSG10-05 ● Anterior Endplate Cement Extravasation Following Vertebroplasty or Kyphoplasty Is Associated with Increased Odds of Adjacent Level Fracture in Osteoporotic Patients

Mary Kristen Jesse MD (Presenter); Brian D Petersen MD; Deborah Glueck *; Sarah M Kreidler MS

PURPOSE
To determine if the location and extent of endplate cement extravasation is associated with adjacent level fracture (ALF) in osteoporotic patients after vertebroplasty or kyphoplasty.

METHOD AND MATERIALS
156 fractureplasty levels in 80 patients were retrospectively reviewed. Data were obtained from a single center between 2008 and 2012. For each patient, demographics including age, gender, T-score, body mass index, and osteoporosis type (primary or secondary) were recorded. Outcomes included presence of adjacent level fracture (ALF), location of cement extravasation (anterior, middle, or posterior third of the vertebral body), and extent of extravasation (percentage of the intervertebral disc height occupied by the bolus). An ALF was defined as a fracture which was: 1) in an unrepaired vertebra; 2) adjacent to a repaired level and 3) not due to trauma or pathology. Separate generalized linear models were fit to assess the association between the odds of ALF and the extent and location of extravasation, while controlling for correlation between levels within a patient. Logistic regression models were fit to examine the association between patient demographics and the odds of at least one ALF.

RESULTS
After exclusions, 98 levels in 52 patients remained. ALF occurred in 20 levels within 14 patients. For levels with adjacent level fracture (ALF), extravasation occurred in 9 levels, with 6 anterior, 3 middle, and no posterior leaks. For levels without ALF, extravasation was seen in 11 levels, with 2 anterior, 6 middle, and 3 posterior leaks. The odds of ALF in a given patient were 5.9 times higher (95% CI: 1.6 to 21.2; p=0.008) with extravasation when compared to no leakage. The odds of ALF in a given patient were 22.6 times higher (95% CI: 3.0 to 170.9; p=0.003) with anterior extravasation when compared to no leakage. Leakage in the middle or posterior two thirds of the vertebral (p=0.30) and extent of extravasation (p=0.024) were not associated with ALF. No associations were observed between ALF and patient demographics.

CONCLUSION
Cement endplate extravasation in general and anterior extravasation in particular have high association with adjacent level fracture after vertebroplasty and kyphoplasty in patients with osteoporosis.

CLINICAL RELEVANCE/APPLICATION
Application of this data will allow a more sophisticated intra-procedural fracture risk assessment following cement leakage.

SSG10-06 ● CT-assisted Pedicle Screw Placement after CT-controlled, Presurgical Guide Wire Implantation in Pelvic Fractures

Katrin Eichler MD (Presenter); Stefan Zangos MD; Thomas J Vogl MD, PhD; Martin G Mack MD

PURPOSE
The aim of this study was to evaluate the feasibility and accuracy of CT-assisted percutaneous placement of iliosacral screws over guide wires in patients with unstable pelvic fractures.

METHOD AND MATERIALS
39 patients (17 women, 22 men; mean age: 49.38 years, range: 16-84 years) with unstable traumatic pelvic fractures were treated with percutaneous screw placement after CT-controlled presurgical guide wire implantation to prevent surgical complications regarding the presacral venous plexus and the sacral nerve root. The patients were placed in prone or supine position on the CT table and general anesthesia was induced. For planning a CT with a collimation of 4x2.5 mm or 64x0.625 mm (120 K V, 80 mAs) was performed. Based on this protocol five points were marked. Then thread Kirschner guide wires with a diameter of 2.5 mm were introduced percutaneously under CT control. After verification of the position of the Kirschner guidewires the distance for the correct placement of the 7 mm-screws was measured, which were then introduced over the guide wire in the operation unit or immediately in the CT intervention room through a small skin incision.

RESULTS
In all cases the guide wires were successfully placed without complications. A total of 101 wires (47 on the right side and 54 on the left side) were introduced. All wires were correctly positioned in the first or second sacral vertebrae. In two patients with sacralized lumbal vertebrae one additional wire was also positioned in L5. In all cases, the screws were placed over the wires without ventral or dorsal perforation of the sacrum and affection of the nerve roots. None of the patients showed radiologic or clinical evidence of instability of the sacroiliac joint or screw migration. The mean clinical and radiologic follow-up period was 16 months (range: 3-24).

CONCLUSION
CT-controlled fixation of unstable pelvic fractures is a safe and feasible method that is able to minimize the complications of surgical treatment.

CLINICAL RELEVANCE/APPLICATION
CT-assistance is helpful for percutaneous placement of iliosacral screws over guide wires in patients with unstable pelvic fractures.

SSG10-07 ● Cervical Interlaminar Epidural Steroid Injection for Cervical Radiculopathy: Median versus Paramedian Approach

Ji Young Yoon MD (Presenter); Jong Won Kwon MD

PURPOSE
To compare the clinical effect of the cervical interlaminar epidural steroid injection (CIESI) for radiculopathy using the median and paramedian approach and to evaluate the prognostic factors of CIESI in general.

METHOD AND MATERIALS
We retrospectively analyzed 212 patients from February 2009 to December 2012 who initially underwent CIESI for cervical unilateral radiculopathy. Inclusion criteria were the availability of a cross-sectional image, such as a CT scan or an MR image, and a follow-up record after injection. We excluded patients with bilateral cervical radiculopathy and axial cervical pain. Short-term clinical outcomes were evaluated at the first follow-up after the administration of CIESI. The outcome was classified as effective or ineffective. Fisher’s exact test was used to analyze the difference of outcome according to the approach of the spinal needle and distribution of contrast media. Other possible outcome predictors, such as age, gender, duration of radiculopathy (more or less than 6 months), cause of radiculopathy (neural foraminal stenosis vs herniated disc) were also analyzed.

RESULTS
CIESI had no significant difference in the clinical outcome between median (66.3%) and paramedian (69.1%) approach (P>0.05). In general, CIESIs were effective in 144 of 212 patients (67.9%) at short-term follow-up. Patients with herniated discs had significantly better results than patients with neural foraminal stenosis (81.7% vs 57.1%) (P0.05).

CONCLUSION
There was no significant difference between median and paramedian approach for the effect of CIESI. The most important outcome predictor of CIESI was the cause of the radiculopathy, and patients with herniated disc experienced better pain relief than those with neural foraminal stenosis.

CLINICAL RELEVANCE/APPLICATION
Patients with herniated disc experienced better pain relief than those with neural foraminal stenosis. We recommend median approach for CIESI rather than paramedian approach that is more challenging.
SSG10-08 • Long-term Results of Combined Intradiscal and Periganglionic Injection of Medical Ozone for the Treatment of Lumbar Disk Herniation: Effects on Disk Size and Lumbar Radiculopathy in 371 Patients

Thomas Lehner MD (Presenter); Nagy N Naguib MSc; Nour-Eldin A Nour-Eldin MD, MSc; Tatjana Gruber-Rouh; Martin Beeres MD; Julian L Wichmann MD; Thomas J Vogl MD, PhD

PURPOSE
To evaluate the therapeutic benefit and morphologic changes in herniated lumbar disk after CT-guided intradiscal and periganglionic ozone-oxygen injection combined with a periganglionic administration of steroids and anesthetic.

METHOD AND MATERIALS
371 patients with lumbar radiculopathy received an intradiscal (3 mL) and periganglionic (7 mL) injection of an ozone-oxygen mixture (ratio 3:97), followed by a periganglionic injection of corticosteroid (1 mL of Celestine Depot, ESSEX PHARMA, Munich, Germany) and anesthetic (2 mL of Carbostesin® 0.25%, AstraZeneca, Wedel, Germany) in the same session. Under CT guidance, intradiscal and periganglionic injection was administered by means of an extraspinal lateral approach, using a 22-gauge 17.8-cm spinal needle (Becton Dickinson and Co., Franklin Lakes, NJ, USA). 6 months after treatment, clinical outcome was assessed by applying the modified MacNab method. The effects on disk matrix and disk volume were evaluated by MRI.

RESULTS
Treatment was successful in 268 patients (72.2%). In the remaining 103 patients (27.8%), treatment was considered to have failed. Among the patients whose treatment was a success, outcome was excellent in 133 patients (49.6%) and good in 135 patients (50.4%). Among the patients whose treatment was a failure, this was poor in 76 patients (73.8%) and poor with recourse to surgery in 27 patients (26.2%). Complications occurred in 36 patients, who presented with episodes of impaired sensation in the lower limb ipsilateral to the treatment; the episode resolved spontaneously within 2 hours.

CONCLUSION
Our study shows that the combined intradiscal and periganglionic injection of medical ozone and periganglionic injection of steroids affects both the mechanical and the inflammatory components of pain caused by disk herniation. For this reason, this is a therapy option for treating lumbar disk herniation that has failed to respond to conservative management, before recourse to surgery or when surgery is not possible.

CLINICAL RELEVANCE/APPLICATION
The ease of execution and non-invasiveness of this therapy permit the successful outpatient treatment of lumbar sciatic pain.

SSG10-09 • A New Simplified CT Guided Peripheral Approach for Greater Occipital Nerve Infiltration in the Management of Arnold’s Neuralgia

Adrian I Kastler MD, MSc (Presenter); Yannick Onana; Sebastien L Aubry MD, PhD; Bruno A Kastler MD, PhD

PURPOSE
To evaluate the efficacy of a new simplified CT guided approach in the management of greater occipital nerve infiltration.

METHOD AND MATERIALS
Local Institution approval was obtained and written informed consent was waived. A total of 23 patients (6 men, 17 women, with a mean age of 46.3 y.o) who underwent 30 procedures were included in this retrospective study between March 2012 and December 2012. All included patients suffered from severe greater occipital nerve neuralgia refractory to conventional specific treatments. Procedures were performed under CT Guidance and local anesthesia. Initial non-enhanced planning CT was performed from C0 to C2. Infiltration of greater occipital nerve was exclusively performed at the most superficial site at the first bend of the GON between inferior obliquus capitis and semispinalis capitis muscles facing C1-C2 level, using a 22G needle. A mixture of fast- and slow-acting anesthetic (1.5 mL lidocaine hydrochloride 1% and 3 mL ropivacain hydrochloride 0.25%) was then injected followed by the injection of 1.5ml of cortivazol at pre-defined target site. Pain was evaluated on VAS scores immediately before and after procedure and on a monthly basis following procedure. Technical success was defined by the ability to accurately position needle tip at target site. Clinical success was defined by pain relief greater than or equal to 50% lasting for at least 1 month.

RESULTS
Mean pain prior procedure was 7.72/10. Eighteen patients suffered from unilateral pain (right, n=10, left, n=8) and 4 from bilateral pain. Technical success of procedure was 100%. Procedure time ranged from 10-15 minutes. Clinical success rate was 81% (21/26 procedures). In case of clinical success, mean pain relief duration following procedure was 5,25 months (3-25 months).

CONCLUSION
This novel simplified CT guided infiltration approach appears to be effective in the management of refractory Arnold’s Neuralgia. With this new technique, infiltration of the GON is safer, faster and technically easier as it does not require the IV contrast injection, compared to other previously described techniques.

CLINICAL RELEVANCE/APPLICATION
This simplified GON Infiltration under CT-guidance aiming at a new peripherals is well suited in the diagnosis and management of Arnold’s neuralgia, a benign but possibly very invalidating condition.

SSG11 • AMA RRA Category 1 Credit ™:1.5 • ARRT Category A+ Credit:1.5

Moderator
Mark E Mullins, MD, PhD
Moderator
Pina C Sanelli, MD

SSG11-01 • The Clinical Applications of Iodixanol 270mgI/ml in Combination with Spectral CT Imaging in Intracranial CTA

Shan Hu (Presenter); Wenzhen Zhu MD, PhD

PURPOSE
To explore the clinical applications of intracranial CTA using iodixanol 270mgI/ml in combination with spectral CT imaging mode.

METHOD AND MATERIALS
Forty patients (20 males and 20 females; average 48±12yrs; BMI=30) with suspected vascular diseases were randomly assigned into two groups and undergo intracranial CTA (Discovery CT750 HD, GE healthcare). Group A (n=20) was administered iodixanol 370 mgI/ml and 120kVp, 400mA. Group B (n=20) was administered iodixanol 270mgI/ml and spectral CT imaging (fast 80/140kVp switching, 550mA). Both groups were at the same injection volume of 0.8ml/kg, 4.8ml/s of injection rate, 0.5s of rotation time, and a pitch of 0.984. All the source images were transmitted to AW4.5 workstation. The keV images with the best CNR for group B were obtained by GS1 viewer software and used for comparison. CT values and their standard deviations for the anterior cerebral artery, middle cerebral artery,
posterior cerebral artery, and basal ganglia as background region were measured, and CNR and SNR values for the arteries were calculated. These values were statistically compared between the 2 groups. Three readers evaluated the image quality on VR images with scores 1-5.

RESULTS
The mean CT value, CNR and SNR for Group B (406.24±60.26HU, 5.13±0.75 and 6.25±0.91, respectively) were statistically higher than those for Group A (406.24±40.94HU, 4.70±0.75 and 5.13±0.75, respectively) (all P<0.05). But more terminal branches were displayed for Group B than Group A. Contrast dose was reduced by 27% in group B and CT dose index volume (CTD1vol) was statistically lower for group B than for group A (35.54mGy vs. 72.11±4.3mGy) (p<0.05).

CONCLUSION
The use of ioxidanol 270mg/I/ml combined with spectral CT imaging in intracranial CTA provided acceptable or better image quality, with contrast dose reduction of 27% and radiation dose reduction up to 50%.

CLINICAL RELEVANCE/APPLICATION
Using ioxidanol 270mg/I/ml in combination with spectral CT imaging mode in intracranial CTA can achieve acceptable or better image quality and less radiation dose.

SSG11-02 • Efficacy of Automated Bone Removal Software for Head CT Angiography: Comparison Against Dual Scan Subtraction
Andres Kohan MD (Presenter) *; Christian Rubbert MD *; Leslie Ciancibello RT; Ekta D Dhariya MS *; Gina M Anderson; Barbara A Bangert MD *

PURPOSE
Evaluate the efficacy of a single scan bone removal software solution in head CTA studies.

METHOD AND MATERIALS
30 head CTA performed through the dual scan technique (non-contrast scan followed by a contrast enhanced) on a 256 or a 64 slice CT scanner were retrospectively analyzed. The studies were processed in two ways: 1. Subtraction of the non-contrast scan from the contrast enhanced scan (Group A) and 2. Automated bone removal from a single contrast enhanced scan (Group B). The technologist recorded the time it took to perform each process. The images were also assessed by an experienced neuroradiologist (19y) with regard to success of bone removal, visualization of anterior and posterior vessels, readability, confidence in diagnosis and delineation of the pathology. For this purpose a 4 point likert-scale (1=Non diagnostic, 2=Poor, 3=Acceptable and 4= Good) was used. Reading of group A and B was performed with 2 weeks separation to reduce recall bias. Reading time needed per study was also recorded. Wilcoxon signed-rank test for paired samples was performed for differences in image quality and time between examinations.

RESULTS
The post-processing of images from Group A took in average 222±68s while for Group B it took 96±17s (p<0.05).

- 50% increased success of bone removal
- 53% better visualization of anterior and posterior vessels
- 53% improved readability
- 63% increased confidence in diagnosis
- 70% improved delineation of the pathology

CONCLUSION
Automatic bone removal from a single scan not only significantly improved the technologist workflow by reducing post-processing times, but has also significantly improved the quality of the studies by removing bone more effectively than the double scan subtraction technique, while maintaining or even improving diagnostic confidence and image quality. The clinical impact of this software relies on its applicability to any scanner and the reduced radiation dose to the patient by avoiding the non-contrast enhanced scan.

CLINICAL RELEVANCE/APPLICATION
Automatic bone removal software maximizes the technologist workflow while allowing a reduction in patient radiation dose.

SSG11-03 • Volume Intra-venous Injection DSA (VIVID) Compared with Intra-arterial Injection DSA (IADSA) for Evaluation of Cerebral Arteries and Veins
Akihiro Imamura MD (Presenter); Hideyuki Takano MD; Hiroyuki Funatsu MD; Naoyuki Ueno; Hidetoshi Taguchi MD

PURPOSE
We analyzed whether the intracranial arteries and veins could be detected using intravenous injection digital angiography (DSA) (VIVID) by using the flat-panel detector angiographic computed tomography CT system (FACT). We compared these results with IADSA.

METHOD AND MATERIALS
We retrospectively analyzed 17 consecutive patients (8 males and 9 females; 23 sides) who underwent both VIVID examinations and IADSA for neuronavigation. One hundred ml of nonionic iodine contrast (350 mg/ml) injection was injected via an 18-gauge plastic needle, at a rate of 10 ml/second, which was then flushed out using 25 ml of saline, followed by rotational DSA. We analyzed data from the rotational DSA processed by the DynaCT software on the workstation using the maximum intensity projection and volume rendering algorithms. The VIVID and IADSA images were analyzed and compared by 3 experienced radiologists independently. The quality of visualization was graded as non-visualized (0), noncontinuous(1), faint and continuous(2), continuous (3),and intense and continuous(4). The averages of grades of the veins were calculated. Comparison of VIVID and IADSA was made. The grades were assigned by reaching a consensus, following a discussion among the observers.

RESULTS
The average grade between VIVID and IADSA were almost equal in Frontopolar artery, Anterior choroidal artery, Ophthalmic artery, Recurrent artery of Heubner, Cortical vein, Trolard vein, Labbe vein, and Internal cerebral vein(p>0.05). In Anterior communicating artery, Posterior communicating artery, Inferior sagittal sinus, Septal vein, Basal vein of Rosenthal, and Cavernous sinus, VIVID was higher average grade than IADSA(p<0.05). In Anterior communicating artery, Posterior communicating artery, Inferior sagittal sinus, Septal vein, Basal vein of Rosenthal, and Cavernous sinus, VIVID was higher average grade than IADSA(p<0.05). In Anterior communicating artery, Posterior communicating artery, Inferior sagittal sinus, Septal vein, Basal vein of Rosenthal, and Cavernous sinus, VIVID was higher average grade than IADSA(p<0.05). In Anterior communicating artery, Posterior communicating artery, Inferior sagittal sinus, Septal vein, Basal vein of Rosenthal, and Cavernous sinus, VIVID was higher average grade than IADSA(p<0.05). In Anterior communicating artery, Posterior communicating artery, Inferior sagittal sinus, Septal vein, Basal vein of Rosenthal, and Cavernous sinus, VIVID was higher average grade than IADSA(p<0.05). In Anterior communicating artery, Posterior communicating artery, Inferior sagittal sinus, Septal vein, Basal vein of Rosenthal, and Cavernous sinus, VIVID was higher average grade than IADSA(p<0.05). In Anterior communicating artery, Posterior communicating artery, Inferior sagittal sinus, Septal vein, Basal vein of Rosenthal, and Cavernous sinus, VIVID was higher average grade than IADSA(p<0.05).

CONCLUSION
VIVID is comparable to IADSA in the detection of the intracranial arteries and veins. VIVID can perform easily and evaluate whole artery and veins and show 3 dimensional anatomy in single examination without severe complications.

CLINICAL RELEVANCE/APPLICATION
Volume intravenous injection digital angiography by using the flat-panel detector angiographic computed tomography CT system is better than IADSA in evaluation of brain vessels anatomy.

SSG11-04 • Dural Arteriovenous Fistula: Diagnosis and Classification with 4D-CTA and DSA
Bing Tian MD (Presenter); Bing Xu; Qi Liu MD, PhD; Jianping Lu MD

PURPOSE
To compare the utility of 4D-CTA and DSA in assessing the presence, location, and classification of Dural Arteriovenous Fistula (DAVF).

METHOD AND MATERIALS
320-Multidetector row 4D-CTA and DSA were applied in 34 patients (mean age, 32 years; range, 18-57 years) with DAVF. 4D-CTA was performed within 2 days before DSA. All the images were independently reviewed by 2 readers for the presence, location, and classification of the DAVF. The result of the DSA was used as the gold standard. The location of DAVF was divided into five areas: Cranial...
RESULTS
34 patients were all diagnosis as DAVF by 4D-CTA and DSA separately. The location of DAVF divided by DSA was cranial sinuses (12), sios cavernosus (7), cyclorama (8), basal venous plexus (6), and mediastinum cerebri (1). There was full agreement for all the patients between 4D-CTA and DSA regarding the location. However, for the Borden classification of DSA, 18 were Borden I, 9 were Borden II, and 7 were Borden II. The classification of 4D-CTA in 32 patients were in accordance with DSA. In the remaining 2 patient, retrograde venous were missed by both readers on 4D-CTA which were classified as Borden I, while as Borden II by DSA.

CONCLUSION
4D-CTA seems be a reliable technique in the screening and surveillance of DAVF form the presence, location, and classification aspect in clinical.

CLINICAL RELEVANCE/APPLICATION
320-MDCT4D-CTA appears to be a valuable new adjunct in the noninvasive diagnostic work-up, treatment planning, and follow-up of patients with DAVF.

SSG11-05 • Volumetric Analysis of Cerebral Arteriovenous Malformation Using CT Angiography: Preliminary Results in Adult Patients

Donghyun Hong MA (Presenter) ; Karen Buch MD ; Hernan Jara PhD * ; Osamu Sakai MD, PhD *

PURPOSE
Conventionally the assessments of the size of cerebral arteriovenous malformation (AVM) are based on 2D DSA image which makes evaluating the volume of the AVM difficult. The purpose of this study is to measure the volume of AVMs using computed tomographic (CT) angiography to generate a more accurate and realistic measure of abnormality.

METHOD AND MATERIALS
We retrospectively enrolled 11 AVM patients (age; 40 ± 17 YO, 6 males) diagnosed by radiologists. Subjects were classified into two groups --Small AVM: < 3cm and Medium AVM: 3~6cm-- based on the Spetzler-Martin grading scale. All patients underwent CT angiography using 64 multi-detector CT (GE, WI). For quantitative volumetric analysis, a program was developed using Mathcad (PTC, MA) in our image-processing laboratory. This image-processing tool generates 3D blood-only images through two segmentation steps: intracranial tissue segmentation followed by pixel value thresholding. From the segmented images with subtracted surrounding brain and meningeal tissues, we calculated the volume of an AVM lesion (the nidus, dilated feeding arteries and draining veins) by calculating the intracranial blood volume difference between both hemispheres. The AVM volume was then correlated with the maximal AVM lesion dimension.

RESULTS
Statistically significant differences were observed between the two subject groups. In the comparisons of the volume (cm³): 12.478 ± 5.743 and 53.963 ± 9.338 (mean ± stdev.) for Small AVMs (< 3cm) and Medium AVMs (3 ~ 6 cm) respectively; P < 0.005 for all. Additionally, we found an exponential correlation between the AVM volume and the maximum length of a nidus (trendline: y = 4.4183e^{0.536x} with R² = 0.945).

CONCLUSION
CT angiograms can be processed to provide a more realistic three-dimensional measures of AVM size with potentially more clinical specificity and higher sensitivity to monitor treatment changes.

CLINICAL RELEVANCE/APPLICATION
Volumetric AVM measures have the potential of providing new standards for AVM size classification and could provide a useful tool for monitoring AVM evolution in time and in response to treatment.

SSG11-06 • Non-contrast-Enhanced High-temporal-Resolution 4D MRA with an Acquisition Window Covering Two Cardiac Cycles: Assessment of Brain Arteriovenous Malformations

Helene Raoult MD (Presenter) ; Elise Bannier ; Peter Schmitt PhD * ; Benjamin Robert * ; Jean-Yves Gauvrit MD

PURPOSE
To assess the feasibility, quality and diagnosis performance of a bSSFP NCE 4D MRA ECG-gated sequence with a high temporal resolution to analyse brain arteriovenous malformations (AVM).

METHOD AND MATERIALS
After approval from the Institutional Review Board, ten patients presenting AVM and referred for digital subtraction angiography (DSA) were included in the study. Patients underwent NCE 4D MRA on a 3T system (MAGNETOM Verio, Siemens Healthcare), using a 32-channel head array coil. The NCE 4D MRA technique combined arterial spin labeling with an ECG-triggered 3D cine segmented multiphase bSSFP readout. Two sequences were performed, with temporal acquisition window over 1 (1-RR) or 2 (2-RR) cardiac cycles and acquisition times of 5-6 or 10-12 min respectively. Imaging parameters for 2-RR NCE 4D MRA were: FOV=220x192mm², 44 slices, 1.5x1.5x1.5mm³ voxel size, TR/TE=59.5ms/2.13ms, variable flip angle evolution, mSENSE 2. For 1-RR NCE 4D MRA, 64 slices achieved similar coverage within imaging times of 5-6 or 10-12 min respectively. Imaging parameters for 1-RR NCE 4D MRA were: FOV=220x192mm², 44 slices, 1.5x1.5x1.5mm³ voxel size, TR/TE=59.5ms/2.13ms, variable flip angle evolution, mSENSE 2. For 1-RR NCE 4D MRA, 64 slices achieved similar coverage with a 1.5x1.5x1.5mm³ voxel size. Other sequences performed were: TOF MRA (0.7x0.6x0.6mm³ voxel size) and 4D CE-MRA (0.9x0.8x1.5mm³ voxel size, 1.5s temporal resolution). All patients also underwent DSA with a filming rate of 3 images/sec. Images were reviewed with respect to image quality and AVM diagnosis value.

RESULTS
Both NCE 4D MRA sequences were successfully performed in all patients achieving mean temporal resolution of 68.1 ms (±3.1; 20-32 phases) and 69.1ms (±5.6; 10-16 phases) and mean image quality score of 3.9/5 (±0.7) and 3.3/5 (±0.8), for 2-RR and 1-RR NCE 4D MRA respectively. All AVM were depicted with their main feeding arteries and global nidus size in agreement with DSA data (fig.1). Venous drainage type was always correctly classified on 2-RR NCE 4D MRA images, but misidentified in five cases on 1-RR NCE 4D MRA. The 2-RR NCE 4D MRA allowed a more accurate delineation of the nidus than combined TOF and CE 4D MRA data.

CONCLUSION
The bSSFP NCE 4D MRA sequence allows brain AVM analysis with a high temporal resolution, offering accurate nidus delineation, target of the treatment. A 2-RR sequence improves depiction of venous drainage, necessary to evaluate hemorrhagic risk.

CLINICAL RELEVANCE/APPLICATION
The bSSFP NCE 4D MRA sequence allows brain AVM analysis with a high temporal resolution, offering accurate nidus delineation, target of the treatment.

SSG11-07 • Evaluation of Brain Arteriovenous Malformations by Using 4D MR Angiography with Arterial Spin Labeling at 3T

Yasuhiro Iryo (Presenter) ; Toshinori Hirai MD ; Masanobu Nakamura ; Minako Azuma ; Yasuyuki Yamashita MD *

PURPOSE
To assess the usefulness of 4D magnetic resonance angiography (MRA) with an arterial spin-labeling (ASL) technique at 3T that yields high spatial resolution and time-resolved hemodynamics without exogenous contrast agents for the evaluation of brain arteriovenous malformations (AVMs).
METHOD AND MATERIALS
Our study included 8 patients (4 men, 4 women; age 7-65 years, mean 39.5 years) with brain AVMs. They underwent 4D ASL-MRA and digital subtraction angiography (DSA). The 4D ASL-MRA imaging was performed on a 3T MRI system; a sensitivity encoding (SENSE) phased-array 32-channel head coil was used. A pseudo-continuous arterial spin labeling (pCASL) preparation scheme with the Look-Locker sampling was employed for spin tagging. Seven phases of labeling and control images were acquired in an interleaved mode. Upon completion of two acquisitions, corresponding temporal phases with identical inversion delay were subtracted. Minimum-intensity-projection (MIP) images were then created for each subtracted data set in three orthogonal directions. The acquisition parameters were: FOV = 220x220 mm, matrix = 224x162, spatial resolution = 1x1x1 mm, flip angle = 12°, TR = 8.5 ms, TE = 4.2 ms, SENSE factor = 3.0, TI/T2/final TI = 100 ms/250 ms/2.0 s. A transverse labeling plane was positioned 9 cm below the imaging center. Total acquisition time is approximately 5 min. Two independent readers reviewed the 4D MRA images for the nidus size, arterial feeders and venous drainage. Two other readers consensually reviewed the DSA images. Interobserver and intermodality agreement was assessed by ? statistics.

RESULTS
On all 4D ASL-MRA studies, the major intracranial arteries were successfully demonstrated at an inflow temporal resolution of 250 ms. Interobserver agreement was excellent for the nidus size (?= 1.0), very good for arterial feeders (?= 0.86) and good for venous drainage (?= 0.80). Intermodality agreement was excellent for the nidus size (?= 1.0), very good for arterial feeders (?= 0.88) and good for venous drainage (?= 0.80).

CONCLUSION
The agreement between 4D ASL-MRA and DSA findings was good to excellent with respect to the AVM nidus size, arterial feeders and venous drainage.

CLINICAL RELEVANCE/APPLICATION
With 4D ASL-MRA at 3T, hemodynamic information on the brain AVMs can be obtained without the use of exogenous contrast agents.

SSG11-08 • 7T versus 1.5T TOF MRA for Assessment of Intracranial Aneurysms: The More Tesla, the Better?
Lale Umutlu MD (Presenter) *; Karsten Wrede; Christoph Moenninghoff MD; Soren Johst; Philipp Dammann; Michael Forsting MD; Marc U Schlamann

PURPOSE
As rupture of intracranial aneurysms is considered the main cause of subarachnoidal haemorrhage, detection and high-quality assessment of aneurysm localization and related features (e.g. parent vessel) is of inevitable value for treatment planning. With 1.5 Tesla MRI being limited in the detection of small aneurysms, ultra-high-field MRI may enable superior examination of intracranial vasculature based on higher spatial resolution due to increased signal-to-noise ratio (SNR). Aim of this trial was to compare the diagnostic ability of 1.5 versus 7 Tesla TOF MRA for assessment of intracranial aneurysms.

METHOD AND MATERIALS
17 subjects were examined on a 1.5 Tesla (Magnetom Aera, Siemens Healthcare) and Time-of-flight MRA with a voxel size of 0.7x0.7x0.7mm3 was obtained. Subsequently all subjects underwent a 7 Tesla examination (7T whole-body MR system; Magnetom 7T, Siemens Healthcare) with a voxel size of 0.2 x 0.2 x 0.2mm3. Two radiologists in consensus assessed the delineation of the (1) aneurysm dome, (2) neck, (3) parent vessel, (4) vessel tissue contrast and (5) image impairment due to artifacts. For qualitative analysis a 5-point scale was used (5= excellent delineation; 1= non-diagnostic). Contrast ratios (CR) of all aneurysms and adjacent parenchyma were calculated. A Wilcoxon rank test was performed for analysis of statistical significance.

RESULTS
According to qualitative analysis 7 Tesla TOF MRA yielded significantly superior delineation of dome (mean 7T:=4.5; mean 1.5T= 3.2; p<0.05). Despite slight impairments based on increased signal alterations, 7 Tesla TOF MRA provided superior assessment of the aneurysms and their related vessel-features based on high-quality vessel-tissue contrast and imaging at improved spatial resolution.

CLINICAL RELEVANCE/APPLICATION
Based on improved spatial resolution imaging, high-resolution 7T TOF MRA may bear the potential to overcome known limitations of 1.5 Tesla MRA in the assessment of intracranial aneurysms.

SSG11-09 • Ultra-high Temporal Resolution Vascular Pulsation of Aneurysms: A Novel Dynamic 4-dimensional Time of Flight MR Angiography Technique to Accurately Evaluate Dynamics of Cerebral Aneurysm
Till Illies MD (Presenter); Jan Sedlack; Jan-Hendrik Buhk MD *; Daniel Kutzner; Jens Fiehler; Andre Kemmling MD

PURPOSE
Time resolved imaging of pulsatility of cerebral aneurysms has been performed using 4D CT angiography. Assessment of wall motion may be useful for stratification of rupture risk. Aim of the study was to implement a 4D TOF MRA technique to image aneurysmal wall motion with high temporal and spatial resolution.

METHOD AND MATERIALS
We performed time resolved MR-TOF angiography in an elastase induced rabbit model of cerebral aneurysm. Dynamic 4-dimensional TOF angiography was achieved with ultra high-temporal resolution of 30 3D-images per cardiac cycle (151 beat/min). Dynamic data sets were reconstructed from ecg-triggered 4D gradient echo TOF images (temporal resolution 75 frames per second, spatial resolution 0.5x0.5x1.0mm, TR 20ms, TE 5.76ms, 32 channel coil system at 3T). The 4D dataset was processed to calculate vessel motion: Voxels were classified as vessels using a semi-automated region-growing algorithm (Analyze 11.0). A relative vessel motility index was calculated using the voxel-wise frequency of a vessel vs. non-vessel classification from 30 time-points over the cardiac cycle.

RESULTS
The aneurysm (5mm diameter) and aortic arch were imaged with diagnostic image quality within 12 min. The temporal resolution of 75 frames/second allowed ready visualization of wall pulsation and vessel displacement in time. The relative vessel motility index showed highest wall motion at the aortic arch and tip of the aneurysm corresponding to qualitative assessment.

CONCLUSION
We successfully implemented a time resolved TOF-MRA-technique allowing 4-dimensional quantification of aneurysmal wall motion at high spatial and temporal resolution (75 frames per second).

CLINICAL RELEVANCE/APPLICATION
Quantification of aneurysmal pulsatility may be a valuable pathophysiological marker for assessing rupture risk.
Cognitive Activity in Late Life

RESULTS

In the study of neurodegenerative diseases, apparent diffusion coefficient (ADC) values in the cerebral cortex are investigated using diffusion-weighted images (DWIs). However, DWIs suffer from geometric distortion due to magnetic field inhomogeneity (MFI) caused by susceptibility effect. It is known that the cortical ADC values increase due to contamination of signal intensity in cerebrospinal fluid by distortion. It is reported that distribution of MFI depends on the subject positioning in the static field. The purpose of this study was to investigate influences of the MFI which depends on the subject positioning on the cortical ADC values using MRI simulator.

METHOD AND MATERIALS

We investigated the differences of ADC values in the cortex among the different patterns of MFI using digital brain phantom. We calculated MFI depending on the subject position in the static field by using the Susceptibility-Voxel Convolution method. We generated different three patterns of MFI: no inhomogeneity, and two different patterns of inhomogeneities. In each pattern of MFI, DWI was generated by MRI simulator according to single-shot echo-planar imaging sequence, and ADC map was generated from DWIs. In our simulator, the diffusion coefficient of cortex was set to $0.89 \times 10^{-3}$ mm$^2$/s. We compared ADC values in six cortical regions of interest among different three patterns of MFI.

RESULTS

In the cortical region close to frontal sinus, the average of ADC value in no inhomogeneity was $1.017 \times 10^{-3}$ mm$^2$/s, and was higher than ideal ADC value in the cortex. The average of ADC values in other two patterns of MFI were $1.114 \times 10^{-3}$ and $0.952 \times 10^{-3}$ mm$^2$/s, respectively. These ADC values showed significant differences among different three patterns of MFI. Although the ADC values showed statistically no significant differences in the other regions among them, ADC values showed the variation.

CONCLUSION

We have investigated influences of the MFI on the cortical ADC values using MRI simulator. Our results suggest that ADC values in the cortical region might vary due to MFI which depends on the subject positioning in the static field.

CLINICAL RELEVANCE/APPLICATION

In interpretation of cortical ADC values in neurodegenerative diseases, influences of the MFI should be taken into account in changes of ADC values.
Matter Demyelination in Multiple Sclerosis

SSG12-07 • Murine Multiple Sclerosis

SSG12-05 • SSG12-04 •

Vasily L Yarnykh

DKI may be a new sensitive tool to detect NAWM damage in MS patients.

CONCLUSION

RESULTS

METHOD AND MATERIALS

Upon translation, treatment efficacy of GA, which reduces MPO-positive monocytes and thus MPO activity in the brain, could be monitored. CLINICAL RELEVANCE/APPLICATION

GA, a current first-line drug in MS directly affects monocyte subsets, decreasing the number of MPO-secreting inflammatory monocytes. The finding of reduced MPO activity detected (3.9±0.9 vs. 3.0±0.7 x 10⁴ cells/brain, p < 0.05; MD: 0.12, 95% CI 0.05; 0.19). For lobar microbleeds alterations in DTI measurements were solely driven by APOE 4 carriers.

RESULTS

Presence of microbleeds was related to a lower mean FA and higher mean MD, in a dose-dependent manner, and was already apparent for a single CMB microbleed (standardized FA: -0.13, 95% CI -0.21; -0.05; MD: 0.12, 95% CI 0.05; 0.19). For lobar microbleeds alterations in DTI measurements were solely driven by APOE 4 carriers.

CONCLUSION

Presence of microbleeds relates to poorer microstructural integrity of brain white matter, independent of cardiovascular risk and other markers of CSVD. Our data suggest that microbleeds reflect diffuse brain pathology, even when just a single microbleed is present.

CLINICAL RELEVANCE/APPLICATION

Microbleeds have emerged as a novel marker of small vessel disease. Our data indicate that the pathology underlying microbleeds is much more widespread than the focal lesions seen on MRI.

SSG12-05 • Molecular Magnetic Resonance Myeloperoxidase Imaging Is Sensitive to Treatment Effects of Glatiramer Acetate in Murine Multiple Sclerosis

Benjamin Pulli MD (Presenter) ; Gregory R Wojtikiewicz MSc ; Muhammad Ali MBBS ; Lionel A Bure MD ; John Chen MD, PhD

PURPOSE

Treatment effects in multiple sclerosis (MS) are difficult to quantify. We hypothesized, that MPO-Gd (bis-5HT-DTPA-Gd), a molecular MRI probe sensitive and specific for the inflammatory enzyme myeloperoxidase (MPO), can detect therapeutic effects of glatiramer acetate (GA), a current first-line drug in MS, on the molecular level non-invasively.

METHOD AND MATERIALS

Thirty female SJL mice were induced with experimental autoimmune encephalomyelitis, a mouse model of MS, and treated with either GA (150 ?g/day) or saline from day 1 post induction onwards. To determine effects of GA on MPO, mice underwent MRI at 4.7T with MPO-Gd (150 ?g) probe sensitive and specific for the inflammatory enzyme myeloperoxidase (MPO), can detect therapeutic effects of glatiramer acetate (GA), a current first-line drug in MS, directly affects monocyte subsets, decreasing the number of MPO-secreting inflammatory monocytes entering the brain. MPO-Gd enhanced MRI is sensitive to these effects of GA and provides a novel way to monitor treatment effects at the molecular level in this disease. This could advance our understanding of the molecular events over the course of MS.

CONCLUSION

GA, a current first-line drug in MS directly affects monocyte subsets, decreasing the number of MPO-secreting inflammatory monocytes entering the brain. MPO-Gd enhanced MRI is sensitive to these effects of GA and provides a novel way to monitor treatment effects at the molecular level in this disease. This could advance our understanding of the molecular events over the course of MS.

CLINICAL RELEVANCE/APPLICATION

Upon translation, treatment efficacy of GA, which reduces MPO-positive monocytes and thus MPO activity in the brain, could be monitored with MPO-Gd.

SSG12-06 • Diffusion Variations of Normal-appearing White Matter in Multiple Sclerosis Using Diffusional Kurtosis Imaging

Lemei Tang MD (Presenter) ; Ni m Fei MA ; Feng Jie MA ; Wei Qiang MA ; Miao Yanwei MD

PURPOSE

METHOD AND MATERIALS

RESULTS

CONCLUSION

CLINICAL RELEVANCE/APPLICATION

Diffusion tensor imaging (DTI) is the gold standard for NAWM damage. However, DTI measures structural changes on a macroscopic level and is therefore not sensitive to early microstructural changes in MS. Diffusional kurtosis imaging (DKI), on the other hand, is more sensitive to microstructural changes.

SSG12-07 • Fast Whole-brain Macromolecular Proton Fraction (MPF) Mapping for Quantitative Imaging of White and Gray Matter Demyelination in Multiple Sclerosis

Vasily L Yarnykh PhD (Presenter) ; James D Bowen MD ; Alexey A Samsonov PhD ; Pavle Repovic MD ; Kenneth R Maravilla MD ; Lily K Jungshen MD ; Angeli Mayadev MD ; Beena Gangadharan PhD ; Hunter R Underhill MD, PhD ; Bart P Keogh MD, PhD ; Mohammad A Ikram MD, PhD

PURPOSE

METHOD AND MATERIALS

RESULTS

CONCLUSION

CLINICAL RELEVANCE/APPLICATION

DKI may be a new sensitive tool to detect NAWM damage in MS patients.
Density Reduction in White Matter in Comparison to Gold Standard MRI

SSG12-08 • Extra Cranial Venous Abnormality in MS Patients with Regard to Chronic Cerebrovascular Venous Insufficiency (CCSVI): A True Pathological Finding or an Anatomical Variant?

Satya N Patro MD (Presenter); Carlos H Torres MD; Cheemun Lum MD; Santanu Chakraborty FRCR; Thanh Nguyen MD*; Miguel Bussiere; Matthew Hogan MD

PURPOSE
To evaluate the extra cranial venous anatomy with contrast enhanced MR Venogram (CE-MRV) in patients without MS. To assess the prevalence of various venous anomalies such as asymmetry and stenosis in this population.

METHOD AND MATERIALS
The study was approved by our local REB and all participants gave informed consent. We recruited 100 patients without MS referred for a contrast enhanced MRI, who underwent additional CEMRV from the skull base to the mediastinum on a 3T scanner. The study started in Feb 2012 and completed in Jul 2010. We included patients between 18 and 60 years old with a male: female ratio of 1:1. Exclusion criteria included prior neck radiation, neck surgery, neck or mediastinal masses or significant cardiac or pulmonary disease. Two neuroradiologists independently evaluated the studies to document the presence of asymmetry and stenosis in the jugular, vertebral and azygous veins.

RESULTS
Asymmetry of the IJVs was found in 70% of patients, 91% of patients had a focal stenosis in the right IJV and 82% in the left IJV. The stenoses were found in the upper third of the vein in 95% of the cases. Stenosis of the azygous vein was found in 21% of patients. There was prominence of the external jugular veins in 39% of cases, of the anterior jugular veins in 27% and of the deep cervical veins in 22.4%.

CONCLUSION
The venous anatomy of non MS patients demonstrates multiple variants including asymmetry and stenoses of the IJVs. We believe the stenoses in the upper third of the IJVs are secondary to indentation of the vessel between the posterior belly of the digastic muscle and the occipital bone. This study will be used as a comparative data to the MS population.

CLINICAL RELEVANCE/APPLICATION
It is recommended to keep in mind the various normal variants of extra cranial venous system while evaluating MS patients with suspected CCSVI.

SSG12-09 • Quantitative Rapid Assessment of Leukoaraiosis: Fully Automated CT-based Quantification of Microangiopathic Density Reduction in White Matter in Comparison to Gold Standard MRI

Uta Hanning (Presenter); Georg Homann; Ludger Feyen; Thomas Niederstadt MD; Volker Hesselmann MD; Walter L Heindel MD; Andre Kemmling MD

PURPOSE
Assessment of white matter lesions is primarily a domain of magnetic resonance imaging (MRI), however, computed tomography (CT) is the more frequently used diagnostic procedure. Particularly in stroke, a rapid objective CT based quantification of microangiopathic WM changes may prove useful to estimate risk of thrombolytic hemorrhage. We present a new CT-based fully automated rater-independent method for quantification of microangiopathic white matter changes.

METHOD AND MATERIALS
Tissue segmentation was performed in 600 normal brains MRI (3.0 Tesla, T1-3D-Turbo-Field-Echo) of two large population studies (BiDirect and SEARCH-Health Study) to obtain a probabilistic WM-tissue-map in standard MNI-152 space as published. A total of 103 patients with varying degree of leukoaraiosis excluding other lesions were retrospectively selected based on availability of CT and MR within 1 month. The tissue-specific density (Hounsfield Unit, HU) within WM-space was determined by the mean of all voxel densities weighted by WM content: $S\left(\text{HU}_{xyz} \times \text{Px}_{xyz}(\text{WM})\right) / S\left(\text{Px}_{xyz}(\text{WM})\right)$; $\text{HU}_{xyz}$ = density of voxelxyz; $\text{Px}_{xyz}$ = partial WM content at voxelxyz). The reduction of HU over WM-space in CT images was correlated with gold standard MR-based WM lesion volume measurements. Results were compared with rater-based Fazekas scores for severity of WM disease.

RESULTS
The process of CT-based tissue-specific segmentation involving automated segmentation of probabilistic white matter space with quantification of WM density was reliable in 103 cases with no algorithm failures. Mean time of processing was 153 second. In comparison with MRI FLAIR-based WM-lesion volume, the CT-based HU-weighted reduction of the white matter density showed a significant correlation coefficient (0.87). Spearman rank correlations between MR or CT based WM lesion quantification did not differ significantly in comparison to visual Fazekas scores, respectively.

CONCLUSION
The presented method allows fully automated observer-independent quantification of microangiopathic HU-induced reduction of the white matter in CT with high correlation to gold standard MRI.

CLINICAL RELEVANCE/APPLICATION
The algorithm targets the need for a rapid objective CT based assessment of WM lesion load which may be used as as risk score of hemorrhage in the setting of thrombolytic stroke therapy.
SSG13-02 • Characterization of Carotid Atherosclerotic Plaque Components Based on Quantitative Phase-contrast Hounsfield Units

Tobias Saam MD (Presenter) *; Marian Willner; Sandra Fill; Julia Herzen; Ulrich Schueller; Holger Hetterich MD; Alexander C Hipp; Maximilian F Reiser MD; Franz Pfeiffer; Fabian Bamberg MD; MPH *

PURPOSE

Conventional CT can distinguish between soft, mixed and calcified plaques but has difficulties to further differentiate soft plaques due to an overlap in Hounsfield units (HU) of fibrous and lipid tissue. Phase-contrast imaging is a novel X-ray based imaging technique that relies on the X-ray phase-shift rather than its absorption, yielding a higher contrast in biological soft tissue. The purpose of our study was to evaluate whether plaque components can be differentiated based on their phase-contrast HU (HU-P), which can be calculated in analogy to absorption-contrast HU.

METHOD AND MATERIALS

Four ex-vivo human carotid arteries were imaged at a laboratory-based set-up using a conventional X-ray tube (35kV) and grating-interferometer. Tomographic images were reconstructed with an effective pixel size of 100\textmu m and correlated with histopathology sections. Regions corresponding to fibrous, lipid or calcified tissue based on histopathology were manually traced. Mean HU-P were calculated for all analyzed regions.

RESULTS

A total number of 80 cross-sections with 72 fibrous, 19 lipid and 24 calcified tissue containing regions were assessed. Fibrous, lipid and calcified tissues were associated with significant different mean HU-P (52.6±7.0, 21.0±9.8 and 371.5±158.0, p<0.05) with no overlap of HU-P between fibrous and lipid tissue (3.1-30.1). Similarly, no overlap of HU-P was observed between calcified tissue (range 174.4 ± 593.7) and the other tissue components. Figure 1 demonstrates axial phase contrast CT images (A) and corresponding histology sections (B, C, Fib=fibrous, Lip=lipid and Cal=calcified tissue; length of the scale bar = 2 mm).

CONCLUSION

In an ex-vivo experimental set-up grating-based phase contrast CT can reliably differentiate between calcified, fibrous and fatty tissue based on quantitative HU-P, indicating its high potential for improved assessment of carotid atherosclerotic disease.

CLINICAL RELEVANCE/APPLICATION

Phase-contrast computed tomography might improve characterization of carotid atherosclerotic plaque morphology compared to conventional absorption CT.

SSG13-03 • Quantitative Image Analysis of MRI for Treatment Response Assessment of Multiple Myeloma

Chuan Zhou PhD (Presenter); Qian Dong MD; Daniel R Couriel; Heang-Ping Chan PhD; Lubomir M Hadjiiski PhD; Jun Wei PhD

PURPOSE

It is challenging for radiologists to visualize early changes in multiple myeloma (MM) within 3-6 months after autologous bone marrow transplant (BMT) due to small amount of marrow infiltration evident on MR images. This pilot study investigated the feasibility of using quantitative image analysis to evaluate early changes of BM in MRI for assessing treatment response.

METHOD AND MATERIALS

With IRB approval, 29 cases with MM requiring BMT were evaluated retrospectively. 31 pairs of spine MRI scans performed pre- and post-BMT (3-6 months), including 2 patients underwent second BMT after 4 and 6 months of the first BMT, respectively, were collected. The vertebral body volumes in sagittal views of T1-weighted sequence were manually outlined and their adjacent disc volumes were automatically extracted using morphological operations. A 3D dynamic intensity energy transformation (DIET) method was developed to characterize BM infiltration after BMT. DIET transformed the voxel intensity of a vertebral body to an energy enhancement value (EEV), defined as the ratio of the intensity entropy at the voxel to the median intensity entropy in the adjacent discs. Treatment response was quantified by an EEV response index (EEV-RI) calculated as the percentage of vertebrae with an increase in the mean EEV over the vertebral body in the post-BMT scan. In addition, the EEV heat map accentuated the intensity distribution pattern of the vertebral body and facilitated radiologist’s visual assessment of the pre-to-post changes of BM infiltration.

RESULTS

Of the 31 follow up MRI scans, 25 were clinically diagnosed as good responders to BMT. The DIET method correctly identified 22 good responders using a decision threshold of > 40% for the EEV-RI. The agreement reached 0.903±0.14 with a kappa value of 0.74. The mean EEV decreased by 19.0±20.5% for the 3 cases that were mistakenly identified as no response. Of the 31 follow up MRI scans, 25 were clinically diagnosed as good responders to BMT. The DIET method correctly identified 22 good responders using a decision threshold of > 40% for the EEV-RI. The agreement reached 0.903±0.14 with a kappa value of 0.74. The mean EEV decreased by 19.0±20.5% for the 3 cases that were mistakenly identified as no response. Of the 31 follow up MRI scans, 25 were clinically diagnosed as good responders to BMT. The DIET method correctly identified 22 good responders using a decision threshold of > 40% for the EEV-RI. The agreement reached 0.903±0.14 with a kappa value of 0.74. The mean EEV decreased by 19.0±20.5% for the 3 cases that were mistakenly identified as no response.

CONCLUSION

The substantial agreement between computer and clinical outcomes demonstrated the feasibility of using the quantitative image metric (EEV) for assessing treatment response for MM.

CLINICAL RELEVANCE/APPLICATION

Quantitative image-based biomarker may improve the accuracy and efficacy for staging and assessing treatment response for MM, allowing clinicians to optimize therapy of individual patients.

SSG13-03 • Use of a Dedicated Extremity Cone-beam CT Scanner for Evaluation of the Weight-bearing and Non-weight-Bearing Knee

Gaurav K Thawait MD (Presenter); Abdullah Muhit PhD; Wojciech Zbijewski PhD *; Joseph W Stayman PhD *; John Yorkston PhD *; Shadpour Demehri MD; John A Carrino MD, MPH *; Jeffrey H Siewerdsen PhD *

PURPOSE

To prospectively compare cone-beam CT (CBCT) examination of the knee in sitting (non-weight-bearing, NWB) position versus upright (weight-bearing, WB) position as a potential indicator of osteoarthritis (OA).
METHOD AND MATERIALS
A prototype CBCT scanner dedicated to extremity imaging was previously reported and assessed in terms of spatial resolution, contrast resolution, radiation dose, and optimal imaging protocols. An IRB approved study was performed in which 13 patients (8 females, 5 males; 31-78 yo, mean 56 yo) were prospectively enrolled for CBCT exams in NWB and WB positions using the prototype scanner. 11 were previously diagnosed with knee OA. 2 musculoskeletal radiologists measured the medial tibiofemoral (TF) joint space width and meniscal protrusion (MP) in coronal plane in consensus. Differences in such morphology were analyzed between NWB and WB images using paired Wilcoxon signed-rank test.

RESULTS
The scanner exhibited spatial resolution of ~15-17 lp/cm, depending on reconstruction technique, with high-contrast bone detail judged comparable or superior to conventional CT. Optimal scan protocol was 80 kVp, 120 mAs, imparting 9.0 mGy (dose at the center of a CT phantoms). Isotropic sub-mm spatial resolution facilitated precise measurement of joint space morphology. For the 2 non-OA patients, the change in joint space between NWB vs WB exams appeared minor (2.67 mm vs 2.41 mm, respectively), and there was no evidence of meniscal protrusion. A greater difference in medial TF joint space was observed in OA patients: 1.91±0.85 mm for the NWB setup versus 1.23±0.8 mm for the WB setup, and the results were statistically significant (p=0.003). 4 of the OA patients exhibited no MP, 4 exhibited MP in both the NWB and WB exams, and 3 exhibited MP only in the WB exam (MINWB = 2.09±2.26 mm, MPWB = 5.16±1.46 mm, p=0.016).

CONCLUSION
The TF joint space width and MP in OA patients was found to change significantly in sitting (NWB) versus upright (WB) exams. The ability to conduct NWB and WB exams in CBCT with a favorable dose profile and image quality sufficient for such morphological analysis could provide a valuable tool for OA diagnosis and treatment assessment.

CLINICAL RELEVANCE/APPLICATION
Weight-bearing CBCT of the knee can provide functional information and precise morphological analysis across a cross sectional imaging not achieved by projection radiographs.

SSG13-04  ●  Comparison of Estimation of Patient Size Specific Dose Estimates (SSDE) Using Attenuation-based Estimation of Patient Size versus Geometrical Diameter for CT Examination of Thorax

Shima Aran MD (Presenter); Laleh Daftaribesheli MD; Bob Liu PhD; Hani H Abujudeh MD, MBA *

PURPOSE
The attenuation-based estimation of patient size and geometrical diameters are 2 methods introduced for the purpose of converting displayed CTDI volume to patient Size Specific Dose Estimates (SSDE). We assessed feasibility of applying the AAPM TG 204 for estimating patient SSDE using water equivalent diameter (Dw) and anteroposterior (DAP), lateral (DL), Sum (DSum= DAP +DL) and effective (DEff) diameters for chest CT.

METHOD AND MATERIALS
In an IRB-approved study, we evaluated 100 consecutive adult chest CT exams (M:F 60:40, mean age 61.5±12.8 years). Patients were classified into 2 groups of

RESULTS
Complete skin to skin measurements were possible in 6% the patients. Geometrical diameters (DLat, DSum and DEff) were significantly different and larger compared with Dw except for DAP (p<0.02). However, SSDE values were significantly lower (p

CONCLUSION
The attenuation values measured from axial CT can be feasibly used to estimate SSDE. These values are significantly larger compared with Geometrical diameters derived SSDE for chest CT. The lack of specific levels of measurement (along the z axis) of attenuation or geometrical diameters has profound effect on SSDE variability.

CLINICAL RELEVANCE/APPLICATION
SSDE estimations are different using attenuation-based vs. geometrical diameters for chest CT. An optimal level of measurements should be defined for best use of SSDE estimations from CTDIvol.

SSG13-05  ●  Evaluating Proximal Femur Bone Strength Prediction by Advanced Characterization of Trabecular Microarchitecture Using Scaling Index Computation and Support Vector Regression

Chien-Chun Yang (Presenter); Mahesh Nagarajan; Markus B Huber PhD; Felix Eckstein MD *; Thomas M Link MD, PhD *; Axel Wismueller MD, PhD; Julio Carballido-Gamio PhD; Thomas Baum MD; Sharmila Majumdar PhD *; Jan S Bauer MD; Eva-Maria Lochmueller MD

PURPOSE
Biomechanical bone strength prediction in proximal femur is important for osteoporosis diagnosis and fracture risk estimation. Our study proposes using advanced geometrical scaling index bone structure characterization in combination with statistical bone mineral density (BMD) features extracted from multi-detector computed tomography (MDCT) images of proximal femur specimens, with subsequent prediction of bone strength through support vector regression (SVR). The performance of this system is compared with a standard approach that uses mean BMD and multi-regression models.

METHOD AND MATERIALS
Axial MDCT images were acquired from 146 proximal femur specimens using a 16-row scanner and a calibration phantom. Adaptive spherical volumes of interest (VOI) were positioned in the femoral head (Huber et al., Radiology 2008) for BMD conversion and image analysis. VOIs of these BMD images were characterized through statistical moments as well as advanced geometrical features extracted with the Scaling Index Method (SIM) (Huber et al., IEEE-TBME 2011). The specimens were then biomechanically tested through a lateral fall on the greater trochanter, and failure load was recorded. All features were analyzed by multi-regression and SVR for predicting bone strength. The performance for different combinations of feature groups was compared using root-mean-square error (RMSE) and coefficient of determination (R²). A Wilcoxon signed-rank test was used to compare two RMSE distributions and test for statistically significant differences in performance.

RESULTS
Combination of SIM features and mean BMD, when used in conjunction with SVR, exhibited the best prediction performance (RMSE = 0.95 ± 0.13; R² = 0.62). This was significantly better than the standard approach of using BMD and multi-regression (RMSE = 1.11 ± 0.141; R² = 0.490).

CONCLUSION
Our results show that the performance of predicting biomechanical strength in proximal femurs can be significantly improved by including SIM-derived geometrical features in addition to mean BMD, and through the use of support vector regression.

CLINICAL RELEVANCE/APPLICATION
Complementing BMD characterization on MDCT images with advanced geometrical features and machine learning can contribute to improved osteoporosis diagnosis and disease progression monitoring.

SSG13-06  ●  A New Method for Automated Anatomic Landmark Detection to Aid Automated Patient-specific Radiation Dosimetry in Tube-current Modulated CT Scans

Tim O’Connell MD, MEng (Presenter) *; Maryam Khatonabadi *; Michael F McNitt-Gray PhD *; Aaron D Sodickson MD, PhD

PURPOSE


SSG13-07 • Fully-automated Segmentation of Cartilage from the MR Images of Knee Using a Multi–atlas and Local Structural Analysis Method

June-Goo Lee PhD (Presenter); Serter Gumus MD; Chan Hong Moon PhD; Cheng Tao MD; Sonu K Bae; Kyongtae T Bae

PURPOSE
To develop a fully-automated method to segment cartilage from the magnetic resonance (MR) images of knee and to evaluate the performance of the method on a public open dataset.

METHOD AND MATERIALS
For the development and testing of a fully-automated program for cartilage segmentation, we used 100 cases of knee MR images from a public open dataset (available at www.ski10.org). MR images were acquired in the sagittal plane with gradient-echo T1-weighting sequence and fat suppression at 0.4*0.4mm in-plane and 1mm slice-thickness resolution. The dataset also includes the segmentation result by experts to label and delineate the bone and cartilage of the femur and tibia. We randomly divided the 100 cases into the training set (60 cases) and the test set (40 cases).

The segmentation process was carried out in two steps, atlas-building and local-adjustment. In the atlas-building step, all training cases were registered to a test case via a non-rigid registration scheme. The final metric values from each registration were recorded for sorting. Nine best matched results were selected and merged to generate the atlas-based segmentation mask by majority voting. In the local-adjustment step, the statistical information of bone, cartilage and surrounding regions was computed from the atlas-based segmentation result. This information was used to determine seed points for a graph-cut algorithm to segment bone regions. Structurally similar points from the registered multiple atlases were identified via a Hessian analysis. Finally, a locally-weighed voting process was applied for a local adjustment. The performance of the segmentation program was evaluated in terms of dice similarity coefficient (DSC), sensitivity and specificity of segmented femoral and tibial cartilages against the reference cartilage segmentation of the test cases from the dataset.

RESULTS
The cartilages were segmented successfully in all test cases. The DSC was 0.67±0.07 for femoral and 0.53±0.08 for tibial cartilage. The segmentation performance was according to (sensitivity, specificity): (57.5±9.6%, 99.9±0.04%) for femoral and (53.0±8.4%, 99.9±0.02%) for tibial cartilage.

CONCLUSION
We have developed a fully-automated segmentation program for knee cartilage from MR images. The performance of the program on 40 test cases was highly promising.

CLINICAL RELEVANCE/APPLICATION
The fully-automated segmentation method will facilitate the quantification of cartilage.

SSG13-08 • Iodine-density Analysis Using Spectral CT Imaging in Differentiating Benign and Malignant Serous Cavity Effusion

Ye Ju (Presenter); Ailian Liu MD; He Qing Wang MSc; Yijun Liu; Renwang Pu MBCh, FRCPC; Wenjun Cui

PURPOSE
To assess the value of quantitatively iodine concentration measurement of enhanced spectral CT imaging in the differential diagnosis of malignant and benign serous cavity effusion.

METHOD AND MATERIALS
Approval for this retrospective HIPAA compliant study was obtained from the institutional review board, and informed consent was waived. From August 2012 to February 2013, totally 45 patients, including 13 cases of benign serous effusion and 32 cases of malignant serous effusion proven by histopathological diagnosis or laboratorial examination, underwent plain and three-phase enhanced spectral CT imaging through fast kVp-switching technique. 140 kVp polychromatic images and iodine-based material density images were reconstructed. The mean CT value (M-CT) was measured at plain and three-phase enhanced 140 kVp images, and the difference of CT values (D-CT) was calculated. The iodine concentration (M-I) was also quantitatively measured at iodine-based material density images and the difference (D-I) was calculated. The difference of these parameters was evaluated statistically by independent-samples t test.

RESULTS
CONCLUSION
The nature of the serous cavity effusion was difficult to be identified only by the CT values on conventional enhancement scanning. The iodine-density images of spectral CT imaging at venous phase and delayed phase play an important role in identifying malignant and benign effusion.

CLINICAL RELEVANCE/APPLICATION
The iodine-density images of enhanced spectral CT scanning provides a sensitive approach for identifying benign and malignant serous cavity effusion.

SSG13-09 • Quantitative Measures of Normal Lung Texture Change during Respiration: Analysis of Variation Using
4-dimensional CT

Shane P Krafft MS, BS (Presenter)

PURPOSE
While image quality is often considered the main barrier to achieving valid, reproducible quantitative image biomarkers, anatomic motion during CT acquisition presents another unique challenge. The implementation of 4-dimensional CT allows us to reconstruct the lung volume at equally spaced phases of the breathing cycle and, as a result, we can estimate the impact of anatomic variability on quantitative analysis of lung parenchyma. The purpose of this study was to demonstrate the variation of lung texture features with the phase of the respiratory cycle.

METHOD AND MATERIALS
4DCT scans were acquired for 10 patients with non-small-cell lung cancer prior to radiotherapy. Normal lung volumes were segmented with a semi-automatic 3D region-growing algorithm on each of the 10 binned phase reconstructions (0-90%). The original 12-bit CT images were reduced to a bit depth of 8 and gray-level co-occurrence and run length matrices were used to extract 17 non-directional 2D texture features from the segmented total lung volume. The extracted features were evaluated for phase dependence relative to the end expiration phase (50%). For each patient, Spearman’s rank correlation (r) was used to determine the relationship between feature and the calculated lung volume from each phase image set.

RESULTS
Within an individual 4DCT scan, change in texture relative to the end exhale phase varied up to 75.3%. Over the entire patient population, 8 of the 17 metrics showed an average change due to respiratory phase of less than 5%; however, the range of measured changes was 0.9-31.2% over all of the considered texture features. 5 of 17 features were highly correlated (|r| > 0.7) to lung volume.

CONCLUSION
Using 4DCT the phase dependence of texture measures was demonstrated. While some of the extracted texture features may be reasonably independent of respiratory phase, large differences were observed for others. The correlation of features to the lung volume highlights the periodic phase dependence of some of the considered texture metrics.

CLINICAL RELEVANCE/APPLICATION
As the respiratory phase influences extracted texture measures of lung parenchyma, anatomic variability must be considered in attempts to standardize quantitative imaging biomarkers.
approximately 6 mGy. The optimal imaging protocols, in terms of dual kVp tube voltages and dose distributions were first simulated with an analytical model which maximized the dual energy signal-to-noise ratio (SNR) with respect to MGD. A three-material phantom, consisting of water, vegetable oil and polyoxymethylene plastic was used for dual energy calibration for water, lipid and protein, respectively. The expected errors due to the calibration materials were also estimated by simulation. The breasts were then chemically decomposed into their respective water, lipid and protein contents after imaging to allow direct comparison with data from dual energy decomposition.

RESULTS
The dual energy breast tissue decomposition in terms of the volumetric percentages of water, lipid and protein contents exhibited strong correlation with data from the chemical analysis, which is considered to be the gold standard. As compared with the chemical analysis, the average root-mean-square (RMS) percentage error in tissue decomposition for all 40 breasts was calculated to be 3.6%.

CONCLUSION
The results of this study suggest that the water, lipid, and protein contents can be accurately measured using dual energy breast CT. The tissue compositional information can potentially improve the sensitivity and specificity for breast cancer diagnosis.

CLINICAL RELEVANCE/APPLICATION
Accurate compositional analysis of breast tissue may potentially improve the sensitivity and specificity of breast cancer detection and reduce the number of biopsies needed for suspicious lesions.

SSG14-03 • Clinical Dual Energy CT (DECT): Can Monoenergetic Imaging Remove Metal Artifacts?

Stefan Kuchenbecker MENG (Presenter) ; Sebastian Faby DIPLPHYS ; Soren Schuller ; Matthias Baer DiplPhys ; Michael M Lell MD * ; Marc Kachelriess PhD

PURPOSE
DECT provides so-called monoenergetic images based on a linear combination of the original polychromatic images. At certain patient-specific energy levels $E\approx130$ keV, corresponding to certain linear combination weights $w\approx1.6$, a significant reduction of metal artifacts is observed. We aim at analyzing the method to identify its limitations.

METHOD AND MATERIALS
DECT can be used to exactly calculate virtual monochromatic images (neglecting scatter). This calculation has to be done in rawdata domain before image reconstruction. Clinical CT, however, uses a simplified version of monochromatic imaging by linearly combining the low and the high kV images, and by assigning a keV-value to that linear combination. Those pseudo monochromatic images are used by radiologists to obtain images with reduced metal artifacts. We analyzed the underlying physics and carried out a series expansion of the polychromatic attenuation equations. The resulting non-linear terms are responsible for the artifacts, but they are not linearly related between the low and the high kV scan: A linear combination of both images cannot eliminate the non-linearities, it can only reduce their impact. Scattered radiation yields additional non-cancelling non-linearities. To quantify the artifact reduction potential of pseudo monochromatic images we simulated the Forbild abdomen phantom with metal implants and we measured a semi anthropomorphic abdomen phantom with inserts of high iodine concentration using a clinical dual source CT system (100 kV, 140 kV Sn). In each case we manually selected an optimal $w$, and we automatically computed an optimal $w$ by minimizing the standard deviation $S$ of the voxel values of the smoothed (to minimize the impact of image noise) soft-tissue regions around the metal implants.

RESULTS
For the initial images $S$=150 HU (100 kV) and 59 HU (140 kV Sn). The manually setting yields $w=1.62$ with $S$=18.2 HU, while the automatic setting yields $w=1.6$ and $S$=18.1 HU. A complete artifact reduction corresponding to $S$=3.71 HU (image noise only), as achieved with rawdata-based processing, was not possible with pseudo monochromatic imaging.

CONCLUSION
Pseudo monochromatic imaging is able to reduce metal artifacts (at the cost of contrast-to-noise ratio) but it cannot remove them.

CLINICAL RELEVANCE/APPLICATION
Artifact reduction through pseudo monochromatic imaging is helpful. But it should be avoided if alternative dedicated artifact reduction approaches are available.

SSG14-04 • Effectiveness of Synthesized Monochromatic Imaging Generated with a Fast Kilovoltage Switching Dual Energy CT Scanner for Improved Patient-to-Patient Uniformity of Aortic Enhancement during Abdominal CT Angiography: An In-Vivo and In-Vitro Study

Chenfan Fananapazir MD (Presenter) ; Rendon C Nelson MD * ; Joshua Wilson PhD ; Kingshuk Choudhury PhD ; Daniele Marin MD

PURPOSE
To investigate whether virtual monochromatic imaging (VMI) generated from a fast kilovoltage-switching single-source dual-energy CT (DECT) acquisition may correct for beam hardening artifacts, improving uniformity of abdominal aortic enhancement across different body sizes.

METHOD AND MATERIALS
A proprietary tapered hollow phantom with a bone-mimicking insert and a hollow tube mimicking the aorta was developed. The tube was filled with different iodine solutions simulating various degrees of aortic enhancement. The phantom was filled with water. Single-source DECT was performed and VMIs were synthesized at different energies (40-140keV, @ 20keV increments). The phantom was also scanned using conventional polychromatic kV settings (80-140kVp, @ 20kV increments). CT numbers in the aorta and water (noise) were measured along the entire length of the phantom. 62 consecutive patients (38 M; mean age 60 years ± 13 SD; mean BMI 30kg/m² ± 6 SD) underwent DECT scans. Aortic attenuation was measured at polychromatic 140kVp and VMI 80keV datasets. The relationship between aortic attenuation and signal-to-noise (SNR) as a function of body diameter was assessed for the phantom and clinical patients.

RESULTS
There was a significant negative correlation between both aortic attenuation/SNR and phantom diameter using polychromatic energy beams (-15.7HU/cm @ 80kVp to -6.8HU/cm at 140kVp) or VMI at energies equal or lower than 60keV (4.8HU/cm @ 60kVp to -3.3HU/cm @ 40kVp). Aortic attenuation and SNR were nearly independent of phantom diameter at 80keV VMI (-4.3HU/cm; P

CONCLUSION
The 80keV VMI improved consistency of aortic enhancement across different body sizes, although this could come at the cost of decreased magnitude in aortic enhancement.

CLINICAL RELEVANCE/APPLICATION
Lower susceptibility to beam-hardening effects using VMI increases consistency in aortic attenuation measurements across different patient body sizes.

SSG14-05 • A Fast and Noise-efficient Estimator for Material Decomposition in Multi-bin Photon Counting X-ray Detectors

Paurakh L Rajbhandary BS (Presenter) ; Scott S Hsieh MS ; Norbert J Pecel ScD *

PURPOSE
We present a fast, noise-efficient, and accurate targeted least squares estimator (TLSE) for material separation using PCXDs with multiple energy bin capability. The proposed estimator uses a novel method of incorporating dynamic weighting that allows noise to be homogenous and close to the Cramer-Rao Lower Bound (CRLB) throughout the operating range.
METHOD AND MATERIALS
The TLSE estimator uses a non-iterative and adaptive least squares method followed by bias correction based on a calibration phantom. In the initial step, a generalized weighted least squares linearized at the center of the operating region is used. The second step utilizes the output from the first estimate as a pointer to localize a region in a 4-by-4 grid of operating range to extract noise-weighting statistics. This dynamically adjusts the weights of the energy bins to optimize noise properties. After this adaptive step, a localized least squares and error correction process akin to A-table method (Alvarez et al) is applied to produce the final estimate. The variance and bias of this estimator between 0 to 6 cm of aluminum and 0 to 50 cm of water is simulated with Monte Carlo methods and compared to alternative estimators.

RESULTS
The proposed estimator produced an average bias of (2.59 ± 4.66) x 10^-5 cm and variance-to-CRLB ratio of 1.039 ± 0.039. Using the same protocol, the gold standard Maximum Likelihood Estimator (MLE) showed average bias and variance-to-CRLB ratio of (2.77 ± 2.25) x 10^-5 cm and 1.035 ± 0.037 but was 50.1 times slower in our simulation. Compared to a previous non-iterative estimator (Alvarez et al), the variance-to-CRLB of TLSE is more homogenous and its average value is reduced from 9.7% to 3.9%. Average variance-to-CRLB ratio for TLSE is lower by as much as 19% in the peripheral region.

CONCLUSION
The TLSE is a computationally efficient method for implementing material decomposition technique using multi-bin PCXDs that offers noise parameters comparable to the gold standard MLE method.

CLINICAL RELEVANCE/APPLICATION
The proposed estimator is a practical method of material decomposition that can be used in clinical applications (such as angiography, virtual pre-contrast imaging) using PCXDs.

SSG14-06 • Value of Monoenergetic Low-kV Dual Energy CT Datasets for Improved Image Quality of CT Pulmonary Angiography
Paul Apfaltrer MD (Presenter) ; Sonja Sudarski ; John W Nance MD ; Christian Fink MD ; Stefan O Schoenberg MD, PhD * ; Thomas Henzler MD ; Holger Haubenreisser ; David Schneider

PURPOSE
High vessel attenuation and high contrast-to-noise ratio (CNR) are prerequisites for high diagnostic confidence in CT pulmonary angiography (CTPA). This study evaluated the impact of reconstructed monoenergetic dual-energy (DE) CTPA datasets on vessel attenuation and CNR.

METHOD AND MATERIALS
RESULTS
CONCLUSION
Virtual 70-keV monoenergetic CTPA image datasets significantly increase vessel attenuation and CNR of DE-CTPA studies, suggesting that clinical application of low-kV monoenergetic reconstructions may allow a decrease in the amount of iodinated contrast required for adequate image quality in DE-CTPA examinations.

CLINICAL RELEVANCE/APPLICATION
DE-low-kV monoenergetic imaging may allow reductions in iodinated contrast material without compromising image quality; this may be particularly relevant in patients with impaired renal function.

SSG14-07 • Half and Quarter Dose Dual Energy CT Enabled by Prior Image Constrained Compressed Sensing
John W Garrett MS (Presenter) * ; Stephen T Brunner BS ; Jie Tang PhD ; Guang-Hong Chen PhD *

PURPOSE
The dose in dual-energy CT (DE-CT) studies is often high due to the decomposition of the CT images, as well as the need to acquire a high and a low energy data set. The Prior Image Constrained Compressed Sensing (PICCS) algorithm may enable half or even quarter dose acquisitions in DE-CT while retaining spatial resolution and diagnostic information.

METHOD AND MATERIALS
RESULTS
CONCLUSION
DE-CT images reconstructed at half or quarter radiation dose with the PICCS algorithm are similar to the full dose FBP reconstruction in terms of noise and diagnostic information. As a result, the application of the PICCS framework in DE-CT enables half or quarter dose studies to be performed with no significant loss of diagnostic information.

CLINICAL RELEVANCE/APPLICATION
This study is clinically relevant because it offers the possibility of performing dual-energy CT studies at half or quarter dose in a clinical setting.

SSG14-08 • Application of Photon-counting CT: Metal Artifact Reduction
Radin A Nasirudin DIPLENG (Presenter) ; Kai Mei ; Petar Penchev DIPLENG, PhD ; Ernst J Rummeny MD ; Martin Fiebich ; Peter B Noel PhD

PURPOSE
Photon-counting detectors (PCD) have the ability to discriminate photons based on their energies, thus providing information on the composition of the scanned object. This work presents an algorithm called Spectral-driven Iterative Reconstruction (SPIR) that utilizes spectral information to reduce metal artifact in Computed Tomography (CT).

METHOD AND MATERIALS
A Monte-Carlo simulator was used to simulate CT acquisitions of a jaw phantom. The phantom consists of teeth, jawbone and bone marrow. One tooth was substituted with a gold implant (density 19g/cm^3). The CT simulation is setup as follows: Cone-beam geometry, photon-counting detector with 6 energy bins and an X-ray source of 125 keV. In the first step of the algorithm, the simulated projection data were decomposed to determine the spatial location and density of the gold. The information of the gold implant was then
incorporated into a penalized maximum likelihood reconstruction algorithm as a prior. The result from the algorithm was objectively and subjectively assessed.

RESULTS
The algorithm was able to distinguish the gold implant from other components of the phantom. The incorporation of prior information into the reconstruction algorithm delivers a notably improved image: streaking artifacts were reduced significantly without compromising the anatomical information, while the dark shadowing around the dental implant were eliminated. The signal-to-noise-ratio (SNR) was significantly improved (13.6), when compared to FBP (2.2) or conventional iterative reconstruction (5.8). Especially the regions surrounding the implant show extreme improved diagnostic quality when using our approach (see Figure).

CONCLUSION
The incorporation of spectral information into statistical reconstruction significantly improves the diagnostic quality, while providing more information on the composition of the scanned object. Thus the implementation of PCDs does not only offer significant dose reduction but also the improvement of diagnostic image quality.

CLINICAL RELEVANCE/APPLICATION
The imminent clinical introduction of PCDs is a promising extension. It will lead to new clinical relevant applications, while also minimizing radiation exposure to the general population.

SSG14-09 • Effective 120 kV CT Images from Dual-energy CT Scans
Yongshuai Ge (Presenter) ; Jie Tang PhD ; Guang-Hong Chen PhD *

PURPOSE
Dual-energy CT (DECT) scans provide monochromatic CT images at different energies and effective atomic number based on the material information acquired from scanned projection data at 80kV and 140kV. However, many conventional clinical diagnostic tasks are performed based on the CT number of materials in 120 kV CT images. There are many potential benefits of generating equivalent 120 kV CT images from DECT scans.

METHOD AND MATERIALS
Using a 64-slice GE Discovery CT750HD scanner, dual energy CT imaging was performed on both a Catphan phantom and human subject studies with IRB approval. From GSI dual energy scans, monochromatic images from 40keV to 140keV were generated at 1keV intervals. A normalized effective x-ray spectrum was generated from the vendor provided 120 kV x-ray spectrum with additional filtration of a 20cm (30cm for human subjects) thick water equivalent slab. The normalized effective x-ray spectrum was used to weight and combine the GSI produced monochromatic images to generate equivalent 120 kV CT images for evaluation. The method was validated using the 120kV phantom results and 120 kV scan of the same subject. In the phantom study, CT numbers were measured in ROIs of 8 different materials with nominal CT numbers ranging from -1000 to 1000 HU. In human subject studies, CT numbers were measured from 21 ROIs in fat and soft tissue.

RESULTS
For the phantom study, the relative errors of the synthesized and 120 kV CT images are 5%, 4%, 2%, 1%, 1%, 2%, 1%, 0%, for Polystyrene, LDPE, PMP, air, Teflon, Delrin, Acrylic and the background material respectively. In the Bland-Altman analysis of human subject results, the bias of CT numbers between the synthesized effective 120 kV and acquired 120 kV CT images is 0.5 HU and the limits are within ±1.7 HU.

CONCLUSION
Effective 120kV CT images can be generated from a GSI dual energy CT scan with high accuracy.

CLINICAL RELEVANCE/APPLICATION
The synthesized 120 kV CT images can help clinicians make routine diagnosis together with quantitative imaging enabled by GSI imaging.

**Physics (X-ray Imaging)**

**Tuesday, 10:30 AM - 12:00 PM • S404AB**

**Back to Top**

**SSG15 • AMA PRA Category 1 Credit ™:1.5 • ARRT Category A+ Credit:1**

**Moderator**
Martin J Yaffe, PhD *
Joseph Manak *

**SSG15-01 • Developments to a Rapid In-clinic Peak Skin and Organ Dose Algorithm for Improved Patient Risk Management During High-dose Fluoroscopically Guided Interventions**

David Borrego MS (Presenter) ; Daniel A Siragusa MD ; Wesley E Bolch PhD

**PURPOSE**
Data from a detailed parameterization of over 23,763 exposure conditions from high frequency and/or high-dose fluoroscopically guided interventions reveal the dynamic nature of these procedures. As such, simple point calibrations of the KAP meter and spectral data assumptions may lead to gross errors in skin and organ dose calculations. This work seeks to investigate new methods and calibrations for improved accuracy gains over previous iterations of the University of Florida's Rapid In-Clinic Peak Skin Dose Algorithm (RIPSa).

**METHOD AND MATERIALS**
Calibration factor maps were developed that accounted for copper filtration, tube voltage, and current. The calibration factor maps were then coded into the RIPSa software for improved accuracy. Organ doses are further dependent on x-ray energy spectra. A first order estimation of the energy spectra was generated along with an energy spectra to match measured first and second HVLs to within ±3% with an in-house spectrum generator based on the TASMIP database. Organ doses were then calculated with the use of MCNPX transport code.

**RESULTS**
The only statistically significant variables affecting the calibration factor are tube voltage within each filtration based on a one-way ANOVA (F(10,97)=3.18, p=0.001, ?=0.05). The KAP meter is highly dependent on the quality of the x-ray spectra, which can introduce errors of up to 40% without the use of the calibration factor maps. Matching spectral data to the first and second HVLs yielded a 17% improvement in organ doses within-in field organs. These additional steps in calculating organ and skin doses have a negligible computational burden on the RIPSa software, with an average time of less than two seconds to calculate skin doses following an irradiation event.

**CONCLUSION**
This work represents robust improvements to the University of Florida's RIPSa software by incorporating detailed x-ray energy spectra and calibration curves for the KAP meter while also overcoming the challenges of characterizing: 1) a dynamic radiological exam and 2) the variability of a patient population when conducting a dose reconstruction that can provide the interventional physician information needed to modify behavior when clinically appropriate.
SSG15-02 • Development of a New Image Operation System with Hand Movements Using a Kinect Sensor for Angiography
Yuki Ishida (Presenter); Toshihiro Ogura PhD; Norio Hayashi PhD; Mitsuji Sato; Mika Okajima; Kunio Doi

PURPOSE
During angiographic examinations, interventional radiologists need various image manipulation such as paging, roamin, enlarging and fusion in order to assess vessels and sources of bleeding. However, radiologist could not touch screen by hand, because of his/her gloves to be kept clean. Usually, radiologists provide verbal instructions to technologists, who may operate to display appropriate images with various image processing. However, if technologist may not be at the console due to the preparation of the catheter or contrast agent, quick operation may not be performed. Therefore, we developed a new image operation system using a motion sensor for angiography. With this system, radiologists could operate various image processing only with movements in hands.

METHOD AND MATERIALS
We used the Kinect technique which is a gesture recognition technology to read the move of radiologists. The Kinect sensor consisted of an infrared laser emitter, an infrared camera and an RGB camera for gesture recognition. Measurements of depth were made by triangulation using the infrared camera. For initialization, radiologist’s hands were recognized by computer for right palm forward protrusion.

RESULTS
CONCLUSION
With the image operation system using a motion sensor for angiography, various image processing can be performed with our hand movements, which would be a new technology for angiography in operating rooms.

CLINICAL RELEVANCE/APPLICATION
This system can be implemented as a useful tool to radiologists for control of image viewing without touching the workstation in existing angiography system in operating rooms.

SSG15-03 • Stationary Chest Tomosynthesis System Using Distributed CNT X-ray Source Array
Jing Shan (Presenter); Andrew Tucker; Yueh Z Lee MD, PhD *; Michael D Heath *; Xiaohui Wang PhD *; David Foos MS *; Jianping Lu *; Otto Zhou PhD *

PURPOSE
The purpose of this work is to investigate the feasibility of constructing a stationary chest tomosynthesis system using a stationary CNT source array, and to evaluate the relationship between source geometry configurations and the tomosynthesis image quality.

METHOD AND MATERIALS
A bench-top chest tomosynthesis system using a CNT source array (XinRay Systems, NC) and a flat panel detector (Carestream Health Inc. NV) was built. The source array contains 75 focal spots operating at 80kVP and 5mA anode current. The tube output and entrance dose were measured. Projection images were reconstructed using commercial software (Realtime Tomography, PA). System in-plane resolution and in-depth resolution were measured using a 100um cross-wire phantom at different source configurations including linear-source geometry with different angular coverage and a square-source geometry. In addition, anthropomorphic chest phantom images were acquired and reconstructed for image quality assessment.

RESULTS
CONCLUSION
The experimental results demonstrate the feasibility of stationary chest tomosynthesis. This can lead to improved system design, potentially faster imaging speed, and reduced patient motion blur. The CNT source array is capable of delivering sufficient x-ray flux and dose required for chest tomosynthesis. The square source geometry shows comparable in-plane and in-depth resolutions as linear geometry.

CLINICAL RELEVANCE/APPLICATION
Stationary tomosynthesis system can improve image quality and reduce image acquisition time, which can improve the workflow and benefit the detection of small lung nodules and other chest pathology.

SSG15-04 • Comparison of Microcalcification Detection in Digital Mammography and Breast Tomosynthesis Using a Hybrid Technical-clinical Method
Lesley Cockmartin (President); Gwen Aerts; Federica Zanca PhD; Nicholas Marshall; Eman Shaheen; David Dance PhD; Kenneth C Young PhD; Hilde Bosmans PhD *

PURPOSE
To compare the detectability of microcalcifications in patient images for digital mammography (2D) and breast tomosynthesis (BT) using a hybrid technical-clinical method.

METHOD AND MATERIALS
Spherical microcalcifications (CaCO3), in groups of 5 in the Voxmam phantom (Leeds Test Objects, UK), were imaged in 2D and BT mode. Templates of microcalcifications embedded in different thicknesses of polymethyl methacrylate (PMMA), were created for 2D and BT projections by dividing exposures of the Voxmam phantom containing microcalcifications in PMMA by images of homogeneous PMMA. The templates were multiplied into projection images of patients with equivalent breast thicknesses and then processed/reconstructed. Four groups of microcalcification diameters were used: 354-224, 283-180, 226-150 and 177-106 μm. All microcalcifications were imaged at 2 different heights (z-positions) above the detector. For the detection study, 511 2D images and 511 BT series were viewed: 355 with microcalcifications and 156 without. Seven observers scored the presence or absence of the microcalcification group in the center of a protrusion.

RESULTS
PEAK CONTRAST
Peaks contrast in the projections ranged from 1.3% to 16% for 2D and from 0.8% to 11% for BT templates. Preliminary ROC results showed a better detection of microcalcifications in 2D compared to BT (p with an area under the curve (AUC) of 0.95 compared to 0.85). A statistically significant difference was found for the two intermediate size groups only. The AUC in 2D and BT were significantly different only for higher breast thicknesses (>5cm). Higher z-positions (>3cm) showed higher significant differences between 2D and BT. Finally, the Wilcoxon matched pairs test indicated a significant difference (p between the counts for 2D and BT.

CONCLUSION
Detection performance of 2D and BT for all microcalcification sizes depends on breast thickness and z-position, suggesting the need for further optimization of acquisition and reconstruction in BT for thicker breast and higher z-positions.

CLINICAL RELEVANCE/APPLICATION
This hybrid method can quantify detectability differences between 2D and BT and allows investigation of influential parameters using real clinical backgrounds.

SSG15-05 • Digital Breast Tomosynthesis: Reader Study of the Effects of Acquisition Geometry on the Perception of Contrast-detail Test Objects
Mitchell M Goodsitt PhD (Presenter); Heang-Ping Chan PhD; Lubomir M Hadijiski PhD; Emmanuel G Christodoulou
A reader study was performed to evaluate the impact of acquisition geometry (total angle and number of projection views (pv)) on the perception of contrast-detail (CD) objects in digital breast tomosynthesis (DBT).

METHOD AND MATERIALS

Modular breast phantoms consisting of slabs that mimic the composition and parenchymal pattern of breast tissue were imaged using a GE prototype DBT system. Two slabs, one with a homogeneous and one with a heterogeneous background were machined to include CD arrays of 25 holes, 1-5 mm in diameter and 0.2-1 mm in depth. Slabs were arranged to create 4 different 5cm thick phantoms with the heterogeneous CD slab and 1 with the homogeneous CD slab. Each phantom was imaged with 12 different acquisition geometries (total angles: 16-64, pv: 9-21). Two acquisitions were repeated to study reproducibility. Identical x-ray technique factors were used with a mean glandular dose of a digital mammogram (~1.2mgY). Focal slices of the SART-reconstructed CD arrays were selected, 91 image pairs (IPs) were formed from the 4 geometries for each phantom, resulting in a total of 455 IP comparisons in a reader preference study. The IPs were randomized and evaluated by 4 trained readers on a 3 part scale (1=preferred image, 0.5=similar, 0=not preferred). The total % scores for all images and readings for each geometry were compared.

RESULTS

For the heterogeneous CD slab, the 3 highest scoring geometries and percent preferred were: 60°21pv(98%), 64°17pv(80%), and 48°17pv(71%). The lowest scoring were: 16°17pv(10%), 24°9pv(18%), and 24°13pv(35%). For the homogeneous CD slab, the highest scoring were: 60°21pv(87%), 32°17pv(82%), and 48°17pv(77%). The lowest scoring were: 16°17pv(1%), 40°11pv(18%), and 24°9pv(20%). Average % scores for repeat scans were within 4% in the homogeneous CD images and 7% in the heterogeneous CD images.

CONCLUSION

In general, CD objects are better perceived with wide-angle than narrow-angle DBT. For this study, the 60°21pv acquisition yielded the highest perception of CD objects. These results may be applicable to mass perception. The optimal acquisition geometry should be a compromise that accounts for perception of calcifications and soft tissue lesions and scan time.

CLINICAL RELEVANCE/APPLICATION

DBT systems can be designed with a range of acquisition angles and angle increments. This study demonstrates the perception of contrast-detail objects and possibly masses is best with wide-angle DBT.

SSG15-06 Cascaded-systems Analyses for Describing the DQE of Low-Z, High-Z and Double-Z Detectors

Seungman Yun; Jesse Tanguay; Ho Kyung Kim; Ian A Cunningham PhD (Presenter) *

PURPOSE

The development of theoretical models of x-ray interaction physics is a critical step in optimal detector design and assessment. While cascaded-systems analyses (CSA) are often used to describe image signal and noise in many systems, past work has considered detectors consisting of a single element (single Z) even though most commonly used and promising candidates are compound materials. In addition, the effects of coherent and incoherent scattering on image quality are usually ignored which can be a poor assumption in low-Z materials.

METHOD AND MATERIALS

A parallel-cascade approach is used to describe photoelectric, coherent and incoherent interactions in low-Z, high-Z and double-Z detectors. This is achieved using an energy-labeled reabsorption process introduced to describe incoherent scatter and allowing for reabsorption of the high-Z characteristic emission by the low-Z atom. Analytic expressions of signal and noise transfer are developed to describe the detectable quantum efficiency (DQE) in terms of the modulation transfer function (MTF) and Wiener noise power spectrum (NPS). The model was validated using Monte Carlo calculations for Si, Se, CsI and Pd and by experimental measurements of the DQE using narrow spectra above and below the K-edge energies with a high-resolution CMOS-based CsI detector. Results were compared with a simpler single-Z model to determine the need for the complex double-Z model in each case.

RESULTS

Excellent agreement was obtained with both Monte Carlo and experimental results for all conditions tested. It is shown that a combination of two single-Z models, weighted by the atomic weight of each material, gave equivalent results to the comprehensive double-Z model within a few percent. Incoherent interactions have the potential to produce a substantial low-frequency drop in the MTF and DQE of low-Z detectors.

CONCLUSION

These results show that combining two simple single-Z models is adequate for a description of the double-Z detectors and the effect of incoherent scatter must be considered for low-Z materials. We believe that this CSA model of the DQE is useful for an optimal design of conventional radiography detectors and the estimation of x-ray imaging performance of novel photoconductor materials.

CLINICAL RELEVANCE/APPLICATION

Development of comprehensive models of the DQE is necessary to ensure high quality images and low patient exposures with new detector designs.

SSG15-07 Volumetric Breast Density Quantification Using Spectral Mammography

Sabee Y Molloi PhD (Presenter) *; Huanjun Ding; Elin Moa MS *; Stephen A Feig MD *

PURPOSE

Breast density is a significant risk factor in developing breast cancer. Breast density is currently reported by radiologists using BI-RADS categories, which is known to have a large inter-observer variability. The purpose of this study is to evaluate spectral mammography for quantification of breast density.

METHOD AND MATERIALS

Four-view mammograms for 93 women from a previous study using a prototype Philips MicroDose Mammography SI system were used and all images were arranged in a random order for a blind comparison study. The system uses a photon counting detector to acquire energy resolved images in a single exposure with no additional dose to the patient. Four-category BI-RADS rankings were assigned independently by 10 radiologists based in the USA and the UK. The four-category ranking was converted to breast density scores (0 ~ 100%) using a linear relationship. Area-based breast density measurements were also performed by a physicist using Cumulus 4 and by an automatic image segmentation method based on a fuzzy C-mean clustering (FCM) technique. Volumetric breast density was calculated with a dual energy decomposition technique using the available spectral information. For all four techniques, the linear regression analysis was performed to investigate the correlation of the breast densities from the right and left breasts.

RESULTS

The breast densities from the right and left breasts showed a reasonably good linear correlation. The normalized variance about the best-fit line, which reflects the precision of the techniques, was estimated to be 8.4, 13.4, 6.1, and 1 for BI-RADS, Cumulus, FCM, and dual energy decomposition, respectively. This indicates that the variability in estimation of breast density is substantially lower using spectral mammography as compared with using BI-RADS, Cumulus and FCM in conjunction with standard mammography.

CONCLUSION

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Spectral mammography may offer quantification of volumetric breast density with excellent precision during standard screening mammography. This will largely eliminate the inter- and intra-observer variability in the currently used BI-RADS ranking.

CLINICAL RELEVANCE/APPLICATION
Breast density quantification is useful for assessing the risk of developing breast cancer. Spectral mammography can be used for accurate quantification of breast density in screening mammography.

SSG15-08 • Clinical Potential of High-energy Phase Sensitive Mammography
Hong Liu PhD (Presenter) ; Xizeng Wu PhD

PURPOSE
The objective of this study is to demonstrate the potential clinical benefits of high kVp phase sensitive x-ray breast imaging through a comparison with conventional mammography.

METHOD AND MATERIALS
A contrast-detail phantom was imaged by an in-line phase sensitive x-ray imaging prototype and by a commercial digital mammography unit. The phase contrast prototype utilizes a microfocus x-ray source (50 um focal spot) operating at 120kVp and 4.5 mAs, and a CsI coated CMOS digital detector with a 50 um pixel pitch. In order to generate phase contrast, sufficiently large source to object and object to detector distances of 68.6 cm and 100 cm were used respectively. An innovative phase retrieval algorithm was applied to the acquired phase contrast images to generate phase-map images of the phantom. For a comparison, the same contrast-detail phantom was also imaged with a clinical GE Senographe DS flat panel digital mammography system, at 28 kVp and 54 mAs as well as 27 kVp and 131 mAs. The mean glandular doses with all images were calculated based on the measured exposure parameters and Monte Carlo simulations. The signal to noise ratio (SNR) of the target disks were measured, and observer-based subjective evaluations were also conducted to compare the disks detectability and absorbed doses of the high energy phase sensitive images and low energy conventional images.

RESULTS
For almost equal mean glandular doses, the measured disk SNR values were about three-times higher for the phase-map images than the images acquired with the clinical mammography system. Observer based contrast-detail analyses also demonstrated improved detectability by the high-energy phase sensitive images for both a similar and a reduced dose, as compared to the low energy conventional images.

CONCLUSION
This preliminary phantom study demonstrates the clinical potential of high-energy in-line phase sensitive mammography in improving the lesion detectability and reducing radiation dose to patients.

CLINICAL RELEVANCE/APPLICATION
The study demonstrates the technical feasibility and potential clinical benefits of high-energy phase sensitive x-ray imaging as compared to conventional digital mammography.

SSG15-09 • The Comparison between 2D Digital Mammography and Digital Breast Tomosynthesis for Morphological Assessment of Microcalcification Clusters: A Simulation Study
Eman Shaheen (Presenter) ; Chantal Van Ongeval MD ; Federica Zanca PhD ; Lesley Cockmartin ; David Dance PhD ; Kenneth C Young PhD ; Hilde Bosmans PhD *

PURPOSE
The detection and characterization of microcalcifications play an important role in the early diagnosis of breast cancer. Morphology and number of microcalcifications are two important determinative factors of the differential diagnosis between benign and malignant calcifications. Therefore, we focused on describing microcalcification clusters based on these parameters in a comparative study between 2D full field digital mammography (FFDM) and breast tomosynthesis (BT).

METHOD AND MATERIALS
Image data was collected from 46 patients. Fifty microcalcification clusters were simulated into raw projection images of 2D and BT at the same insertion positions for the same patient. The projections were then processed (2D) or reconstructed (BT). The simulated clusters were validated for realistic appearance by radiologists in a previous study where no significant difference was found between real and simulated clusters. In this study, six radiologists evaluated the clusters using the following parameters: morphology in terms of the Le Gal classification determining the dominant type, and the number of calcifications counted in the cluster. The 2D and BT images were read in separate sessions. The observed agreement and a corresponding p-value were reported for the dominant Le Gal type for every observer. The Wilcoxon rank test and linear regression were applied to compare the number of microcalcifications. P-value < 0.05 indicates significant difference.

RESULTS
For the dominant Le Gal, the observed agreements ranged from 0.34 to 0.84 and p-values from 0.076 to 0.611 indicating no statistically significant difference between 2D and BT for all observers. The Wilcoxon test showed significant differences, regarding the number of calcifications in 2D compared to BT, for all observers (p-values < 0.05).

CONCLUSION
Our results show that no significant difference was found comparing 2D FFDM and BT for the morphological description based on the Le Gal classification, but 2D outperformed BT in the number of microcalcifications. Further development in BT will address this.

CLINICAL RELEVANCE/APPLICATION
No systematic change in Le Gal classification was found between 2D and BT but the number of counted calcifications was lower in BT suggesting future clinical studies examine microcalcifications in BT.
RESULTS
The overall errors are 0.1±0.1, 0.3±0.3, 0.2±0.3mm in LAT, AP and SI respectively, and 0.7±0.89 in RX. The error in LAT is significantly less than errors from AP and SI (p=0.07-0.69, 1.2±1.89 in RX). The Pearson correlation between noise and error are 0.60, 0.61, 0.67, and 0.78 in LAT, AP, SI, and RX respectively. The correlations between noise and error in SI and RX are relatively high because there are approximately linear dependencies between SI motion/RX rotation and the markers' projection position shifts.

CONCLUSION
The approach proposed can accurately detect prostate's translations and rotations based on a single kV projection.

CLINICAL RELEVANCE/APPLICATION
Our method can be further used to track the prostate motion during treatment delivery, thus allowing the possibility to adjust the treatment if the prostate motion is out of a pre-defined tolerance.

SSG16-02  ● Study of Selecting Optimal Monochromatic Level for Artifacts Reduction Using Spectral CT Imaging after 125I Radioactive Particles Implantation

Qiuxia Yang (Presenter) ; Sheng Peng ; Rong Zhang ; Jing Wu ; Mingyan He ; Chuanmiao Xie ; Fujun Zhang

PURPOSE
To select the optimal monochromatic level for gemstone spectral imaging (GSI) to minimize both the image noise and metal artifacts caused by 125I radioactive particles after 125I particles implantation in non-enhanced CT scan.

METHOD AND MATERIALS
Nine patients (8 males, 1 female, average age: 57.8, 5 cases of hepatocellular carcinoma, 1 case of cholangiocellular carcinoma, 3 cases of metastatic tumor) after 125I radioactive particles implantation underwent spectral CT examinations using Discovery CT750 HD scanner to evaluate the implant position and treatment. Both conventional 140kVp polychromatic and monochromatic images (40-140keV, interval 5keV) were generated from GSI scan acquisition and non-enhanced CT series were evaluated. The CT value and standard variations were measured in the region of 5mm and 10mm distance from particles while the background noise was measured in region of same tissue without artifacts. The artifact index (AI) is defined as the square root of the squared noise difference between the region with and without artifact of the same tissue. All the measurements were recorded and statistically compared.

RESULTS
For the non-enhanced abdominal spectral CT images, 40keV was found the highest noise and Artifact Index of monochromatic images (SD=27.38, AI=206.40). Slope of AI curve (k value) from 75keV images was smaller (k=1.02) than that of rest lower keV images. The optimal monochromatic level was found at 75 keV which can provide almost the least image noise (SD=10.01) and good performance of artifact reduction (AI=102.73). Image noise and AI reduction was decreased by 63.44% and 50.23%, compared with 40keV. There was significant difference in CT value and variations between the region of inner 5mm and outer 5mm distance from particles (P<0.017).

CONCLUSION
Monochromatic images obtained with spectral CT imaging can substantially reduce metal artifacts caused by 125I radioactive particles and provide more accurate CT images for estimating the efficacy of the treatment.

CLINICAL RELEVANCE/APPLICATION
Clinical relation: Spectral CT showed its potential applications in monitoring disease progressions after125I radioactive particles implantation.

SSG16-03  ● Clinical Results of Salvage Radiation Therapy after Prostatectomy for Patients with Prostate Cancer-Single Institute Experience

Tomonari Sasaki MD, PhD (Presenter) ; Katsumasa Nakamura MD, PhD ; Yoshiyuki Shiyama ; Saiji Ohga MD ; Tadamasa Yoshihata MD ; Hiroshi Honda MD ; Makoto Shinoto ; Kotaro Terashima ; Kaori Asai ; Keiji Matsumoto ; Hideki Hirata

PURPOSE
This study attempts to evaluate the efficacy of salvage radiation therapy (RT) after radical prostatectomy (RP) for patients with prostate cancer in our institute, and to identify specific operative and pre-RT characteristics associated with eventual success in this population.

METHOD AND MATERIALS
We performed a retrospective analysis of 80 males who received salvage RT after RP from 2005 to 2011 at our hospital. All patients had elevation of prostate specific antigen (PSA) level or clinical recurrence after RP. Patients who received hormone therapy concurrently with RT and who had short follow-up period less than 6 months were excluded.

RESULTS
A median dose of 66 Gy was delivered to the prostate bed. Sixty-nine patients irradiated to prostatic bed alone. Eleven patients received small or whole pelvic irradiation. After a median follow-up period of 60 months, 31 patients had experienced biochemical failure, and 5 of them had clinical failure (one regional, 4 distant). Actuarial 5-year overall, clinical relapse-free and biochemical relapse-free survival estimates were 96.7%, 93.3% and 60.2%, respectively. On univariate and multivariate analyses, Gleason score 8-10 and serum PSA level >0.4 ng/ml before RT were significant for biochemical relapse survival. Only one patient experienced adverse event greater than grade 2.

CONCLUSION
Salvage RT after RP for patients with prostate cancer is safe and feasible. Patients with Gleason score 8-10 prostate cancer or with pre-RT PSA greater than 0.4 ng/ml have an increased risk for biochemical relapse after salvage RT.

CLINICAL RELEVANCE/APPLICATION
Salvage radiation therapy after radical prostatectomy for patients with prostate cancer is safe and feasible.

SSG16-04  ● Vagueness of Time-fixed Bladder Volume Control Assessed during Proton Beam Irradiation of Prostate Cancer

Shigeyuki Takamatsu MD, PhD (Presenter) ; Kazutaka Yamamoto MD, PhD ; Mariko Kawamura ; Satoko Asahi ; Tamaki Kondou ; Tsuyoshi Takanaka MD, PhD ; Yuji Tameshige ; Yoshikazu Maeda ; Makoto Sasaki ; Hiroyasu Tamamura MD

SSG16-05  ● IMRT with MR Guidance for Prostate Cancer - A Dynamic Therapeutic Approach with Screening Implications

Joseph M Baisden MD,PhD (Presenter) ; Dana O Olson MD

PURPOSE
This study highlights the usefulness of magnetic resonance imaging (MR) in the treatment of prostate cancer with implications for screening. MR was used for planning prostate cancer radiation treatment and to evaluate the value of periodic limited MR during the course of therapy. This was evaluated in the community clinic setting.

METHOD AND MATERIALS
Planning CT images were acquired and individual treatment plans were performed for localized prostate cancer patients. MR images
were acquired at 1.5 T at the community hospital. T2-weighted axial images were fused for planning purposes, and a second plan was generated using the fused images. Patients were treated with IMRT with daily CT image guidance using helical tomotherapy to a total dose of 81 Gy. Periodic limited MR imaging, including T2, diffusion and STIR were acquired twice weekly to evaluate the dynamic MR response to therapy.

RESULTS
Rectal doses were decreased significantly for the patients as treated with fused-MR planning, compared to plans generated with CT data only. Discrepancies in prostate volume and associated Planning Target Volume (PTV) were variable, highlighting the advantage of MR over CT in delineated prostate anatomy. There was a 29.3% decrease in mean prostate volume with MR compared to CT. Regarding rectal dose, the V60, V70, V60 and V50 were decreased by 82.6, 65.9, 54.7 and 43.7%, respectively. Similar improvements were seen in dose to the bladder and penile bulb. Patients tolerated the treatments with no Grade 3 or higher acute toxicities. The MR imaging during the course of therapy demonstrated changes including a general decrease in MR prostate spatial frequency and mild gland enlargement.

CONCLUSION
Fusion of MR for planning purposes results in significant sparing of normal organs for prostate cancer IGRT/IMRT in the community setting. Patients tolerated 81 Gy with side effect profiles consistent with other reports. Further dose escalation is being pursued. Periodic limited MR imaging may be useful for ongoing therapy guidance and the changes noted may provide a useful approach to using this technology as an effective screening tool.

CLINICAL RELEVANCE/APPLICATION
MR serves a valuable role in prostate cancer therapy, both guidance and outcome assessment. MR allows more accurate radiation targeting and normal organ sparing, permitting safe dose escalation.

SSG16-06 • Comparison of Testicular Dose Delivered by Intensity-modulated Radiation Therapy (IMRT) and Volumetric-modulated Arc Therapy (VMAT) in Prostate Cancer Patients
Jeffrey M Martin MD (Presenter) ; Elizabeth Handorf ; George Cherian ; Mark K Buyyounouski MD * ; David Y Chen MD ; Alexander Kutikov ; Robert A Price PhD ; Eric M Horwitz MD

SSG16-07 • Comparison of Image Guidance Techniques for the Post-prostatectomy Patient
Matthew E Johnson MD (Presenter) ; Tianyu Li ; Richard E Greenberg ; Alexander Kutikov ; Mark K Buyyounouski MD * ; Marc Smaldone ; Mark L Sobczak ; Eric M Horwitz MD

SSG16-08 • Prognostic Factors for Toxicity in Prostate Cancer Patients Treated with Arc Radiation Therapy
Jose Lopez ; Raul Matute ; Fernando Puebla ; Jose C Arduan MD, PhD (Presenter) ; Nicolas Isaa ; Catalina Acebedo ; Rafael Lengua ; Maria Jose Ortiz Gordillo ; Javier Jaen ; Juan Manuel Praena-Fernandez ; Mercedes Arduan Perez ; Ignacio Azinovic

SSG16-09 • A Prospective Feasibility Study of Hypofractionated Radiotherapy in Localised Prostate Cancer in Indian Scenario
Shilpa Reddy (Presenter) ; Vijay Anand Palkonda ; Sajal Kakkar MD ; Kaushik Bhattacharya MD ; Vinitha Reddy MD ; Prashanth Upadhyay MD ; Nanditha Sesikeran ; Shantlingi Ngudji ; Vinod Reddy Maddireddy MBBS

Vascular/Interventional (Ablative Therapies) Tuesday, 10:30 AM - 12:00 PM • E353A Back to Top or SSG17 • AMA PRA Category 1 Credit ™:1.5 • ARRT Category A+ Credit:1.5 Moderator Govindarajan Narayanan , MD * ; Moderator Kent T Sato , MD
SSG17-04 • Hepatic Radiofrequency (RF) Ablation-induced Stimulation of Distant Subcutaneous Tumor Growth: Suppression with a c-MET Kinase Inhibitor
Muneeb Ahmed MD (Presenter) ; Gaurav Kumar PhD ; Marwan Moussa MD ; Nir Rozenblum MA ; S. Nahum Goldberg MD *

PURPOSE
To determine if hepatic radiofrequency ablation (RFA)-induced stimulation of distant subcutaneous tumor growth can be suppressed with an adjuvant c-MET kinase inhibitor in a small animal tumor model.

METHOD AND MATERIALS
Single R3230 adenocarcinoma subcutaneous tumors were implanted in Fisher 344 rats (total n=38). At diameters of 10-11mm, tumors were randomized to receive standardized RFA (21g electrode, 1 cm active tip, tip temperature 70°C±5min) or sham procedure (electrode placement without RFA) to normal liver (2 groups, n=13 each) and then with adjuvant intraperitoneal PHA-665752 (c-MET inhibitor) administered 3d after RFA (2 groups, n=6 each). Animals were sacrificed and tumors harvested 7d post-treatment. Tumor growth analysis (absolute diameter, change in diameter, and growth curve slope) and evaluation of proliferative indices (Ki-67 % positivity) was performed.

RESULTS
With RFA of normal liver, distant subcutaneous tumors were substantially larger at 7d compared to sham (17.1±2.2mm vs. 13.7±0.9mm, p

CONCLUSION
RF ablation of normal liver can stimulate distant subcutaneous tumor growth in this animal model. This effect can be successfully suppressed with an adjuvant c-MET kinase inhibitor.

CLINICAL RELEVANCE/APPLICATION
Achieving an ablative margin during hepatic RFA may stimulate distant tumor growth. The c-met pathway is one potential mechanism that can be targeted to suppress these deleterious effects.

SSG17-02 • Inhibition of PI3K-AKT-mTOR Signaling Enhances Heat Stress Induced HCC Cell Killing
Scott M Thompson BA (Presenter) ; Matthew R Callstrom MD, PhD * ; Joseph P Grande MD, PhD ; Lewis R Roberts MBChB, PhD ; David A Woodrum MD, PhD

PURPOSE
AKT and ERK signaling pathways are frequently dysregulated in hepatocellular carcinoma (HCC) and promote HCC cell survival. The aim of the present study was to test the hypothesis that inhibition of PI3K-AKT-mTOR and/or MEK-ERK signaling enhances heat stress induced HCC cell killing.

METHOD AND MATERIALS
Intentional partial laser or sham ablation was performed on orthotopic N1S1 HCC tumors under US-guidance and liver/tumor tissue assessed for phospho-AKT and ERK immunostaining at 6 or 24 hours post-ablation (N=8). The HCC cell lines N1S1 and AS30D were pre-treated for 1-hour with small molecule inhibitors against PI3K-mTOR, MEK, both or vehicle control followed by sublethal heat stress (45.0°C) or control (37°C) for 10 minutes and recovered up to 48 hours in complete media at 37°C (N=3). Samples were assessed for heat stress induced AKT and ERK signaling immediately post-heat stress by Western immunoblotting and cell viability at 48 hours post heat stress by WST-1 assay.

RESULTS
Immunohistochemical analysis of the ablation zone demonstrated markedly increased AKT and ERK phosphorylation at the tumor ablation margin but not at the liver ablation margin. There was no evidence of increased AKT or ERK phosphorylation in the tumor or at the margin between liver and tumor in the sham ablation group. Western immunoblotting demonstrated that inhibition of PI3K-mTOR and MEK blocked constitutive and heat stress induced AKT and ERK phosphorylation, respectively, in both the N1S1 and AS30D HCC cell lines. Viability assessment demonstrated that inhibition of PI3K-mTOR enhanced heat stress induced HCC cell killing over heat stress or drug alone in both cell lines (p
CONCLUSION
These data demonstrate that thermal ablation induces AKT and ERK phosphorylation at the tumor ablation margin in vivo and that inhibition of PI3K-mTOR prevents heat stress AKT signaling and enhances heat stress induced HCC cell killing.

CLINICAL RELEVANCE/APPLICATION
Inhibition of PI3K-AKT-mTOR signaling may be a promising therapeutic target in combination with thermal ablation as a method to enhance ablation induced HCC cell killing.

SSG17-03 ● Optimizing Pulsed Irreversible Electroporation Deposition
Ayeeet Wandel MD (Presenter); Muchamad Faruja MD; Isaac Nissenbaum BSc; Eliel Ben-David MD; Liat Appelbaum MD; S. Nahum Goldberg MD *

PURPOSE
To determine optimal settings for creating large zones of IRE-induced ablation.

METHOD AND MATERIALS
IRE ablation (n = 33) was performed in vivo in pig liver (n= 7, Yorkshire swine 92±105 kg) under ultrasound guidance using two IRE electrodes, 18 gauge, tip exposure of 2cm, 1.5-2cm inter-electrode spacing and Nanonknife generator (Angiodynamics, Fremont, CA). Energy deposition was applied at 2,250 to 3,000V for 10, 100 pulses per application cycle. In addition, to varying the number of pulses, the number cycles of IRE application (1-12) and the time interval between IRE applications (10-900 sec) were systematically varied. Electrical parameters including applied current and tissue resistance were measured throughout the ablation. Cross-sectional zones of ablation were measured by gross and histopathology. These data were compared and correlated with IRE pulse parameters to determine optimal settings.

RESULTS
For a 15 min application time, optimal ablation of 6.7 ± 0.2 x 3.3 ± 0.1 cm was produced at 100 pulses of 100 ± sec and 3000V with 100 sec time intervals. This was substantially larger than the 5.5 ± 0.2 x 2.0 ± 0.3 cm produced by continuous application at otherwise controlled parameters (p < 0.01). Varying the time interval between cycles of IRE application from 100 to 900 seconds altered both the maximum resistance and the diameter of treatment in a dose-dependent. For example, for 4 cycles of 50 pulses, 100 - 300 sec interval delay between cycles decreased the active resistance by 30 ± 6 ohms and produced a diameter of 3.6 ± 0.2 with 600 - 900 sec delay showing virtually no change in resistance and producing a diameter of 3.0 ± 0.3 (p < 0.01). Altering the number of pulses or voltage for a constant 100 sec interval delay also produced dose dependant changes in max resistance (210-320 ohms range) and short-axis coagulation diameter (from 2.4 ± 0.3 to 3.1 ± 0.4 cm).

CONCLUSION
These results establish that IRE not only induces tissue ablation, but also dynamically alters tissue characteristics in ways that can be used to further improve the treatment effect. Introduction of relatively shorter refractory period can indeed create larger, more clinically useful zones of ablation than continuous application.

CLINICAL RELEVANCE/APPLICATION
Optimization of IRE ablation parameters will enable the creation of larger volumes of treatment effect in the most efficient manner.

SSG17-04 ● Early Residual Tumor Differentiation from Benign Periablational Thermal Injury after Radiofrequency Ablation by Dual-energy Computed Tomography: A Phantom and Animal Study
Yuekao Li (Presenter); Gaofeng Shi MD; Runze Wu

PURPOSE
The inflammatory reaction to the thermal injury after the radiofrequency ablation (RFA) makes it difficult to timely determine the treatment response using conventional computed tomography (CT). In this study, we applied iodine quantification with Dual-Energy CT (DECT) in rabbits with VX2 carcinoma after incomplete RFA to distinguish benign periablational reactive tissue from residual tumor and evaluated the therapeutic response of RFA.

METHOD AND MATERIALS
A phantom with ten tubes which contain solutions of varying iodine concentration was scanned with DECT to evaluate the feasibility of iodine quantification. Iodine concentration was calculated and compared with the true iodine concentration. In animal study, triple-phase contrast-enhanced DECT data on 24 rabbits with VX2 carcinoma were assessed by 2 reviewers independently after 3-day (n=6), 1-week (n=6), 2-week (n=6) and 3-week (n=6) of incomplete RFA. The iodine map images were obtained based on three materials decomposition theory after post-processing to CT images. Regions of interest (ROI) were positioned on the iodine image over the lesion and aorta as a reference, for the recording of iodine concentration in the lesion and in the aorta respectively. The pathologic specimens were sectioned in the same plane as CT imaging. The differences of lesion iodine concentration and lesion-to-aorta iodine ratio between residual tumor and benign periablational reactive tissue were statistically analyzed.

RESULTS
The calculated iodine showed excellent correlation with the true iodine concentration (R2 = 0.999, P < 0.0001) in the phantom study. The lesion iodine concentration and lesion-to-aorta iodine ratio in residual tumor were significantly higher than that in benign periablational reactive tissue in 2-week group during the arterial phase (AP) (P < 0.01), and in 3-week group during both AP (P < 0.01) and portal venous phase (PVP) (P < 0.05). There was no significant difference of lesion iodine concentration or lesion-to-aorta iodine ratio between residual tumor and benign periablational reactive tissue in 2-week group during the AP (P < 0.01), and in 3-week group during both AP (P < 0.05) and PVP (P < 0.05). The calculated iodine showed excellent correlation with the true iodine concentration (R2 = 0.999, P < 0.0001) in the animal study. These data demonstrated that iodine quantification with DECT is accurate in the phantom study and could be used to differentiate benign periablational reactive tissue from residual tumor in VX2 carcinoma 2 weeks after RFA.

CONCLUSION
The results of this study indicated that iodine quantification with DECT is accurate in the phantom study and could be used to differentiate benign periablational reactive tissue from residual tumor in VX2 carcinoma 2 weeks after RFA.

CLINICAL RELEVANCE/APPLICATION
Optimization of IRE ablation parameters could be performed to 2 to 3 weeks after RFA clinically to early evaluate therapeutic response.

SSG17-05 ● Clinical Utility of Automatic Real-time Fusion System for Radiofrequency Ablation in Target Localization, Electrode Placement and Monitoring of Ablation Procedure
Jeong-Min Lee MD (Presenter); Jeong Hee Yoon MD; Dong Hyeon Kim MD; Joon Koo Han MD; Byung Ihn Choi MD, PhD *

PURPOSE
To prospectively evaluate clinical utility of automatic multimodality image fusion for radiofrequency ablation (RFA) procedures, and to determine clinical outcomes of fusion-guided RFA procedures.

METHOD AND MATERIALS
80 patients (M:F=66:14) with 89 liver malignancies (80 HCCs and 9 metastases) were treated with switching monopolar RFA using multiple electrodes under the guidance of image fusion system (PercuNav system, Philips Healthcare). Image fusion system was used in undergoing RFA to assist in target localization, electrode placement, and procedure monitoring. A preprocedural CT scan was obtained that slight inspiration phase with six sterile passive fiducial markers on the skin. Visibility of target tumor, planning of safe access route, operator’s confidence for technical feasibility were graded by an operator using conventional B-mode ultrasound and using the image fusion system. In addition, registration time was recorded. Technique effectiveness, local recurrence rate and remote recurrence rate at 1, 6, 12, and 18 months were evaluated using the Kaplan-Meier method.
RESULTS
Real-time fusion of US with CT/MR provided information crucial for successful execution of the RFA procedure in 43.8% (35/80) patients, and may enable procedures that are not feasible with US guidance in 23.8% of cases. Total additional setup time for the navigation system was 3.7 min ± 1.9. Tumor visibility was significantly improved on fusion system compared with B mode US and (p < 0.0001). In addition, image fusion system provided better planning of safe access route without a risk for major vascular injury, and increased operator confidence for technical feasibility compared with B-mode ultrasound (p < 0.0001). Technique effectiveness rate, determined 1 month after RFA was 100%. Local tumor progression rates at 6, 12 and 18 months were 2.5%, 6%, and 6%. In addition, intrahepatic remote recurrence rates at 6, 12 and 18 months after RFA were 12%, 16.5%, 22.4%.

CONCLUSION
Real-time multimodality fusion system provided information crucial for successful execution of the RFA procedure in 43.8% (35/80), and automatic real time fusion guided RFA safely provided successful local tumor control, and therefore, improved survival may be achieved with this technique.

CLINICAL RELEVANCE/APPLICATION
Real-time fusion imaging provided better visibility of target tumor, and increased operator confidence for RFA, which allowed a higher local tumor control rate.

SSG17-06 • Radiofrequency Ablation Using a Multiple-electrode Switching System for Lung Tumors Measuring 2cm or Larger: Phase-II Clinical Study

Hiroshi Kodama (Presenter) ; Koichiro Yamakado MD, PhD ; Takaaki Hasegawa ; Masashi Fujimori MD ; Takashi Yamanaka MD ; Haruyuki Takaki MD ; Junji Uraki MD ; Atsushi Nakatsuka MD ; Hajime Sakuma MD *

PURPOSE
To prospectively evaluate the safety and effectiveness of radiofrequency (RF) ablation using a multiple-electrode switching system for the treatment of lung tumors measuring 2 cm or larger.

METHOD AND MATERIALS
Our institutional review board approved this phase-II study and written informed consent was obtained from all patients. Inclusion criteria were not surgical candidates who had 3 or less malignant lung tumor with maximum tumor diameter of 2 cm. The primary endpoint was safety and evaluated using the Common Terminology Criteria for Adverse Events (CTCAE). Patients were observed at least one year, and local tumor progression and overall survival were analyzed using Kaplan-Meier method.

RESULTS
Thirty-three consecutive patients (26 male and 7 female; mean age, 70.5 years; 46±87 years) were included. A total of 35 tumors with mean maximum tumor diameter of 3.0±0.7 cm (range, 2.0–4.4 cm) were ablated using a multiple-electrode switching system in 35 sessions. There was no procedure-related death and Grade-4 adverse event. Grade-3 adverse event occurred in 4 sessions (11.4%, 4/35): pleural effusion requiring chest tube placement (n=2), pneumothorax requiring pleural adhesion (n=1), and pulmonary hemorrhage treated with coil embolization of pulmonary artery (n=1). Grade-1 or -2 adverse events were detected in 37.1% (13/35) of RF sessions. The 1-year local tumor progression rates were 12.7% (95% confidence interval [CI], 1.0–25.5%). All of the tumors with local tumor progression (n=4) was adjacent to bronchi or vessels greater than 2mm. The 1-year overall survival rates were 81.2% (95% CI, 67.6–94.8%).

CONCLUSION
RF ablation using a multiple-electrode switching system is safe and effective for treatment of lung tumors measuring 2 cm or larger.

CLINICAL RELEVANCE/APPLICATION
RF ablation using a multiple-electrode switching system can be useful when the tumor is 2 cm or larger.

SSG17-07 • Nanoparticle Distribution after Treatment of Rabbit VX2 Hepatic Tumor with Nanoparticle Embolization and Irreversible Electroporation (IRE) or Radiofrequency Ablation (RFA)

Alda L Tam MD (Presenter) * ; Marites P Melancon PhD ; Joe Ensor * ; Laura Pageon DVM ; Mohamed E Abdelsalam MD ; Tomas Appleton Figueira MD ; Katherine Dixon RT ; Jennifer J Miller ; Amanda McMatters ; Chun Li PhD ; Sanjay Gupta MD

PURPOSE
To investigate the intratumoral uptake of radiolabeled, hollow gold nanoparticles loaded with doxorubicin (64Cu-labeled PEG-HAuNS-DOX) after IRE or RFA in rabbit VX2 hepatic tumors.

METHOD AND MATERIALS
Twelve VX2 tumor-bearing rabbits were randomized to three treatment arms: (i) nanoparticle with 64Cu-labeled PEG-HAuNS-DOX (NE) alone; (ii) NE followed by IRE (NE+IRE); (iii) NE followed by RFA (NE+RFA). PET/CT imaging was obtained at 24-hours after intervention, after which animals were euthanized and tissue samples were collected for autoradiograph and TEM analysis. Dunnett's multiple comparison procedure was performed to evaluate differences in the mean uptake of nanoparticles in the tumor.

RESULTS
Based on PET/CT evaluation, the uptake and retention of the nanoparticles in the tumor following NE+RFA was significantly greater than following NE (p=0.02) but there was no difference in the uptake and retention of the nanoparticles following NE+IRE when compared to NE (p=0.75). The autoradiograph analysis demonstrates that following NE+IRE, there is nanoparticle deposition in the tumor tissue, whereas, following NE or NE+RFA, there is no nanoparticle deposition around the tumor but not in it. The TEM results indicate that following NE+IRE, intracellular uptake of nanoparticles was noted in tumor, ablated and normal liver cells. There was no intracellular uptake of nanoparticles following NE or NE+RFA.

CONCLUSION
Combining NE with IRE or RFA results in the retention of the nanoparticles in or around the tumor for up to 18-hours post-intervention; however, nanoparticles are found inside cells only after IRE.

CLINICAL RELEVANCE/APPLICATION
A combined nanoparticle ablation technique for liver tumors is feasible.

SSG17-08 • Renal Cryoablation: A New Paradigm for Nearly Any Tumor Location

Hussein D Aoun MD (Presenter) ; Peter J Litttrup MD * ; Barbara A Adam MSN ; Evan N Fletcher MS, BA ; Mark J Krycia BS

PURPOSE
To assess technical feasibility, efficacy and complication rates of CT guided percutaneous renal mass cryoablation in a large series on long term follow up.

METHOD AND MATERIALS
CT and/or CT-US fluoroscopic-guided percutaneous cryoablations were performed in 247 procedures on 262 tumors (210 RCC, 45 metastasis, 6 oncocytomas and 1 angiomylolipoma) in 214 patients noting tumor size and location. Thirty-seven patients had multiple renal tumors ablated. Follow-up CT or MRI was utilized to assess efficacy and evaluate for local recurrences or new multicentric tumors. Hydrodissection with normal saline/contrast (60:1) solution was performed to protect adjacent vital structures.
RESULTS
All the procedures were performed under conscious sedation and were virtually painless during and after the procedure. Average tumor and ablation size was 3cm and 5cm, respectively, with the largest 10.4cm. Hydrodissection was performed in 73 procedures. Major complication (only grade 3) rate attributable to the procedure was 2.4% (6/247). Of the major complications, 3 (3/5) were related to hemorrhage requiring transfusion (Grade 3). A ureteral stricture prior to ureteral stent placement for central tumors and bowel injury prior to protective hydrodissection techniques were observed early on in our experience. Median follow-up was 1.8 years with 72 patients having > 3 year follow-up and 36 patients having > 5 year follow-up. Local recurrence rate was 2% (6/262), with 4 technical failures and 2 tract recurrences. Of the local recurrences, 4 were re-ablated (2 tract and 2 technical) without residual disease on follow-up for a secondary efficacy of 99%.

CONCLUSION
Renal cryoablation has established low complication and local recurrence rates which do not appear to be significantly affected by tumor size or central location. CT guided percutaneous cryotherapy is a low cost and low morbidity alternative for patients with complex renal tumors.

CLINICAL RELEVANCE/APPLICATION
The rising cost of health care mandates consideration of renal cryoablation as a cost effective treatment option, justified by comparable low recurrence and complication rates for any renal location.

SSG17-09 • RCC Perfusion before and after Radiofrequency Ablation Measured with DCE-MRI: A Pilot Study
Tze M Wah MBChB, FRCR (Presenter) ; Steven Sourbron PhD ; Daniel Wilson MS ; Derek Magee PhD ; Walter Gregory PhD ; Peter J Selby MD, DSc ; David L Buckley PhD

PURPOSE
The treatment efficacy of radiofrequency ablation (RFA) of renal cell carcinoma (RCC) is usually assessed with contrast enhanced CT or MRI. The lack of contrast enhancement in the zone of ablation is usually interpreted as successful ablation. However, the zone of ablation typically exhibits some enhancement rather than no enhancement at all, and it is this variability that can pose a clinical dilemma when deciding whether there is complete tumor cell death. Dynamic contrast enhanced (DCE) –MRI is routinely performed in our institution to assess the treatment effect for patients undergoing RFA. This pilot study aims to investigate if early treatment effects of RFA in RCC can be detected with DCE-MRI perfusion measurements.

METHOD AND MATERIALS
Twenty patients undergoing percutaneous RFA of their twenty one RCCs were evaluated with DCE-MRI immediately before and at one- month after RFA treatment. DCE-MRI was performed with volume acquisition under free breathing. The tumor perfusion was estimated using the maximum slope technique in two independent settings. Blood flow to the renal tumors was correlated with total RF treatment time. This study was granted approval by our institution IRB.

RESULTS
DCE-MRI examinations were successfully evaluated for 21 renal tumors (size from 1.3 to 4 cm) with RFA time (7.4 to 63.4 minutes). The perfusion measurement of the RCCs decreased significantly (p<0.01) it is feasible to measure RCC perfusion before and after RFA using DCE-MRI. Pre-RFA tumor blood flow may be used to predict RFA treatment time which may help planning treatment. Perfusion values significantly decrease in the zone of ablation, suggesting they may be useful for the assessment of treatment.

CLINICAL RELEVANCE/APPLICATION
It is feasible to measure RCC perfusion with DCE-MRI before and after RFA to assess treatment effect; blood flow to the RCC before RFA may be used to predict required ablation time.

BREAST IMAGING (SCREENING AND DENSITY) TUESDAY, 03:00 PM - 04:00 PM • Arie Crown Theater

SSJ01-01 • Patient Awareness of Breast Density and Interest in Supplemental Screening Tests for Women with Dense Breasts among Women at a County Hospital Compared to Women at an Outpatient Radiology Clinic of an Academic Medical Center
Jennifer Trinh MD ; Long Trinh MD (Presenter) ; Kevin K Lee MD ; Haatal B Dave MD, MS ; Kei Hanafusa MD ; Jafi A Lipson MD

PURPOSE
We compared patient awareness of breast density and interest in supplemental screening tests for women with dense breasts among women obtaining screening mammograms at a county hospital compared to at an outpatient radiology clinic of an academic medical center.

METHOD AND MATERIALS
Over a three month period, a nine question survey was given to 153 women at a county hospital prior to their screening mammogram appointments. Surveys were available in English, Spanish, and Vietnamese. Women were asked if they were aware of their breast density. They were then informed about the decreased sensitivity of mammography in dense breast and the association between dense breasts and cancer risk. They were asked about their interest in and willingness to pay for additional screening tests such as whole breast ultrasound and contrast enhanced spectral mammography if they had dense breast. The Student’s test (two tailed) was used to compare the survey results with the responses obtained from a similar survey conducted at an outpatient radiology clinic.

RESULTS
5% of women (6 out of 132) were aware of their breast density compared to 24% (25 out of 105) at the outpatient radiology clinic (p<0.01).

CONCLUSION
Both populations have an interest in knowing their breast density and in additional screening studies despite false positives. However, women receiving care at the county hospital are less willing to incur out-of-pocket expenses in contrast to their counterparts at the outpatient radiology clinic. This study demonstrates the potential disparity in healthcare if supplemental screening tests are not covered by insurance.

CLINICAL RELEVANCE/APPLICATION
Five states require radiologists to inform patients of their breast density. With the exception of one state, coverage for additional screening tests remains a medical and political debate.

SSJ01-02 • The Relationship of Breast Density in Mammography and Magnetic Resonance (MR) Imaging in Women at High Risk for Developing Breast Cancer and Women with Breast Cancer
Freya Schnabel MD ; Jennifer Chun MPH ; Marissa L Albert MD,MSc (Presenter) ; Jiyon Lee MD ; Shira Schwartz ; Linda Moy MD
Mammographic breast density (BD) is associated with a 4 to 6-fold increased risk for developing breast cancer. Background parenchymal enhancement (BPE) in MRI has also been correlated with breast cancer risk. The purpose of our study was to evaluate the relationship between BD, BPE, and FGT (assessment of fibroglandular tissue with contiguous MR images) in women with breast cancer (BC) and at high risk (HR) for developing breast cancer.

METHOD AND MATERIALS
From January 2010 to February 2013, 475 women enrolled in our longitudinal databases and underwent mammography and MRI at our institution. Variables included age, BD, BPE, FGT, family history of breast cancer (FHBC), BRCA status, atypical hyperplasia (AH), and lobular carcinoma in situ (LCIS). BD was defined by ACR classifications 1-4. FGT was assessed on a similar scale. BPE was categorized as minimal, mild, moderate, or marked. Statistical analyses included Pearson’s Chi Square, Fisher’s Exact Tests, and logistic regression.

RESULTS
A total of 403 (85%) women had BD and 72 (15%) were at high risk for developing BC. In the HR group, the etiology of breast cancer risk (FHBC, BRCA status, AH, and/or LCIS) had no relationship to BD, FGT, and BPE. In the BC group, there was also no relationship between background risk factors with BD, FGT, and BPE. However, when we compared the HR and BC groups, we found that BD (p=0.0005), BPE (p<0.0001), and FGT (p<0.0001) were all significantly higher in the BC group than in the HR group. BD and BPE positivity increased with age in the BC group, whereas FGT positivity decreased with age in the BC group. The odds ratios in our analysis may give a sense of the magnitude of risk that may be useful in improving quantitative breast cancer risk assessment models.

CONCLUSION
Increased BD, BPE, and possibly FGT are seen in women with breast cancer when compared with women with high risk. This suggests that women with dense breasts and increased BPE and FGT may be at an increased risk of developing breast cancer. The odds ratios in our analysis may give a sense of the magnitude of risk that may be useful in improving quantitative breast cancer risk assessment models.

CLINICAL RELEVANCE/APPLICATION
As BD, BPE, and FGT may be associated with breast cancer, our study supports the need to include them as risk factors in developing better quantitative and individualized risk assessment models.
Mammographic percent density (PD%) is a strong risk factor for breast cancer. We investigate if quantitative measures of parenchymal texture, which capture the local appearance and structure of breast tissue, can provide complementary information to PD% for breast cancer risk assessment.

METHOD AND MATERIALS
Contralateral, mediobasal oblique view digital mammography images from 106 women with unilateral invasive breast cancer and 318 age and side-matched controls were retrospectively analyzed. Breast PD% and a total of 24 parenchymal texture features, including histogram statistics (11), run-length (3), gray-level co-occurrence (7) and structure features (3) were extracted using validated software. Established risk factors for each woman’s family history of breast cancer, ethnicity, age at menarche, parity, and number of biopsies were biopsied via archived questionnaire. A logistic regression model with feature selection comprised of texture features adjusted for PD% and standard risk predictors was compared to a model with only standard risk factors and PD% as input variables. Area under the curve (AUC) of the receiver operating characteristic (ROC) was used to evaluate model performance. DeLong’s test was used to compare the two models.

RESULTS
Standard risk factors and PD% alone have an AUC of 0.64 (p

CONCLUSION
Measures of breast parenchymal texture provide statistically significant, complementary information regarding a woman’s risk for breast cancer, after adjusting for standard risk factors and breast PD%, potentially leading to improvements in breast cancer risk estimation.

CLINICAL RELEVANCE/APPLICATION
Breast cancer risk assessment may be improved by using measures of local parenchymal tissue texture and structure, in addition to breast density and standard demographic and reproductive risk factors.

SSJ01-06 • Non-invasive Optical Assessment of Breast Density and Identification of High-risk Subjects
Paola Taroni PhD (Presenter) ; Giovanna Quarto PhD ; Antonio Pifferi PhD ; Rinaldo Cubeddu ; Francesca Ieva ; Maria Paganoni ; Francesca Abbate MD ; Nicola Balestreri ; Serena Ganino ; Simona Menna ; Enrico Cassano

PURPOSE
Breast density is a strong independent risk factor for breast cancer. At present it is assessed through mammography, thus implying the use of ionizing radiation. The ability to non-invasively identify high-risk women could allow earlier design of personalized screening paths and preventive interventions.

METHOD AND MATERIALS
Time domain multi-wavelength (635-1060 nm) optical mammography was performed on 147 subjects. Average breast tissue composition (water, lipid, collagen, oxy- and deoxyhemoglobin) and scattering parameters (amplitude and slope) were estimated using the diffusion approximation to the radiative transfer theory to model photon propagation in tissue. Mammographic density was classified through BI-RADS categories.

RESULTS
An increase in BI-RADS category corresponds to increasing amounts of optically estimated water and collagen content, while lipid content decreases. A gradual increase is also observed in scattering amplitude and slope. Such observations are consistent with known differences in composition and microscopic structure between fatty and fibroglandular (dense) tissue. The best regression logistic model for the risk probability resulted to depend on collagen content and scattering parameters. It provided a total misclassification error of 12.3%, corresponding to a simple kappa of 0.84, which compares favorably with the reproducibility of BI-RADS measures even intra-radiologist.

CONCLUSION
An optical tool was developed to assess non-invasively breast density, and provided promising initial results for the identification of high-risk subjects.

CLINICAL RELEVANCE/APPLICATION
The optical estimate of breast density is non-invasive, feasible in clinical practice, and could allow the design of more effective screening and preventive paths for high-risk subjects.

ISP: Breast Imaging (Computed Tomography) Tuesday, 03:00 PM - 04:00 PM • E450A

SSJ02 • Breast Imaging Keynote Speaker: Breast CT
John M Boone PhD (Presenter) *

PURPOSE
Breast CT is an emerging technology that will likely have a role to play in clinical breast imaging in the near future. This RSNA Integrating Science and Practice (ISP) scientific session is the first to be dedicated exclusively to breast CT per se, and this reflects the advancements in breast CT technology as well as the growing catalog of widespread research imaging with prototype breast CT systems. In this introduction, a brief review of breast CT technology will be discussed to familiarize the audience with the capabilities and limitations of these systems.

SSJ02-02 • Is Contrast Enhanced Dedicated Breast Computed Tomography Superior to Digital Breast Tomosynthesis and Digital Mammography in the Evaluation of BI-RADS 4 and 5 Breast Lesions?
Shadi Aminololama-Shakeri MD (Presenter) ; Anita Nosratieh ; Karen K Lindfors MD * ; John M Boone PhD *

PURPOSE
To compare the conspicuity of BI-RADS 4 and 5 lesions on digital breast tomosynthesis (DBT), contrast enhanced breast CT (CEbCT) and digital mammography (DM).

METHOD AND MATERIALS
105 patients with 103 BI-RADS 4 or 5 lesions were prospectively enrolled in our IRB-approved study. Patients had DM & DBT (14), DM & CEbCT (45), or DM, DBT & CEbCT (44). All lesions were biopsied. Patients received 100 ml of IV iodixanol 320 at a rate of 3 ml/s for CEbCT. 2 experienced radiologists independently assigned a conspicuity score (CS) of 0-10 for each biopsied lesion (0=not seen, 10=excellent conspicuity). Results are shown as mean CS+/−SD. Significant differences among conspicuity of lesions on DM, DBT & CEbCT (p
RESULTS
Of 103 breast lesions, 58 (56%) were malignant and 45 (44%) were benign. 27 (27%) of the malignant lesions were masses and 31 (30%) were calcifications. Of 45 benign lesions, 18 (40%) were masses and 27 (60%) were calcifications. Malignant masses were significantly more conspicuous on CEbCT than on DBT or DM (9.7+/−0.5 n=23 vs 7.0+/−2.9 n=13 and 6.9+/−2.7 n=27 respectively).

CONCLUSION
CEbCT and DBT are promising new techniques for detection of breast lesions. We show that CEbCT and DBT are similar to DM in detection of malignant calcifications and benign masses. But malignant masses are more conspicuous and benign calcifications are less conspicuous on CEbCT than DBT & DM. While these results favor CEbCT for detection of malignant masses in comparison to the other 2 modalities, the latter observation underscores the potential of decreasing false positive evaluations.

CLINICAL RELEVANCE/APPLICATION
DBT and CEbCT are emerging technologies showing promise as complementary tools to DM.

SSJ02-03 • Is Lesion Depiction on Contrast Enhanced Dedicated Breast Computed Tomography Affected by Contrast Timing?
Shadi Aminololama-Shakeri MD (Presenter); Peymon Gazi MS; Karen K Lindfors MD *; John M Boone PhD *

PURPOSE
Patients undergoing contrast enhanced dedicated breast computed tomography (CEbCT) have sequential imaging of both breasts following an intravenous injection of iodine based contrast material. This sequential scanning protocol with one breast imaged at a slightly more delayed time post contrast than the contralateral side has raised questions regarding lesion depiction. The goal of this study was to measure lesion depiction as a function of time after contrast injection.

METHOD AND MATERIALS
90 consecutive patients with BI-RADS 4 or 5 lesions were prospectively enrolled. All patients had CEbCT after IV injection of 100 ml of iodixanol 320 at a rate of 3 ml/s, followed by core biopsy. Two experienced radiologists independently reviewed each study and assigned a conspicuity score (CS) of 0-10 for each biopsied lesion (0=not seen, 10=excellent conspicuity). A subset of patients (50) also had qualitative assessment of the background breast parenchymal enhancement, subjectively categorized into minimal, mild, moderate or marked by the readers and correlated to the early and late contrast delay times. Time from contrast injection to CEbCT imaging ranged from 70 to 492 sec. Contrast delay times of 70-95s were defined as early (n=73) and times ranging from 165 to 492s were defined as late (n=17). CS and delay times are shown as mean +/-SD. Significant differences among conspicuity of lesions in early versus late delay time groups (p

RESULTS
Breast lesions were equally conspicuous in the early and late contrast delay time groups with CS of 7.3+/−3.2, n=39 and 7.1+/−3.7, n=39 respectively. Background parenchymal enhancement categories were equally distributed with early and delayed contrast times. 83% (34/41) of breasts imaged at the early contrast time showed minimal/mild and 17% (7/41) showed moderate/ marked background parenchymal enhancement. 78% (7/9) of the breasts imaged at the late contrast delay time showed minimal/mild and 22% (2/7) showed moderate/ marked background parenchymal enhancement.

CONCLUSION
There is no correlation between conspicuity scores of BI-RADS 4 and 5 breast lesions and contrast timing on CEbCT. Contrast time does not correlate with background parenchymal enhancement and does not affect conspicuity of breast lesions on CEbCT.

CLINICAL RELEVANCE/APPLICATION
CEbCT lesion depiction is not contrast time dependent.

SSJ02-04 • Dedicated High-resolution Breast CT Can Outperform Digital Mammography and Breast Tomosynthesis at Equivalent Dose Levels
Willi A Kalender PhD (Presenter) *; Daniel Kolditz PhD *; Ann-Christin Roessler MSc; Christian Steiding MSc *; Evelyn Wenkel MD; Ruediger Schultz-Wendtland

PURPOSE
There is general consensus that computed tomography (CT) can provide good soft-tissue discrimination and dynamic contrast-enhanced studies of the breast, but with insufficient spatial resolution and dose values exceeding the limits set for screening examinations. We re-evaluated if this assumption still holds true for an innovative high-resolution breast CT (bCT) system.

METHOD AND MATERIALS
We compared the performance of a bCT prototype (CT Imaging GmbH, Erlangen, Germany) to two clinical systems of two different manufacturers for each digital mammography (DM) and breast tomosynthesis (BT) with respect to detectability of the structures presented by the American College of Radiology (ACR) accreditation phantom. bCT examines one breast at a time with the patient lying prone on the patient bed without exposing the body trunk. The prototype employs a new cadmium telluride detector with 100 laldar pixel size, single photon counting electronics and close to 100% detection efficiency [Kalender WA et al. Eur Radiol 2012; 22(1):1-8]. The tests focused on the question if fibers down to 0.75 mm, masses down to 0.50 mm, and specks down to 0.24 mm were clearly distinguished as recommended by the ACR. Tests were also performed to determine image quality and dose. We did not add overlaying structures, which would be potentially confounding the ACR structures for DM and BT.

RESULTS
Acceptance testing for all 5 systems confirmed that they met the requirements for screening mammography; the bCT system provided better than 100 mm spatial resolution at average glandular dose levels below 5 mGy. Measurements of the ACR phantom revealed the following: DM and BT showed fibers, masses and specks as required; bCT went beyond this and revealed even the finest structures presented in the ACR phantom, i.e. fibers of 0.4 mm, masses of 0.25 mm and specks of 0.16 mm.

CONCLUSION
Fully 3D high-resolution breast CT showed performance superior to DM and BT, even in the benevolent situation with no confounding structures superimposed. Smaller structures may have to be introduced in test phantoms to provide adequate tests for finer details.

CLINICAL RELEVANCE/APPLICATION
High-resolution breast CT appears to offer potential for superposition-free fully 3D imaging of the breast at improved detail resolution and dose levels accepted for screening procedures.

SSJ02-05 • Cone Beam Breast Computed Tomography’s Ability to Detect Mammographically Occult Lesions
Posy J Seifert DO (Presenter); Andrea L Arieno BS; Renee Morgan RT

PURPOSE
To review lesions that were mammographically occult and imaged with cone beam breast Computed Tomography (CT) with or without contrast.

METHOD AND MATERIALS
From June 2008 to December 2012, 411 subjects were prospectively enrolled in 2 IRB approved studies; all had non contrast CT (NCCT) and 69 had contrast enhanced CT (CECT). 27 lesions in 25 subjects were considered to be mammographically occult at diagnostic work-up and are the basis of this study; all had NCCT and 18 also had CECT. Data recorded included subject demographics, method of detection, lesion characteristics, core biopsy pathology and open surgical pathology when applicable.
RESULTS
25 subjects with 27 lesions were determined to be mammographically occult but detected by diagnostic work-up; all were masses. Of the 27 lesions, 19 were detected by breast CT. Average lesion size at diagnostic work-up was 1.5 cm (range 0.3 to 4.5 cm). Average lesion size on breast CT was 1.4 cm (range 0.3 to 4.5 cm). Overall, 10 lesions were biopsy-proven malignant; 9 invasive and 1 non-invasive. Sixteen lesions were biopsy-proven benign and 1 atypical. Eight lesions were mammographically occult and also CT occult, but found on ultrasound. One was biopsy proven invasive ductal carcinoma, one was atypical and 6 were biopsy proven benign.

8 myocardially occult lesions were detected by CT only; 6 seen on both NCCT and CECT, 1 only on CECT and 1 only on NCCT (this subject did not have CECT). After additional work-up, 5 were biopsy proven invasive carcinomas and 3 were benign. Two of the 5 malignancies were seen and biopsied with MRI, 2 were seen on MRI, but went directly to surgery; the fifth malignancy, seen only on CT, proceeded to surgery for final diagnosis. The 3 benign findings were seen and biopsied with US.

CONCLUSION
In this small study, breast CT (NCT and CECT) showed value in detecting mammographically occult lesions. CT detected 19 lesions that were not detected by mammography and additionally was able to detect one new lesion not detected on any other imaging. Out of all cancers in this cohort, only one was not seen by CT. This study showed that CT has the potential to have high sensitivity for the detection of breast lesions.

CLINICAL RELEVANCE/APPLICATION
Breast CT is a new imaging technology that may have a role in the detection of breast disease. In this small study cohort, breast CT demonstrated the ability to detect mammographically occult lesions.

SSJ02-06  •  Clinical Application and Analysis of Contrast-enhanced Cone-beam Breast CT (CE-CBBCT) in Differentiating Benign and Malignant Breast Lesions

Peng Han MD, MBBS (Presenter) ; Zhao Xiang Ye

PURPOSE
To evaluate the contrast enhancement and the optimal enhancement timing for contrast-enhanced cone-beam breast computed tomography (CE-CBBCT) in differentiating benign and malignant breast lesions.

METHOD AND MATERIALS
Twenty-one subjects were enrolled under an Institutional Review Board (IRB) approved study protocol in Tianjin Cancer Hospital, China, and had CE-CBBCT before biopsy and treatment. All subjects were female. They were between 36 and 68 years old with a median age of 52.2. The subjects received diagnostic mammography or ultrasound within two weeks and were categorized as BI-RADS 4 or 5. The CE-CBBCT exam included one pre-contrast scan and two post-contrast scans (initiated at 40 seconds and 120 seconds from the start of injecting contrast material). All statistical analyses were performed in SPSS.

RESULTS
CONCLUSION
Both benign and malignant lesions had more enhancements at 120s than 40s after the contrast injection. Malignant lesions had more enhancement compared to benign lesions. CE-CBBCT may improve the conspicuity of breast lesions, detect minimal disease in the case of multiple lesions, and improve the early detection and diagnosis of breast cancer.

CLINICAL RELEVANCE/APPLICATION
Cone-beam breast CT is a dedicated breast CT with low radiation dose and short scan time. True three-dimensional breast image can be reconstructed after a circular scan of the breast.

Cardiac (Contrast II) Tuesday, 03:00 PM - 04:00 PM  •  E350  Back to Top C  SSJ03  •  AMA PRA Category 1 Credit™: 1  •  ARRT Category A+ Credit: 1  Moderator Richard D White , MD

SSJ03-01  •  Optimization of Contrast Injection Protocol for Tube Potential during Cardiovascular Computed Tomography

Yajuan Wang PhD (Presenter) * ; Anjali Kottha ; Corey Kemper PhD * ; John F Kalafut PhD * ; Sandra S Halliburton PhD *

PURPOSE
X-ray tube potential affects iodine attenuation on CT images but is rarely considered in contrast protocol planning. This study investigated modification of a commercial contrast injection algorithm (P3T®, Bayer Radiology) to account for tube potential at cardiovascular CT.

METHOD AND MATERIALS
59 patients referred for evaluation pre- or post- endovascular stent graft repair were imaged (Definition FLASH, Siemens). Prospectively ECG-triggered helical techniques were used with a tube potential of 100 (n=34) or 120 kV (n=25), depending on patient weight. Patient weight, timing bolus characteristics, and scan time were inputs to the contrast protocol algorithm. Average attenuation and noise (standard deviation of attenuation) from 6 circular regions of interest (ROI) placed along the length of the aorta were computed and compared using a Student’s t test. A pharmacokinetic model (ACES, Bayer Radiology) was used to simulate aortic attenuation at 100kV and investigate the potential to achieve a desired enhancement (350 HU) at contrast volume reductions of 20, 30 and 40%.

RESULTS
Both cohorts had similar age, M/F ratios, scan duration and scan length. 100kV cohort had lower body mass index (24.8±3.4 vs. 29.4±3.5 kg/m²), total contrast volume (93±19 vs 106±6 mL) and size-specific dose estimates (2.9±0.9 vs 4.4±1.2 mGy). Average aortic attenuation was 27% higher at 100kV (482±96 HU vs 381±62 HU) and image noise was slightly greater (36±6 vs. 29.4±3.5 kg/m²).

CONCLUSION
This study demonstrated the ability to detect mammographically occult lesions.

CLINICAL RELEVANCE/APPLICATION
Contrast injection protocols can be optimized for tube potential permitting use of less contrast in some patients to achieve the desired blood enhancement.

SSJ03-02  •  Transluminal Attenuation Gradient in Normal Coronary Arteries with 320-row Prospectively ECG-gated Computed Tomography Angiography (CTA) in Three Consecutive Cardiac Cycles: Association with Intracoronary Mean Contrast Effect and Cardiac Functions

Yukihiro Nagatani MD (Presenter) ; Masashi Takahashi MD ; Norihisa Nitta MD ; Noritoshi Ushio RT ; Hiroshi Sakai ; Takashi Yamamoto ; Hideji Otoni MD ; Kazumasa Kobashi ; Jyousei Ueda ; Kiyoshi Murata MD
Angiography (CCTA)  

**SSJ03-04 •** Thoracic Aorta: Is a Blood Pool Agent Required?  

**Shujing Yu**

quickly after contrast. Therefore the additional cost of gadofosveset might not be justified for routine thoracic MRA studies.  

**RESULTS**  

In all the 3 NCA, MCE at the 3rd CC was higher than MCE at the 1st CC. In right coronary artery (RCA), TAG at the 3rd CC (-1.6±5.3) was larger than that at r-CTA (-6.7±3.6) (p=0.01). In left circumflex artery (LCX), TAG was larger at the 3rd CC (-14.9±16.4) than at the 2nd CC (-18.5±14.2) (p=0.041). In RCA, MCE at every CC correlated with body mass index. In left anterior descending artery, MCE at the 3rd CC and TAG at the 1st CC correlated with body surface area (r=0.658 and 0.634, respectively). In LCX, TAG at the 3rd CC correlated with ejection fraction (r=0.526).  

**CONCLUSION**  

Increase in MCE at the 3rd CC could have potentiality to approximate TAG to 0-level in RCA and LCX regardless of considerable influence of body surface area and ejection fraction.  

**CLINICAL RELEVANCE/APPLICATION**  

Approximation of TAG to level due to increased MCE in three consecutive CC may enhance value of TAG as a novel non-invasive indicator of coronary stenosis.

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**SSJ03-03 •** Oral Use of Gadobenate Dimeglumine for Visualization of Oesophagus during MRA in Patients Candidated to Catheter Ablation  

**Alessandro Rapolinio** MD ; **Riccardo Faletti** (Presenter) ; **Angela Grasso** MD ; **Camilla Bogetti** MD ; **Chiara Perazzini** MD ; **Annelis Dominguez** MD ; **Paolo Fonio** ; **Giovanni Gandini** MD

**PURPOSE**  

Atrio-oesophageal fistula was first reported as a fatal complication of surgical endocardial and percutaneous endocardial radiofrequency ablation for atrial fibrillation, with an incidence after catheter ablation between 0.03% and 0.5%. Cardiac magnetic resonance angiography (MRA) was usually performed to obtain pre-procedural 3D images, used to create an electro-anatomical map guiding step-by-step ablation strategy of AF. Our purpose was to assess oesophageal anatomy during MRA due to obtain a ‘real-time’ visualization of the oesophageal position during RFCA.  

**METHOD AND MATERIALS**  

In 35 consecutive patients a MRA sequence, was performed in axial plane 24 hours before catheter ablation using intravenous gadobenate dimeglumine contrast media and oral administration for oesophagus intensification of 2-3 spoonsfuls of a gel solution (0.8-1 ml gadobenate dimeglumine contrast media mixed with approximately 50 mg thickened water gel), while they were on scanning table immediately before MRA breath-old sequence acquisition.  

**RESULTS**  

Oesophagus visualization was obtained in all patients and well merged, as left atrium and pulmonary veins, during percutaneous endocardial radiofrequency ablation, successfully creating an electro-anatomical map. All patients well tolerate the study protocol and any immediately or late complication was observed after oral contrast agent administration. MRA acquisition time with double contrast agent administration did not show any significance difference from conventional MRA.  

**CONCLUSION**  

In our experience oesophagus visualization with gadobenate dimeglumine oral administration MRA is a feasibly imaging technique for Integration of esophagus anatomy images into the electroanatomical map preventing oesophageal injuries during AF ablation without patients undesirable side effects and without increasing significatively cost and examination time.  

**CLINICAL RELEVANCE/APPLICATION**  

Oesophagus visualization in electro-anatomical map during RFCA procedure is an important help to avoid fatal complication as atrio-oesophageal fistula.

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**SSJ03-04 •** Gadofosveset versus Gadobenate for Steady-state 3D Contrast-Enhanced MRA (SS CE-MRA) Evaluation of the Thoracic Aorta: Is a Blood Pool Agent Required?  

**Vikram Bamra** MD (Presenter) ; **Jeffrey H Maki** MD, PhD * ; **Dinesh Kumar** MBBS

**PURPOSE**  

Compare the image quality (SNR and vessel edge sharpness) of gadobenate (MultiHance, Bracco) vs. gadofosveset trisodium (Ablavar, Lantheus) for steady state, ECG-triggered 3D CE-MRA evaluation of the thoracic vasculature. Gadofosveset is a blood pool contrast agent with extended intravascular retention and high R1 relaxivity designed for MRA. These properties allow for imaging could be performed with the high relaxivity extracellular agent gadobenate.  

**METHOD AND MATERIALS**  

**RESULTS**  

No significant difference noted in mean SNR (15.5 vs. 15.2) or image sharpness (2.4 vs. 2.1 mm) for gadofosveset vs. gadobenate (both p >> 0.05). Vessel sharpness trended better with gadobenate, with a trend also toward more blurring and less SNR in the ascending aorta that may be due to greater flow and motion.  

**CONCLUSION**  

Steady-state ECG-triggered thoracic CE-MRA performed in the early equilibrium period (within 5 min) with a high relaxivity contrast agent is equivalent to that with a blood pool agent.  

**CLINICAL RELEVANCE/APPLICATION**  

Gadofosveset and gadobenate provide similar image quality for thoracic SS CE-MRA when gadobenate SS MRA is started relatively quickly after contrast. Therefore the additional cost of gadofosveset might not be justified for routine thoracic MRA studies.

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**SSJ03-05 •** A Pilot Study of Optimized Injection Rate of Contrast Media(CM) on Image Quality of Coronary CT Angiography(CCTA)  

**Shujing Yu** MD (Presenter) ; **Lianli Zhao** ; **Yanfeng Xu** MD ; **Jing Zheng** MD ; **Li Zhang** MD ; **Zhi Wang** MD

**PURPOSE**  

To compare both mean contrast effect (MCE) and transluminal attenuation gradient (TAG) among three consecutive cardiac cycles (CC) and evaluate their relations to cardiac functions and body habitus indices in respective three normal coronary arteries (NCA).  

**METHOD AND MATERIALS**  

Study group consisted of 40 patients with NCA who underwent both 320-row ECG-gated CTA and trans-thoracic echocardiography within 1 month of each other. They were classified into 20 patients in group-A (respectively ECG-gated CTA in the three consecutive CC) and 20 patients in Group-B (retrospectively ECG-gated CTA: r-CTA). Each patient received 240mg/kg body weight of a non-ionic contrast medium in 10-sec, and data acquisition was started when both a threshold of 250 Hounsfield Unit (HU) in left atrium and that of 80 HU in descending aorta was reached. In group-A, image data were reconstructed at each CC. Both TAG and MCE were calculated as linear regression coefficient between luminal attenuation and axial distance based on multiple measurements with even 10-mm intervals, and as average of CT attenuation value in all the measurements, respectively. Pearson’s correlation coefficients between TAG and some cardiac functional indices were obtained in each CC and r-CTA. Both TAG and MCE were compared among three consecutive CC using Friedman and Wilcoxon signed-rank test in group-A, and between each CC and r-CTA using Man-Whitney U test.  

**RESULTS**  

In all the 3 NCA, MCE at the 3rd CC was higher than MCE at the 1st CC. In right coronary artery (RCA), TAG at the 3rd CC (-1.6±5.3) was larger than that at r-CTA (-6.7±3.6) (p=0.01). In left circumflex artery (LCX), TAG was larger at the 3rd CC (-14.9±16.4) than at the 2nd CC (-18.5±14.2) (p=0.041). In RCA, MCE at every CC correlated with body mass index. In left anterior descending artery, MCE at the 3rd CC and TAG at the 1st CC correlated with body surface area (r=0.658 and 0.634, respectively). In LCX, TAG at the 3rd CC correlated with ejection fraction (r=0.526).  

**CONCLUSION**  

Increase in MCE at the 3rd CC could have potentiality to approximate TAG to 0-level in RCA and LCX regardless of considerable influence of body surface area and ejection fraction.  

**CLINICAL RELEVANCE/APPLICATION**  

Approximation of TAG to level due to increased MCE in three consecutive CC may enhance value of TAG as a novel non-invasive indicator of coronary stenosis.
METHOD AND MATERIALS
We enrolled 252 patients, aged between 30 and 70, with normal heart and lung functions and all the subjects were scanned using DVCT (Aquilion ONE, Toshiba, 16cm detector). The heart rate of all the subjects was controlled below 65 beats per minute, which guaranteed the data acquisition within one heart beat. Of these, patients were assigned to 2 groups: A, BMI>24, scanned using 120kV tube voltage with 65ml CM and B, BMI=24, scanned using 100kV with 55ml CM. Each group was divided into six sub-groups by giving 370 or 350 mg I/ml of CM (65 ml) at the rate of 4, 5 or 6 ml/s. The three coronary trunks were divided into 15 segments. Two different and subjective methods were used for evaluating the image quality for each of the 15 segments. For the objective method, signal-to-noise ratio (SNR) and contrast-to-noise ratio (CNR) of each segment were calculated and compared between groups. For the subjective method, two experienced radiologists evaluated the image quality by 4-point(1=bad, 2=good, 3=very good, 4=perfect).

RESULTS
The injection rate had no significant effect on the image quality of coronary artery for both Group A and B (p>0.05). The image quality of Group B was significantly higher than that of Group A (p<0.05). Different injection rate had no effect on image quality, that means we can try to use lower injection rate, such as 4ml/s for CCTA. This should be further tested in a large cohort of subjects.

CONCLUSION
This study confirmed that lower injection rate will generate similar image quality with the higher ones. This conclusion will have very good benefit for patients.

SSJ03-06 • Quantification of Iodine Concentration at Various Heart Rates by Using Cardiac Gemstone Spectral Imaging: An In Vitro Validation

Zhang Zhang (Presenter); Ningnannan Zhang PhD; Chun-Shui Yu; Dong Li MD; Jing Yu; Wenjia Zhang; Jiaojiao Li; Qingqing Lu; Huiting Liu; Qian Cui; Tielian Yu

PURPOSE
CT attenuation values from the traditional polychromatic X-ray imaging (TPXI) are variable due to X-ray absorptivity varying on different energy levels. It is hard to make accurate diagnoses only based on the CT attenuation values, which cannot distinguish the different tissues or materials, such as iodine and calcium in coronary plaques. Material decomposition, which derived from gemstone spectral imaging (GSI), may allow us to measure the relative value for certain material. The purpose of the current study was to validate the iodine concentration quantification, and to discuss the relationship between the CT attenuation value and iodine concentration at various heart rates by using cardiac GSI.

METHOD AND MATERIALS
A polypropylene phantom (Quantitative Standard Pulsating Phantom QSP-1, Fuyo Corporation) with eight test tubes (in which iodine concentrations of solution were 50, 40, 30, 20, 15, 10, 5, 1 mg/ml) underwent TPXI and cardiac GSI on a single-source dual-energy spectral CT (Discovery CT750 HD CT FREEdom Edition scanner, GE Healthcare, Milwaukee, WI, USA) at various simulated pulsating rates (0, 40, 50, 60, 70 bpm). All the spectral imaging data were analyzed with GSI viewer to reconstruct the virtual monochromatic spectral (VMS) images. The CT attenuation values of both TPXI and VMS were measured for each data set. The iodine concentration was measured on the water-suppressed image (iodine-water as the basic substances).

RESULTS
The correlation coefficients between the CT attenuation value and known iodine concentration were improved by the VMS method, signal-to-noise ratio (SNR) and contrast-to-noise ratio (CNR) of each segment were calculated and compared between TPXI and GSI.

CONCLUSION
Comparing to TPXI, VMS can produce better correlation coefficients between the CT attenuation values and iodine concentrations. And the iodine concentration could be accurately quantified from the iodine-water basic substances imaging.

CLINICAL RELEVANCE/APPLICATION
The cardiac GSI may provide an accurate coronary artery assessment for the clinicians.
Use of low x-ray tube voltage and iterative image reconstruction allows decreasing the iodine load and effective radiation dose at cCTA while image quality is maintained.

CLINICAL RELEVANCE/APPLICATION
Continuous reduction in radiation exposure and iodine load associated with cCTA should enhance the safety and clinical acceptance of this test.

SSJ04-02 • CT Coronary Angiography: Effect of Iodine CONcentration on Vascular Attenuation: The CT-CON Multicentric Study Preliminary Results

Marco Rengo MD (Presenter) ; Anoeshka S Dharampal MD ; Marco Das MD *; Marc C Kock MD ; Andre Niezen ; Fiek Van Tilborg ; Damiano Caruso MD ; Koen Nieman MD ; Gabriel P Krestin MD, PhD *

PURPOSE
To explore the relative impacts of iodine concentration versus iodine delivery rate on intra-coronary attenuation. To describe the effect of iodine concentration on contrast bolus characteristics.

METHOD AND MATERIALS
675 patients were prospectively randomized in 4 groups and underwent CT Coronary Angiography (CTCA). Four CM with different iodine concentrations (300, 350, 370, 400 mgI/ml) were delivered at a fix iodine delivery rate (2.0 mgI/s). Intra coronary attenuation values were measured and grouped on a per-vessel and per-segment bases. Time-to-peak, and pressure curves during CM injection were evaluated and compared.

RESULTS
Injection fluxes were 6.7 ml/sec, 5.7 ml/sec, 5.4 ml/sec and 5 ml/sec for group A, B, C and D respectively. No significant differences were observed among four groups in terms of intravascular density on a per-segment and per-vessels analysis. Time-to-peak was significantly earlier in group A (15.3 sec) than in the other three groups. The injection peak pressure was significantly lower in group A (185.16 psi) and C (189.05 psi) than in group B (215.89 psi) and D (243.33 psi). No extravasations were noted in all groups.

CONCLUSION
Contrast media with different iodine concentrations, if injected at the same IDR, provide similar intravascular attenuation values. The lower concentration contrast medium provided significantly lower injection pressure values and a significantly shorter time to peak enhancement.

CLINICAL RELEVANCE/APPLICATION
Intravascular attenuation in CT coronary angiography is mainly influenced by iodine delivery rate and is independent by iodine concentration.

SSJ04-03 • Postmarketing Surveillance Study with Iodixanol (VISIPAQUE®) 270/320 mgI/ml Injection in 20,185 Chinese Patients in Routine Clinical Settings

Bin Lu MD (Presenter) ; Ya-Wei Xu ; Wei-Hua Yin ; Zhi-Hui Hou MD ; Yang Gao ; Fang-Fang Yu ; Bu-Chun Zhang ; Lei Hou

PURPOSE
This study was to investigate the incidence and nature of immediate and delayed adverse drug reactions (ADRs) as well as patient discomfort in patients using iodixanol.

METHOD AND MATERIALS
A multicenter, open-label, prospective, observational study was conducted at 95 centers in China from June 2011 to October 2012. Demographics, medical conditions, details of the diagnostic procedure, contrast agent administration and ADR data were collected using a standardized case report form. Patients were asked to report immediate (occurring within one hour of administration of iodixanol) or delayed (occurring from 1 hour up to 7 days after administration of iodixanol) adverse reactions. Discomfort was rated by patients on a scale of from 0 to 10 for pain, heat, and coldness (score 0 = no discomfort; 1-3 = mild; 4-7 = moderate; 8-10 = severe); individual scores were combined into a composite score (0-30). The incidence of ADR was summarized and discomfort score was converted to no, mild, moderate or severe discomfort and summarized.

RESULTS
A total of 20,185 patients were enrolled. The mean age of this group was 60.4 years. Overall incidence of ADRs were 1.52% (307/20,185 patients), of which 0.58% was immediate, and 0.97% was delayed onset. Five patients experienced both immediate and delayed ADR. The most common immediate ADRs were nausea, vomiting, and other gastrointestinal disorders with an incidence of 0.22% (45/20,185 patients). The most common delayed ADRs were rash, pruritus, mucocutaneous rash and other skin and subcutaneous tissue disorders with a total incidence of 0.68% (138/20,185 patients). Serious ADRs occurred in two patients (0.01%). There were 73.3% (14,791/20,185) of patients in this study had no pain after injection of iodixanol, and 21.5% (4,338) reported a composite score of 1-3 (mild discomfort), 5.2% of 4-15 (moderate discomfort), 2 reported over 15 (severe discomfort).

CONCLUSION
There were no unexpected serious ADRs were observed. Patients' discomforts during administration were mild or absent. The results of this postmarketing surveillance study indicated that iodixanol was a safe contrast agent in Chinese population.

CLINICAL RELEVANCE/APPLICATION
Iodinated radiographic contrast media are considered as safe diagnostic drugs with a low incidence of adverse drug reactions.

SSJ04-04 • A Prospective Study of Low Concentration of Contrast Medium in Coronary CT Angiography with Low kVp Technique

Xu Li (Presenter) ; Liren Zhang MD ; Yanping Liu ; Dongsheng Xu

PURPOSE
To prospectively investigate the utility of low tube voltage to reduce contrast medium dose in coronary CT angiography (CTCA).

METHOD AND MATERIALS
90 consecutive patients (BMI < 28, 52 men, 38 women; mean age:54.42±8.64 years) suspected with cardiac disease were included. Group A(10=46) underwent conventional CTCA with 120kvp and normal contrast medium (Omnipaque, 350 mgI/ml) dose at 0.8ml/kg on a LightSpeed VCT scanner, group B underwent modified CTCA with 100kvp and low contrast medium (Visipaque, 270 mgI/ml) dose at 0.8ml/kg (n=44) on a Discovery CT 750 HD scanner. FBP image and 30° AHA were reconstructed for group A and B respectively. The CT value and SD value of aortic root(LAD), left main coronary artery(LM), left anterior descending artery(LAD), left circumflex(LCX), and right coronary artery (RCA) were measured. The CNR of AO,LM,LAD,LCX,RCA were calculated. Two radiologists assessed all images with 4-point scale. Data were analyzed using student T-test and Wilcoxon rank sum test by SPSS 13.0 statistical analysis software.

RESULTS
Both the mean ages and BMIs of two groups(age, 53.00±8.39 vs 55.8±8.47, P=0.12; BMI,24.44±2.93 vs 24.16±1.71, P=0.58) had no significant difference. The mean ED in group B (0.87±0.22mSv) was reduced by 44.9% than that in group A (1.58±0.46mSv). The mean enhancements of three main coronary arteries were similar between two groups (LAD, 384.59±64.98 vs 390.69±59.87; LCX 370.5±38.23 vs 374.77±57.4; RCA 408.75±66.44 vs 412.79±52.62, each P>0.05). The SD values of three
SSJ05-05 • Initial Experience of Contrast Agent Dose Reduction with Low Tube Voltage and Adaptive Statistical Iterative Reconstruction (ASiR) in Coronary Computed Tomography Angiography

Hao Zhang (Presenter) ; Tong Zhang ; Bao-Zhong Shen

PURPOSE
To evaluate the feasibility of reducing both contrast and radiation doses using lower concentration contrast agent and a lower peak kilovoltage (kVp) with adaptive statistical iterative reconstruction (ASiR) in coronary computed tomography angiography (CCTA).

METHOD AND MATERIALS
100 patients with stable and low heart rates of (mean±SD) 70±10 per minute were included in the study. The mean CNR values for the 4 coronary arteries were 13.4±3.2 in group A and 13.1±3.2 in group B, with no difference (t-test, P > 0.05). There was also no difference between the two groups in image quality score (livescore vs. 3.48±0.59, p>0.05). On the other hand, contrast dose was reduced by 33% in group B, and effective radiation dose was about 43% lower with the 80kVp protocol (1.8±0.7mSv) than with the 120kVp (4.21±1.20mSv).

CONCLUSION
33% contrast and 39% radiation dose reduction can be achieved by using 270mgI/ml concentration contrast agent and 80kVp tube voltage with 50%ASiR in CCTA without image quality deterioration.

CLINICAL RELEVANCE/APPLICATION
This coronary CTA method is suitable for patients with renal dysfunction, and can reduce the contrast-induced nephropathy and the potential carcinogenic of risk of coronary CTA.

SSJ04-06 • Novel Connecting Tube for Saline Chaser in Contrast-enhanced CT: The Effect of Spiral Flow of Saline on Contrast Enhancement

Masafumi Kidoh ; Takeshi Nakaura (Presenter) ; Kazuo Awai ; Koji Yuba ; Kazunori Harada ; Yasuyuki Yamashita ; Takayuki Kobayashi ; Young-Kwan Park ; Takanobu Yagi

PURPOSE
We developed a new connecting tube for the saline chaser, which generates a spiral flow of saline. The purpose of this study was to evaluate the effect of a newly developed connecting tube on aortic and hepatic contrast enhancement during hepatic-arterial and portal venous phase (HAP, PVP) Computed Tomography.

METHOD AND MATERIALS
We developed a new connecting tube for the saline chaser, which generates a spiral flow of saline. The purpose of this study was to evaluate the effect of a newly developed connecting tube on aortic and hepatic contrast enhancement during hepatic-arterial and portal venous phase (HAP, PVP) Computed Tomography.

RESULTS
CONCLUSION
Our study demonstrated that the new connecting tube increased the effect of saline chaser and significantly improved aortic contrast enhancement during HAP.

CLINICAL RELEVANCE/APPLICATION
The new connecting tube increases the effect of saline chaser. The new connecting tube may further reduce the volume of contrast material without a subsequent decrease in arterial attenuation in CTA.

Cardiac (CV Outcomes and Risk Assessment) Tuesday, 03:00 PM - 04:00 PM • SSJ04AB Back to Top SSJ05 • AMA PRA Category 1 Credit ™ • ARRT Category A+ Credit:1 Moderator Jill E Jacobs , MD

Modmerator Scott D Flamm , MD *

Modmerator Pamela K Woodward , MD *

SSJ05-01 • Prognostic Value of Coronary CT Angiography (CCTA) for the Prediction of Major Cardiovascular Events - ‘Warranty Time’ after a Normal (No Visible Plaque) CCTA

Hugo M Marques (Presenter) ; Antonio Ferreira ; Rosana G Santos ; Cecilia I Leal ; Nuno Cardim ; Vasco V Mascarenhas ; Adalgisa Guerra ; Pedro A Goncalves ; Pedro Araujo Goncalves

PURPOSE
Coronary CT angiography is now an established method for the evaluation of patients with suspected coronary disease. The time without major cardiac events after a normal (no visible plaque) CCTA is still to be completely accessed and is of particularly importance since it may impact on the downstream use of other tests. The purpose of this study was to evaluate the mid/long term prognostic value of a normal CCTA.

METHOD AND MATERIALS
From a prospective registry of consecutive 2062 patients that underwent CCTA (dual-source 64s) from February 2007 to December 2010, we excluded all with previous revascularization and/or those undergoing the study for suspected acute coronary syndrome. The presence of coronary plaque and the severity of stenosis ( < 50% vs >or =50%) was assessed. The final study population was 623 patients (46%) had a normal CCTA (without visible plaque), 514 (38%) had plaque with 50% stenosis. There were no events on patients with a normal CCTA within the first 2.5years of follow up.

CONCLUSION
CCTA provides important and durable prognostic information. There were no events on patients with a normal CCTA (no plaque visualized) within the first 2.5years of follow up.

CLINICAL RELEVANCE/APPLICATION
The time without major cardiac events after a normal (no visible plaque) CCTA is still to be completely accessed and is of particularly importance since it may impact on the downstream use of other
Determinants of stroke recurrence after ischemic stroke using cardiac computed tomography (CCT) is not well established. We investigated the CCT findings predictive of recurrent stroke in ischemic stroke patients and determined the incremental risk stratification benefit of CCT findings as compared to transesophageal echocardiography (TEE) in ischemic stroke patients.

**METHOD AND MATERIALS**
Among 465 consecutive patients, 374 ischemic stroke patients (67.9% were male with a mean age of 63.1 years) who underwent TEE and CCT were prospectively enrolled in this study. TEE and CCT images were assessed for cardiacoembolic sources including thrombus, tumor, spontaneous echo contrast (SEC), valvular vegetation, septal abnormality, and aortic plaque. The primary end-point was recurrence of stroke. We assessed prognostic factors with Cox univariate and multivariate analysis. Time-dependent receiver operating characteristic (ROC) curve method was used and integrated area under the curve (IAUC) was calculated to compare the predictive prognostic between CT and TEE parameters.

**RESULTS**
During the median follow-up period of 239 days, there were a total of 24 recurrent stroke. CT parameters of plaque thickness (HR: 1.178, 95% CI: 1.015-1.366, p = 0.031) and complexity of plaque (HR: 5.304, 95% CI: 2.264-12.425, p = 0.004, respectively). Similarly, both AC and PWV were independently associated with increased risk for nonfatal extra-cardiac composite events after multivariate adjustment (HR 1.16 per 1SD increase, p=0.09). Both AC and PWV were independently associated with increased risk for cardiovascular death (HR 2.27 per 1SD increase, p=0.02; and HR 1.46 per 1SD increase, p=0.04). Compared with participants in the highest quartile AC (most compliant), those in the lowest quartile AC (66%) had risk-predictive advantages compared to TEE parameters.

**CONCLUSION**
Cardiac CT can be used to assess cardioembolic sources and also determine risk of recurrent stroke in stroke patients.

**CLINICAL RELEVANCE/APPLICATION**
Cardiac CT can be used to assess cardioembolic sources and also determine risk of recurrent stroke in stroke patients.
OBJECTIVE
We evaluated a new 16,158 patients with known CAD with normal CCTA or non-obstructive disease (defined as CCS ≤ 0.5).

RESULTS
At a 2.3 + 1.1-year follow-up, MACE occurred in 251 patients (0.6% annual event rate). Women were more likely to be dyslipidemic, hypertensive, diabetic and have a family history of CAD (p < 0.05). The median CCS for both groups was 0 (25th, 75th percentile: 0, 4; p > 0.05). When adjusting for the time between diagnosis/RT and CT, RT patients had a significantly lower risk of a positive CCS compared to noRT patients, with a hazard ratio of 0.54 (95% confidence interval, 0.32-0.93, p < 0.001). Our data confirms similar risk of non-obstructive CAD on CCTA among women and men who undergo breast cancer survivors after RT.

CONCLUSION
Breast cancer survivors after radiation therapy (RT) are not more likely to show coronary calcifications on subsequent CT imaging. Our preliminary results thus do not support radiation-induced accelerated CAD as an explanation for higher rates of heart disease in this group.

CLINICAL RELEVANCE/APPLICATION
The search for a culprit should be widened to include other potential causes of higher heart disease rates in breast cancer survivors after RT.

METHOD AND MATERIALS
This IRB-approved, HIPAA-compliant study enrolled 158 subjects (115 positive, 43 negative for CT-confirmed pulmonary nodules) at four tertiary care institutions. Subjects were imaged by chest CT, CXR (PA and lateral), DE, and DT on a flat-panel imaging device (VolumeRAD, GE Healthcare, Chalfont St. Giles, UK). Three experienced thoracic radiologists confirmed presence and location of nodules (344 of 3-5 mm, 130 of >5-8 mm, and 42 of >8-20 mm) were identified by CT. Overall detection sensitivity was 3.8% (95% confidence interval, 2.4-5.3). Among the 2,491 total nodules, DE outperformed CXR for lung nodule detection and for determination of actionability using Fleishner Society criteria. The addition of DE improved determination of actionability when paired with CXR but not when paired with DT.
SSJ06-02 • Comparative Study between Mobile Computed Radiography and Mobile Flat-panel Radiography with and without Anti-scatter Grid for Bedside Chest Radiography: Impact on Image Quality

Thomas Lehnert MD (Presenter); Nagy N Naguib MSc; Josef Matthias Kerl MD *; Ralf W Bauer MD *; Maya C Larson; Thorsten Burkhard MD; Boris Schulz MD; Thomas J Vogl MD, PhD

PURPOSE
To evaluate the effect of an anti-scatter grid on perceived image quality in adult bedside chest radiographs using both a mobile digital radiography (DR) system and a conventional computed radiography (CR) system.

METHOD AND MATERIALS
We included 103 intensive care patients (mean age: 66.4 years). Patients received bedside chest radiographs using four acquisition techniques (CR and DR with and without grid). Image quality was evaluated independently by four radiologists using a 9-point visibility scale. Evaluated were: lung parenchyma, soft tissues, thoracic spine, foreign bodies and overall image quality. Inter-observer agreement and differences between systems were tested using inter-class correlation test. Mean scores were compared by analysis of variance (ANOVA) followed by post-hoc pairwise testing (Tukey test) in case of multiple group comparison and by student’s t-test in case of single group comparison (p < 0.05 = significant).

RESULTS
The image quality of the DR images with a grid was significantly higher than that obtained without a grid (p CONCLUSION
The use of an anti-scatter grid significantly improved the image quality of bedside DR radiographs. A similar effect was seen with CR radiographs but only for lung parenchyma, soft tissue and overall image quality. Mobile DR outperformed CR in all structures.

SSJ06-03 • Impact of Digital Scatter Correction on the Image Quality of Bedside Chest Radiographs

Sarah Poetter-Lang (Presenter); Helmut Prosch; Daniela Kienzl; Barbara J Fueger MD; Michael Weber; Cornelia M Schaefer-Prokop MD *; Martin Uffmann MD

PURPOSE
The use of an anti-scatter grid for bedside chest radiographs in intensive care unit patients yields improved image quality at the cost of increased patient dose, higher demands on the acquisition technique and a heavier cassette weight. The aim of our study was to evaluate the impact on image quality of a newly developed processing method that allows for digital correction of scattered radiation.

METHOD AND MATERIALS
On consecutive days, 51 intensive care unit patients received clinically indicated bedside chest radiographs (MobileDiagnost wDR, Philips, Hamburg) with an anti-scatter grid (method A), and without an anti-scatter grid, but at a 1.6-fold reduced radiation dose (method B). The reduced-dose images were processed using scatter correction software (method C). Four readers evaluated the 153 images independently, in random order, scoring the visibility of five image quality features on a 10-point scale from 1 (very bad) to 10 (excellent), and with 4 indicating the minimum requirement for diagnostically acceptable image quality. Delineation of anatomic landmarks in high- and low-absorption areas was used as a surrogate for image quality, and thus, delineation of abnormalities. An analysis of variance with repeated measures was used to test the significance of differences of reader ratings at a p level below 0.05.

RESULTS
For all imaging features, quality was rated significantly different (p CONCLUSION
The scatter correction algorithm yielded significantly higher image quality for bedside chest radiographs compared to non-corrected images, but were inferior to grid images. The scatter-corrected images were comparable to grid images based on a threshold chosen to determine potentially diagnostically relevant differences.

CLINICAL RELEVANCE/APPLICATION
Scatter correction applied to bedside chest radiographs may obviate the need for anti-scatter grids, and therefore, enables a substantial radiation dose reduction.

SSJ06-04 • Yield of Screening Chest Radiography for a Positive PPD Test in New York City

Grace C Lo MD (Presenter); Michael A Kadoch MD; Vivian Bishay MD; Thomas J Ward MD; Matthew D Cham MD; Adam Jacobi MD

PURPOSE
The Centers for Disease Control recommends that individuals with a positive PPD test undergo chest radiography to exclude a diagnosis of tuberculosis (TB). There are more reported cases of TB in New York City (NYC) each year than in any other city in the country. The purpose of this study was to review the prevalence of radiographic abnormalities of TB on chest x-rays (CXR) performed for a positive PPD in a single, urban tertiary medical center in NYC.

METHOD AND MATERIALS
Institutional review board approval was obtained. CXR reports of 904 consecutive asymptomatic individuals with a positive PPD test between January 1, 2011 and December 31, 2012 were reviewed. The prevalence of radiographic abnormalities of TB, the amount of downstream testing generated, and the results of sputum cultures, when available, were recorded.

RESULTS
Of the 904 cases reviewed (676 females, 228 males, mean age 34.74), not a single case of confirmed active TB was identified. Active TB could not be excluded based on CXR alone in 4 patients (0.4%), but all sputum cultures that were obtained in these individuals were negative. Granulomas were present in 26 patients (2.9%). No cavitory lesions were identified. A single case of lung cancer was identified (0.1%). Follow-up exams were recommended in 30 patients (3.3%), which included 15 CT scans (1.7%), 11 radiographs (1.2%), 2 echocardiograms (0.2%), 1 ultrasound (0.1%), and 1 mammogram (0.1%).

CONCLUSION
Despite the fact that there are more reported cases of TB in NYC than in any other city in the country, universal screening of asymptomatic PPD positive patients with chest radiography is still a low-yield study for the detection of active TB. It also generates a significant amount of downstream testing. These exams may also represent an unnecessary source of radiation exposure.

CLINICAL RELEVANCE/APPLICATION
Screening chest radiography among asymptomatic PPD patients appears to be a low-yield study for the detection of active TB. Therefore, it may be time to reconsider this universal recommendation.
**SSJ06-05 • Bulb’s Eye Imaging for the Evaluation of Pulmonary Blood Flow Using Non Enhancement Dynamic Chest X-ray:**

In Comparison with 99mTc-MAA Perfusion Scintigraphy

Takehiko Abe MD (Presenter); Norihisa Motohashi MD, Ph.D.; Yuka Sasaki; Tomomichi Izuka; Naoko Koyanagi; Atsuko Kurosaki MD; Sumiya Nagatsuka MS; Hideo Ogata; Shoji Kudoh MD, PhD

**PURPOSE**

To evaluate the bulb’s eye imaging of pulmonary regional blood flow using non enhancement dynamic chest X-ray in comparison with 99mTc-MAA scintigraphy.

**METHOD AND MATERIALS**

Dynamic chest pulsed X-ray at 15 frames per second in total 10 second of tidal breathing was performed in 69 patients (male:38, female:31 65.3years± 12.1years) with pulmonary disease. The institutional review board approval and written informed consent was obtained in all patients. Image data-sets were extracted by signal intensity pixels of blood flows by using a band-pass filter optimized for heart beats. Two trained radiologists were diagnosed and determined main vessel phase, capillary phase, and Maximum intensity projection (MIP) of each frames in one heart beat was adjustment to the bulb’s eye fields and divided into 6 fields (upper, middle, lower, in right and left in every 2 hours). The signal value rate of the dynamic chest x-ray was compared with the 99mTc-MAA scintigraphy.

**RESULTS**

All the patients were performed technically with the total exposed dose of 0.25mGy.

The signal rate of the blood flows of main vessels in each upper, middle, lower fields was 11.9%±2.3, 23.1%±4.2, 20.7%±5.3, and 12.1%±2.8, 23.0%±5.5 and 9.2%±3.6 in the left.

The signal rate of capillary blood flow was 13.6%±2.4, 16.5%±2.8 and 23.6%±5.1 in the right, and 13.5%±3.1, 16.2%±3.4, and 16.5%±5.0 in each upper, middle, lower fields. The rate of the MIP was 13.0%±1.4, 20.4%±2.2 and 22.4%±3.1 in the right, and 12.9%±1.9, 19.0%±2.6 and 12.4%±3.4 in the left.

In those cases, The 99mTc-MAA uptake was 7.3%±2.8, 21.3%±5.6 and 27.6%±8.2 in the right and 7.3%±3.0, 18.4%±5.7 and 18.0%±7.9 in the left, respectively.

Comparison of the examinations had good correlations with R=0.59 in main vessel phase, R=0.43 in capillary phase, and R=0.67 in MIP in this study.

**CONCLUSION**

Bulb’s eye imaging of dynamic chest X-ray blood flows had some collation with 99mTc-MAA scintigraphy. This method has potential to allow measurement and quantification of pulmonary blood flows.

**CLINICAL RELEVANCE/APPLICATION**

Bulb’s eye imaging for the evaluation of pulmonary blood flow using non enhancement dynamic chest X-ray was shown some collation with 99mTc-MAA scintigraphy.

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**SSJ06-06 • Performance of a Next Generation Computer-aided Detection Algorithm for the Detection of Overlooked Lung Cancers on Chest Radiographs**

Calen Frolkis BA (Presenter); Robert C Gilkeson MD *

**PURPOSE**

This retrospective study sought to evaluate a next generation CAD algorithm on the detection of previously overlooked lung cancer on prior chest radiographs.

**METHOD AND MATERIALS**

Institutional Review Board approval was granted for this retrospective study. Patient consent was not necessary given the retrospective nature of the data collection. Retrospective review of 606 patients presented within the last year at our institutions thoracic tumor board was performed. Clinical reports from cross-sectional imaging, pathology and prior chest radiographs were analyzed. Of this cohort, analysis revealed 41 patients whose lung cancer was initially overlooked on a chest radiograph. A board certified chest radiologist with 15 years experience confirmed that this overlooked lesion corresponded to the site of the malignant lesion. A subtlety rating from 1-10 (1 + very subtle) was assigned to each radiograph. Anatomic distribution of nodules was recorded. All 41 images were analyzed by a next generation CAD algorithm (OnGuard 5.2 Riverain Medical). The time lapse between index CXR and eventual clinical diagnosis was recorded.

**RESULTS**

Overlooked lung nodules were found in 41 patients (age range 44-91yrs, average: 69yrs; 23 women, 18 men) on 41 chest radiographs. Subtlety ratings ranged from 1-9, mean of 2.39, mode of 2. Overlooked lesions were distributed in the upper lobes, 41.4% in the Right upper lobe, and 19.5% in the Left upper lobe. The time interval between the index CXR and diagnosis ranged from 1-11yrs to 9yrs, with an average interval of 3.77 days (1.3yrs). The CAD algorithm detected 28 of 41 of these lesions (sensitivity 67%). Location of the lesions detected by CAD were right upper lobe and apex (13, 31.7%), and left upper lobe (8, 41.4%). The most common pathologic diagnosis in our cohort was Adenocarcinoma (24, 58.5%), Squamous cell carcinoma (14, 34.1%), and metastatic lesions (3, 7%). There was a false positive average of 0.75 per image in this cohort. The majority of false positive marks were located in the upper lobes, often overlying bony structures, and pleural surfaces.

**CONCLUSION**

When compared to the prior literature, this CAD algorithm demonstrates marked improvement in performance in the radiologic evaluation of subtle lung cancer.

**CLINICAL RELEVANCE/APPLICATION**

Our study suggests that adoption of a next generation CAD system has the potential to improve time to diagnosis in patients with lung cancer.

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**Emergency Radiology (Brain Emergencies) Tuesday, 03:00 PM - 04:00 PM • N227**

Back to Top AM A PRA Category 1 Credit ™ \* ARRT Category A+ Credit:1 Moderator Wayne S Kubal, MD *

**SSJ07 • Monoenergetic Reconstruction of Acute NC DECT Head at 68 keV and 108 keV Results in Superior Image Quality in Comparison to Polychromatic CT in Improvement of Grey-white Matter Differentiation and Reduction in Posterior Fossa Artifact**

Adrian Reagan MD (Presenter); Niv Khorrmani; Savvas Nicolaou MD; Luck J Louis MD; Ana-Maria Bilawich MD; Sharon Gershony MD

**PURPOSE**

To determine whether DECT head generated monoenergetic data sets reduces petrous apex beam hardening artifact and improves assessment of gray-white differentiation in the ED.

**METHOD AND MATERIALS**

A total of 20 consecutive DECT head studies were scanned on the 128-slice dual source scanner in the ED. Protocol included the following parameters, 64 by 6.6mm collimation reconstructed to, 3mm, axial slices at 100 kv and 140kv Sn. The 3 mm 20 D34 axial DECT scans were uploaded in the monoenergetic dual energy class on the multimodality workplace and ME energy levels from 40 to
SSJ07-02 • Non-contrast Head CT with 3rd Generation Integrated Circuit CT Detector: Subjective Improvement in Grey-white Matter Differentiation in the Acute Setting

Patrick Mclaughlin FFRRCSI (Presenter) ; Graeme J McNeill MRCP, FFRRCSI ; Shamir Rai BSc ; Taryn L Reddy FRANZCR ; Teresa Liang MD, BSc ; Nivmand Khorrami-Arani MBBS, BSc ; John R Mayo MD * ; Hugue A Ouellette MD ; Savvas Nicolaou MD

PURPOSE
Accurate and reliable differentiation between cerebral grey and white matter structures demands both high contrast and spatial resolution from a CT system. Recently 3rd generation CT detectors, which employ integrated (IC) rather than discrete (DC) electronics in the detector circuits, have been introduced into clinical practice. Phantom studies demonstrate reduced electronic noise and increased spatial resolution but the clinical benefits of IC detectors for head CT have yet to be evaluated.

METHOD AND MATERIALS
853 consecutive patients underwent non-contrast helical Head CT over a 28 day period in the ED using a dual source 128-slice CT system with IC detectors (Stellar; Siemens Healthcare, Forcheim, Germany). 77 patients who were previously imaged using the same CT system and protocol (120kvp, ref mAs 350, 128x0.6 mm) with DC detectors were included in this retrospective intra-individual study. Subjective analysis of deep and superficial grey and white matter differentiation (GWD) was independently performed by 1 general and 1 subspecialty neuroradiologist using a semi-objective 1-5 point scoring scheme at a standardized window width, level and slice thickness (W=48, L=40HU, 3mm). Objective analysis of image noise was also performed for all datasets.

RESULTS
CONCLUSION
The use of integrated 3rd generation CT detectors results in improved subjective grey and white matter differentiation in the frontal, parietal and insular regions on helical CT head examinations.

CLINICAL RELEVANCE/APPLICATION
The use of integrated 3rd generation CT detectors results in improved subjective grey and white matter differentiation in the frontal, parietal and insular regions on helical CT head examinations.

SSJ07-03 • Whole-brain 320-detector Row Dynamic Volume CT Perfusion Performed on Hyperacute Ischemic Stroke Patients within 4.5 hours Improves Diagnostic Sensitivity and Accuracy

Zhu-Ren Luo (Presenter) ; Xiong-Jie Zhuang ; Rong-Zhou Zhang ; Bao-Zhong Shen

PURPOSE
To determine if use of whole-brain CT perfusion (CTP) with an extended range covering the entire brain could improve diagnostic sensitivity and accuracy relative to non-contrast CT (NCCT) for patients presenting with stroke symptoms.

METHOD AND MATERIALS
A total of 30 patients presenting to our emergency department with symptoms of ischemic stroke within 4.5 h of the event were included in the study. All were subject to whole-brain Perfusion CT, which includes NCCT, and were then immediately evaluated by diffusion-weighted MRI or DWI. The NCCT and CTP were evaluated by two physicians for evidence of acute infarct and vascular territory, if present. CTP covered the whole brain (16 cm coverage); low relative cerebral blood volume (CBV) in a region of low cerebral blood flow (CBF) or elevated time to peak (TTP) was the operational definition for ischemia or infarct. A third physician rated the DWI for acute infarct and vascular territory, if present. Sensitivity, specificity, and negative and positive predictive values were calculated. Statistical analysis was performed using an exact McNemar test and generalized by estimating equations from a binary logistic regression model to assess the difference in detection rates between modalities. A two-sided P value < 0.05 was considered significant.

RESULTS
Of the 30 patients evaluated, NCCT revealed two (6.7%) acute infarcts without false positives. CTP revealed 28 (93.3%) acute infarcts with one false positive. Of the two infarcts missed on CTP, one was a small cortical infarct, whereas the other was a lacunar type infarct (< 10 mm in size). CTP was significantly more sensitive (93.3 vs. 6.7%, P < 0.05), accurate (76.0 vs. 52.0%, P < 0.05), and had a better negative predictive value (93.5 vs. 51.7%, P < 0.05) than NCCT.

CONCLUSION
A 320-slice CT allows completing dynamic visualization of entire brain and enables calculation of whole-organ perfusion maps. Whole-brain CTP improved sensitivity and accuracy relative to NCCT in this cohort of 30 patients with symptoms of hyperacute stroke evaluated within 4.5 hours of the event.

CLINICAL RELEVANCE/APPLICATION
320-slice CT can enable calculation of whole-brain perfusion maps and improve sensitivity and accuracy for diagnosing hyperacute stroke.

SSJ07-04 • Improvement of Image Quality (IQ) with Model Based Iterative Reconstruction (MBIR) Algorithm in Cranial CT (CCT) in Trauma Patients

Susan Notohamiprodjo MD (Presenter) ; Zsuzsanna Deak MD ; Fabian Mueck ; Felix Meurer ; Maximilian F Reiser MD ; Stefan Wirth MD *

PURPOSE
CCT is a frequently needed examination in emergency medicine. Compared to the current clinical standard of image reconstruction.
SSJ07-05 • Acute Intracranial Hemorrhage in Computed Tomography - Benefits of Sinogram-affirmed Iterative Reconstruction Techniques

Boris Bodelle MD (Presenter) ; Boris Schulz MD ; Firas Al-Butmeh ; Thomas Lehnert MD ; Julian L Wichmann MD ; Claudia Frelesen ; Ralf W Bauer MD * ; Josef Matthias Kerl MD * ; Thomas J Vogl MD, PhD

PURPOSE
To compare image quality (IQ) and intracranial hemorrhage (ICH) in brain computed tomography (CT) with sinogram-affirmed iterative reconstruction (SAFIRE) and filtered-back-projection (FBP) reconstruction techniques at standard and low dose tube current levels.

METHOD AND MATERIALS
The study was approved by the IRB. 54 patients (mean age 64 ± 20 years) in group 1 and 40 patients in group 2 (mean age 57 ± 23 years) received CT at two different tube current time products (group 1: 340 mAs; group 2: 260 mAs) in a multi-detector CT. Images were reconstructed with FBP and five different iterative strengths (S1-5) and were ranked (5-point scale) by two radiologists for IQ and ICH in a blinded manner. Image noise (IN), signal-to-noise ratio (SNR), dose-length product (DLP, mGycm) and mean effective dose (mSv) were calculated.

RESULTS
FBP at standard 340 mAs and S1 at 260 mAs showed no statistical significance (p < 0.05) for subjective rating. IN was higher (p < 0.05) in group 2. SNR increased with higher strength of SAFIRE in both groups. There was predominantly no significant difference in SNR between FBP and S1. Highest SNR was achieved with S5. Best score for subjective rating of IQ/ICH was achieved with S3/S4-5. Patients were exposed to a significantly lower dose in group 2 (mean: 744 mGycm/1.71 mSv) than group 1 (mean: 1045 mGycm/2.40 mSv, p

CONCLUSION
SAFIRE provides better IQ and visualization of ICH in brain CT. Dose reduction by almost one-third is possible without significant loss in diagnostic quality.

CLINICAL RELEVANCE/APPLICATION
Sinogram-affirmed iterative reconstruction technique provides better image quality and visualization of intracranial hemorrhage in brain CT with almost one-third dose reduction compared with FBP.

SSJ07-06 • Screening CT in Mild Traumatic Brain Injury: Comparison of Two Mostly Used Clinical Guidelines in a Tertiary Referral Hospital in Northeastern Japan

Daddy Mata Mbemba MD, PhD (Presenter) ; Shunji Mugikura MD, PhD ; Atsuhito Nakagawa ; Takaki Murata MD ; Li Li MD, PhD ; Kei Takase ; Teiji Tominaga ; Shigeki Kushimoto PhD ; Shoki Takahashi MD

PURPOSE
To avoid unnecessary CT, Canadian CT Head Rule (CCHR) and New Orleans Criteria (NOC), each containing 7 clinical items, are widely-used guidelines to indicate screening CT in mild traumatic brain injury (TBI). We aimed to compare the two guidelines in predicting Clinically Important CT Findings (CICF), by introducing two scoring systems.

METHOD AND MATERIALS
Consecutive 142 mild TBI {Glasgow coma scale (GCS):13-15} patients (age: 17-88 years), who underwent CT examination indicated by either CCHR or NOC, were included. We introduced two 8-graded (0 to 7) scores and assigned them to each patient, Canadian score (CCHR score) and New Orleans score (NOC) from NOC: a patient score represented a sum of the number of positive items, each of which was rated +1 if present. Two neuroradiologists reviewed screening CT for CICF. In all the GCS13-15 patients, we examined whether both scores were related to CICF by univariate analysis, logistic regression and receiver operator characteristic curve. We also used logistic regression to determine which of the 14 clinical items included in either guideline, independently predicts CICF. Since NOC is applied only for GCS-15 patients, we additionally compared two scoring systems only in GCS-15 group (n=67).

RESULTS
Of the 142 mild TBI patients, 49 patients (34.5%) showed CICF. In GCS 13-15 group, both scores showed a significant relationship to CICF (P < 0.05) in univariate analysis. However, in multivariate analyses, only Canadian score was a predictor of CICF (P=0.0130) yielding a better performance (AUC=0.69) than New Orleans score (AUC=0.63). In addition, among all 14 clinical items included in either guidelines, the item of GCS was rated +1 if present. Two neuroradiologists reviewed screening CT for CICF. In all the GCS13-15 patients, we examined whether both scores were related to CICF by univariate analysis, logistic regression and receiver operator characteristic curve. We also used logistic regression to determine which of the 14 clinical items included in either guideline, independently predicts CICF. Since NOC is applied only for GCS-15 patients, we additionally compared two scoring systems only in GCS-15 group (n=67).

CONCLUSION
In mild TBI, CCHR is a better predictor of CICF in a tertiary referral hospital in northeastern Japan. Our results are consistent with a big-scale western-study.

CLINICAL RELEVANCE/APPLICATION
In mild TBI, selective use of CT decreases unnecessary irradiation, but improper selection can lead to missing life-threatening lesions. Our study encourages the use of CCHR for efficient CT scanning.
Evaluating increased conspicuity of hyperenhancing hepatocellular carcinoma (HCC) using lower viewing keV and iodine material decomposition images.

METHOD AND MATERIALS
IRB approved/HPAA compliant retrospective study of consecutive cirrhotic outpatients with HCC evaluated with rapidly switching DECT at outpatient facility of tertiary care where 120 liver transplants are performed each year. Variables evaluated on independent dual energy workstation included: iodine concentrations (x100 mcg/cc), Hounsfield units (HU) at 70 and 52 keV, and image noise; absolute contrast difference between tumoral and nontumoral liver (abHU), iodine difference, and conspicuity (abHU or iodine difference/image noise) were calculated and compared using t test and ANOVA.

RESULTS
47 subjects (18 females) had 86 tumors, median size 2.2 cm. Mean tumor HU at 52keV was statistically different than at 70 keV (99.0 HU and 161.3 HU, respectively, p = 0.002). HCC conspicuity is best on iodine material decomposition images. HCCs are better visualized at lower viewing energy using rapid switching DECT compared to routine 70 keV images simulating routine PACS viewing.

CONCLUSION
Iodine material decomposition images and lower viewing energies are recommended for enhanced detection hyperenhancing hepatocellular carcinoma using rapid switching dual energy MDCT.

SSJ08-02 • Quantitative Correlation between Liver Fat and Biopsy Score Using Multi-material Decomposition and Fast-kV Switching Dual-energy CT

Masayuki Kudo PhD, RT (Presenter) * ; Tomoko Hyodo MD ; Takamichi Murakami MD, PhD * ; Peter Lamb * ; Paulo R Mendonca PhD * ; Masanobu Uemura MD

PURPOSE
The purpose of this study was to investigate the correlation between liver fat volume percentage (LFV%), obtained using a method based on multi-material decomposition (MMD) and histopathologic biopsy score in patients with nonalcoholic fatty liver disease (NAFLD) and alcoholic steatohepatitis.

METHOD AND MATERIALS
This study included 31 patients who underwent non-contrast (NC) and contrast-enhanced (CE) CT of the upper abdomen with dual energy CT (DECT) within 4 weeks prior to liver biopsy. The scan parameters employed for this study were 80/140kVp, 630mA, 0.6 sec/rot, 5mmTH, and helical mode. For CE studies, a non-ionic contrast agent was used and imaging was performed at the arterial, portal venous, and equilibrium phases. LFV% maps were generated from DECT data using MMD. For NC and CE exams, the measured LFV% was the average of 3 regions-of-interest (ROIs) that were placed in the hepatic parenchyma of the LFV% maps corresponding to the planned biopsy site. LFV% measurements were correlated with histopathologic grade of steatosis by the NAFLD activity score (NAS) score. Differences in the mean LFV% for NC and CE data were tested by two-factor analysis of variance (ANOVA) with post hoc Tukey-Kramer test. Spearman rank correlations were calculated between NC LFV% and NAS steatosis score.

RESULTS
NAS steatosis scores were 0 in 4 patients, 1 in 15 patients, 2 in 12 patients and 3 in 0 patients. The mean LFV% of each NAS steatosis score group was 1.2%, 6.0% and 15.2%, respectively. Two-factor ANOVA results showed a statistically significant difference in LFV% by NAS score (P < 0.0001). MMD-based LFV%, from both NC-CT and CE-CT data, shows statistically significant correlation to histopathologic biopsy grade, implying MMD can be used to accurately LFV% in the liver. Due to the agreement between LFV% across all phases of imaging (NC and CE), MMD can potentially obviate the need for the NC acquisition in DECT imaging of patients with fatty liver disease, which can lead to a significant reduction of radiation dose to patients.

CONCLUSION
MMD-based method of LFV% using fast-kV switching DECT enables accurate, non-invasive, and rapid measurement of LFV%. MMD may reduce total radiation dose by obviating the need for a NC-CT acquisition.

SSJ08-03 • Spectral CT Imaging in Differential Diagnosis of Pancreatic Ductal Adenocarcinoma and Mass Forming Panreatitis

Xiao Zhu Lin MD (Presenter) ; Su Zhang ; Chao Li ; Xueqin Xu ; Kemin Chen MD, PhD ; Fuhua Yan MD

PURPOSE
The objective of this study is to investigate the spectral CT imaging features of pancreatic ductal adenocarcinoma (PDAC) and mass forming pancreatitis (MFP) and to assess its value in differential diagnosis between them.

METHOD AND MATERIALS
RESULTS
CONCLUSION
The PDAC and MFP had different characteristic on spectral CT imaging. CT value on 70keV in late arterial phase was the best parameter for the differential diagnosis between PDAC and MFP.

CLINICAL RELEVANCE/APPLICATION
Spectral CT imaging with multiple parameters is a new technique for differential diagnosis between PDAC and MFP, which has a potential to improve the diagnosis accuracy.

SSJ08-04 • Detection of Stones and Calcifications in the Hepatobiliary System on Virtual Nonenhanced Dual-energy CT

Da-Ming Zhang MD (Presenter) ; Xuan Wang MD ; Huadan Xue MD ; Hao Sun MD ; Yu Chen MD ; Zhengyu Jin MD

PURPOSE
To retrospectively determine the features of stones and calcifications in hepatobiliary system after virtual elimination of contrast medium at dual-energy computed tomography (CT).

METHOD AND MATERIALS
The institutional ethics committee approved this retrospective study with waiver of informed consent. A total of 128 stones (gallstones and bile duct ) and calcifications of liver found in 110 patients were examined with single-energy nonenhanced CT and dual-source dual-energy CT in the portal venous phase (100kVp and 140 kVp). Virtual nonenhanced (VNE) images were generated from the portal venous phase dual-energy CT data sets by using commercially available software (Syngo, Dual Energy Liver VNC; Siemens Healthcare). The CT numbers for the stone, liver, and bile; stone size; and image noise were assessed for each image set. The conspicuity and size of the stones, image quality of the VNE images as a replacement for true nonenhanced (TNE) images were assessed.

RESULTS
CONCLUSION
SSJO8-05 • Differentiating Liver Lesion Types by DECT keV Spectrum

Xiaohui Qi MD; Gaofeng Shi MD; Qi Wang BSc (Presenter); Runze Wu

PURPOSE

To investigate the possibility of using dual-energy CT keV spectrum to differentiate hepatic carcinoma (HCC), liver metastasis, hemangioma and cysts.

METHOD AND MATERIALS

Eighty-one patients with liver diseases were enrolled. The dual-energy CT was performed at the portal venous phase with tube voltage 100/Sn140 kV, tube current 230/178 mAs, collimation 32 * 0.6 mm, slice thick 5 mm, reconstruction interval 5 mm. After the injection 90 ml contrast agent at flow rate of 3 ml/s, arterial and venous phase images were acquired at 30 and 70 s delay. The venous phase keV images were calculated on a commercial workstation using the images of high and low kVp. The region of interest were carefully placed on the lesions to measure the CT value for 40, 80 and 110 keV. The surrogate slope of keV spectrum was calculated by difference of CT value at 40 and 110 keV divided by 70. After grouped by lesion types, the slopes were compared between HCC, metastatic lesion, hemangioma and cyst.

RESULTS

CONCLUSION

The slope of DECT keV spectrum had the potential to differentiate HCC/hemangioma, metastasis and cyst.

SSJO8-06 • Evaluation of Dual Energy Spectral CT Imaging in Rectal Cancer

Huanhuan Liu (Presenter); Huan Zhang; Lei Shi MD; Lifang Pang MD; Zilai Pan MD; Fuhua Yan

PURPOSE

To investigate the value of dual energy spectral CT (DECT) in preoperative TN-staging and differentiating histological grading of rectal cancer.

METHOD AND MATERIALS

56 patients with primary rectal cancer proved by pathology underwent plain scan and dual-phase pelvic enhanced scans (arterial phase (AP) and portal venous phase (PP)) with DECT mode. The reconstructed images, including the conventional polychromatic images, polychromatic images with photon energy from 40 to 140keV and material-decomposition images, were reformatted and analyzed. The accuracies for TN staging between the conventional polychromatic and monochromatic images were compared. Iodine concentrations (IC) in the lesions and lymph nodes were measured on iodine-based material-decomposition images, and were normalized to external iliac artery to obtain the normalized IC (nIC). The nIC values at AP and PP and the difference of nIC (dnIC) between AP and PP for the primary lesions of different histological grading and the metastatic and non-metastatic lymph nodes were analyzed. Results were correlated with pathological findings.

RESULTS

The accuracies for T, N staging were (89.3%, 80.9%) and (82.1%, 71.4%) for rectal cancer on 70 keV monochromatic images and conventional 120kVp images, respectively. The improvement of the accuracy in T and N staging with 70 keV monochromatic images was statistically significant (P=0.04, P=0.03). For the primary lesions, significant differences existed for nIC in PP and dnIC(PP-AP) between different histological grades (P=0.03, P=0.02). The nIC values between metastatic and non-metastatic lymph nodes in AP and the changes between AP and PP (dnIC) were also significantly different (P=0.02, P=0.01).

CONCLUSION

The derived monochromatic images from DECT could improve the accuracy of T and N staging in rectal cancer. nIC and dnIC values may help to differentiate between primary rectal cancer with different histological grading, and between metastatic and non-metastatic lymph nodes.

Gastrointestinal (Pancreas Focal Lesions and Carcinoma) Tuesday, 03:00 PM - 04:00 PM • E353C Back to Top SSJO9

• AMA PRA Category 1 Credit ™:1 • ARRT Category A+ Credit:1 Moderator Fatih Akisik, MD *

SSJO9-01 • Objective Imaging Criteria for Intraductal Papillary Mucinous Neoplasms of the Pancreas - Diagnostic Predictability and Interobserver Confidence

Thula Walter (Presenter); Ingo Steffen; Lars H Stelter; Timm Denecke MD; Marcus Bahra MD; Bernd K Hamm MD *; Christian Grieser

PURPOSE

The purpose of this study was to investigate the diagnostic predictability of the histologic entity of IPMN based on objective imaging criteria, such as the Sendai criteria and observer confidence.

METHOD AND MATERIALS

43 patients with 46 distinct pancreatic lesions, which were histologically confirmed to be IPMNs, were included in this retrospective study. A total of 61 imaging studies were evaluated (33 CT, 28 MRI). Three independent and blinded observers (O1 - O3) were asked to review the imaging and predict malignancy based on existing imaging criteria (main duct > 10mm, mural nodules/solid components, size > 30mm) and to provide the diagnostic certainty of this prediction on a scale from 0 - 10 (0 = very likely benign, 10 = very likely malignant). Moreover, they were asked to rate the histologic entity; i.e. adenoma, borderline type, carcinoma in situ (CIS), invasive carcinoma (IPMC) or solid carcinoma (CA).

RESULTS

Of the 46 evaluated lesions, 29 were benign (IPMN Adenoma, 14; IPMN Borderline, 15) and 16 malignant (CIS, 2; IPMC, 6, solid CA, 8); 4 main duct IPMN, 31 branch duct IPMN, and 11 mixed type IPMN. Mural nodules and lesion size (> 30 mm) were significant for malignant lesions (p=0.0069 and p=0.0076, respectively). The odds ratio (OR) for nodules was 6.50 (p = 0.0107), while the OR for size was 1.03 (p = 0.0485). Main duct involvement (MD > 10mm) was not found to be a significant predictor of malignancy in our study population (p > 0.05). The accuracy (ACC) of differentiation between benign and malignant IPMN was 84 - 86% for CT and 87 - 90% for MRI for all observers (interobserver agreement (IA): range, 79-94%, and 78-100%, respectively;
over 25 years, suggesting probable evolution of the appearance of tumor with age. Lesion calcification is rare. The prognosis

RESULTS

A retrospective review radiology and pathology database revealed 26 cases of SPT with preoperative imaging. The images were considered. Key exclusions were age

METHOD AND MATERIALS

12.5% and specificity 98.82% under the criterion value of >2(P=.01) with moderate agreement between two raters(K= .651).

CONCLUSION

1.08. No metastases were seen. Following tumor resection, no recurrence was seen in 20-years old at presentation. In these, the most common appearance was a thin-walled, cystic, noncalcified mass with internal

RESULTS

Participants were categorized by age, sex, and disease severity as: Clinic (n=112), Transplant (n=35), and MR (n=117). Male patients comprised 69%, 55%, and 75% of the 3

RESULTS

METHOD AND MATERIALS

CONCLUSION

PCL prevalence in patients with advanced liver disease.

RESULTS

Seven-hundred and twenty-three patients were screened and 585 were eligible (cystic mass with CT or MR scans). From these 585 patients, 65 were excluded due to age, pancreatitis, and polycystic liver and/or kidney disease. Two-hundred and twenty-eight patients were in the Clinic group, 150 in the MR group, and 142 in the Transplant group. Mean age was 59, 57, and 56 in the 3 groups, respectively. Male patients comprised 69%, 55%, and 75% of the 3 groups, respectively. Additionally, median MELD score and interquartile range in patients with cysts (n=43) was 15 (10-18) and without cysts (n=457) was 11 (9-15), p<.003. PCL prevalence in patients with non-alcoholic steatohepatitis (NASH) related cirrhosis was 1/64 (1.6%) compared to PCL prevalence of 42/456 (9.2%) in all other liver disease.

CONCLUSION

Overall, there is a marked increase in PCL prevalence in our cirrhosis cohorts compared to the non-cirrhotic population.

CLINICAL RELEVANCE/APPLICATION

Prospective studies are needed to define pathogenesis and management of these incidental lesions in cirrhotic patients.

SSJ09-02 • Intraductal Papillary Mucinous Neoplasm of the Pancreas: Evaluation of Unresectability with MR Only

Seongho Kim (Presenter) ; Jeong-Min Lee MD * ; Eun Sun Lee MD, PhD ; Jeehyun Baek MD ; Joon Koo Han MD ; Byung Ihn Choi MD, PhD *

PURPOSE

To evaluate the capacity of intraoperative ultrasound in differentiating between malignant and non-malignant IPMNs. MRI demonstrated a statistically significant higher sensitivity and specificity compared to ultrasound in differentiating between benign and malignant IPMNs.

RESULTS

In 1 patient, the cyst was non-malignant/cystic neoplasm with solid components in the head of the pancreas. In 19 patients, the cysts were malignant with invasion of the body and tail of the pancreas.

CONCLUSION

Malignant cysts have a significantly higher occurrence of solid components and invasion of the body and tail of the pancreas. Ultrasound was not reliable for detecting malignancy, therefore, MR is better in differentiating between malignant and non-malignant IPMNs.

CLINICAL RELEVANCE/APPLICATION

Ultrasound is not recommended for evaluating IPMN malignancy potential and invasion.
following surgical excision of SPT is good.

**CLINICAL RELEVANCE/APPLICATION**
Unlike most other cystic pancreatic masses, SPT is usually associated with internal hemorrhage. In older patients, it may present as a solid enhancing mass, simulating a neuroendocrine tumor.

**SSJ09-05 • Pancreatic Adenocarcinoma: Comparison of Six MRI Sequences Including Diffusion-weighted Imaging for Tumor Conspicuity**

François-Xavier Arnaud MD (Presenter); Laurence Legrand; Elodie Sibleau MD; Isabelle Boulay-Coletta MD; Samir Benadjlaoud; Marc Zins MD

**PURPOSE**
To assess the best MR sequences among conventional, dynamic contrast-enhanced and diffusion-weighted imaging for pancreatic adenocarcinoma relative conspicuity.

**METHOD AND MATERIALS**
Our local institutional review board approved this retrospective study and waived the informed consent requirement. 55 consecutive patients with pathologically proven pancreatic adenocarcinoma who underwent MRI (1.5T, n=25 or 3T, n=30) were retrospectively included. Fat-suppressed (FS) T1-weighted gradient-echo (GRE), FS T2-weighted fast-recovery fast spin echo, 3D FS dynamic T1 and gadolinium-enhanced GRE during arterial, portal and delayed phases and diffusion-weighted imaging (DWI) with b values of 0 and 600 or 800 sec/mm² were obtained. Apparent diffusion coefficient cartographies were generated. For each sequence, two gastrointestinal radiologists independently assessed the lesion’s signal intensity relative to non tumoral pancreas and the subjective visual conspicuity using a four-point rating scale (0 to 3). They designated the sequence with the best visual conspicuity. The study coordinator performed a quantitative analysis of the lesion conspicuity on each sequence, placing regions of interest for tumor-to-pancreas contrast (either proximal or distal non tumoral pancreas). Visual conspicuity scores and tumor-to-pancreas contrast ratios in each sequence were compared using paired Wilcoxon or t-tests. p-values were considered statistically significant at p<0.05.

**RESULTS**
92% of Pancreatic adenocarcinomas appeared hypointense on 3D FS T1 GRE arterial phase, which was the best sequence for tumor conspicuity (2.7), followed by portal phase (2.4) and DWI (2.2). (p<0.01).

**CONCLUSION**
3D T1 FS GRE arterial phase is the best sequence for pancreatic adenocarcinoma conspicuity. DWI is limited for clear delineation of pancreatic adenocarcinoma.

**CLINICAL RELEVANCE/APPLICATION**
Contrast-enhanced MRI is highly needed to improve pancreatic adenocarcinoma conspicuity.

**SSJ09-06 • CT-evaluation of Extrapancreatic Perineural Invasion in Patients with Resectable Cancer of Pancreatic Head**

Ekaterina Kasatkina (Presenter); Vladimir Lyadov; Igor Shrayner; Svetlana Bogomazova; Elena Mershina; Valentin E Sinitsyn MD, PhD

**PURPOSE**
The aim of the study was to find whether multi-detector computed tomography (MDCT) is capable to detect extrapancreatic perineural invasion (EPI) in resectable adenocarcinoma of pancreatic head.

**METHOD AND MATERIALS**
Preoperative CT-series of 31 patients with resectable adenocarcinoma of pancreatic head were evaluated retrospectively. Extrapancreatic perineural invasion was identified as confluent tissue of similar attenuation to primary pancreatic cancer extending along neural plexuses pathways. Plexus Pancreaticus Capitalis II (PLX-II): the area along the infero-posterior pancreatoduodenal artery (IPDA) and the jejunal trunk was selected for analysis as this area is more susceptible for extrapancreatic invasion of pancreatic head cancer. Two patterns of peripancreatic spread were established: confluent tumor spread (Pattern 1) and infiltration (Pattern 2) along known path way or in retropancreatic adipose tissue.

**RESULTS**
All patients underwent Whipple procedure, histologically adenocarcinoma of pancreatic head was confirmed in all patients. Extrapancreatic perineural invasion was found in 25 patients (77.4%), 17 of them showed carcinoma invasion in pancreatic parenchyma. Extrapancreatic perineural invasion was more prominent in larger tumors. All 25 patients with positive PLX-II invasion were correctly diagnosed on preoperative CT-scans. Pattern 1 was found in 16 patients, Pattern 2 in 9 patients. Two false-positive results were present in patients with Pattern 2 which was subtle infiltration of adjacent adipose tissue.

**CONCLUSION**
MDCT provides sufficient diagnostic information to detect PLX-II invasion on preoperative CT-series in patients with adenocarcinoma of the pancreatic head. Further research, follow-up and prospective studies are needed to confirm the accuracy of MDCT in detecting EPI.

**CLINICAL RELEVANCE/APPLICATION**
Preoperative detection of EPI which is significant cause of positive surgical margin and tumor recurrence can influence clinical management of patient - choice to perform surgery or neoadjuvant therapy.

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**Gastrointestinal (Stomach) Tuesday, 03:00 PM - 04:00 PM • E450B**

**SSJ10-01 • Is Gadoxetic Acid-enhanced MR Cholangiography a Useful Tool Predicting the Presence of Bile Reflux Gastritis?**

Eudeeum Shim (Presenter); Suk Keeu Yeom MD; Sang Hoon Cha MD; Jong Jin Hyun; Seung Wha Lee; Hwan Hoon Chung; Baek Hyun Kim MD

**PURPOSE**
Contrast media excreted from the biliary tract is often seen in the stomach on Gadoxetic acid-enhanced MR cholangiography (Gadoxetic-MRC). The aim of this study is to evaluate the relationship between biliary contrast media in stomach and the presence of bile reflux gastritis.

**METHOD AND MATERIALS**
A total of 111 consecutive patients who underwent both Gadoxetic-MRC and upper gastrointestinal endoscopy from May 2009 to April 2012 were included in this study. Two radiologists performed a blinded review of Gadoxetic-MRC set images consisting of axial and coronal images obtained 60 minutes after injection of contrast media. Presence of contrast media in duodenum and stomach with the endoscopy finding of reflux if the contrast media was seen in stomach: grade 1, antrum; grade 2, body; and grade 3, fundus. Endoscopic images were reviewed by an expert gastroenterologist blinded to the result of Gadoxetic-MRC. Sydney classification of gastritis was used to categorize gastritis if present.

**RESULTS**
Among a total of 111 patients, contrast media was present in the stomach on 60 minutes delayed images in 39 patients. Of these 39 patients, 13 patients had bile reflux gastritis and 3 patients showed bile in the stomach without evidence of erythematous mucosal changes. Of the 72 patients who did not show contrast media in the stomach, none of them had bile reflux gastritis and 2 patients showed bile stain in the stomach without evidence of erythematous mucosal changes. Bile reflux gastritis was significantly
more frequent in patients with contrast media in the stomach on Gadoxetic-MRC (13/39, 33.3%) than those without (0/72, 0%) (p < 0.001). However, there was no significant difference between bile reflux gastritis and the extension grade of reflux (grade 1: 2/12, grade 2: 4/11, grade 3: 7/16) (p = 0.335).

CONCLUSION
About a third of patients with biliary excreted contrast media in stomach had bile reflux gastritis which was more significantly frequent compared to those without. Biliary excreted contrast media in stomach on Gadoxetic-MRC obtained at 60 minutes could be an indication of the presence of bile reflux gastritis.

CLINICAL RELEVANCE/APPLICATION
Biliary excreted contrast media in stomach on Gadoxetic-MRC obtained at 60 minutes could be an indication of the presence of bile reflux gastritis.

**SSJ10-02 • A New Sandwich Sign of Borrmann Type 4 Gastric Cancer on Diffusion-weighted MRI:**

**Radiological-histopathological Correlation**

**Lei Tang** MD (Presenter) ; **Xiao-Peng Zhang** MD ; **Ying-Shi Sun** MD, PhD ; **Zi-Yu Li** ; **Jia-Fu Ji** ; **Zhong-Wu Li** ; **Xiaoting Li**

**PURPOSE**
To explore the histopathological basis of a new finding sandwich sign of Borrmann type 4 gastric cancer on diffusion-weighted MRI (DW-MRI).

**METHOD AND MATERIALS**
The abdominal DW-MRI was performed using SS-EPI sequence with b-factors of 0 and 1000 s/mm² on a 1.5T scanner, in patients with Borrmann type 4 gastric cancer. Radical gastrectomy was performed in one week after DW-MRI examination. Histopathological analysis of the resected specimens was performed by one pathologist and one radiologist together, with emphasis on the correlation of the DW-MRI signs and the histopathological findings, by means of layer-to-layer comparison.

**RESULTS**
DW-MRI was performed on 30 patients with Borrmann type 4 gastric cancer. A three-layer sandwich sign that demonstrated high signal in the inner and outer layer and low signal in the intermediate layer was observed in 73.3% (22/30) of cases on DW-MRI. Through the comparison with pathological large sections, we found that the intermediate low signal on DW-MRI corresponded to the muscularis propria. Further enlargement of the pathological sections demonstrated that the cancer cells were interspersed in the muscularis propria. The even distribution of the pathological sections caused the decreased restriction of water molecular movement and lower down the signal on DW-MRI; thereby create the three-layer sandwich sign.

**CONCLUSION**
DW-MRI can highlight the signals of Borrmann type 4 gastric cancer, which often present a characteristic three-layer sandwich sign. The uneven distribution of cancer cells in different layers of cancerous gastric wall maybe the histopathological basis of this unique sign.

**CLINICAL RELEVANCE/APPLICATION**
DW-MRI can be a useful method for the clinical evaluation of Borrmann type 4 gastric cancer.

**SSJ10-03 • Preliminary Study of Spectral CT Imaging in the Differentiating Normal and Malignant Residual Stomach Wall Thickening**

**He Qing Wang** MSc (Presenter) ; **Ailian Liu** MD ; **Ye Ju** ; **Sheng Wang** ; **Shifeng Tian** ; **Longmin Zhang**

**PURPOSE**
To investigate the value of spectral CT imaging in the differential diagnosis of normal and malignant residual stomach wall thickening.

**METHOD AND MATERIALS**
32 cases (pathological finding proved 11 cases of residual stomach cancer, long-term clinical follow-up confirmed 21 cases of stomach normal postoperative change). Nine patients underwent the plain scan, 23 patients underwent both the plain scan and the dynamic enhancement. With dual-kVp spectral CT imaging, monochromatic images (40-140keV) and the iodine and water-based material decomposition images were reconstructed. CT values of 70 keV and effective iodine content (eIC) were measured. One-way analysis of variance was performed for analyzing the resulting parameters, and p

**RESULTS**
There was a statistically significant difference between malignant and normal gastric wall tissue in 40 -140keV 101 monoenergetic images: arterial phase 40keV, 50keV, 60keV, 70keV, material value based water and iodine and portal phase 40keV, 50keV, 60keV, 70keV,80keV, effective monoenergetic spectrum value, material value based iodine. Significant differences were seen in 40-140keV 101 monoenergetic images: arterial phase 40keV, 50keV monoenergetic spectrum value between malignant and normal gastric wall tissue.

**CONCLUSION**
CT Gemstone Spectral Imaging could provide additional imaging information that may improve the differentiation of the normal and malignant wall of the residual stomach. Spectral CT curve is expected to be a new non-invasive method to differentiate them.

**CLINICAL RELEVANCE/APPLICATION**
Using spectral CT multiple parameters might be a new noninvasive method to differentiate the normal and malignant residual stomach wall for the conventional polychromatic CT images.

**SSJ10-04 • The Value of Diffusion-weighted MR Image in Diagnosing Metastatic Lymph Nodes in Patients with Gastric Cancer**

**Zhuping Zhou** (Presenter) ; **Jian He** MD, PhD ; **Song Liu** ; **Bin Zhu** ; **Zhou Z Ping** ; **Zhengyang Zhou**

**PURPOSE**
To explore the characteristics of lymph nodes in patients with gastric cancer by diffusion weighted(DW) MR image, and investigate the value of apparent diffusion coefficient (ADC) and short axis measurement in diagnosing metastatic lymph nodes.

**METHOD AND MATERIALS**
This prospective study was approved by local ethics committee and the patient informed consent was obtained. Fifty-five patients (34 male, 18 female) with gastric cancer underwent preoperative DW MR imaging. All the detectable lymph nodes on DW images were divided into metastatic and non-metastatic groups with the reference of post-operative histopathological findings. The ADC values and short diameter of lymph nodes were measured and compared between the two groups. Diagnostic performance of ADC value and short diameter for diagnosing metastasis were compared by receiver characteristic curve(ROC) analysis.

**RESULTS**
ADC value from DW MR imaging is superior to short diameter measurement in diagnosing metastatic lymph nodes in patients with gastric cancer.

**CLINICAL RELEVANCE/APPLICATION**
RESULTS
Our radiographic method generated significant contrast effect for both CT and near infra-red range optical devices. Significant and persistent accumulation of the hybrid contrast signal was observed in the draining lymphatic system, which remained throughout the entire experiment (over 5 hours) achieving the effect of lymph node labeling. Pre-operative CT provided information on anatomy oriented lymph node mapping. We were able to identify 40 lymph nodes showing enhancement on CT scan in 9 beagles. Optical imaging ensured high resolution visualization of both the draining lymph nodes and intervening lymphatic vessels. In addition, adopting intra-operative compatible optical devices (such as Robot-assisted surgery in this study) enabled real time high resolution imaging during surgery, and therefore considerably enhanced the sensitivity and confidence on sentinel lymph node assessment.

CONCLUSION
Our CT-optics based hybrid imaging is a feasible and effective method for lymphangiography, which can be used for preoperative mapping, labeling and intra-operative navigation of sentinel lymph nodes. We believe these advantages can be exploited to design minimally invasive treatment strategies with extended indications.

CLINICAL RELEVANCE/APPLICATION
Nano-scale iodine-indocyanine green oil emulsion based hybrid (CT and optical) lymphangiography can be used for sentinel lymph node assessment and non-invasive treatment of early gastric cancer.

SSJ10-05 • Preclinical Study on CT-optics Hybrid Lymphangiography for Stomach Sentinel Lymph Node Mapping, Labeling and Intra-operative Navigation in a Beagle Model

Hon Soul Kim MD, PhD (Presenter) ; Sang Kil Lee ; Se Hoon Kim ; Soo-Jeong Lim ; Woo Jin Hyung MD ; Joonseok Lim MD

PURPOSE
Multi-modality hybrid imaging of loco-regional lymphatic system would improve preoperative mapping and intra-operative navigation of the sentinel lymph nodes. We assumed that if a reliable method for sentinel lymph node labeling is available, the application of minimally invasive treatment for stomach cancer could be expanded.

METHOD AND MATERIALS
Animal experiments were approved by our institutional animal care and use committee. We developed a nano-scale iodine-indocyanine green oil emulsion that can be used for both CT and optical imaging. We endoscopically injected this hybrid contrast agent in the gastric submucosal compartment of 9 beagles. Serial pre-operative CT scans were obtained. The degree of lymph node enhancement was qualitatively and quantitatively measured. Each beagle underwent either open laparotomy, laparoscopy-assisted surgery or robot(equipped with integrated infra-red optical camera)-assisted surgery. Specimen CT and near infra-red fluorescence imaging was performed.

RESULTS
Our lymphangiography method generated significant contrast effect for both CT and near infra-red range optical devices. Significant and persistent accumulation of the hybrid contrast signal was observed in the draining lymphatic system, which remained throughout the entire experiment (over 5 hours) achieving the effect of lymph node labeling. Pre-operative CT provided information on anatomy oriented lymph node mapping. We were able to identify 40 lymph nodes showing enhancement on CT scan in 9 beagles. Optical imaging ensured high resolution visualization of both the draining lymph nodes and intervening lymphatic vessels. In addition, adopting intra-operative compatible optical devices (such as Robot-assisted surgery in this study) enabled real time high resolution imaging during surgery, and therefore considerably enhanced the sensitivity and confidence on sentinel lymph node assessment.

CONCLUSION
Our CT-optics based hybrid imaging is a feasible and effective method for lymphangiography, which can be used for preoperative mapping, labeling and intra-operative navigation of sentinel lymph nodes. We believe these advantages can be exploited to design minimally invasive treatment strategies with extended indications.

CLINICAL RELEVANCE/APPLICATION
Nano-scale iodine-indocyanine green oil emulsion based hybrid (CT and optical) lymphangiography can be used for sentinel lymph node assessment and non-invasive treatment of early gastric cancer.

SSJ10-06 • Diagnosis of Esophageal or Duodenal Invasion of Advanced Gastric Cancer: Comparison of CT and Endoscopy

Yoon Jin Lee MD (Presenter) ; Young Hoon Kim MD, PhD ; Ji Hoon Park MD ; Kyoung Ho Lee MD ; Hye Seung Lee MD ; Do Joong Park ; Hyung-Ho Kim MD, PhD

PURPOSE
To retrospectively compare the accuracy of CT with that of endoscopy in the diagnosis of esophageal or duodenal invasion of advanced gastric cancer.

METHOD AND MATERIALS
Forty-five patients (26 men, 19 women; median age, 68 years; range, 40-82 years) who underwent gastrectomy and had pathologically confirmed advanced gastric cancer with esophageal or duodenal invasion were included. The preoperative reports of CT and endoscopic exams were compared for the diagnosis of esophageal or duodenal invasion. The longitudinal length of tumor invasion into the esophagus or duodenum was retrospectively measured on CT images and histopathological specimens under microscopy. Other histopathological data were also collected, including the invasion pattern (mucosal or submucosal spread), Borrmann type, and WHO histologic classification. The sensitivity of CT and endoscopy were calculated and histopathological data were evaluated for the association with false negative findings.

RESULTS
The overall accuracy of CT was significantly higher than that of endoscopy (66% [31/47] vs. 38% [18/47], P = .001). CT was significantly more accurate than endoscopy in diagnosing both esophageal (71% [22/31] vs. 45% [14/31], P = .008) and duodenal invasion (56% [9/16] vs. 25% [4/16], P = .013). Longitudinal tumor invasion lengths showed strong correlation between CT (median, 9.4 mm; interquartile range, 5.0-12.8 mm) and histopathologic (median 6.5, interquartile range, 3.3-11.0) measurements (Spearman’s rho = 0.86, P < .001).

CONCLUSION
CT is more accurate than endoscopy in the diagnosis of esophageal or duodenal invasion in patients with advanced gastric cancer.

CLINICAL RELEVANCE/APPLICATION
CT is more accurate than endoscopy for the prediction of esophageal or duodenal invasion, and may be more helpful for the decision of optimal longitudinal surgical extent.

Genitourinary (Imaging of Pregnancy and Its Complications) Tuesday, 03:00 PM - 04:00 PM • E351 Back to Top

SSJ11 • AMA PRA Category 1 Credit ™: 1 • ARRT Category A+ Credit: 1 Moderator Mary C Frates, MD

Moderator: Vikram S Dogra, MD *

SSJ11-01 • Presence of a Chorionic Bump May Not Be Associated with a Guarded Prognosis

Elizabeth K Arleo MD (Presenter) ; Robert N Troiano MD

PURPOSE
To prospectively observe the presence of a bump in patients with the sonographic finding of a chorionic 'bump,' an irregular, convex bulge from the choriodendelial surface into the first-trimester gestational sac.

METHOD AND MATERIALS

RESULTS
13% (7/53) of the pregnancies with chorionic bump on first-trimester ultrasound were anembryonic. Of the remaining 46 embryonic pregnancies with first-trimester chorionic bumps, 74% (34/46) resulted in live births, all at term with the exception of one set of twins and one set of triplets, who were electively delivered early at 35 weeks and 32 weeks, respectively. There was only one fetal anatomic anomaly, a left forearm limb reduction defect diagnosed antenatally in one case. Bump size was not correlated with pregnancy outcome. In most patients, the bump was avascular, but in two cases slow intra-luminal flow was noted.

CONCLUSION
The presence of a chorionic bump on first trimester ultrasound is not necessarily a poor prognostic indicator. The likelihood of...
subsequent first-trimester survival is significantly higher if an embryo is seen at the time of chorionic bump diagnosis. In such a scenario, in this series, the largest to date of such a cohort, the live birth rate (74%) was significantly higher than previously reported in smaller series (live birth rate

**CLINICAL RELEVANCE/APPLICATION**

This largest series on chorionic bumps demonstrates that this US finding is not necessarily a poor prognostic indicator and therefore, interpreting radiologists should recommend close interval followup.

### SSJ11-02 • Brand-new MRI Finding as Predictor of Placental Invasion: Evaluation of 64 Patients with Clinical and Histopathological Correlation

**Yoshiko Ueno (Presenter); Kazuhiro Kitajima MD; Tetsuo Maeda; Yuko Suenaga; Satoru Takahashi MD; Kazuro Sugimura MD, PhD**

**PURPOSE**

To identify new MR criteria and review established MR criteria for the diagnosis of placental invasion.

**METHOD AND MATERIALS**

A retrospective review of prenatal MR scans of 64 patients (mean age, 34 years) who underwent MR examination for suspected placental invasion by prenatal sonogram was performed. All MRI examinations were performed on a 1.5-T unit with body array coils, including axial, coronal, and sagittal T2 half-Fourier single-shot turbo spin echo imaging and/or a T2 true fast imaging with steady-state acquisition sequence. According to surgical and/or pathological findings, 14 patients were diagnosed with placenta accreta, placenta increta, or placenta percreta, and 50 were without placental invasion. Two experienced radiologists who were blinded to the pathology and surgery findings reviewed the MRI and evaluated a total of eight MRI features of placenta, including our new finding; the presence of placental protrusion into internal os. Interrater reliability was assessed using kappa statistics. The features with a kappa statistics >0.40 were evaluated to compare the capabilities for placental invasion assessment with a multivariable logistic regression analysis.

**RESULTS**

Intraplacental T2 dark bands, Intraplacental abnormal vascularity, uterine bulging, total placental previa, partial placental previa and placental protrusion into internal os had moderate or better interobserver reliability. Using multivariable logistic regression analysis, we found that the findings of intraplacental abnormal vascularity (A) and placental protrusion into internal os (B) had significant odds ratios of an increased risk of placental invasion. (A: odds ratio, 82.7; 95% CI, 4.1 to 5942; p=0.002, B: odds ratio, 83.1; 95% CI, 3.61 to 6329; p=0.0047)

**CONCLUSION**

In this study, the predictions of intraplacental abnormal vascularity and protrusion of placenta into the internal os were good predictors of placental invasion.

**CLINICAL RELEVANCE/APPLICATION**

This study showed that the presence of placental protrusion into internal os is a new useful MRI finding for the diagnosis of invasive placentation.

### SSJ11-03 • Outcome of Cesarean Scar Implantation Pregnancies Diagnosed Sonographically in the First Trimester

**Aya Michaels MD (Presenter); Erin Washburn MD; Katherine Pocius MD; Carol B Benson MD; Peter M Doubilet MD, PhD; Daniela Carusi MD**

**PURPOSE**

To determine the outcome of cesarean scar implantation pregnancies diagnosed during the first trimester.

**METHOD AND MATERIALS**

We retrospectively identified all cesarean scar implantation pregnancies diagnosed by ultrasound prior to 14 weeks between 2000 and 2012 at our institution. We reviewed the patients' sonographic images and medical records, and recorded information about sonographic findings and pregnancy outcome.

**RESULTS**

37 cases met study entry criteria. Gestational age (GA) at diagnosis was 6.8 ± 1.6 weeks (mean ± SD). Anterior myometrial thickness overlying the gestational sac was 2.7 ± 2.2 mm. 11 patients had no embryonic cardiac activity at the time of diagnosis or thereafter, 6 of whom underwent ultrasound-guided D&C or were given systemic methotrexate. Of these 11, only 1 required hysterectomy, which occurred a month after initial diagnosis for persistent bleeding. Among the 26 patients with embryonic cardiac activity, 9 (35%) continued the pregnancy, 2 required emergent hysterectomy for dehiscence at the time of diagnosis (GA 10 and 11 weeks), and 15 underwent interruption of the pregnancy during the first trimester by one of several methods: intrasac KCl injection (8 cases); ultrasound-guided D&C (6 cases); laparoscopic resection (1 case). None of the latter 15 interrupted cases subsequently required hysterectomy. Of the 9 uninterrupted pregnancies, 3 had miscarriages (GA 9, 9, and 20 weeks) and 6 had liveborn deliveries, of whom 4 had placenta accreta, 3 requiring hysterectomy.

**CONCLUSION**

In a woman with a cesarean scar implantation pregnancy and embryonic cardiac activity, allowing the pregnancy to proceed has high risk of subsequent miscarriage (33%). Those pregnancies that continue to delivery of a liveborn infant are at substantial risk of placenta accreta (66%) requiring hysterectomy (50%).

**CLINICAL RELEVANCE/APPLICATION**

This largest series on chorionic bumps demonstrates that this US finding is not necessarily a poor prognostic indicator and therefore, interpreting radiologists should recommend close interval followup.

### SSJ11-04 • Placental MR Imaging in Fetuses with Placental Insufficiency

**Yoshimitsu Ohgiya MD (Presenter); Hiroshi Nobusawa MD, PhD; Noritaka Seino; Jumpei Suyama MD, PhD; Masanori Hirose MD; Takehiko Gokan MD**

**PURPOSE**

To evaluate morphologic and signal intensity (SI) changes of placental insufficiency on MRI and to assess value of morphologic changes and decreased flow voids (FVs) on T2-weighted RARE imaging for diagnosing placental insufficiency.

**METHOD AND MATERIALS**

Fifty singleton fetuses with abnormal findings at US underwent MRI that included T2-weighted half-Fourier RARE imaging and T1-weighted FLASH imaging using a 1.5 T MR scanner. Placental insufficiency was diagnosed if fetal weight estimated with US was below the 5th percentile. Histopathologic examinations were available in all placentas. Placental thicknesses, placental areas, placental volumes, placental SI, and amniotic fluid SI were measured on MR images. Two radiologists reviewed T2-weighted RARE images for globular appearances of the placentas and FVs between the uterus and the placenta. A thickened appearance or no tapering edges of the placenta was diagnosed as positive signs of a globular appearance. None or decreased size and number of FVs between the uterus and the placenta was diagnosed as positive signs of decreased FVs. The t tests and McNemar's tests were used at 5% levels of significance.

**RESULTS**

Twenty-five of the 50 pregnancies were categorized as having an insufficient placenta. The mean placental thicknesses with placental insufficiency were larger than that without placental insufficiency (p < 0.01). The mean placental areas and the mean...
placenta to amniotic fluid signal intensity ratio (SIR) with placental insufficiency were smaller than those without placental insufficiency (p < 0.01). There was no significant difference in placental volumes. The sensitivity, specificity, and accuracy were as follows; 76.0%, 80.0%, and 78.0% with globular appearances, 52.0%, 88.0%, and 70.0% with decreased FVs, 88.0%, 76.0%, and 82.0% with globular appearances plus decreased FVs. There is a significant difference in sensitivity between decreased FVs and globular appearances plus decreased FVs.

CONCLUSION
Placental insufficiency is associated with placental areas, placental thicknesses, and placenta to amniotic fluid SIR. Evaluating FVs on T2-weighted RARE images can be useful for detecting placental insufficiency, particularly in placentas without globular appearances on MRI.

CLINICAL RELEVANCE/APPLICATION
T2-weighted RARE imaging can demonstrate morphologic changes of the placentas and decreased flow voids between the uterus and the placenta in placental insufficiency.

SSJ11-05 • Adnexal Masses during Pregnancy: MR Imaging Characterization Using ADNEX MR Score
Isabelle Thomassin-Nagagara MD (Presenter) ; Marie-Claude Chevrier MD ; Lamia Jarboui MD ; Audrey Morel MD ; Sophie Dechoux ; Marc J Bazot MD

PURPOSE
To retrospectively evaluate the accuracy of pelvic magnetic resonance (MR) imaging performed to characterize indeterminate sonographic adnexal masses during pregnancy and to test the accuracy and the reproducibility of the ADNEXMR score in this population.

METHOD AND MATERIALS
Institutional ethics committee approved the study and granted a waiver of informed consent. Our study population comprised 31 pregnant women (mean age: 32 (19-42) with a mean gestational age at the diagnosis of 16 weeks (16-26) who underwent MR imaging for characterization of indeterminate adnexal masses detected in our center. Two radiologists with 1 and 10 years experience retrospectively evaluated MR criteria for characterization of complex adnexal masses and ADNEXMR score was tested using ROC curve analysis and Kappa values. The reference standard was surgical pathology or at least a one-year imaging follow-up.

RESULTS
During pregnancy, MR imaging is an accurate tool to differentiate benign form malignant adnexal masses without any cancer missed. ADNEXMR score is as accurate and reproducible as in general population. Thus, our study suggests its potential to improve patient management. Larger multicenter prospective validation of the score is warranted.

CLINICAL RELEVANCE/APPLICATION
MR imaging is highly accurate to characterize adnexal masses during pregnancy and may be helpful to determine the risk with the patient to opt for the absence of surgery specifically until childbirth.

SSJ11-06 • Improving the Clinical Utility and Consistency of Placental MRI Reports: Introduction of a Novel Placental MRI Grading Scale to Assign a Confidence Score in Diagnosing Abnormal Placental Implantation
Angela Trinh MD (Presenter) ; Jeanne M Horowitz MD ; Sena Berggren MD ; Helena Gabriel MD ; Adrienne Vargo MD ; Frank H Miller MD

PURPOSE
To assess feasibility of a novel MRI grading scale using major and minor imaging criteria to assign confidence in diagnosing abnormal placental implantation (API), and improve the accuracy, consistency, and clinical utility of placental MRI.

METHOD AND MATERIALS
Two board certified radiologists blinded to all reports independently, retrospectively reviewed 20 randomized placental MRI exams (10 with API by surgery and/or pathology and 10 negative cases). Assessment was made for major and minor diagnostic criteria of API, based on MRI signs reported in literature. Major criteria included placental invasion outside the uterus, intraplacental bands, uterine bulging, very heterogeneous placenta, and bladder tenting. Minor criteria included mild/moderately heterogeneous placenta, tortuous flow voids, focal interruption of the myometrial wall and myometrial thinning. Confidence levels (CL) were assigned for the diagnosis of any level of API, including placental accreta, increta, and percreta. CL were: 90% confidence for cases with 2 or more major criteria, 75% confidence with either 1 major criterion or all 4 minor criteria, 50% confidence with 3 minor criteria, 25% confidence if no criteria met.

RESULTS
Between the two radiologists, there was complete agreement on 12 of 20 cases based on CL. 6 cases demonstrated a difference of only one CL. 2 cases demonstrated complete disagreement. When grouping the 90% and 75% CL into high suspicion and the 25% and 10% CL into low suspicion of API, the radiologists agreed on 18 of 20 cases. Of these 18 cases, 7 were high suspicion and 11 were low suspicion. The 7 high suspicion cases and 9 of the 11 low suspicion cases matched the surgical/pathology results. 2 of the 11 low suspicion cases were positive for placenta accreta. This resulted in a sensitivity of 0.7-0.89 and specificity of 0.91-1.0 for detection of API between the radiologists. Accuracy ranged from 0.85-0.91.

CONCLUSION
Utilizing major and minor imaging criteria on MRI to diagnose API can make placental MRI reporting more consistent and accurate and thus aid in surgical planning.

CLINICAL RELEVANCE/APPLICATION
Introducing a placental MRI grading scale with major and minor imaging criteria to assign confidence in diagnosing abnormal placental implantation, improving reports accuracy and consistency.
Independent assessment of pelvic pathology and tubal patency was done by two experienced radiologists (8y, 11y). Upon discrepancy, agreement was reached by consensus. Descriptive and analytical statistical analyses were performed, and frequencies were calculated. Mann-Whitney U test for independent samples was performed to detect significant differences.

RESULTS

CONCLUSION
MRHSG showed high acceptability and success rate for tubal patency assessment while simultaneously evaluating and diagnosing relevant diseases in infertility, thus becoming a potential one-stop-shop solution for female infertility.

CLINICAL RELEVANCE/APPLICATION
Female infertility is usually evaluated with many separate imaging studies (US, HSG, MR) or, even worse, laparoscopy. MRHSG could be a one-stop-shop exam for this patient population.

SSJ12-02 • Menstrual Cycle-specific Apparent Diffusion Coefficient of Normal Uterine Zonal Structures in Healthy Reproductive-age Women

Bo Jiang MD, PhD (Presenter); Bitao Pan; Ximin Pan; Meiyu Hu

PURPOSE
To assess the influence of three different physiological phases on the Apparent Diffusion Coefficient of normal uterus during menstrual cycle in healthy reproductive-age women.

METHOD AND MATERIALS
Eighteen healthy reproductive-age women underwent magnetic resonance diffusion-weighted imaging (DWI) at the menstrual, proliferative and secretory phases in a regular menstrual cycle. The apparent diffusion coefficient (ADC) was calculated of endometrium, junction and myometrium in uterine zones with b-values of 0,500 s/mm² and 0,1000s/mm², respectively. The ADC of each uterine zone was compared among the three phases and between two sets of different b value combination as well.

RESULTS
In the menstrual, proliferative and secretory phases, the ADC of endometrium was 1.37±0.62, 1.64±0.54, 1.51±0.35 at b valued 0 and 500 (F=7.83, p<0.05, respectively ) and at b valued 0 and 1000 (q=4.09, p<0.05, respectively ). The ADC of endometrium in menstrual, proliferative and secretory phases was higher in b valued 0 and 500 than in b valued 0 and 1000 (t=2.05, p<0.05, respectively ).

CONCLUSION
The different physiological phases in menstrual cycle exert significant effect on the ADC of endometrium but less effect on the ADC of both junctional zone and myometrium in healthy reproductive-age women. Higher-b value DWI warrants a more stable ADC.

CLINICAL RELEVANCE/APPLICATION
The menstrual cycle could be an important consideration when interpreting the usefulness of ADC of endometrium in reproductive-age women, and an appropriate time window selection for DWI is necessary.

SSJ12-03 • Comparison between Magnetic Resonance Hysterosalpingography Performed with 1.5 Tesla and 3 Tesla

Valentina Cipolla; Renato Argiro (Presenter); Daniele Guerrieri MD; Domiziana Santucci; Carlo De Felice MD

PURPOSE
The aim of this study was to compare results of magnetic resonance hysterosalpingography performed with 1.5 Tesla and with 3 Telsa (1.5 T MR-HSG and 3T MR-HSG) for the diagnostic workup of infertile women.

METHOD AND MATERIALS
We retrospectively analyzed 326 MR-HSG performed at our institution in a period of 30 mounth. The MR examination was performed with 1.5-T or 3-T MR unit. In both cases T2weighted and fat saturated T1 weighted images after intracavitary injection of normal steril salin were obtained using routine clinical parameters to assess intracavitary and extraterine abnormalities. For the evaluation of tubal patency, fat-saturated T1-weighted gradient echo 3D dynamic sequences were acquired during the hand-injection of a small amount of a contrast solution consisted of gadolinium diluted in normal sterile saline. Contrast solution employed in 3T MR-HSG was more diluted than 1.5 T MR-HSG. The procedure was repeated for 1, 2 or 3 times depending of the case. Two readers reviewed all examinations and compared the following parameter: visibility of the tubes, failure rate and execution time.

RESULTS
One hundred and ten MR-HSG were performed with 1.5 T and 216 with 3 T. Comparative analysis of examination show that intramural and ampullary portions of the tube were visualized in 73.3% of cases with 1.5 T and in 85.7% of cases with 3 T. Failure rate was 5.6% with 1.5 T and 2.5% with 3 T. Mean execution time was 25 min for 1.5T MR-HSG versus 18 min required for 3T MR-HSG. Gadolinium dose was reduced from 2 ml to 0.5 ml with 3T.

CONCLUSION
3T MR-HSG achieve a shorter execution time and a lower failure rate and offers a better visualization of the fallopian tubes compared to 1.5-T MR-HSG. Thanks to higher CNR, 3T allow gadolinium dose reduction an potential cost saving. 3T MR-HSG should be considered more accurate and faster single comprehensive examination to be employed in female infertility investigation.

CLINICAL RELEVANCE/APPLICATION
3T MR-HSG represent a faster and more accurate imaging approach compared to 1.5T MR-HSG in the diagnostic workup of female infertility.

SSJ12-04 • Improvement of 3T MR-HSG as ‘One-stop-Shop’ Imaging Approach to Female Infertility: Our Experience Over the Years

Valentina Cipolla (Presenter); Renato Argiro; Daniele Guerrieri MD; Domiziana Santucci; Carlo De Felice MD

PURPOSE
To confirm the improvement over the years of 3 Tesla magnetic resonance imaging hysterosalpingography (3T MR-HSG), as single comprehensive imaging approach to female infertility.

METHOD AND MATERIALS
Two hundred and sixteen infertile women underwent 3T MR-HSG. After standard imaging of the pelvis, dynamic study was performed by acquiring T1-weighted 3D time-resolved imaging of contrast kinetics (TRICKS) sequences during manual injection of 4-5 ml of contrast solution consisting of gadolinium (0.5 ml) and normal saline (20 ml). This procedure was carried out 1, 2 or 3 times. Two radiologists independently analyzed images. Regarding tubal patency, possible diagnoses were: fast tubal patency; delayed tubal patency; asymmetrical tubal patency; loss of regular tubo-ovarian relationship; bilateral tubal occlusion.

RESULTS
3T MR-HSG was successfully completed in 97.5%, failure rate was 2.5%. Analysis of morphological sequences revealed extratubal-extracavitary abnormalities in 44.9%, while uterine cavity abnormalities were found in 25% of patients. Overall extratubal abnormalities were detected in 69.9% of cases. Dynamic sequences showed intramural and ampullary portions of the tube in 85.7% while diagnosis of tubal patency was made indirectly in the remaining 14.3%. Bilateral tubal patency was found in
62%, among which 34.5% presented fast and symmetrical bilateral tubal patency and regular tubo-ovarian relationship. Unilateral tubal patency was found in 25%, among which 14.6% presented fast unilateral tubal patency with regular tubo-ovarian relationship. Bilateral tubal occlusion was detected in 9.4%. Average examination time was 18 min.

CONCLUSION
Over the years 3T MR-HSG showed a sensitive improvement in diagnostic accuracy for extratubal abnormalities and tubal visualization, allowing the clear depiction of intratubal spillage of contrast media, despite the very small amount injected. Execution time and failure rate were also reduced. After a three years experience, we could affirm that 3T MR-HSG is a simple, fast, safe and well tolerated examination. 3T MR-HSG represents a comprehensive one-stop-shop examination and should be employed as first level imaging technique in female infertility investigation.

CLINICAL RELEVANCE/APPLICATION
3T MR-HSG represents a fast and accurate, comprehensive imaging examination for female infertility.

**SSJ12-05 • Pearls and Pitfalls of Essure Microinsert Imaging: Does Abnormal Shape on U/S Predict Complications on HSG?**

*Wendaline M McEachern MD (Presenter) • Ian Suchet • John Thiel*

**PURPOSE**
We hypothesize that the shape of the Essure microinsert on ultrasound is able to predict complications evident on hysterosalpingogram (HSG), the accepted gold standard.

**METHOD AND MATERIALS**
From July 2, 2009 to July 2, 2012, 441 women at our institution received Essure microinsert placement for the purpose of permanent sterilization. 2D, 3D and 4D volume contrast imaging-coronal plane (VCI-C) transvaginal ultrasounds were performed three months after Essure microinsert placement. Those patients with complications identified on ultrasound, a non-diagnostic ultrasound or complications from the insertion procedure were referred for HSG. Patients with both HSG and ultrasound performed were retrospectively selected and anonymized. The ultrasounds were prospectively reviewed using previously archived 3D and 4D US volumes by a single, blinded radiologist. The shape of each Essure microinsert was described using a numeric grading system. This numeric descriptor was then recorded and compared to the previously reported HSG result.

**RESULTS**
The sensitivity of Essure microinsert shape on ultrasound in predicting complications, compared with standard HSG, was 94%, with a positive predictive value of 85%; specificity was 95%, with a negative predictive value of 98%.

**CONCLUSION**
Abnormal microinsert morphology is an excellent predictor of abnormality (sensitivity 94%). The positive predictive value of 85% results in slightly more individuals classified as abnormal, but is safer for patients as it leads to appropriate referral for HSG and recommendation for interim secondary form of contraception.

**CLINICAL RELEVANCE/APPLICATION**
Ultrasound as a frontline modality for Essure microinsert assessment may contribute to a future FDA label change which mandates HSG post-insertion.

**SSJ12-06 • Virtual Hysterosalpingography in 10000 Cases**

*Patricia M Carrascosa MD (Presenter) • Javier Vallesjos MD • Carlos Capunay MD • Mariano Baronio • Jorge M Carrascosa MD*

**PURPOSE**
To illustrate the typical findings of V-HSG by MDCT in daily practice and the differential diagnosis with other pathologies.

**METHOD AND MATERIALS**
We evaluated the V-HSG studies of 10000 patients (mean age 35.4 ± 3.5 years) derived from our institution. Studies were performed using 64,128 and 256 multislice CT scanners. Scanning parameters were: On 64-row CT: slice thickness of 9 mm and a reconstruction interval of 0.45 mm, 120 kV and 100-250 mAs, with an average duration of each scan of 3.6 seconds. On 128 and 256-slice CT: slice thickness of 6 mm and a reconstruction interval of 3 mm, 80 kV and 100-150 mAs, with an average duration of each scan of 1.3 seconds. For visualization of the internal genital organs 10-20 ml of a dilution of low-osmolality iodinated contrast was instilled into the uterine cavity. Images were analyzed using multiplanar reconstructions, 3D and virtual endoscopy. The duration of the CT scan, the radiation exposure and the degree of discomfort of the patients were documented.

**RESULTS**
Using 64-row CT scanners, the mean radiation dose was 0.9 mSv. Using 128 to 256-slice CT scanners the mean radiation dose was 0.3 mSv. In the cervical region were identified parietal irregularities (26%), thickening of folds (10%), polyps (8%), diverticula (6%), stricture (6%) and adhesions (1%). At the level of the uterine cavity showed polyps (35%), submucous fibroids (9%) and adhesions (4%). In addition changes were observed in the wall of the uterus: fibroids (19%), malformations (3,6%), adenomyosis (6%) and cesarean section (11%). 4% of the uterine tubes are not visualized completely. Unilateral hydrosalpinx was visualized (8%) and bilateral (1,5%). Patients reported no or mild discomfort in 85% of the cases.

**CONCLUSION**
The virtual-HSG allowed a proper assessment of the internal genital organs, providing useful diagnostic information on infertility and other gynecological disorders. The technique is painless, well tolerated by patients with low doses of radiation. These advantages place this modality as a valid alternative algorithm study in patients with infertility.

**CLINICAL RELEVANCE/APPLICATION**
CT Virtual Hysteroscopy provides a complete, minimally invasive evaluation of the female reproductive system. Low radiation doses are very important.
A focused clinical question was constructed and the literature was searched using the patient, intervention, comparison, outcome (PICO) method comparing CECT vs. its combination with NECT for detection or characterization of liver metastases, the radiologists' confidence level, and detection of significant incidental findings in patients with breast, melanoma, neuroendocrine or thyroid cancer. Retrieved articles were appraised and assigned a level of evidence based on the Oxford University Centre for Evidence-Based Medicine hierarchy of validity for diagnostic studies.

The diagnostic performance for different phases of CT for characterization of liver metastases showed sensitivity/specificity of 97%/76% for NECT, 97%/75% for arterial CT and 98%/76% for portal CT in patients with breast cancer (level 2 of evidence; reported in 1999); sensitivity of 96% (arterial and portal CT) vs. 100% (NECT, arterial and portal CT) in patients with melanoma (level 3 of evidence; reported in 1999); and sensitivity of 43% (portal CT) vs. 17% (NECT) in patients with neuroendocrine tumor (level 3 of evidence; reported in 2009). No primary study was found evaluating performance of CT phases in patients with thyroid cancer. Available evidence showed radiologists reported more conspicuous liver masses on CECT compared to NECT in patients with breast and neuroendocrine cancer; however, NECT was reported to add value to portal phase CT in 42% of patients with breast cancer.

CONCLUSION

NECT adds only a small incremental value to CECT for detection/characterization of liver metastases. Further, addition of NECT increases patient’s risk of exposure to radiation, and the time and cost of imaging interpretation. The role of adding NECT to CECT in confidence level of radiologists or characterization of significant incidental findings is less clear.

CLINICAL RELEVANCE/APPLICATION

A critical appraisal of literature shows addition of NECT to CECT for characterization of liver metastases in patients with breast, melanoma, neuroendocrine or thyroid cancer is of limited benefit.

SSJ13-03 • Mobile Mammography Utilization Trends and Disparities Over a Decade at a Comprehensive Urban Cancer Center

Sarah G Mizuguchi MD ; Elizabeth Riley MD * ; Laura E Barkley MD (Presenter) ; Lane M Roland MD ; Shesh N Rai PhD ; Jianmin Pan PhD ; Connie L Sorrell MPH ; Stacey M Crawford MD ; Laura Fry MBA

PURPOSE

Mobile mammography units (MMU) have become a model of community outreach. The purpose of this study is to assess the utilization of MMU in the largest county in Kentucky as it relates to race and insurance status.

METHOD AND MATERIALS

From January 2001 - December 2010, our MMU performed 21,858 screening mammograms. Demographic data was retrospectively reviewed to identity differences in screening utilization and return rates by race and insurance status. This data set was compared to existing census data for Jefferson County (JC) and Kentucky (KY). Descriptive statistics for patient age, race and insurance status were computed by entire cohort and within the subsets of cohorts. To study the patterns of frequency distributions, in-discrete variables were performed using Pearson Chi-square tests. For continuous variable range, a 95% confidence interval of mean was estimated. The comparison with a p-value < 0.05 was considered statistically significant.

RESULTS

Self reported Blacks (B) constitute 29% of the MMU utilization over the 10 year period. Whites (W) and Hispanics (H) represent 64% and 4%, respectively. Census data demographic reports are 19%, 74% and 3%, respectively. This discordance between demographic data of the MMU and the census data is statistically significant across all races (p < 0.05).

CONCLUSION

MMU captures minorities in greater density than JC and KY census data would predict. This data alone will help tailor future outreach and outcome initiatives to this specific patient population.

CLINICAL RELEVANCE/APPLICATION

Mobile mammography programs increase access to screening of disadvantaged populations. Understanding utilization by race and insurance has implications for funding, patterns of outreach and access.

SSJ13-04 • Follow-up of Pulmonary Nodule Detected on Abdominal CT: Cost Implications for Adhering to Nationally Recommended Best-practice Guidelines

David A Rosman MD (Presenter) * ; Carol C Wu MD * ; Michael T Lu MD ; Tarik K Alkasab MD, PhD ; Matthew D Gilman MD ; Jo-Anne O Shepard MD * ; Debra A Gervais MD * ; Keith J Dreyer DO, PhD * ; Daniel I Rosenthal MD ; Giles W Boland MD

PURPOSE

Incidental pulmonary nodules are commonly identified on abdominal CT, which often require imaging follow-up, but cost implications for these recommendations are unknown. Our department has adopted a modified Fleischner guideline for use by abdominal radiologists, which is embedded into a point-of-care clinical decision support (CDS) tool for radiologists. We evaluated the cost implications when radiologists adhered to the guidelines using the CDS tool compared to recommendations made without use of the tool.

METHOD AND MATERIALS

The RIS was mined for abdominal CT reports from 1/1/12 - 10/22/12 describing a pulmonary nodule, which did not have prior abdominal/chest CT or concurrent chest CT. Inclusion criteria included solid, noncalcified, pulmonary nodule < 3 cm. The numbers of additional CT examinations recommended over 2 year f/u assuming no additional findings with and without the use of the CDS tool were compared. Without the tool, some recommendations varied from unnecessary additional imaging, insufficient imaging and appropriate imaging when compared to guidelines. CDS tool recommendations conformed to departmental guidelines.

RESULTS

Of 20,578 consecutive abdominal CT reports analyzed, 462 documented a pulmonary nodule. Manual review yielded 268 patients with micrometastasis criteria. Without use of the CDS tool imaging was recommended on 59% (143/268) which would have led to 409 f/u CTs over two years. Furthermore, excessive imaging was recommended for 23% (61/268) and insufficient imaging was recommended for 28% (74/268). The ideal algorithm using the CDS tool would have recommended 592 f/u CT examinations in 190 patients (an additional 183 exams compared to without the CDS tool). Using MPFS payment for a non-contrast CT (71250 - $212.98), the total cost of recommended f/u without use of the tool would be $87,108.82 over two years. Recommendations conforming to departmental guidelines would have resulted in an increase of $36,975.35 for a total $126,084.16 in cost.

CONCLUSION

Compliance with nationally accepted best practice algorithms for follow-up of pulmonary nodules identified on abdominal CT leads to an increase in initial cost due to the greater number of imaging recommendations.

CLINICAL RELEVANCE/APPLICATION

Following departmental guidelines for pulmonary nodule workup would increase the short term cost. The effect on outcomes and long-term cost is not known.

SSJ13-05 • Breast Cancer Risk, Worry, and Anxiety: Effect on Patient Perceptions of False-positive Screening Results

Jessica Chubiz MS ; Janie M Lee MD (Presenter) * ; John S Swan MD ; Tina Motazed BS ; Elkan F Halpern PhD * ; G.
SSJ13-06 • Appraisal of LI-RADS, AASLD and EASL-EORTC Guidelines for the Non-invasive Diagnosis of Hepatocellular Carcinoma in Patients with Liver Cirrhosis

Anne Carroll MBCh (Presenter) ; Lisa P Lavelle MBCh ; Eve O’Toole PhD ; Edmund Ronan Ryan MBCh ; Dermot E Malone MD

PURPOSE
There are some differences between leading guidelines in their recommendations for the non-invasive diagnosis of Hepatocellular Carcinoma (HCC) in patients with liver cirrhosis. This study was performed to establish the relative validity of these guidelines using Evidence-Based Medicine (EBM) methodology.

METHOD AND MATERIALS
The American Association for the Study of Liver Disease (AASLD) 2010 guidelines, the European Association for the Study of the Liver and the European Association for Research and Treatment of Cancer (EASL-EORTC) 2011 joint guidelines and the American College of Radiology Liver Imaging Reporting and Data System (LI-RADS) v.2013.1 guidelines were appraised. To assess the methodological rigor and transparency used in developing the guidelines, the internationally recognized Appraisal of Guidelines for Research and Evaluation (AGREE) 2 Instrument was used. Each guideline was appraised under 6 different domains, followed by an overall assessment. The domains were: Scope and Purpose, Stakeholder Involvement, Rigor of Development, Clarity of Presentation, Applicability and Editorial Independence. The appraisal was performed by 3 individual radiologists, under the guidance of the Research and Evaluation Manager of the Irish National Cancer Control Programme, and consensus results were compiled.

RESULTS
The Agree 2 scaled domain scores were calculated as follows: (obtained score - minimum possible score) / (maximum possible score - minimum possible score) x 100. The EASL-EORTC guidelines scored the highest at 83%. The AASLD guidelines scored 72% and the LI-RADS guidelines scored 50%. All 3 guidelines were recommended for use, but AASLD and LI-RADS guidelines would be improved by better referencing and better identification of the level of evidence behind the recommendations.

CONCLUSION
The methodological rigor and transparency of leading guidelines varies as described. If guidelines disagree, the EASL-EORTC 2011 guidelines have the highest validity by EBM criteria.

CLINICAL RELEVANCE/APPLICATION
EASL-EORTC 2011 are the highest quality current guidelines addressing the non-invasive diagnosis of HCC. They should be followed if conflict with AASLD or LI-RADS recommendations is noted.

Informatics (Business Analytics) Tuesday, 03:00 PM - 04:00 PM • S402AB

Jaron Chong MD (Presenter)

CONCLUSION
We believe ctSQL extensions will offer a more expressive, accessible, and automated method for users to query for clinically significant events across a patient's entire timeline.

Background
Traditional search applications utilize keyword and exact phrase matching to derive relevant search results. While very flexible in basic searches, clinical applications often require the consideration of not just the presence of concepts within a single document, but a series of events. This project describes the theoretical and practical implementation of syntax extensions to traditional boolean query operators to allow a search engine to implement clinical timeline searches.

Evaluation
Clinical Temporal Structured Query Language (ctSQL) is a syntax translation layer built upon existing PHP/Sphinx API's that converts a ctSQL query into a series of nested queries in SPHINX EXTENDED2 query format. Core concepts include (1) concept lists, (2) temporal operators, and (3) result chains. Concept lists are equivalent to traditional search queries and represent a series of keywords and boolean operators that can be matched to single full-text documents. Temporal queries represent chains of concept lists that have a particular event sequence specified using custom operator symbols that traverse multiple reports under a single patient identifier. Result chains are the natural consequence of ctSQL's emphasis on clinical timelines, with results returned as report chains instead of individual documents.

Discussion
Using this framework, more complex clinical queries can be resolved in an automated fashion delivering search results that can address more advanced clinical scenarios. We describe application examples involving (1) critical findings of pneumothorax and automated documentation of treatment (Closed Loop Pattern), (2) IVC filter insertion and retrieval (Closed Loop Pattern), and (3) lung nodule growth versus stability (Long-Term Timeline). Additionally, meta-information present within result chains allows for the straightforward calculation of quality-control metrics such as delays in management, follow-up, or disease progression.
SSJ14-02 • Taking the Hunting and Gathering Out of Radiology with Intelligent Personal Assistants

Mark A Flyer MD (Presenter); Jonathon Dreyer BS *

CONCLUSION
Virtual assistants will provide an intelligent layer between radiologists and their RIS or PACS. This will enable them to improve the quality of their reports while reducing the time it takes to create and deliver actionable information to the referring physician and, in turn, the patient.

Background
As the industry transitions from a traditional fee-for-service payment to value-based reimbursement, there is a risk that radiology will become marginalized. One emerging solution that aims to address this issue is an intelligent virtual assistant that can streamline the hunting and gathering of information for radiologists.

Evaluation
How can radiologists raise their visibility in the face of the integrated patient care cycle, underlining their importance and contribution to the goals of healthcare today? By leveraging virtual assistants to streamline tasks that involve time-intensive hunting and gathering of information. A virtual assistant is an embeddable piece of technology that actively listens and takes directives from a user, a radiologist or other clinical professional, and engages in conversational, human-like dialogs to fulfill specific requests. For example, virtual assistants can provide radiologists with more accurate, timely access to clinical guidelines and alert them to missing information in records. This presentation will discuss the wide ranging use cases and benefits associated with the integration of virtual assistants as part of the radiologists’ workflow.

Discussion
As we’ve grown accustomed to the benefits and ease of use of voice-enabled personal assistants like Siri in our everyday lives (Send text to my wife and let her know I’ll be late for dinner), we’ve also come to expect this same type of experience in our work lives. Nowhere is this type of virtual assistant technology a solution that can streamline administrative tasks and aid in information retrieval more critical than in the healthcare realm. Moreover, the ability to leverage a conversational user interface to make these interactions natural and human-like is critical as radiologists and clinicians alike face more complexity and increasing workloads as a result of ever-evolving state of healthcare.

SSJ14-03 • Implementation of a Pseudonymized Feedback System to Improve Individual Turnaround-times for Radiology Reports

Achim Escher (Presenter); Tobias Heye MD; Elmar M Merkle MD *

PURPOSE
To analyze turnaround-times for radiology reports as a key performance indicator (KPI) for referring physician satisfaction and to implement a pseudonymized feedback system.

METHOD AND MATERIALS
The time period until a preliminary report was available for clinicians in the hospital information system and the time interval between preliminary to final reports were defined as report turn-around times. Calculation was based on data retrieved from the radiology information system (RIS) and a pseudonymized feedback system was developed and implemented. Hereby, an algorithm respecting complex schedules, including on-/off service times on nights and weekends providing a balanced assessment of turnaround times was used. The feedback system gives an overview of the average turnaround-times of the entire department, all sections (n = 6) and each department member (n = 45) in a pseudonymized fashion. Each department member can locate himself/herself on pseudonymized graphs illustrating average turnaround-time of all department members by the identification code only provided to him/her.

The feedback system is composed of three different elements:

a) Monthly target-reporting stratified by sections presented in the department board-meeting to review the achievement of objectives.

b) Monthly benchmarking reports on the average turnaround-times stratified by the individual radiologist in a pseudonymized fashion.

c) The daily current workload for each section within the department was displayed as screen saver on all PACS workstations updated every ten minutes.

RESULTS
Initial results comparing data from introduction of the feedback system in March 2013 with February 2013 showed an improvement in average turnaround-time by 11.4% for preliminary reports and by 8.5% for final reports. 70% of department members improved in their individual turnaround-times.

CONCLUSION
Initial results demonstrate that transparency, feedback and comparison of individual performances in relation to the pseudonymized peer group improve turnaround-times of radiology reports as an important KPI.

CLINICAL RELEVANCE/APPLICATION
Timely availability of radiology reports by improved turnaround-times expedites communication of relevant information to clinicians thus optimizing patient care.

SSJ14-04 • Trends in Inpatient Imaging Utilization Over the Last Decade

Atul B Shinagare MD (Presenter); Ivan Ip MD, MPH; Sarah K Abbett MD, MPH; Richard Hanson *; Steven E Seltzer MD *

PURPOSE
We have previously reported inpatient imaging utilization trends at our institution from fiscal years (FY) 1984 through 2002. In this study, we assessed the trends in imaging utilization for inpatients from FY 2003 through 2012.

METHOD AND MATERIALS
In this institutional review board-approved, retrospective study performed at a 793-bed tertiary care academic institution, we reviewed imaging utilization in adult inpatients from October 1, 2002 through September 30, 2012 (FY 2003 through 2012) and recorded the gross number of imaging studies coded by modality (conventional [plain films and fluoroscopy], sonography, nuclear medicine [NM], CT, and MRI) and associated relative value units (RVUs). We used linear regression to assess trends in number of imaging studies as well as CT, NM and conventional studies adjusted for CMAA decreased (p=0.02, p=0.0006, p=0.0008 and p=0.001 respectively; Fig. 1); CT per CMAA increased until 2009 and then decreased through 2012. Utilization of ultrasound and MRI did not change significantly (p=0.15 and p=0.22, respectively). Unadjusted global RVUs increased until 2009 and then showed a slight decrease through 2012 (p=0.04), while RVUs per CMAA did not change significantly (p=0.18).

CONCLUSION
After decades of continued rise, imaging utilization for inpatients significantly decreased by most measures between 2009 and 2012. Future studies to evaluate the contribution of various factors to this decline, including efforts to reduce inappropriate use of imaging and concerns about potential harms of radiation exposure, may be helpful in optimizing imaging utilization and resource planning.
SSJ14-05 ● The Comoditization of Healthcare Information Systems: Is the Time Now?

Nogah Haramati MD *; Anne C Krok (Presenter); Mony Weschler MSC, BSC; Gad Levy MD; Roni Zaharia *

PURPOSE
We assessed the advantages and disadvantages of at least partially commoditizing radiology healthcare information systems.

METHOD AND MATERIALS
Components included in the study: viewer, archive, worklist or workflow manager, 3D/volume rendering, CAD, decision support tools, integration/interoperability/data exchange engines or tools. Offerings of tools, as well as system components were analyzed from available products. Incorporation of additional functionalities deemed useful in practice but not available as part of an existing commercial turn-key PACS was included in this study.

RESULTS
VIEWER: Majority of commercial systems have viewers that lack essential tools. Open market viewers exist that offer DICOM compatibility to existing archives. ARCHIVE: Vendor neutral DICOM archive (VNA) is the component that is most aggressively being marketed today. Many options exist in this space. Worklist or workflow manager: Rudimentary but not robust tools needed to create worklists exist as a commodity product. SEE NOTE A 3D/volume rendering: Advanced tools exist. Desktop integration into a viewer is variable. CAD: No consensus achieved within radiology regarding effectiveness and necessity of CAD tools. Availability and ease of incorporation of tools into an viewer is variable. DECISION SUPPORT TOOLS: This area is one in which many of the needed tools are likely still lacking. SEE NOTE A. INTEGRATION/INTEROPERABILITY/DATA EXCHANGE ENGINES OR TOOLS: Many vendors are demonstrating IHE XDS/XDSi capabilities at IHE connectathons. Ability to pull data in real-time from other clinical systems within an enterprise, even from the same vendor still lacking. NOTE A: Incorporating such tools into a commoditized system, rather than waiting for a vendor to incorporate these tools would likely result in a shorter time cycle from the research bench to the clinical workplace.

CONCLUSION
Viewer and archive commoditized products exist and rival those of commercial turnkey systems. Areas exist in which commoditized systems may be suitable to bring these functionalities to the desktop in a shorter time as compared to commercial vendor turnkey systems.

CLINICAL RELEVANCE/APPLICATION
Commoditized products are generally less expensive than complete systems. As healthcare organizations reach PACS end of life and look for a replacement, a commoditized alternative may offer higher function.

SSJ14-06 ● The Evaluation of Academic Productivity Using Bibliometric Profiling

Nickalus R Khan BSc (Presenter); Asim F Choudhri MD

CONCLUSION
The analysis of academic productivity using bibliometric profiling is a robust way to delineate an individuals productivity. These indexes have use in academic medicine and may precede changes in academic rank or departmental rank. Understanding the calculation and use of these indices is paramount in the future of academic productivity evaluations.

Background
Bibliometrics is defined as the study of statistical and mathematical methods used to quantitatively analyze scientific literature. The application of bibliometrics in academic medicine is in its infancy. Recently there have been many new metrics introduced to evaluate academic productivity such as the h-index, contemporary h-index, m-quotient, g-index, e-index, Google’s i10, and more. Of these the h-index has gained the most attention. The authors describe the calculation, interpretation, and comparison of these bibliometric measures in academic medicine.

Evaluation
The h-index, g-index, m-quotient, and contemporary h-index are compared using Scopus, Web of Science, and Google Scholar. The differences between these databases are evaluated. The authors discuss the description of how to calculate these indexes and how to apply the indexes in the evaluation of academic productivity.

Discussion
There are important differences among individuals when using the three different currently available bibliometric databases. The interpretation of the h-index, g-index, m-quotient, and contemporary h-index can provide different perspectives into an individuals academic profile. There are large variations depending on which database is used and caution is advised when searching for individuals using Google Scholar or Web of Science.

Molecular Imaging (Neurosciences) Tuesday, 03:00 PM - 04:00 PM ● SSJ04CD

Eric Wehenenberg-Klee MD (Presenter); Navid Redjal MD; Alicia Leece; Pedram Heidari MD; Nafize S Turker PhD; Khalid Shah PhD; Umar Mahmood MD, PhD

PURPOSE
Distinguishing true progression of glioblastoma multiforme (GBM) from pseudoprogression after surgery with chemoradiation is quite challenging using current imaging techniques. EGFR is overexpressed on 40% of GBMs, and we hypothesized that targeted imaging could provide a novel mechanism for distinguishing recurrence from pseudoprogression in the large fraction of patients with confirmed baseline EGFR expression. We developed and preclinically tested a novel PET probe, 64Cu-DOTA-EGFR F(ab)’2, for direct tumor imaging based on EGFR expression, with optimized pharmacokinetics for clinically translatable PET imaging.

METHOD AND MATERIALS
An EGFR-specific imaging probe, 64Cu-DOTA-EGFR F(ab)’2 was developed with F(ab)’2 fragmentation and chelator conjugation of a humanized monoclonal antibody to EGFR. Probe affinity was assessed using Ga-67 labeling and saturation binding studies with EGFR positive A345 cells. For in-vivo studies, Glr-36, an EGFR expressing GBM cell line transfected to express luciferase, was used. Nude (nu) mice (n=3) were injected with SX100 (n=3) and SX101 (n=3) (EGFR overexpressing) cell lines. PET imaging, tumor uptake was confirmed with bioluminescence. In vivo agent kinetics were established by imaging (n=3) mice at 4, 8, 16, and 22h after injection of 100 uCi of 64Cu-DOTA-EGFR F(ab)’2. Blocking studies were performed by injecting mice (n=3) with escalating doses of cetuximab 24h prior to agent administration.

RESULTS
Specific PET imaging of glioblastoma multiforme tumors that express EGFR is possible using the kinetically optimized novel PET imaging agent 64Cu-DOTA-EGFR F(ab)’2.
**SSJ15-02 • EGFR MAb-bioconjugated Superparamagnetic Iron Oxide Nanoparticles as a Specific MRI Contrast Agent for Detection of Brain Glioma In Vivo**

**Wenzhen Zhu MD, PhD (Presenter) ; Shun Zhang ; Ketao Mu PhD**

**PURPOSE**

Superparamagnetic iron oxide nanoparticle (SPIONPs) delivery system has become a model system in which to study the target molecular-specific biodistribution, rapid exertion and undesired side-effects using in vivo small animal MRI. As a cellular transmembrane receptor, EGFR regulates important cellular processes and is linked to a poor prognosis in various human cancers. In this study, we developed a potentially valuable new targeted nanocarrier based on SPION delivery system, EGFRmAb-bioconjugated nanoparticles EGFRmAb-SPIONPs. The purpose of this study was to elucidate strategies for further improvement of this promising approach.

**METHOD AND MATERIALS**

EGFRmAb-SPIONPs were prepared and characterized. The preferential accumulation of the EGFRmAb-SPIONPs within gliomas and subsequent MRI contrast enhancement were demonstrated in vitro in C6 cells and in vivo in tumors of rat model. MRI scanning was performed using a 3.0T MRI scanner and a research coil insert designed specifically for imaging rats was used to MRI

**RESULTS**

The average particle size of about 10.21 nm, hydrodynamic diameter of about 161.5 nm, saturation magnetization of 55 emu/g Fe and T2 relaxivity of 92.73 S-1mM-1 of the EGFRmAb-SPIONPs suggested its applicability for MRI. MR T2WI of iron uptake in C6 cells treated with the nanoparticles (EGFRmAb-SPIONPs and SPIONPs) of various iron concentrations were shown. This result demonstrated that, EGFRmAb-SPIONPs could efficiently and specifically label the C6 cells compared to SPIONPs. Using a rat model of C6 glioma, EGFRmAb-SPIONPs provided a better picture or more sensitivity to depict brain glioma on MR images than that of SPIONs. Significantly enhanced T2-weighted images of brain glioma were documented in vivo with EGFRmAb-SPIONs until 48h after injection. The results from cytotoxicity, histopathology and blood toxicity assays suggested that the EGFRmAb-SPIONs had good biocompatibility and exhibited no toxicity.

**CONCLUSION**

EGFRmAb-SPIONPs could be specifically and efficiently uptaken by C6 glioma cells, and selectively improve the detection of tumor by MRI; it could produce the remarkable contrast change of brain glioma in vivo following intra-carotid administration of EGFRmAb-SPIONPs.

**CLINICAL RELEVANCE/APPLICATION**

EGFRmAb-SPIONPs is suitable for use as negative MRI contrast agent, and had good biocompatibility and exhibited no toxicity, which was very important for the clinical application.

**SSJ15-03 • Imaging Biomarker Evaluation of Cytoskeletal Stabilization Therapy for Traumatic Brain Injury**

**Donna J Cross PhD (Presenter) ; Rodney Ho PhD ; Todd L Richards PhD ; Vasily L Yarnykh PhD ; Greg Garwin ; Pierre Mourad ; David Cook ; Satoshi Minoshima MD, PhD**

**PURPOSE**

Currently, there is no effective pharmacological intervention to improve outcome in traumatic brain injury (TBI). The goal of this study is to evaluate a microtubule-stabilizing drug as a therapeutic intervention following TBI using neurological assessments and MR imaging biomarkers in a rodent model.

**METHOD AND MATERIALS**

Subjects, C57BL6 mice, n=12, 10wks) had craniotomy plus controlled cortical impact (CCI) surgery under isoflurane anesthesia, (Leica Biosystems, Richmond, IL), followed by 200 µg/kg paclitaxel (n=6) or vehicle (n=6) applied to the brain injury site. Sham surgery (craniotomy no CCI) was performed on controls (n=3). At 2 days post surgery, subjects had gait assessment by CatWalk automated gait analysis (Noldus Information Tech, The Netherlands) followed by high-tesla MR imaging (14T MR Avance III UltraShield, Bruker BioSpin, Billerica, MA). T1-weighted and quantitative T2 maps were obtained: MDEFT, FA:12; TR:5000ms, TE:1.9ms, resolution 0.140x0.140x0.25mm³, 64 slices and, T2 map: TR=2000ms, 16 echoes, spacing:6.7ms, TE 1: 6.7ms, TE 2: 13.4ms, resolution 0.12x0.12x1.0mm³, 15 slices. Manual VOI analysis of lesion volume and volume of edema related to injury was performed.

**RESULTS**

Lesion analysis on T2 and T1 images, blinded to therapeutic regimen, indicated 20% reduction in volume with paclitaxel treatment (9.92±2.3 versus 7.94±1.5mm³, p<0.05) and hyperintense voxels (edema) on quantitative T2 maps were reduced 26% (11.92±3.0 versus 8.86±2.2mm², p=0.05). Paclitaxel resulted in improved gait (computer-recorded objective analysis) for maximum print area (0.38±00.09 versus 0.29±0.08cm², p=0.05) and mean intensity (79.45±14.26 versus 66.38±5.52, p<0.05) over vehicle group.

**CONCLUSION**

The results indicate that administering drugs to stabilize axonal cytoskeleton following TBI improves outcome in neurological/gait assessment, also demonstrated as improvement on MR imaging biomarkers. This improvement appears to be mediated by reduced lesion size and corresponding post-injury edema. Evaluations of structural integrity on DTI and myelin degradation with magnetization transfer as well as western blot protein analysis are ongoing to better characterize the mechanisms of improved outcome after treatment.

**CLINICAL RELEVANCE/APPLICATION**

This study provides evidence of the efficacy for microtubule-stabilizing drugs to improve outcome following traumatic brain injury and imaging assessment that can be translated to patient evaluation.

**SSJ15-04 • Dual-modality Imaging of Exogenous Endothelial Progenitor Cells in Ischemic Stroke Mouse**

**Ying Ying Bai (Presenter) ; Sheng Hong Ju MD, PhD**

**PURPOSE**

The objective was to noninvasively visualize the homing, migration and differentiation of exogenous EPCs in vivo using a dual-modality imaging probe, and to examine the effect of transplanted EPCs on the recovery of ischemic stroke.

**METHOD AND MATERIALS**

Bone-marrow derived EPCs were labeled with a multifunctional probe modified with gadolinium, Cy5.5 and rhodamine. EPCs (5x10⁵) were transplanted via ipsilateral internal carotid artery into cortical ischemia mice induced by photothrombosis. Magnetic Resonance(MR) and near-infrared(NIR) optical imaging were performed at different time points. The infarct areas were determined by T2WI-MR and behavioral deficits were detected with cylinder tests, foot-fault tests and mNSS scores. The microvessel density, proliferation of immature neural cells and cell apoptosis were evaluated by immunofluorescence. Moreover, the expression of cytokines and related proteins during EPCs therapy in stroke area was detected by Western blot analysis.

**RESULTS**
MR Arthrography (MRA) of the Shoulder: Does Approach Really Impact Diagnostic Accuracy and Confidence?

**Purpose**

Axonal dysfunction is an early feature of Alzheimer disease (AD). Research implicates altered axonal transport as a possible cause. We hypothesize that the axonal transport rate in the olfactory tracts will decrease with age in triple transgenic AD mice.

**Method and Materials**

To determine whether needle approach has clinically relevant impact on diagnostic accuracy and confidence of shoulder MRA.

**Results**

Conventional contrast-enhanced MRI measures blood-brain-barrier breakdown, but not necessarily inflammation. We hypothesized that MPO-Gd (bis-5HT-DTPA-Gd), a molecular MRI probe sensitive and specific for the inflammatory enzyme myeloperoxidase (MPO), can detect therapeutic effects of Interferon-β (Ifn-β), a current first-line drug in MS and reveal changes in the immune response.

**Conclusion**

 Compared with wild-type mice, axonal transport significantly decreases in AD Tg mice as they age and develop known AD pathology. Although there is mild decrease in uptake and transport in aged WT mice, there is a significantly greater axonal transport decrease in AD Tg mice.

**Clinical Relevance/Application**

Investigation of axonal transport provides critical insights into pathogenesis of AD and facilitates new imaging developments that can be applied in the clinic.

**SSJ15-06 • Molecular Magnetic Resonance Immunoradiology Reveals Novel Effect of Interferon-Β on Myeloid Cells in Murine Multiple Sclerosis**

**Purpose**

Myeloid cells are critical for the neurodegenerative pathogenesis of multiple sclerosis (MS) via the secretion of the inflammatory enzyme myeloperoxidase (MPO). We hypothesized that MPO-Gd (bis-5HT-DTPA-Gd), a molecular MRI probe sensitive and specific for MPO, could be used for molecular imaging to study the progression of inflammation in MS. We performed MRI on a mouse model of MS, and treated with either Ifn-β (1μg/day) or saline. To determine effects of Ifn-β on MPO, mice underwent MRI at 4.7T with MPO-Gd at the disease peak (day 12). Lesion volumes and CNR at 10 and 60 minutes post MPO-Gd injection were quantified. MPO activity assay and MPO secretion experiments were performed.

**Results**

Lesion volumes and CNR at 10 and 60 minutes post MPO-Gd injection were quantified. MPO activity assay and MPO secretion experiments were performed.

**Conclusion**

Our results revealed a new mechanism: Ifn-β directly acts on myeloid cells to decrease MPO secretion, contributing to the efficacy of this widely used drug. MPO-Gd enhanced MRI can detect inhibition of MPO secretion by Ifn-β non-invasively. This study also demonstrated the unique capability of molecular imaging to probe immunology in vivo.

**Clinical Relevance/Application**

Upon translation, MPO-Gd molecular imaging could be used to monitor treatment efficacy of Ifn-β and similar drugs in MS patients.

**SSJ16-01 • MR Arthrography (MRA) of the Shoulder: Does Approach Really Impact Diagnostic Accuracy and Confidence?**

**Purpose**

To determine whether needle approach has clinically relevant impact on diagnostic accuracy and confidence of shoulder MRA.

**Method and Materials**

A retrospective database search for consecutive shoulder MRAs with surgical correlation within 6 months was performed in a year timeframe. Exclusion criteria included prior surgery and technically limited study. The study group was categorized into two subgroups (anterior and posterior approach) based on needle technique. The MRAs were de-identified and randomized. Four musculoskeletal radiologists measured the following variables independently and blinded to needle approach: capsular distension, extravasation, SLAP, Bankart/variant, reversed Bankart/variant, and SGHL/MGHL/IGHL tears. For each variable the diagnostic confidence was graded from 0 to 5. Sensitivity, specificity, accuracy, NPV and PPV were calculated for each diagnosis as well as for each needle approach.
RESULTS
31 MRAs were included, 14 were performed using anterior approach (F:2; M:12; mean age 33.1 (range:15-59). 17 were performed using a posterior approach (F:1; M:16; mean age 37.7 (range: 21-62). In the anterior approach group, Ss/Sp/accuracy/NPV/PPV (%) were as follows: SLAP 54.5/75/58.9/31/88.9 and Bankart/variant 75/80.6/78.6/85.3/68.2. In the posterior approach group, Ss/Sp/accuracy/NPV/PPV (%) were as follows: SLAP 60.7/80.0/72.1/74.4/68 and Bankart/variant 100/63.5/72.1/100/45.7. When comparing anterior (A) to posterior (P) approach in regards to specificity for detection (A%/P%/P-value) of IGHL tear: 73.2/89.9, MGHL tear 85.7/89.3/0.527; SGHL tear 85.7/89.2/0.618; Reverse Bankart 83.9/77.9/0.588. Inter-reader agreement in terms of detection was moderate for the anterior approach (Kappa: 0.4 - 0.6) and moderate to substantial for the posterior approach (Kappa: 0.4 - 0.7). There was no statistically significant difference for reader confidence scores.

CONCLUSION
Our findings demonstrate a statistically significant improvement in NPV for evaluation of Bankart lesions and SLAP tears using a posterior approach and moderate agreement (kappa=0.4) for both approaches in terms of the detection of any one attribute.

CLINICAL RELEVANCE/APPLICATION
Posterior needle approach for MRA of the shoulder has a greater negative predictive value for both Bankart lesions and SLAP tears when compared to an anterior approach.

SSJ16-02 • Indirect Shoulder MRI Arthrography: A Novel Technique for Young Patients
Azam A Eghbal MD (Presenter); Kerwin Jones MD
PURPOSE
The purpose of this study is to compare the sensitivity of indirect magnetic resonance imaging arthrography (I-MRI) for detecting shoulder labral pathology in patients less than 21 years of age to direct MR arthrography replacement (D-MRI). The significance of the study is that shoulder I-MRI may be a reasonable and less invasive alternative to direct magnetic resonance arthrography in this population.

METHOD AND MATERIALS
A retrospective review identified 68 cases of indirect shoulder arthrography performed over a two-year period at a single pediatric institution. There were 37 of which had subsequent shoulder arthroscopic findings available for review. The I-MRI reports were compared to the operative images for the presence or absence of labral pathology by an independent pediatric orthopedic surgeon. An independent pediatric radiologist on staff provided the MRI reports. Labral pathology was defined as a labral tear or fraying. All MRI images were also reviewed by a second pediatric radiologist for labral pathology without knowledge of surgical findings. Descriptive statistics were used to analyze data.

RESULTS
Of the 37 cases included in the study, the I-MRI reports correctly identified the presence or absence of labral pathology found during surgery in 32 cases. Compared to arthroscopic findings, the sensitivity of I-MRI for detecting labral pathology in young patients was 94%, with a positive predictive value of 90% and a 6% false negative percentage. The sensitivity for the second pediatric radiologist was 100%, with a positive predictive value of 94%, and a 0% false negative percentage.

CONCLUSION
Direct shoulder arthrography is currently the gold standard imaging technique in the diagnosis of labral pathology. However, indirect shoulder arthrography is a less invasive alternative, which is extremely helpful in the young population. In this series, the sensitivity of I-MRI for detecting labral pathology was 94% (100% for the second reader) which is comparable to the historical range reported for D-MRI of 88-96%. It appears that I-MRI may be a reasonable and less invasive alternative to D-MRI in young patients.

CLINICAL RELEVANCE/APPLICATION
Indirect shoulder arthrography is a less invasive alternative to Direct shoulder arthrography with comparable sensitivity.

SSJ16-03 • Usefulness of Pre and Post MR Arthrogram Imaging of the Shoulder in Detection of Unstable Labral Tears
Thomas H Magee MD (Presenter)
PURPOSE
Shoulder surgeons commonly intervene on unstable labral tears (those tears that displace with patient movement). Surgeons can detect unstable tears at surgery. It is difficult to be certain a tear is unstable on a static MR image. We report the benefit of pre and post arthrogram MR imaging in detection of unstable labral tears.

METHOD AND MATERIALS
One hundred fifty consecutive shoulder MR and MR arthrography exams performed on the same patients were reviewed retrospectively by consensus reading of two musculoskeletal radiologists. Both conventional MR and MR arthrogram exams were performed on each patient on the same day. Labral tears were assessed. It was also determined if there was any difference in position of the labral tear comparing pre and post arthrographic images. All patients went on to arthroscopy.

RESULTS
Of these one hundred fifty patients, ninety -four had SLAP (superior labral anterior to posterior) tears, fifty three had posterior labral tears and forty two had anterior labral tears on MR exam.
All one hundred fifty patients went on to arthroscopy. All lesions described on MR were described on arthroscopy. Twenty three SLAP tears, sixteen posterior labral tears and seventeen anterior labral tears demonstrated a change in the position of the labral tear on pre versus post arthrographic images. All of these labral tears were considered unstable by the surgeon and all of these patients had surgical tacking performed.
There were five SLAP tears, three anterior labral tears and four posterior labral tears seen on arthroscopy not seen on MR or MR arthrography examination.

CONCLUSION
In this study, pre and post arthrogram MR imaging of the shoulder was useful in demonstrating unstable labral tears in twenty three patients with SLAP tears, sixteen patients with posterior labral tears and seventeen patients with anterior labral tears. This information was useful in surgical planning.

CLINICAL RELEVANCE/APPLICATION
Pre and post arthrogram MR imaging of the shoulder is useful in demonstrating unstable labral tears. This information is useful in pre surgical planning.

SSJ16-04 • Postoperative CT Arthographic Features of Superior Labral Anterior-to-Posterior Lesions: Correlation with Functional and Clinical Outcome
Bohwa Choi (Presenter); Na Ra Kim MD; Sung Gyu Moon MD; Jin-Young Park MD
PURPOSE
To assess the presence of a superior labral cleft on postoperative CT arthrography after superior labral anterior to posterior lesion (SLAP) repair and to evaluate whether such superior labral clefts are correlated to functional and clinical outcome.
METHOD AND MATERIALS
Forty six patients (37 men, nine women; mean age, 35 years) were included and underwent CT arthrography of the shoulder after arthroscopic SLAP repair. Two musculoskeletal radiologists reviewed CT arthrographic images for the presence and size of a superior labral cleft defined as a detectable contrast material-filled focal discontinuity of the labrum within anchor fixation sites of the glenoid on an oblique coronal image. The extent, direction of curvature, and marginal irregularity of a superior labral cleft were assessed on axial, oblique coronal and oblique sagittal CT arthrographic images. The functional and clinical outcome was evaluated by using the American Shoulder and Elbow Surgeons (ASES) scoring. The mean time interval between surgery and postoperative CT arthrography was 16.9 months (range, 7 to 63 months).

RESULTS
The superior labral cleft was found in 52% (24 of 46). The mean width and depth of the superior labral cleft were 2.0mm ± 1.1 and 2.8mm ± 0.9. When present, the superior labral cleft extended posterior to the biceps anchor in 62.5% (15 of 24), was curved moderately (22 of 24), and had a smooth slope. No significant association was seen between the presence, width and depth of a superior labral cleft, and ASES score (P = .569, .633 and .067, respectively). The superior labral clefts were more commonly found in long time interval between surgery and postoperative CT arthrography (P = .018).

CONCLUSION
Shallow superior labral clefts can be frequently seen after arthroscopic SLAP repair at long-term follow-up. The presence of superior labral clefts do not necessarily correlate with functional and clinical outcome after SLAP repair.

CLINICAL RELEVANCE/APPLICATION
Shallow superior labral clefts can be frequently seen after SLAP repair. The presence of superior labral clefts do not necessarily correlate with functional and clinical outcome after SLAP repair.

SSJ16-05 • Novel CT Metal Artifact Reduction Prototype for Evaluation of Shoulder Arthroplasties
Naveen Subhas MD (Presenter) *; Sahar Shiraj MD; Andrew Primak PhD *; Joshua M Polster MD; Andreas Krauss PhD *; Jean P Schils MD; Joseph Iannotti *

PURPOSE
Iterative metal artifact reduction (IMAR) is a new sinogram inpainting technique to reduce CT metal artifact which adds high frequency data to improve visualization close to metal edges. Our purpose was to compare the image quality and accuracy of attenuation values near hardware of IMAR and standard filtered back projection (FBP) in patients with shoulder arthroplasties (SA).

METHOD AND MATERIALS
8 patients (6 male, avg age 60) with 9 SAs were scanned on a FLASH CT (Siemens) with a standard protocol (140 kVp, 300 eff mAs, 0.6mm collimation, eff pitch 0.35-0.8). Images were reconstructed on a standalone workstation with a smooth kernel (B30) and 0.6mm slice thickness. 3 IMAR reconstructions with different amounts of high frequency data: IMAR (least), IMAR1.5 (more), IMAR2.5 (most) and FBP were ranked for image quality by 5 readers in a side by side comparison from best=1 to worst=4 for bone, soft tissue, metal-bone interface and overall quality. Accuracy of attenuation near hardware was quantified as the absolute difference (AD) between avg HU within a region of interest (ROI) near hardware and for an ROI containing similar tissues on a slice without hardware.

RESULTS
IMAR1.5 was ranked best for humeral cortex (avg 1.4), glenoid trabeculae (avg 1.36) and glenoid cortex (avg 1.4). IMAR2.5 was ranked best for humeral trabeculae (avg 1.2). IMAR was ranked the best for deltoid muscle (avg 1.2). IMAR1.5 and 2.5 were ranked best for metal-bone interface (avg 1.3). FBP was ranked worst for all structures (avg 3.38 -3.49). All readers ranked IMAR1.5 and 2.5 over FBP (p < .001). IMAR, especially with added high frequency data, had superior image quality and more accurate attenuation values near hardware than standard FBP in patients with shoulder arthroplasties.

CLINICAL RELEVANCE/APPLICATION
IMAR is a promising new CT technique to reduce metal artifact that is fully automatic and computationally inexpensive and has the potential to replace standard FBP in patients with hardware.

SSJ16-06 • CT Metal Artifact Reduction in Internally Fixed Proximal Humeral Shaft Fractures: Comparison between Monoenergetic Extrapolation of Dual Energy and Iterative Artifact Reduction Algorithms
Sebastian Winklhofer MD (Presenter); Fabian Morsbach; Emanuel Benninger MD; Stefan Rahm MD; Steffen Ross MD; Bernhard Jost MD; Christian Spross MD; Paul Stolzmann MD; Michael J Thali MD; Hatem Alkadhi MD; Roman Guggenberger

PURPOSE
To assess the value of monoenergetic extrapolations from dual-energy computed tomography (DECT) and standard filtered back projections (FBP) from single-energy computed tomography (SECT) compared to a new iterative frequency split-normalized (IFS) metal artifact reconstruction (MAR) algorithm for artifact reduction in internally fixated humeral fractures.

METHOD AND MATERIALS
In a cadaveric study, artifacts in seven internally fixated human proximal humeral fractures of five subjects were examined with SECT and DECT. Postprocessing included routinely used FBP algorithm, a new IFS-MAR algorithm, and monoenergetic extrapolation of DECT images. Image analysis included quantitative assessment of image artifacts (HU measurements) as well as evaluation of image quality and osteosynthesis material and visualization of screw position in FBP, IFS-MAR, and DECT using a five-point Likert scale.

RESULTS
HU values of streak artifacts were significantly (P < .05) different between FBP (115.7±222.4) and IFS-MAR (68.7±106.3), and between FBP and monoenergetic DECT (10.1±146.1). Between IFS-MAR and DECT no significant differences were detected (P = .30). Artifact scores improved significantly from FBP (3.9) to IFS-MAR (2.0; P < .001) and DECT (2.6; P < .05), whereas no significant differences were seen between IFS-MAR of the superior labral cleft were differed significantly (P < .05) between FBP (2.9) and IFS-MAR (2.3) and between IFS-MAR and DECT (1.4). Screw position of 57/57 screws was identically rated in FBP and IFS-MAR, but different between IFS-MAR and DECT in 11 cases, with a subjectively better visualization in DECT.

CONCLUSION
IFS-MAR algorithm in SECT as well as monoenergetic extrapolations from DECT allow for an improved image quality, a reduction of artifacts and better assessment of screw-position compared to standard FBP in SECT.

CLINICAL RELEVANCE/APPLICATION
Both, dual-energy CT and a newly applied iterative frequency split-normalized metal artifact reconstruction algorithm for CT are promising techniques for metal artifact reduction in internally fixed fractures.
**Rabbit Knee Joint Osteochondritis Dissecans (OCD) Models: Correlation with Histological Examination**

H Tao (Presenter); Zhan Wang; Shuang Chen MD

**PURPOSE**
To quantitatively evaluate the MRI appearances of repair tissue (RT) after microfracture treatment for osteochondritis dissecans (OCD) models compared to joint debridement and investigate the correlation with histological examination.

**METHOD AND MATERIALS**
The animal experiment was approved by the Animal Care and Use Committee of our college. Twenty-seven OCD models in rabbit knee joints were assigned into two groups, 18 for microfracture group and 9 for joint debridement. At 3, 5, 7, 3 weeks post-op respectively, a third of each group would take MRI scan mainly including 3D double echo steady state sequence (3D-DESS) and multi-echo spin echo technique (T2-mapping). Operation sites were removed to make H-E, Masson and Safranin-O staining sections. MR images were used to quantitatively calculate the thickness index and T2 value index of RT. The histological performances were semi-quantitatively evaluated by using the modified O'Driscoll score system. Comparisons were made with respect to MRI and histological findings between two groups at each time point. Effects of two groups were evaluated longitudinally by comparing the results at each time point. Statistical analysis was performed by unpaired Student t tests and the one-way ANOVA, with significance defined as P < .05.

**RESULTS**
The thickness index and semi-quantitative histological scores of RT in two groups were increasing gradually post-op, while T2 value index was decreasing. At 3 weeks, the T2 value index of microfracture group was lower than that of joint debridement (P=.000). But at 5 weeks and 7 weeks, it was higher than joint debridement (P=.032 and .013). For microfracture group, the RT was mainly composed of hyaline-like cartilage tissue, with more production of well-organized collagen fibrils and glycosaminoglycan (GAG). However, for joint debridement, RT was mainly composed of fibrous and scar tissue.

**CONCLUSION**
The study revealed the correlation between MRI and histological performance, which indicated the potential value of using MRI 3D-DESS and T2-mapping as a noninvasive tool to evaluate the process of cartilage repair.

**CLINICAL RELEVANCE/APPLICATION**
MR 3D-DESS and T2-mapping which can reflect information about thickness and biochemical properties of RT provides a noninvasive and effective tool to evaluate RT condition after microfracture for OCD.

**SSJ17-02 • In Vitro Comparative Study of T2 and T2* Mappings of Human Articular Cartilage Using 3-Tesla Magnetic Resonance Imaging: MRI-histologic Correlation after Total Knee Arthroplasty**

Tayhee Kim (Presenter); Kyu-Sung Kwack MD, PhD; Hakil Kim; Xuenan Cui

**PURPOSE**
Even though many different authors have reported usefulness of T2 and T2* mappings for articular cartilage evaluation, there has been no coherent consensus about the correlation between T2 value, T2* value and histologic grade. The aim of this study were to investigate the correlation between these parameters and to show the diagnostic performance of T2 and T2* mappings in various histological grades of naturally degenerated human articular cartilage.

**METHOD AND MATERIALS**
Fourteen osteochondral specimens from 13 patients who underwent total knee arthroplasty were examined using a 3T MRI with standard turbo spin echo pulse sequence for T2 mapping and fast field echo pulse sequence for T2* mapping. Eight to ten regions of interest (ROIs) were positioned within articular cartilage of each lateral tibial condyle. A total of 134 ROIs were analyzed. Two readers in consensus assessed the degree of cartilage damage in H&E and Masson's trichrome stained histological slides with the David-Vaudey grade. Histological assessment was undertaken in all ROIs to correlate the observations of T2 and T2* mappings. Correlation analysis was performed.

**RESULTS**
The mean relaxation values for tibial cartilage were 56.6 ± 14.1 ms for T2 and 24.2 ± 14.3 ms for T2*. The mean difference between T2 and T2* values was 31 ± 20.5 ms. Pearson correlation analysis proved a positive correlation between T2 values and histologic grade (correlation coefficient = 0.386, p = 0.004).

**CONCLUSION**
As previously reported in other studies, T2 mapping is well correlated to histological degeneration of the cartilage and may be good biomarker for osteoarthritis in human articular cartilage. Although T2* value had been known to be decreased with increasing cartilage degeneration, T2* value didn't show statistical significant correlation in this study. Therefore, T2* mapping may not be appropriate for initial diagnosis of cartilage degeneration.

**CLINICAL RELEVANCE/APPLICATION**
T2 mapping is superior to T2* mapping for the evaluation of human articular cartilage degeneration. T2* mapping may not be appropriate for initial diagnosis of cartilage degeneration.

**SSJ17-03 • Assessment of Morphology, gagCEST and T2 Mapping in Cartilage Repair Tissue after Chondrosphere-based Autologous Chondrocyte Transplantation**

Benjamin Schmitt (Presenter) *; Ferzan Suezer *; Patrik Zamecnik MD; Marco Essig MD *; Siegfried Trattnig MD; Rainer Siebold

**PURPOSE**
To compare results from morphological imaging, glycosaminoglycan-dependent chemical exchange saturation transfer (gagCEST) imaging and T2 mapping in a population of 30 patients after a novel chondrosphere-based autologous chondrocyte transplantation in the knee at 3 Tesla.

**METHOD AND MATERIALS**
Multiple voxel MR. T2 mapping and gagCEST imaging were performed on a clinical 3T MR scanner. Scan time for 3D gagCEST of one knee was 12:48 min with a saturation module optimized by simulation of Bloch equations, and T2 mapping was performed with a multi-echo spin echo approach. Results from gagCEST and T2 mapping in repair tissue were compared with results from native cartilage in the corresponding area of the contralateral knee as an unbiased reference. Due to regional variations in biological composition of cartilage, results from repair tissue grouped for trochlea, femoral condyles and patella were compared in groups with histological performance, which were semi-quantitatively evaluated by using the modified O'Driscoll score system. Comparisons were made with respect to MRI and morphological examinations between two groups at each time point. Effects of two groups were evaluated longitudinally by comparing the results at each time point. Statistical analysis was performed by unpaired Student t tests and the one-way ANOVA, with significance defined as P < .05.

**RESULTS**
The thickness index and semi-quantitative histological scores of RT in two groups were increasing gradually post-op, while T2 value index was decreasing. At 3 weeks, the T2 value index of microfracture group was lower than that of joint debridement (P=.000). But at 5 weeks and 7 weeks, it was higher than joint debridement (P=.032 and .013). For microfracture group, the RT was mainly composed of hyaline-like cartilage tissue, with more production of well-organized collagen fibrils and glycosaminoglycan (GAG). However, for joint debridement, RT was mainly composed of fibrous and scar tissue.

**CONCLUSION**
The study revealed the correlation between MRI and histological performance, which indicated the potential value of using MRI 3D-DESS and T2-mapping as a noninvasive tool to evaluate the process of cartilage repair.

**CLINICAL RELEVANCE/APPLICATION**
MR 3D-DESS and T2-mapping which can reflect information about thickness and biochemical properties of RT provides a noninvasive and effective tool to evaluate RT condition after microfracture for OCD.
cartilage in the biochemical imaging techniques suggests a high quality of the transplants. Furthermore our study indicates that using the contralateral knee as a reference to assess outcomes of repair tissue is a key element to avoid a bias compared with using a potentially biochemically different native part of cartilage from the same knee.

CLINICAL RELEVANCE/APPLICATION
Functional and morphological imaging showed no differences to reference tissue for the assessed cartilage repair technique indicating better performance than alternative techniques.

SSJ17-04 • The Effect of Initial Methotrexate Therapy on Cartilage Composition in Early Rheumatoid Arthritis: Follow-up with Biochemical MRI of Finger Cartilage

Falk R Miese MD (Presenter); Benedikt Ostendorf; Hans-Joerg Wittsack PhD; Christoph Schleich; Christoph Nowak; Gerald Antoch MD *

PURPOSE
To test for initial status and subsequent recovery of cartilage glycosaminoglycane content in metacarpophalangeal joints (MCP) in patients with early rheumatoid arthritis (eRA) undergoing Methotrexate (MTX) therapy with delayed Gd(DTPA)2- enhanced MRI of the cartilage (dGEMRIC).

METHOD AND MATERIALS
MCP II and III in 19 patients with eRA and 13 healthy volunteers and were examined (eRA patients: 13 females, six males, mean age 51 years, range 25-69; eRA 6 months follow-up patients: 7 females, one male, mean age 48 years, range 33-68; healthy volunteers: ten females, three males, mean age 51 years, range 25-66). dGEMRIC was acquired using the variable flip angle technique (VFA). dGEMRIC index was measured in phalangeal and metacarpal cartilage with manually drawn region-of-interest evaluation. Cartilage thickness was determined as a conventional measure of cartilage integrity. Statistical analysis used non-parametric Mann-Whitney-U-Test to test for significant differences between the groups. Remission was assessed using DAS 28 and CRP.

RESULTS
dGEMRIC index was significantly decreased in eRA patients compared to healthy subjects (healthy volunteers: MCP II 488 ms ± 90 ms, MCP III 523 ms ± 100 ms; eRA patients: MCP II 414 ms ± 119 ms (p

CONCLUSION
Our data do not indicate that MTX may protect cartilage despite remission.

SSJ17-05 • Aiming for a Shorter MR Screening Protocol of the Hand in Early Arthritis: Is there Additional Value of Gadolinium?

Wouter Stomp MD (Presenter); Annemarie Krabben; Desiree M Van Der Heijde MD, PhD; Tom W Huizinga; Johan L Bloem MD, PhD; Annette Van Der Helm-Van Mil; Monique Reijnierse MD

PURPOSE
Gadolinium contrast enhanced MRI images are used to assess synovitis and tenosynovitis in arthritis. We compared wrist synovitis and tenosynovitis on MRI images without gadolinium (Gd-) with gadolinium-enhanced MRI (Gd+) as the reference method to determine whether contrast administration can be omitted.

METHOD AND MATERIALS
MRI imaging of the wrist was performed in 93 early arthritis patients on a 1.5 Tesla extremity MRI. Sequences included coronal T1, coronal fat-suppressed T2 and post-gadolinium coronal and axial T1 with fat suppression. Additionally a transversal T2-weighted sequence was added to facilitate evaluation. All datasets were scored twice by 2 experienced readers, once using only unenhanced images, and another time using the complete image sets, according the OMERACT RA MRI scoring system (RAMRIS) and a tenosynovitis score.

RESULTS
Intrarreader intraclass correlations between Gd- and Gd+ sequences were 0.76 for synovitis and 0.71 for tenosynovitis for reader 1 and 0.83 and 0.57 for reader 2 respectively. At the individual joint/tendon level, concordance rates for presence or absence of inflammation were 74-77% for synovitis and 84-85% for tenosynovitis. Disconcordance of more than 1 point in RAMRIS score was rare (1.8% of synovitis scores and 0.3-0.5% of tenosynovitis scores). Without gadolinium contrast, the sensitivity of synovitis depiction in individual joints was 72 and 91% for both readers; the specificity was 52 and 81% for both readers, indicating that without Gd synovitis was inappropriately identified in 19-48% of joints. For tenosynovitis sensitivity was 54 and 67% and specificity 88 and 91% for each reader.

CONCLUSION
When assessing arthritic joints, omitting gadolinium contrast gives suboptimal results. Although total scores show moderate to good agreement, sensitivity and specificity are markedly decreased and therefore it cannot be recommended for clinical evaluation. When only total scores are important, e.g. when monitoring therapy response, it may be considered at the cost of reduced reliability.

CLINICAL RELEVANCE/APPLICATION
Omitting gadolinium decreases invasiveness, lowers costs and shortens imaging time, however our data show that this is achieved at the cost of reduced sensitivity and specificity.

SSJ17-06 • Frequency of Subclinical Axial Inflammation in Skin Psoriasis by Whole-body MRI

Vlad A Bratu MD (Presenter); Ulrich Weber MD; Peter Hausermann MD; Ulrich A Walker MD; Thomas Daikeler MD; Veronika Zubler; Ueli Studer MD

PURPOSE
Our aim was to assess the prevalence of axial skeleton changes by whole-body MRI (wbMRI) in skin psoriasis patients without clinical evidence of arthritis and in age- and sex-matched healthy controls.

METHOD AND MATERIALS
Twenty-five age- and sex-matched healthy controls with no history of inflammatory back pain or skin psoriasis were recruited by the internal medicine department. Magnetic resonance imaging of the axial skeleton was performed using whole-body MRI sequences, including a T1-weighted axial, coronal fat-suppressed T2 and post-gadolinium coronal and axial T1 with fat suppression. Additionally a transversal T2-weighted sequence was added to facilitate evaluation. All datasets were scored twice by 2 experienced readers, once using only unenhanced images, and another time using the complete image sets, according the OMERACT RA MRI scoring system (RAMRIS) and a tenosynovitis score.

RESULTS
Intrarreader intraclass correlations between Gd- and Gd+ sequences were 0.76 for synovitis and 0.71 for tenosynovitis for reader 1 and 0.83 and 0.57 for reader 2 respectively. At the individual joint/tendon level, concordance rates for presence or absence of inflammation were 74-77% for synovitis and 84-85% for tenosynovitis. Disconcordance of more than 1 point in RAMRIS score was rare (1.8% of synovitis scores and 0.3-0.5% of tenosynovitis scores). Without gadolinium contrast, the sensitivity of synovitis depiction in individual joints was 72 and 91% for both readers; the specificity was 52 and 81% for both readers, indicating that without Gd synovitis was inappropriately identified in 19-48% of joints. For tenosynovitis sensitivity was 54 and 67% and specificity 88 and 91% for each reader.

CONCLUSION
When assessing arthritic joints, omitting gadolinium contrast gives suboptimal results. Although total scores show moderate to good agreement, sensitivity and specificity are markedly decreased and therefore it cannot be recommended for clinical evaluation. When only total scores are important, e.g. when monitoring therapy response, it may be considered at the cost of reduced reliability.

CLINICAL RELEVANCE/APPLICATION
Omitting gadolinium decreases invasiveness, lowers costs and shortens imaging time, however our data show that this is achieved at the cost of reduced sensitivity and specificity.
RESULTS
24% of healthy controls and 30% of skin psoriasis patients were classified as axial SpA by global wbMRI assessment. A high classification confidence (8-10) was recorded in 12% of controls and 18% of patients. The differences between the 2 groups were not statistically significant, both for the global and the lesion-based assessment in the spine and the SIJ.

CONCLUSION
On wbMRI every fourth healthy control was falsely classified as axial SpA. Skin psoriasis patients without clinical evidence of axial or peripheral arthritis showed a similar frequency of SIJ and spinal changes as healthy controls.

CLINICAL RELEVANCE/APPLICATION
Subclinical axial inflammation in skin psoriasis patients might be underestimated on wbMRI since matched healthy subjects showed a similar frequency of MRI-findings.

Neuroradiology (Cognitive and Psychiatric Disorders) Tuesday, 03:00 PM - 04:00 PM • N226

SSJ18-01 • Quantitative Susceptibility Mapping in Patients with Systemic Lupus Erythematosus: Detection of Abnormalities in Normal-appearing Basal Ganglia

Atsushi Ogasawara (Presenter) ; Shingo Kakeda MD ; Keita Watanabe ; Tian Liu PhD ; Yi Wang PhD ; Yukunori Korogi MD, PhD

PURPOSE
Although the substantial population of the systemic lupus erythematosus (SLE) have neuropsychiatric symptoms, many of them may not show abnormal brain MR findings, probably because the metabolic and/or functional alterations of the disease usually precede the anatomic disturbance. Quantitative susceptibility mapping (QSM) is a novel technique to compute quantitative maps of the underlying magnetic susceptibility distribution. Our aims were to evaluate whether QSM can detect the abnormalities within normal-appearing basal ganglia at conventional MRI in the patients with systemic lupus erythematosus.

METHOD AND MATERIALS
The institutional review board approved this study. All studies were performed with a 3T MRI system (Signa EXCITE 3T; GE Healthcare). Twenty-three SLE patients with (n =7) or without (n =16) neuropsychiatric symptoms were enrolled; all of them showed no abnormalities in the basal ganglia at conventional MR study. The age/sex-matched 23 controls were also enrolled. For SLE patients and controls, two radiologists independently measured mean susceptibility values and R2* rates in seven brain structures (thalamus, putamen, caudate, globus pallidus, pons, splenium of corpus callosum, and frontal white matter) that appears normal on conventional MR images.

RESULTS
In the putamen and globus pallidus, the mean susceptibility values were significantly higher for the SLE patients than for the controls (P<0.05 corrected by Monte-Carlo simulation). In the SLE patients with normal basal ganglia at conventional MRI, QSM detected the subtle susceptibility changes more sensitively than R2* mapping.

CLINICAL RELEVANCE/APPLICATION
In the patients with neuropsychiatric SLE, QSM seems useful for the detection of subtle tissue changes of the basal ganglia, which may lead to early diagnosis at their subclinical stage.

SSJ18-02 • In Vivo Assessment of Gray Matter Integrity in Systemic Lupus Erythematosus Patients and Its Correlation with Episodic Memory

Bernardo C Bizzo MD ; Thomas M Doring MSc (Presenter) ; Gustavo Tukamoto ; Tadeu T Kubo MSc ; Denise Greca ; Tania M Netto PhD ; Nicolle Zimmermann ; Tiago A Sanchez ; Rochelle P Fonseca ; Emerson L Gasparetto MD

PURPOSE
Systemic lupus erythematosus (SLE) is an inflammatory disease, characterized by multisystem microvascular inflammation with the generation of autoantibodies and, in brain, leading to a wide range of neurological symptoms and also cognitive decline. Several studies have evaluated cognition dysfunction on SLE patients, but only a few correlated gray matter integrity to these findings. The aim of this study was to assess the cortical thickness on SLE and correlate it with episodic memory (EM) deficit.

METHOD AND MATERIALS
We used the Rey Auditory Verbal Learning Test (RAVLT) to select 17 patients with SLE and EM deficit (mean 43.9 years, SD +/- 10.4), and 33 SLE patients without EM deficit (mean 45.3 years, SD +/- 11.2). We also evaluated 34 healthy controls (mean 45.5 years, SD +/- 9.3). Using T1-MPRAGE sequence in a 1.5 Tesla scanner, the cortical reconstruction was performed using tools within FreeSurfer. To investigate the correlation between cortical thickness measurements between groups, we performed a surface-based group analysis using tools within FreeSurfer.

RESULTS
Cortical thickness between SLE patients with and without EM deficit was found in which EM deficit patients had thinner cortices (P < .05 corrected by Monte-Carlo simulation) in regions including precentral, postcentral and supramarginal in the left hemisphere, and none in the right hemisphere. When SLE patients with EM deficit were compared to control subjects, there were only precuneus and superior parietal in left hemisphere. Comparing SLE patients without EM deficit and controls, none survived the Monte-Carlo classification confidence (8-10) was recorded in 12% of controls and 18% of patients. The differences between the 2 groups were not statistically significant, both for the global and the lesion-based assessment in the spine and the SIJ.

CONCLUSION
Corroborating previous findings among the areas of statistic significant reduction of cortical thickness, the precuneus has been implicated in visuo-spatial imagery, episodic memory retrieval, perspective taking and the experience of ‘agency’. Moreover, the precuneus has rich cortical and subcortical connections with other regions, including the supramarginal and postcentral gyri, with also have reduced cortical thickness in these patients. These findings corroborate the central nervous system involvement in patients with SLE and demonstrate the correlation between structural and functional abnormalities.

CLINICAL RELEVANCE/APPLICATION
SLE is a disease with frequent associated cognitive impairments, and there is not enough knowledge on the relationship between the cortical thickness of brain regions and episodic memory deficits.

SSJ18-03 • A Diffusion Tensor Imaging and Neuropsychological Study of Abstraction/Executive Impairment in HIV-infected Patients

Rafael F Cabral MD (Presenter) ; Denise Greca ; Tania M Netto PhD ; Thomas M Doring MSc ; Tadeu T Kubo MSc ; Rochelle P Fonseca ; Romue C Domingues MD ; Emerson L Gasparetto MD

PURPOSE
HIV-infected patients develop brain injury and neurocognitive impairment despite the regular use of highly active antiretroviral therapy (HAART). The purpose of this study is to evaluate whether abnormal fractional anisotropy (FA) and mean diffusivity (MD) in normal-appearing white matter (WM) of HIV-infected patients is related to abstraction / executive impairment on
METHOD AND MATERIALS
We evaluated 55 HIV-infected patients (40 males, mean age 41 years) and 27 healthy individuals matched by sex, age, years of education and Mini Mental State Examination. Images were obtained using a 1.5T scanner, with a single-shot spin-echo diffusion-weighted echo-planar pulse sequence with 73 sections covering the whole brain at 2.1-mm section thickness (TR / TE = 11320/ 94 ms). The assessment of the integrity of white matter was performed by measures of FA and MD using regions-of-interest (ROI). We analyzed correlation between the deficit score of abstraction / executive function within the mean values of FA and MD of specific areas of cerebral WM. The statistical analysis was performed assessing the relationship of deficit score of abstraction / executive function on HIV-infected patients / FA / MD values, and p

RESULTS
The mean FA was reduced in the white matter of frontal lobes, and there were small areas of increased MD in theses lobes. There was a high and significant inverse correlation between FA and deficit score of abstraction / executive function on HIV-infected patients (p

CONCLUSION
The presented results corroborate previous studies that show CNS involvement in HIV-infected patients, showing specific areas of change in white matter in these cases. Correlation between these findings and neuropsychological evaluations allows us to suggest that injuries caused by HIV are strongly related to the onset of neurocognitive impairment in HIV-infected patients.

CLINICAL RELEVANCE/APPLICATION
The unique spatial distribution of white matter injury at different stages of HIV infection, as measured by DTI, may provide a useful marker to monitor HIV-associated central nervous system injury.

SSJ18-04 • Comparative 3?¹H MR Spectroscopy and FDG-PET Study of the Brain Metabolism in HIV-infection
Anna V Trofimova MD, PhD (Presenter); Tatiana Trofimova; Galina Kataeva; Svyatoslav Medvedev; Elena Gromova; Nikolay Belyakov

PURPOSE
To reveal patterns of brain metabolism changes in HIV using 3T ¹H MR spectroscopy and FDG-PET

METHOD AND MATERIALS
We studied 15 patients with early HIV (plasma CD4-lymphocytes >350 cells/mcl),19 patients with later HIV (plasma CD4-lymphocytes ¹H MR spectroscopy: frontal white matter, basal nuclei, hippocampus, brain stem. 2D ¹H MR spectroscopy was performed with a preselected volume at the supraventricular level, metabolites ratios were analyzed in white and gray matter in anterior, posterior frontal and parietal regions. PET-FDG study with relative evaluation of rCMRglu were performed. ROIs corresponded to Brodmann areas, subcortical nuclei and hemispheres of cerebellum. Individual images were spatially normalized with SPM. WFU Pick Atlas was used to calculate mean regional values. Statistics were calculated by using STATISTICA software package, factorial ANOVA with p

RESULTS
SV ¹H MR spectroscopy did not reveal difference between groups. 2D ¹H MR spectroscopy revealed decrease of Naa/Cr in the parietal white matter in later HIV (2,051±0,03) as compared to controls (2,189±0,03). In the cortex Naa/Cr was decreased in the frontal lobe in early (1,57±0,017) and later HIV (1,60±0,015) as compared to controls (1,68±0,017). Cho/Cr was significantly higher in early HIV in all white matter (1,146±0,013) and in the frontal gray matter (1,034±0,014) as compared to later HIV (1,069±0,012 and 0,903±0,014) and controls (1,005±0,013 and 0,880±0,014). Naa/Cho was decreased in all white matter in both HIV groups. In the cortex Naa/Cho was decreased in early HIV in anterior (1,652±0,031) and posterior frontal lobe (1,815±0,038), in later HIV was decreased in anterior frontal lobe (1,640±0,029). FDG-PET study revealed decrease of rCMRglu in Brodmann areas 24 and 32 bilaterally in both HIV groups, what corresponded to Naa/Cho decrease and Cho/Cr increase in the frontal gray matter. In other ROIs (cerebellum, Brodmann areas 27, 28, 34, 35, 36 of the left hemisphere) significant decrease was revealed only in early HIV.

CONCLUSION
Brain metabolism alterations are more prominent in early HIV, with similar pattern of cortex involvement revealed by ¹H MR spectroscopy and FDG-PET.

CLINICAL RELEVANCE/APPLICATION
¹H MR spectroscopy reveals brain metabolism alterations in early HIV and can be used to assess extent of the CNS involvement, disease progression.

SSJ18-05 • Aberrant Brain Functional Connectivity Related to Insulin Resistance in Type 2 Diabetes: A Resting-state Functional MR Imaging Study
Yu-Chen Chen (Presenter); Yun Jiao PhD; Ying Cui; Gao-Jun Teng MD

PURPOSE
Insulin resistance is a causal factor in type 2 diabetes mellitus (T2DM) patients, and plays a role in developing Alzheimer’s disease (AD). Our study mainly aims to investigate the relationship between abnormal resting-state brain functional connectivity and insulin resistance in T2DM patients.

METHOD AND MATERIALS
30 patients with T2DM and 31 healthy well-matched volunteers were prospectively examined. Resting-state brain functional connectivity analysis was used to examine the correlation between posterior cingulate cortex (PCC) and whole-brain regions. Further analysis involved evaluation of possible relationships between functional connectivity measures and insulin resistance indexed by the homeostasis model assessment of insulin resistance (HOMA-IR).

RESULTS
Compared with healthy controls, we observed significantly decreased functional connectivity within some default mode network (DMN) regions including the right middle temporal gyrus (MTG), right middle frontal gyrus, right inferior parietal lobule and other selected regions including left lingual gyrus, left middle occipital gyrus, and increased functional connectivity in right superior frontal gyrus, left precentral gyrus. Moreover, a significant negative correlation between the PCC-MTG connectivity and HOMA-IR was found in T2DM patients (p=0.022; r=-0.417).

CONCLUSION
T2DM patients have aberrant functional connectivity in the DMN, which is related to insulin resistance in selected brain regions. Resting-state connectivity disturbance of PCC-MTG may be a central role for cognitive dysfunction in T2DM patients with insulin resistance.

CLINICAL RELEVANCE/APPLICATION
fMRI can be used to track the very early progression of brain functional alterations associated with T2DM. Abnormal PCC-MTG values may be regarded as a potential marker to identify cognitive decline.

SSJ18-06 • Study on Brain Structure and Cognitive Function in Patients with Chronic Mountain Sickness in 3T MRI
Hai Hua Bao (Presenter); Mingli He

PURPOSE
METHOD AND MATERIALS
17 cases of CMS and 15 normal subjects included in the study. The examination was performed on Philips 3T scanner and sequences were T1WI, T2WI, DWI and DTI. The FA and ADC values of the two groups were obtained from the regions of interest in the frontal lobe white matter, lenticular nucleus, external capsule, corpus callosum, et al., and then were compared. The relationships between FA/ADC values and CMS severity and cognitive function (Mini-Mental State Examination score) were investigated.

RESULTS
(1) In the CMS group, 6 patients showed slight cerebral edema, multiple ischemic foci and lacunar infarction foci in 15 patients and lacunar infarction complicated by ischemic foci in 3 patients. (2) Statistical results showed that the FA values of the right frontal lobe white matter in the CMS group were significantly lower (t = -2.736, P < 0.05). The ADC values of the anterior limb of the right internal capsule in the CMS group were significantly higher (t = 2.353, P < 0.05). In the CMS group, the FA values in the left caudate nucleus and the ADC values in the left thalamus were positively correlated with hemoglobin values (r = 0.533, P = 0.027; r = 0.674, P = 0.003). In the CMS group, the FA values in the anterior limb of the left internal capsule and the ADC values in the right hippocampus were negatively correlated with the MMSE scores (r = -0.667, P = 0.009; r = -0.590, P = 0.026). In the CMS group, ruptured or twisted white matter fiber tracts at the bleeding part were observed in 3 patients with intracranial hemorrhage.

CONCLUSION

CLINICAL RELEVANCE/APPLICATION
Providing imaging reference materials of CMS patients for clinical doctors.

Neuroradiology (Epilepsy) Tuesday, 03:00 PM - 04:00 PM • N228

Ritva L Vanninen MD (Presenter) ; Ignacio Delgado MD ; Angel Sanchez-Montanez ; Alfonz Macaya ; Veronica Del Prete ; Elena Carreras MD

PURPOSE
1. To prove the value of cerebral MRI in diagnosing TSC in fetuses with intracardiac rhabdomyomas.
2. To establish that MRI should be a component of fetal diagnostic workup in suspected TSC
3. To remark the importance to be aware that a negative fetal MRI does not exclude TSC

METHOD AND MATERIALS
12 fetuses with cardiac rhabdomyomas (22±36 weeks' gestation) underwent cerebral MRI in our tertiary center. The study was approved by the local ethics committee and written informed consent was obtained from all patients. MRI examinations were performed on a Siemens Avanto scanner (Siemens, Erlangen, Germany) using a body phased array coil. Images were acquired using a T2-W HASTE, a T2*-GRE, Fat-Sat T2-W HASTE and a T1-W gradient-echo sequences in axial, sagittal and coronal planes, with a slice thickness of 4 mm. The women were imaged in the supine position without sedation. Obtained images were read by two pediatric neuroradiologists experienced in neurofetal imaging. MR imaging results were correlated with postnatal imaging, genetic data and/or histology. To avoid confusing these lesions with artifacts, we set our criteria for subependymal lesions to be seen on at least two scanning sequences in orthogonal planes and to cause a contour deformity of the ventricular wall.

RESULTS
In 10 cases, fetal MRI demonstrated typical characteristics of TSC, which were confirmed by postnatal MRI in pregnancies that continue gestation, or history in those that were interrupted. There was one false-negative case, in which TSC diagnosis was established postnatally based on the presence of a single SEN that was not seen on prenatal MRI. Genetic testing of the mother also failed to prove TSC in this case. One early case was a false-positive, in which a single SEN was suspected on fetal MRI, but was not confirmed postnatally.

CONCLUSION
Our results prove that fetal MRI is a sensitive modality for detecting cerebral lesions in TSC and should become a component of early interdisciplinary diagnostic workup in suspected TSC. Although an MR diagnosis of TSC has been reported as early as 21 weeks' gestation, in our experience the diagnosis is more difficult before 28 weeks' gestation. Presence of multiplicity of lesions increases the diagnostic confidence whereas a solitary lesion may be cause of false negative or positive diagnosis.

CLINICAL RELEVANCE/APPLICATION
Fetal MRI is a sensitive modality for detecting cerebral lesions in TSC

SSJ19-02 • Temporal Anteroinferior Encephalocele: A Poorly Recognized Etiology of Temporal Lobe Epilepsy?

Taavi Saavalainen MD (Presenter) ; Leena Jutila ; Esa Mervaala MD, PhD ; Arto Immonen MD, PhD ; Reetta Kalvainen ; Ritva L Vanninen MD

PURPOSE
To report the increasing frequency of temporal anteroinferior encephalocele diagnosis in our tertiary care epilepsy center and to illustrate mainly the imaging characteristics of this condition in a series of 19 patients. Altogether 22 patients have been reported in the literature, largest series being 3 patients.

METHOD AND MATERIALS
Epilepsy patients diagnosed with temporal anteroinferior encephalocele during the study period (January 2007 - March 2013) in our hospital were included. All patients had MRI examinations (mainly 3T, Philips Achieva TX) according to an epilepsy protocol which was complemented with additional sequences. 3D-CT and PET-CT were acquired from surgical candidates when necessary.

RESULTS
Nineteen epilepsy patients (12 females, mean age 40 years) were diagnosed with temporal anteroinferior encephalocele. Eleven patients had two or more encephaloceles and five patients had bilateral encephaloceles. The estimated prevalence of this condition was 0.3% in MRI examinations performed due to newly diagnosed epilepsy (n=4) and 2.2% in drug-resistant patients referred to our institute as epilepsy surgery candidates (n=15). High-quality, thin-slice, preferably three-dimensional MRI and computed tomography studies facilitated the detection of this condition. The mean of maximal diameter of the lesions was 11.6 mm (range, 3-46 mm) and the mean of maximal diameter of the bony defect orifice was 8.7 mm (range, 3-46 mm). PET-CT showed temporal lobe hypometabolism in 6/9 patients, all were ipsilateral to the lesion. Ten patients had epilepsy surgery. Patients with local encephalocele disconnection (n=3) or anterior temporal lobectomy and amygdalohippocampectomy (n=5) have become seizure free in a mean 1.6 years (range 3 months - 3 years) of follow up. The remaining two surgically treated patients are very recent and lack follow up data. Histologically gliosis was present in temporal lobe samples in all surgically treated patients and encephaloceles also showed cortical laminar disorganization.

CONCLUSION
The possibility of temporal encephalocele should be considered when interpreting MRI examinations of patients with medically intractable temporal lobe epilepsy. These patients can significantly benefit from epilepsy surgery.
SSJ19-03 • Altered Axonal Connectivity in Medial Temporal Lobe Epilepsy: Association with Disease Severity

Ali Tabesh PhD (Presenter) ; Travis O Nesland PhD ; Jens H Jensen PhD ; Maria Vittoria Spampinato MD ; Jonathan C Edwards ; Joseph A Helpern PhD * ; Leonardo Bonilha MD, PhD

PURPOSE

Although medial temporal lobe epilepsy (MTLE) is a common neurological disorder, there remains a lack of reliable biomarkers for monitoring its clinical course and treatment response. Diffusion MRI (dMRI) tractography is a unique and powerful tool for characterization of white matter (WM) connectivity and may provide entirely new insights into network abnormalities associated with MTLE. The goals of this study were to investigate WM connectivity changes in MTLE, and to evaluate the association between these alterations and disease severity (seizure frequency) in patients.

METHOD AND MATERIALS

Nineteen patients with MTLE and 28 age- and sex-matched healthy control subjects underwent dMRI scans. Patients were divided into a well-controlled (= 4 seizures a year) and a poorly controlled subgroup based on their response to antiepileptic drug therapy. The two subgroups did not significantly differ in terms of age, age of seizure onset, or duration of disease. Streamline tractography was employed to quantify the WM connectivity of the temporal lobe ipsilateral to the seizure onset zone.

RESULTS

Patients showed a significantly lower degree of connectivity than controls in the connections between the following pairs of regions: isthmus of cingulate gyrus and parahippocampal cortex (PHC), fusiform gyrus and PHC, and inferior temporal cortex and PHC. Poorly-controlled patients showed a significantly higher degree of connectivity than well-controlled patients in the connections between the following regions: temporal pole and putamen, and entorhinal cortex and amygdala.

CONCLUSION

Our results suggest that WM connectivity measures derived from dMRI tractography may be sensitive to altered axonal connectivity in MTLE. Moreover, WM connectivity markers may potentially enable more reliable identification of patients with medication-refractory MTLE. Supported by the Foundation of the American Society of Neuroradiology and the South Carolina Clinical and Translational Research Institute.

CLINICAL RELEVANCE/APPLICATION

Axonal connectivity measures based on dMRI tractography may provide complementary information for clinical evaluation of MTLE.

SSJ19-04 • Evaluation of Focus Laterality in Temporal Lobe Epilepsy: A Quantitative Study Comparing Double Inversion-recovery MR Imaging at 3T with FDG-PET

Emiko Morimoto MD (Presenter) ; Tomohisa Okada MD, PhD ; Mitsunori Kanagaki MD, PhD ; Akira Yamamoto MD, PhD ; Yasutaka Fushimi MD, PhD ; Riki Matsumoto MD, PhD ; Shigetoshi Takaya MD, PhD ; Akio Ikeda MD, PhD ; Takeharu Kunieda MD, PhD ; Takayuki Kikuchi MD, PhD ; Dominik Paul * ; Susumu Miyamoto MD, PhD ; Ryosuke Takahashi MD, PhD ; Kaori Togashi MD, PhD *

PURPOSE

To quantitatively compare diagnostic capability of double inversion recovery (DIR) with fluorine-18 fluorodeoxyglucose positron emission tomography (FDG-PET) for detection of seizure focus laterality in temporal lobe epilepsy (TLE).

METHOD AND MATERIALS

This study was approved by the institutional review board, and written informed consent was obtained. Fifteen TLE patients and 38 healthy volunteers were enrolled. All MR images were acquired using a 3T-MRI system. Voxel-based analysis was conducted for FDG-PET images and white matter segments of DIR images (DIR-WM) focused on the whole temporal lobe (TL) and the anterior part of the temporal lobe (ATL). Distribution of hypometabolic areas on FDG-PET and increased signal intensity areas on DIR-WM was evaluated, and their laterality was compared with clinically-determined seizure focus laterality. Correct diagnostic rates of laterality were evaluated, and agreement between DIR-WM and FDG-PET was assessed using ? statistics.

RESULTS

Increased signal intensity areas on DIR-WM were located at the vicinity of the hypometabolic areas on FDG-PET, especially in the ATL. Correct diagnostic rates of seizure focus laterality for DIR-WM (0.80 and 0.67 for the TL and the ATL, respectively) were significantly higher than those for FDG-PET (0.67 and 0.60 for the TL and the ATL, respectively). Agreement of laterality between DIR-WM and FDG-PET was substantial for the TL and almost perfect for the ATL (? = 0.67 and 0.86, respectively).

CONCLUSION

High agreement in localization between DIR-WM and FDG-PET and nearly equivalent detectability of them show us an additional role of MRI in temporal lobe epilepsy.

CLINICAL RELEVANCE/APPLICATION

For evaluation of seizure focus in TLE, DIR would play an indispensable role to avoid radiation exposure, especially in children, and when FDG-PET examination is not available.

SSJ19-05 • DTI Fiber Tracking Biomarkers for Characterization of Focal Cortical Dysplasias

Rammohan Vadapalli MD (Presenter) ; Sita Jayalakshmi ; Manas Panigrahi MChir ; Anuj Jain MD ; Abhinav Sriram S Vadapalli ; Meghna Vadapalli BEng

PURPOSE

To evaluate the role of new generation Diffusion tensor imaging biomarkers for characterization of Focal cortical dysplasias, especially the Radial (perpendicular)Diffusivity(?2+ ?3 );?3 maps, Radial diffusivity:FA ratio by depicting the microstructural patterns.

METHOD AND MATERIALS

seventy six patients in age group of 6 -44 years with M: F ratio of 3:2 with refractory epilepsy had undergone a MRI study on a 3T MRI(achieva Philips) TLE+ETLE protocol (T2 relaxometry, volumetry and MRS of Hippocampi with MRS,3D T1,3D T2 followed by a Medium to high resolution DTI(diffusion Tensor Imaging) with following parameters. Axial Plane B value: 1000 Number of directions 128 320x320x256;Slice thickness 2mm with 0.5 inter slice gap,NSA 2,Matrix 112x112 bandwidth 29.8 .These data were post processed using Fibertrack and Intrasense (Myrian) SW to generate FA maps, Eigen vector Maps ? 1,2 ,3 Radial diffusivity maps and ROI and mirror ROI in contralateral side. Areas of Focal cortical dysplasia were mapped and analysed.

RESULTS

Results: Qualitative biomarkers like asymmetry,Fiber architecture in region of dysplasia and Quantitative Parameters like FA, Mean Diffusivity,Fiber density count were studied.

Type 1B FCD(n=11)
1. reduced FA
2. Increased MD. Mean value of Radial Diffusivity (Perpendicular Diffusivity) increased.

4. Fiber architecture appeared normal with normal fiber density.

5. MTA is significantly increased.

Type II, IIB (n=34).

- Reduced FA
- Abnormal color coded directionality maps due to disorganized fiber structure in dysplasia (n=34).
-Radial or Perpendicular diffusion is significantly increased with RD : FA ratio of >10.

Type III: showed Ipsilateral MTS (n=26), Bilateral MTS (n=3).

In all the cases of associated FCD with Secondary MTS reduced FA, increased perpendicular diffusivity and fiber architectural abnormalities are evident.

CONCLUSION
1. FCD Type IB are better seen on Radial Diffusivity maps. 2. Radial diffusivity is increased in Type IIB > IIA > IB (p=MD or FA).

> Conventional MR sequences 4. FA/RD ratio is a specific biomarker of Type II FCD. (p=

CLINICAL RELEVANCE/APPLICATION

Dysplastic cortex is known to be extending beyond MR visible abnormality and DTI visible subtle White matter abnormalities also extend beyond, hence these biomarkers can map the true extent of FCD.

SSJ19-06 • Three-dimensional MRI Texture Analysis Reveals Subtle Textural Alterations in the White Matter and Deep Gray Matter in Progressive Myoclonic Epilepsy Type 1 or Unverricht-Lundborg Disease (EPM1)

Sanna Suoranta MD (Presenter); Kirsi K Holli MSc, PhD; Eini I Niskanen PhD; Paivi Koskenkorva MD; Reetta Kalvainen; Ritva L Vanninen MD

PURPOSE
To investigate the feasibility of three-dimensional MRI texture analysis (3DTA) in the detection of subtle white matter (WM) and deep gray matter (GM) changes in EPM1. EPM1 is a rare neurodegenerative disorder caused by the mutations in the Cystatin B gene (CSTB). Despite severe neurological symptoms no focal MR changes of the brain are found in visual assessment. Diffusion tensor imaging (DTI) in humans and mice has indicated widespread WM degeneration, and voxel-based morphometry (VBM) has revealed GM atrophy in EPM1.

METHOD AND MATERIALS
Sixteen genetically verified patients with EPM1 and 16 healthy controls underwent MRI (MPRage, 1.5 T, Siemens Avanto) and 3DTA (M4zd2a software). Volumes of interest (VOIs) were placed manually in WM and deep GM covering all structures in the whole brain. Altogether 223 different texture parameters per each VOI were computed. Textural differences between EPM1 patients and healthy controls were analyzed by the Mann-Whitney U test.

RESULTS
Visual assessment revealed no focal signal changes. Compared to the healthy controls, EPM1 patients showed statistically significant textural differences both in WM and GM. Compared to the WM VOIs, textural differences predominated in the deep GM. In right thalamus 28%, left thalamus 37%, and right putamen 26% of the textural parameters differed amongst the 223 parameters analyzed. In WM, numbers of differing parameters were less frequent; left pons 19%, corpus callosum genu 12%, corpus 10% and splenium 18%; left corona radiate 24%; right centrum semiovale 14%. The number of differing parameters was less than 10% in the remaining VOIs. The differing textural features included parameters based on histogram, gradient, co-occurrence matrix and run-length matrix.

CONCLUSION
WM textural alterations are widespread but less obvious than the deep GM findings. The 3DTA findings indicate that the texture of WM and deep GM in EPM1 patients is more coarse, complex and heterogeneous than in controls supporting widespread WM pathology in line with the previous DTI findings.

CLINICAL RELEVANCE/APPLICATION

3DTA is able to reveal subtle morphological changes in MR images that cannot be detected by visual inspection. In patients with EPM1 3DTA is more sensitive to show alterations in deep GM than in WM.

Neuroradiology (Neuroradiological Interventional Radiology) Tuesday, 03:00 PM - 04:00 PM • N229

SSJ20-01 • Radiological Sinus Lift: A New Minimally Invasive CT-scan Guided Procedure to Maxillary Sinus Floor Elevation in Implant Dentistry

Jean-Francois Matern MD (Presenter); Francis P Veillon MD; Thomas Bridonneau; Jean Carvahlo MD; Pierre Keller DMD, MSc

PURPOSE
Implant therapy has become an excellent treatment modality since its inception into the modern era of dentistry. However, when patients present with advanced atrophy of the maxilla ridge, the procedure of choice to restore the anatomic bone deficiency is surgical maxillary sinus floor elevation. The purpose of this study is to describe the CT-scan guided sinus lift technique and to prove the minimal invasive aspect of this new radiological procedure.

METHOD AND MATERIALS
For this prospective study, 17 cadaver heads were analyzed by cone beam CT (CBCT) and panoramic to response to our inclusion criteria (maxillary edentulous posterior sector and bone height inferior to 5mm). For each step, procedure was controlled by CT-scan and sinus endoscopy. The radiological sinus lift technique consists of the following 4 stages: 1. Approach. A 14.5 G Osteotomy file was inserted mesial to the canine eminence and manually drilling was performed in parallel direction to the sinus floor. 2. Osteotomy. Inner obturator was introduced to compress bone and to create an osseous window opened to the submucosal space. 3. Lifting. The sinus lift was performed by hydrodissection with diluted iodinated contrast media agent. 4. Filing. The submucosal space filling was performed by injection of diluted collagen. A dome shape visualized in the maxillary alveolar recess defines the success of the radiological sinus lift procedure. All radiological maxillary sinus floor elevations were scanned postoperatively with panoramic and maxillary CBCT.

RESULTS
Twelve maxillary sinuses were included to radiological sinus floor elevation procedure. Dome shape of the Schneiderian membrane performed in 8 maxillary sinuses (66.7%). All failures (n=4) were caused by mucosal perforation at the time of maxillary sinus osteotomy. Mean elevated membrane height was 12.0 mm for a mean intervention time of 45 minutes. Radiological exposures were 79.0 mGy.cm DLP and 22.8 mGy CTDIv.

CONCLUSION
The present experimental study reports a new minimally radiological procedure to maxillary sinus floor elevation. This study proposes a radiological interventional alternative to classic surgical approach with an equivalent success rate according to the literature.

CLINICAL RELEVANCE/APPLICATION
The radiological sinus lift will provide less tissue injury, a more physiological approach to more homogenous maxillary sinus membrane elevation and less failure over surgical procedure.
SSJ20-02 • Quantitative Evaluation of Acute Tumor Response Following Focused Ultrasound and Microbubble Treatment Using Dynamic Contrast Enhanced-computed Tomography

Hassaan Ahmed BSc (Presenter) ; Ting-Yim Lee MSc, PhD * ; Kullervo H Hynynen PhD ; Rajiv Chopra PhD *

PURPOSE
To quantitatively evaluate acute tumor response following focused ultrasound (FUS) and microbubble (MB) treatment using dynamic contrast-enhanced computed tomography (DCE-CT) in a rat glioma model.

METHOD AND MATERIALS
A stereotactic frame was used to surgically implant \(1 \times 10^6\) C6 glioma cells in the right cerebral hemisphere of three rats. When the tumor was about 50% of the size of the hemisphere, it was transcranially sonicated with a 10ms burst length and a 1 Hz repetition frequency for 120s, at an acoustic power of 0.5W using a 0.563-MHz FUS system (FUS Instruments Inc., Canada). The sonications were guided by baseline axial CT images and the corresponding blood-brain-barrier (BBB) permeability surface area product (PS) and cerebral blood flow (CBF) maps calculated by CT Perfusion (GE Healthcare). A region in the contralateral hemisphere was also sonicated 5 minutes following the tumor sonication to confirm the targeted axial slice. Definity (Lantheus Medical Imaging, USA) microbubbles at a dose of 20 μl/kg were administered simultaneously with both sonications. Serial DCE-CT scans were performed out to 4 hours post sonication to monitor the acute response in BBB PS and CBF.

RESULTS
The tumor BBB PS at 150 minutes post sonication (2.7 +/- 1.3 ml/min/100g) was significantly lower (p < 0.05) than at baseline (5.7 +/- 1.7 ml/min/100g), but that at 15 minutes post (6.0 +/- 1.8 ml/min/100g) was similar to baseline. The tumor CBF indicated a decreasing trend immediately following sonication, and returned to baseline levels at around 150 minutes post sonication.

CONCLUSION
A decreasing BBB PS following FUS and MB treatment over the tumor region, as opposed to the transient 3-4 times increase that is observed over healthy tissue, was a surprising result. The trend of an acute drop in CBF following sonication suggests that the tumor may undergo vasoconstriction following treatment. Although FUS and MB treatment in a tumor may not be beneficial for increased drug delivery, our preliminary results suggest that perhaps it could be used to disrupt or destroy tumor vasculature as a form of treatment.

CLINICAL RELEVANCE/APPLICATION
FUS and MB treatment have been shown to increase drug delivery over healthy and brain tumor regions, but our results suggest it may also be used to disrupt or potentially destroy tumor vasculature.

SSJ20-03 • Uncertainty and Discordance in the Management of Unruptured Intracranial Aneurysms

Sara Jamali MD (Presenter) ; Tim E Darsaut MD ; Max Findlay MD ; Jean Raymond MD

PURPOSE
The management of Unruptured Intracranial Aneurysms (UIAs) remains controversial. The goal of this study was to evaluate the clinical community agreement in decision making regarding UIAs.

METHOD AND MATERIALS
A portfolio of 41 cases of UIAs with angiographic images, along with a short description of the patient presentation, was sent to 28, mainly Canadian, clinicians with various years of experience in the management of UIAs (15 radiologists and 13 surgeons). Five clinicians responded twice at least 3 months apart. Nineteen cases were selected from patients recruited in a randomized trial comparing coiling and clipping, the Cures trial. In each case, the respondents were to choose between 3 treatment options (observation, surgical clipping, or endovascular coiling) and indicate their level of certainty on a quantitative scale. The variability was studied using k statistics from 0 to 1, 0 meaning no agreement, 1 perfect and 0.6 substantial agreement.

RESULTS
Decisions to coil were more frequent (612 or 53%) than decisions to clip (289 or 25%) or to observe (259 or 22%). Inter-judge agreement was only fair (k= 0.31 +/- 0.02) for all cases and all judges, despite the fact that intra-judge agreements were substantial (between 0.44 and 0.83 +/- 0.1) and mean certainty levels high for each case (from 6.5 to 9.4 +/- 2.0 on a scale of 1-10). Agreement was no better within specialties (surgeons or radiologists), within groups proficient in endovascular coiling, surgical clipping or both, or within strata of years of experience. There was no link between certainty levels and years of experience. Agreement was lower (k= 0.18 +/- 0.2) in cases selected from the randomized trial than others (0.35 +/- 0.2).

CONCLUSION
There is poor agreement in decisions regarding the management of UIAs, even between individuals sharing a similar experience or the same specialty. In the absence of reliable evidence decision making is variable.

CLINICAL RELEVANCE/APPLICATION
Decision making can perhaps be improved by concerted efforts to provide reliable evidence.

SSJ20-04 • MR Imaging in Intracranial Aneurysms Treated by Intra-aneurismal Flow Disrupter: the LUNA™ Aneurysm Embolization System (AES)

Elisa Pomero (Presenter) ; Arnaud Flores ; Celia Billion Grand ; Francoise Cattin ; Alessandra Biondi MD *

PURPOSE
New devices in the treatment of intracranial aneurysms include intra-aneurysmal flow disrupters. The MR imaging of these new devices has not been reported. The purpose of our study is to report MR findings in a consecutive series of patients treated with the LUNA™ Aneurysm Embolization System, a new intra-aneurysmal self-expandable, round-ovoid flow disrupter implant.

METHOD AND MATERIALS
A total of 12 unruptured aneurysms were treated in 12 patients. Ten lesions were located in the anterior circulation and 2 lesions were in the posterior circulation. In addition, all patients underwent 24 hours DSA control and 24-48 hours MR study including product (PS) and cerebral blood flow (CBF) maps calculated by CT Perfusion (GE Healthcare). A region in the contralateral hemisphere was also sonicated 5 minutes following the tumor sonication to confirm the targeted axial slice. Definity (Lantheus Medical Imaging, USA) microbubbles at a dose of 20 μl/kg were administered simultaneously with both sonications. Serial DCE-CT scans were performed out to 4 hours post sonication to monitor the acute response in BBB PS and CBF.

RESULTS
Immediate angiographic occlusion was achieved in 3 cases, near complete in 3 and incomplete occlusion in 6. The LUNA™ device presents a marked signal void in all sequence. Evaluation of aneurysm occlusion on MR images without contrast injection showed a good correlation with angiographic findings in 80% of cases. The thrombosed aneurysm sac was evident on PDWI and T2WI sequences. In patients with an angiographically thrombosed aneurysm, T1 WIs showed a hyperintense halo in 91% of cases corresponding to the thrombosed space between the device and the aneurysm wall. A crescent moon sign due to the device shape and related to persistent flow at the base of the aneurysm was seen in TOF sequences. Residual or recurrent aneurysm (20 %) could be visualized on the MR study only after contrast injection suggesting that LUNA™ device masks the slow flow signal.

CONCLUSION
Although DSA FU is mandatory, preliminary results suggest that contrast enhanced MRI is an efficient tool in assessing the occlusion
SSJ21-05 • Ethanol and/or Radiofrequency Ablation: Efficacy and Safety for Treatment of Venolymphatic Malformation Manifested as a Bulging Mass in the Head and Neck

Hyun Jung Koo MD (Presenter) ; Jeong Hyun Lee MD, PhD ; Ragnyoung Yoon ; So Hyun Cho MD ; Young Jun Choi MD ; Jung Hwan Baek ; Seung-Ho Choi ; Soon Yuhl Nam ; Sang Yoon Kim ; Dae Chul Suh

PURPOSE
To evaluated the efficacy and safety of ethanol and/or radiofrequency ablation of venolymphatic malformation (VLM) manifested as a bulging mass in the head and neck

METHOD AND MATERIALS
From July 2009 to February 2013, thirteen patients (F : M = 7 : 4; a mean age of 26, ranging from 5 to 48 years) with VLM presented as a bulging mass in the head and neck were treated with ethanol ablation (EA) and/or radiofrequency ablation (RFA). Treatment response was assessed by the degree of volume reduction and cosmetic grading scores (1-4) which was recorded before and at the last follow-up. Volume reduction was compared with the characteristics of the target lesions including component (venous, macrocystic lymphatic, and microcystic lymphatic), the initial volume and the presence of any functional structures close to the treated lesions. Complication after EA and/or RFA was also evaluated.

RESULTS
Five patients with macrocystic lymphatic malformation (MLM) were treated with EA, 4 with venous malformation (VM) with RFA, and 4 with microcystic lymphatic malformation (mLM) with RFA (n=2) or both EA and RFA (n=2). Median number of total treatment sessions was 1 ranging from 1-4. Volume reduction at the last follow-up was near complete (> 90%) in all five patients with MLM, three of four with VM, and one of four with mLM. Moderate response (> 50% and =90%) was seen in VM (n=1) or mLM close to the mandibular branch of the facial nerve (n=3) showed moderate response. The mean cosmetic grading score was decreased from 3.8 ± 0.4 to 1.5 ± 0.8 (p < 0.05). The initial volume was not significantly correlated with number of treatment session or treatment response. No major complications were encountered.

CONCLUSION
EA and/or RFA is an effective and safe treatment method for VLM presented as a bulging mass in the head and neck, which showed > 90% of volume reduction in 9 of 13 patients and significant cosmetic improvement in all patients regardless of the internal component, the initial volume or the presence of any functional structures close to the treated lesions.

Nuclear Medicine (GI, GU and Endocrine) Tuesday, 03:00 PM - 04:00 PM • SS05AB

SSJ20-06 • An Assembled Prototype Multi-material 3D Printed Model of the Neck for CT and Ultrasound-guided Interventional Procedures

Ramin Javan MD (Presenter)

PURPOSE
The aim of this project was to design a prototype semi-realistic multi-material model of the neck for CT and ultrasound-guided interventional procedures.

METHOD AND MATERIALS
Autodesk 3D Studio Max, MeshLab, OsiriX and Materialise Mimics software were used to three-dimensionally reconstruct a multitude of virtual 3D models, including the cervical spine vertebral column, cervical spine cord, trachea, thyroid gland, internal jugular vein and carotid arteries. A variety of rapid prototyping techniques and materials were used to 3D print the elements of the final assembled model using commercially available services. A gypsum-based model of the cervical spine that contains the cervical portion of the spinal cord and its respective nerve roots extending outside the neuroforamina. The tracheal lumen was made with polyamide material and also serves as the assembly reference point of the entire model with struts as support apparatus. The hollow vessels were created with tango-black rubber-like flexible material. A thyroid gland mold was made with polyamide. The thyroid gland itself is composed of ballistic-grade gelatin mixed with psyllium to simulate echotexture and with calcium chloride to simulate iodine content. It contains masses of high or low density/echogenicity, which are made by injecting sodium alginate solution with or without hydrogel particles into calcium chloride solution. Level II lymph nodes and parotid glands, which are made the same way as the thyroid masses, are mounted on struts emanating from the trachea. The assembled model was submerged in a container filled with high-concentration gelatin/pectin, which was allowed to congeal in cold temperature, simulating soft tissues of the neck.

RESULTS
The cervical spine is radiodense due to high calcium content of the gyspum, which can be used to practice cervical spine pain management interventions. The rubber-like vessel walls allow for passage of needles simulating vascular access. The thyroid nodules and lymph nodes can be used for practicing fine-needle aspirations. The model is designed to be both CT and ultrasound compatible.

CONCLUSION
A prototype dual-modality interventional phantom of the neck was successfully developed using 3D printing and molding techniques with a multitude of materials.

Nuclear Medicine (GI, GU and Endocrine) Tuesday, 03:00 PM - 04:00 PM • SS05AB • SSJ21 • AMA PRA Category 1 Credit™:1 • ARRT Category A+ Credit:0.5 • Moderator M. Elizabeth Oates, MD

Moderator William G Spies, MD

SSJ21-01 • Efficacy of a One-week Stringent Low Iodine Diet for Decreasing Urinary Iodine Concentration and Enhancing I-131 Uptake in rhTSH-aided Radioiodine Ablation for Papillary Thyroid Cancer

Kunihiro Nakada (Presenter) ; Mika Tamura BS ; Yasushi Satoh BS ; Yusushi Furuta MD, PhD ; Hiroki Sugie MD ; Masayuki Sakurai

PURPOSE
Low iodine diet (LID) is an important preparation for radioiodine I-131 therapy for differentiated thyroid cancer. However, practice of LID for longer period is not easy for residents in iodine sufficient district. The aim of the study was to determine efficacy of a one-week LID program on total body iodine and radioiodine uptake in the remnant tissue after total thyroidectomy.

METHOD AND MATERIALS
RESULTS
CONCLUSION
A one-week LID successfully decreased total body iodine in patients with post surgical thyroid cancer without causing any significant side-effects. Moreover, low UIE enhanced I-131 uptake in the remnant tissue. A one-week LID may be simple and valuable in rhTSH-aided ablation for thyroid cancer.

CLINICAL RELEVANCE/APPLICATION
In patients undergoing rhTSH-aided ablation without stopping I-T4 replacement, low iodine diet for just 1 week may be as efficient as that for 2 to 3 weeks in enhancing I-131 uptake.

SSJ21-02 • Does the Finding of Two Foci of Tc-99m Sestamibi Retention on Parathyroid Scintigraphy Necessarily Indicate Double Parathyroid Adenoma?

Charles M Intenzo MD (Presenter) ; John Kairys MD ; Edmund Pribitkin MD ; Arnold Baskies MD ; Stacey Milan MD ; Sung M Kim MD ; David Capuzzi MD

PURPOSE
Tc-99m sestamibi (MIBI) scintigraphy is commonly utilized for the preoperative location of parathyroid adenomas. A focal area of tracer retention that persists on delayed images is fairly specific for a parathyroid adenoma. Occasionally, there are 2 foci of MIBI retention on delayed imaging, which theoretically suggests a double parathyroid adenoma. Our aim was to determine just how often this finding was shown to represent a double adenoma.

METHOD AND MATERIALS
Over a 4-year interval, all parathyroid scans with the finding of 2 areas of MIBI concentration in initial images of the neck, that retained the tracer on 3-hour delayed images were collected and corresponding histopathological results were reviewed.

RESULTS
A total of 16 patients demonstrated the above finding. Of these, 14 underwent neck exploration; 12 were diagnosed as having asymmetric parathyroid gland hyperplasia, while only 2 were diagnosed with double parathyroid adenoma.

CONCLUSION
Of the group of 14 patients whose parathyroid scintigraphy showed 2 areas of MIBI retention on 3-hour delayed images of neck, 12 (85.7%) had asymmetric parathyroid hyperplasia, whereas only 2 patients with this finding had true double adenoma.

CLINICAL RELEVANCE/APPLICATION
In parathyroid scintigraphy, 2 foci of tracer retention more than likely indicate parathyroid gland hyperplasia, as opposed to double parathyroid adenoma.

SSJ21-03 • Bleeding Focus on Tc 99m Red Blood Cell (RBC) Scintigraphy in Acute Lower Gastrointestinal Bleeding (LGIB): Relationship between Intensity of Bleeding Focus and Positive Rate of Subsequent Conventional Angiography

Timothy L Haaga MD (Presenter) ; Sun Ho Ahn MD ; Gregory J Dubel MD ; Don C Yoo MD ; Richard B Noto MD *

PURPOSE
Tc99m-labelled red blood cell (Tc99m RBC) scans detect bleeding at a rate of roughly 0.1 mL/h, approximately ten times slower than that detectable with conventional angiography. The primary purpose of this study is to evaluate how the intensity of a bleeding focus on Tc99m RBC scanning relates to the likelihood of positive findings on conventional angiography.

METHOD AND MATERIALS
A retrospective review was conducted on PACS of all Tc99m RBC scans performed from 2003 through July 2011, and all visceral angiograms performed following Tc99m RBC scans during the same time period. Tc99m RBC scans initially interpreted as positive were reviewed independently by two board-certified, nuclear medicine (NM) fellowship-trained radiologists who were blinded to the initial interpretation. An RBC scan was considered 'intensely positive' by NM readers if intensity of the bleeding focus exceeded that of aortic blood pool and liver. Two board-certified, fellowship-trained interventional radiologists (IR), blinded to any interpretation of the Tc99m RBC scans, independently reviewed visceral angiograms. An angiogram was considered positive if it demonstrated extravasation or an etiology for bleeding.

RESULTS
174 Tc99m RBC scans and 112 visceral angiograms were reviewed. Of the 112 patients who proceeded to angiogram following RBC scan, 60 and 47 RBC scans were read as intensely positive by NM readers A and B, respectively. 21/112 angiograms were read as positive by both IR readers. Of 21 patients with positive angiograms, the preceding RBC scans were read as intensely positive in 19/21 cases for reader A and 15/21 cases for reader B. Sensitivity, specificity, PPV and NPV of an intensely positive RBC scan for a positive angiogram were thus 91%, 55%, 32% and 91%, respectively, for reader A and 71%, 65%, 32% and 96%, respectively, for reader B.

CONCLUSION
Intensity of a bleeding focus on Tc99m RBC scan greater than that of aorta and liver has a high negative predictive value for a positive angiogram. If a bleeding focus demonstrates equal or lesser activity than that of liver or aorta on Tc99m RBC scan there is thus a high likelihood of a negative subsequent conventional angiogram.

CLINICAL RELEVANCE/APPLICATION
By clarifying patients' pre-test probability of positive angiography, grading of bleeding intensity on RBC scan has the potential to lessen the number of unnecessary visceral angiograms performed.

SSJ21-04 • 18F-FDG PET/CT Imaging has High Sensitivity in Detecting Clinically Active IgG4-related Disease

Leslie K Lee MD (Presenter) ; Arezou Khosroshahi MD ; Emine Atac ; Mollie Carruthers MD ; John Stone MD, MPH ; Dushyant V Sahani MD

PURPOSE
IgG4-related disease (IgG4-RD) is an inflammatory disorder with varied manifestations that depend on the extent of organ involvement. Active disease may be clinically quiescent while rendering organ damage; serum markers can be insensitive in diagnosis and monitoring of the disease. In this retrospective series of 25 patients with biopsy-proven IgG4-RD, the sensitivity of serum IgG4 levels was compared to that of 18F-FDG PET/CT imaging.

METHOD AND MATERIALS
In this IRB-approved study, patients with biopsy-proven IgG4-RD who had undergone 18F-FDG PET/CT of the chest, abdomen, and pelvis were identified. IgG4-RD history, symptoms, serum IgG4 levels, and PET/CT findings were recorded. The sensitivities of 18F-FDG PET imaging, and that of abnormal serum IgG4 levels, were compared with Fisher’s exact test.

RESULTS
From 2006 to 2012, a total of 25 patients with biopsy-proven IgG4-RD had undergone 18F-FDG PET/CT imaging. 18 patients were male (72%). Median age was 61 years (range, 27 to 81). All patients (100%) were deemed clinically to have at least one active IgG4-RD organ. Serum IgG4 levels were not available in 2 patients; levels were abnormally elevated in 10 of 23 patients (43%). PET imaging was abnormal in 24 of 25 patients (96%); PET/CT was abnormal in 25 of 25 patients (100%). Correlation of PET findings to biopsy sites was positive in 24 patients; abnormal 18F-FDG uptake was observed in 23 patients (96%). At the organ level, abnormal 18F-FDG uptake was observed at 26 of 29 sites (90%) from which biopsy had shown features of IgG4-RD. In 8
patients (32%), PET demonstrated an uptake abnormality at a site distinct from or more extensive than that suspected by the clinical presentation. Among the 23 patients for whom serum IgG4 levels were available, PET imaging was significantly more sensitive: PET was abnormal in 22 patients (96%), while serum IgG4 was abnormally elevated in 10 patients (43%), p

CONCLUSION
18F-FDG PET/CT is significantly more sensitive than serum IgG4 levels in identifying patients with active IgG4-RD, and can demonstrate additional sites of disease not obvious by clinical presentation or laboratory markers.

CLINICAL RELEVANCE/APPLICATION
18F-FDG PET/CT has high sensitivity in detecting clinically active IgG4-RD, a disorder in which clinical and laboratory evaluation may underestimate disease status.

SSJ21-05 • Can We Ignore Spleen Lesions that Are Not Metabolically Active?

Manish Dhyani MBBS (Presenter) ; Michael S Gee MD, PhD ; Anuradha S Shenoy-Bhangle MD ; Peter F Hahn MD, PhD *

PURPOSE
We undertook this study to determine the negative predictive value of PET for splenic lesions. Although PET has been used extensively for evaluation of space-occupying lesions in other organs, the current medical literature is conflicting on the current role of 18F-FDG-PET for characterization of splenic masses. Some studies have demonstrated high accuracy with good sensitivity and specificity when clinical data was used as the gold standard while others have demonstrated poor accuracy when histopathology was used as a gold standard.

METHOD AND MATERIALS
In this IRB approved single center retrospective study we searched an institutional database and reviewed imaging of all patients with a focal splenic lesion >6mm who had undergone an FDG-PET/CT scan with or without IV contrast. Splenic lesions with at least one-year follow-up and had metabolic activity less than or similar to the remainder of the spleen were identified. Lesions that exhibited >30% increase on the follow-up study were categorized as aggressive and included in the study.

RESULTS
Twenty-four subjects (M:F = 15:9) with a mean age of 55 years (mean = 21-80 years) with one or more PET-negative splenic lesions were identified to have aggressive splenic lesions on subsequent studies. 22 of 24 had a primary extra-splenic or systemic malignancy. The most common primary malignancy in this cohort of patients was lymphoma (n=6, 25%) followed by lung cancer (n=5, 21%) and melanoma (n=3, 12.5%). Two of the lesions were primary splenic tumors (follicular dendritic cell tumor, littoral cell angiosarcoma); the other 8 arose in patients with extra-splenic malignancy and were clinically considered metastases.

CONCLUSION
Aggressive PET-negative lesions can arise in the spleen.

CLINICAL RELEVANCE/APPLICATION
Low metabolic activity as determined by FDG-PET cannot be used alone to exclude aggressive behavior of a splenic lesion.

SSJ21-06 • Imaging Cold Activated Brown Adipose Tissue Using Functional MRI and 18F-FDG PET CT

Bart Van Rooijen (Presenter) ; Anouk A Van Der Lans ; Boudewijn Brans ; Joachim E Wildberger MD, PhD ; Patrick Schrauwen ; Wouter Van Marken Lichtenbelt ; Walter H Backes PhD

PURPOSE
Brown adipose tissue (BAT) is involved in non-shivering thermogenesis (NST). Novel non-invasive imaging methods are required to monitor the pharmacological targeting of BAT as a potential treatment of obesity. FDG-PET combined with CT is so far the only non-invasive method to detect active BAT. The aim of this work was to investigate the use of MRI to determine the presence of active BAT.

METHOD AND MATERIALS
Eleven healthy young adults were included. The subjects underwent MRI and FDG-PET/CT imaging of the supra-clavicular/cervical fat depots containing BAT. Cooling was performed by wrapping the subjects in a water-perfused suit connected to temperature controlled water baths. Prior to the PET/CT, subjects were exposed to mild cold conditions during which maximum NST occurs. Subjects were injected with 74 MBq FDG as a tracer of metabolic activity. BAT activity was quantified by auto-contouring BAT with a set threshold. In the MRI water-fat (Dixon) imaging was performed under normal ambient conditions followed by dynamic T2* weighted imaging during which subjects were exposed to a repeated boxcar cooling paradigm to activate the BAT.

RESULTS
Water-fat MRI showed that supra-clavicular/cervical fat depots had an average fat content of 65.2 ± 7.0%. For the regions identified as active BAT on PET/CT, the fat content was 66.0 ± 9.3%. The volume fraction of activated voxels in the depots as measured by fMRI correlated with the activity concentration of FDG uptake on the PET/CT (R=0.63, P

CONCLUSION
Our results suggest (active) BAT cannot be identified based on the fat fraction of the supra-clavicular/cervical depots. The use of fMRI to measure the presence of active BAT is promising as the fraction of activating voxels correlated with FDG uptake on PET/CT.

CLINICAL RELEVANCE/APPLICATION
Pharmaceutical targeting of BAT may be a potential strategy in the treatment of obesity and imaging methods are needed to monitor its response.

Mathew Thomas BS (Presenter) ; Yohei Matsutani ; Jae Y Choi DPhil ; Despina Kontos PhD ; Emily F Conant MD * ; Andrew D Maidment PhD *

PURPOSE
To characterize the effect of breast density and thickness on mean glandular dose (MGD) in digital mammography (DM) and digital breast tomosynthesis (DBT).

METHOD AND MATERIALS
Participants in this prospective screening trial were imaged with 2-view DM and 2-view combined DM/DBT obtained at 15% reduced dose. The MGD was calculated from exposure parameters for the combination-DM/DBT. Area (PD) and volumetric (VD) percent breast densities were estimated using fully-automated, FDA-cleared software (Hologic R2 Quantra). PD and VD in each image was averaged for each breast. MGD unadjusted for glandularity was calculated from exposure factors in the DICOM header on a per-acquisition basis. MGD was adjusted for patient glandularity by Dance coefficient conversions. Statistical comparisons were made by paired t-test and regression analysis.

RESULTS
Data was available for analysis on 330 patients with 1,320 images. Compressed breast thickness was 54.6 mm and 56.0 mm for CC and MLO, respectively. VD was 11.9% and 12.5% for LCC and RCC, respectively; PD was 23.4% and 21.6%, respectively. Volumetric density was 45.7% lower than area density (p < 0.0001).

**CONCLUSION**

MDG for mammography is dependent upon thickness and glandularity, while MDG in tomosynthesis is predominately thickness-dependent. The VD was lower than the PD, and both were substantially below 50% in all images. Reporting MDG without adjusting for glandularity underestimates actual dose delivered to the breast tissue per acquisition.

**CLINICAL RELEVANCE/APPLICATION**

This work characterizes key factors affecting MDG in combination-DM/DBT screening and provides more accurate estimates of MDG for prospective screening.

**SSJ22-02 • Fetal Radiation Doses in Computed Tomography Examinations of Pregnant Patients: A Comparison between Whole-body and Individual Organ Doses at Three Different Gestational Ages**

**Nelia Long** MS (Presenter) ; **Matthew Maynard** MS ; **Roger Y Shifrin** MD ; **Nash S Moawad** MD, MS ; **Wesley E Bolch** PhD

**PURPOSE**

The purpose of this study was to compare values of whole fetal averaged absorbed dose to that for individual fetal organs following CT examination of the adult pregnant female. These differences were compared across three gestational ages and with variations in maternal perimeter at a given gestational age.

**METHOD AND MATERIALS**

In this study, the University of Florida (UF) series of anatomic computational models of the adult pregnant female were employed which provided detailed anatomic modeling of the developing fetus at 10, 25, and 38 weeks gestation to determine the fetal size range at which the average whole-body fetal dose would be sufficient to approximate the dose to specific fetal organs. Monte Carlo simulations were used to calculate individual fetal organ doses as well as whole-body doses for a Toshiba Aquilion ONE scanner at 100 mAs per rotation. Variations in radiation dose to the fetus with changes in maternal size as given by the maternal abdominal perimeter were also explored.

**RESULTS**

Calculated CT doses for abdomen-pelvis CT exams for soft-tissue organs differed by up to 26% from whole body averaged fetal doses. However, skeletal tissue doses were at most 110% larger than whole-body doses within the 25-38 week models. Skeletal doses were as high as 25 mGy per 100 mAs per rotation. Skeletal doses within the 10-week model were no more than 30% larger than the calculated whole-body dose. At greater gestational ages, the significant differences in results between the average whole-body dose and the skeletal dose during abdomen-pelvis CT exams should be considered when prospectively assessing stochastic risks to these tissues.

**CONCLUSION**

Although whole-body fetal dose is often the only quantity quoted in CT dosimetry, the imaging community should be aware that although organ doses are very similar to this number, the skeletal dose can be more than twice as large as the whole-body dose. These differences should be taken into consideration when making projections of stochastic risks resulting from exposures to the fetal skeletal tissues.

**CLINICAL RELEVANCE/APPLICATION**

Stochastic risk estimates to the skeletal tissues following in utero exposures during CT imaging of pregnant patients may be under reported if approximated using estimates of whole-body fetal dose.

**SSJ22-03 • Radiation Dose from 3D Rotational Neurovascular Studies vs. Conventional 2D DSA**

**Elena Tonkopi** MS (Presenter) ; **Ahmed H Al-Habsi** MD ; **Jai Shankar**

**PURPOSE**

To compare patient effective dose resulting from two alternative imaging methods for pre-intervention assessment of intracranial aneurysms: a series of Digital Subtraction Angiography (DSA) runs taken at different positions, and a 3D RA technique.

**METHOD AND MATERIALS**

In a retrospective analysis, we investigated the planning studies of 44 patients who underwent endovascular coiling in our institution between January and October 2012. Images were acquired on a bi-plane II-based system (Siemens Axiom Artis) not equipped with a DAP meter. Conventional 2D projection DSA images were simulated with an anthropomorphic head phantom using 12 s runs with a rate of 2 f/s. Entrance skin exposure was measured with a 60 cc ionization chamber (Radcal, Accu-Pro) for AP, LAT, and Oblique projections. A commercially available Monte Carlo simulation program PCXMC was used to calculate patient effective dose. The second technique involved acquisition of 128 images during a 200° rotation of the C-arm around the patient’s head resulting in the 3D reconstruction. A 16 cm CT dosimetry phantom and a 100 mm pencil ion chamber were used to measure the CT dose index resulting from the RA. The ImPACT patient dosimetry software was employed for patient effective dose calculations. Scatter radiation was measured at 152 cm from the head phantom during both acquisitions. An unpaired two-tailed t-test was used to determine the significance of differences between patient doses in each group.

**RESULTS**

The sixteen patients underwent 2D projection DSA with a mean number of cine runs of 5.1 (minimum 4, maximum 8). Twenty eight patients were assessed using the 3D RA protocol, which included an AP/LAT run and one rotational spin. In the 2D DSA group the mean effective dose was 2.11 mSv (range 1.69–3.43 mSv), and in the 3D RA group effective dose was 1.29 mSv (p=0.00028). Scatter to the staff was 2.2 times higher during the cine run than from the one spin RA (p=0.00016).

**CONCLUSION**

Our study demonstrated that the patient effective dose and scatter radiation to the staff were significantly lower from the 3D RA than from the 2D projection DSA runs used in the planning of cerebral aneurismal coiling.

**CLINICAL RELEVANCE/APPLICATION**

3D rotational angiography (RA) has the potential to decrease radiation dose and to improve the efficiency of the procedure.

**SSJ22-04 • Predictive Models for Estimating Organ Dose from Fixed and Tube Current Modulated CT Scans Using Regional CTDIvol and Water Equivalent Diameter**

**Maryam Khatonabadi** (Presenter) * ; **Grace Kim** MD ; **Dianna D Cody** PhD * ; **Gary Arbique** PhD * ; **S. Bruce Greenberg** MD ; **Christopher H Cagnon** PhD ; **John J Demarco** PhD ; **Michael F McNitt-Gray** PhD *

**PURPOSE**

To create predictive models that estimate organ doses from fixed mA or tube current modulated CT scans and that were applicable to both chest and abdomen exams. These models employ water equivalent diameter (WED) to describe patient size and a regional descriptor of scanner output, regional-CTDIvol.

**METHOD AND MATERIALS**

A total of 334 CT exams (188 chest and 146 abdomen/pelvis) of adult females, adult males and pediatric patients, were collected from 64-slice CT scanners from three different manufacturers (Siemens Healthcare, GE Healthcare and Toshiba Medical); all scans were performed with TCM. Voxelized patient models were created from image data from each exam and organs were identified by semi-automated segmentation to obtain: liver, spleen, and kidneys for abd/pel exams and lungs and glandular breasts tissue for...
chest exams. For patient size, WED was calculated for each image. For all patients, regional landmarks were manually identified and used to calculate regional CTDIvol. A validated Monte Carlo based CT dosimetry simulation package was used to estimate dose to all segmented organs, once using TCM data and once simulating fixed mA scans. Predictive models based on WED and regional CTDIvol values were developed to estimate organ dose using 60% of cases as a training set. The model was evaluated using the remaining 40% of cases as a test set and compared the predicted values to detailed simulated results for each case. RMS of absolute percent errors between simulated and estimated organ doses were reported across all organs, scanners and scan types as well as for individual organs.

RESULTS
The overall RMS of absolute percent error was 6.7% for fixed mA and 13.9% for TCM simulations. RMS errors were less than 10% for all organs in fixed mA simulations and range from 11-14.8%, for TCM CT scans. Smaller sized patients tended to have larger percent errors.

CONCLUSION
Predictive models were generated based on regional information of the scanner output and size and agreed with detailed simulations to within 7% for fixed and 14% for TCM across all scanners, organs, and exam types. The TCM predictive model could possibly be further improved by tailoring it to smaller patients.

CLINICAL RELEVANCE/APPLICATION
Organ doses can be estimated in a robust fashion for patients undergoing CT exams using predictive models based on regional descriptors of scanner output and patient size.

SSJ22-05 • Decreased Radiation Dose and Preserved Diagnostic Accuracy with Iterative Reconstruction at Coronary Computed Tomography Angiography: Intra-Individual Comparisons

Wei-Hua Yin (Presenter) ; Bin Lu MD ; U. Joseph Schoepf MD * ; Zhi-Hui Hou MD ; Run-Ze Wu ; Nan Li ; Lei Han ; Yang Gao ; Fang-Fang Yu

PURPOSE
Iterative reconstruction techniques show promise to decrease radiation requirements at coronary CT angiography (CCTA). No study performed a direct head-to-head, intra-individual comparison of iterative reconstruction algorithms with traditional filtered back projection (FBP) vis-à-vis diagnostic accuracy and radiation dose at CCTA.

METHOD AND MATERIALS
RESULTS
Sensitivity and specificity for diagnosing =50% coronary artery stenosis on a per-segment level were 88.5% and 92.1% with FBP and 84.2% and 93.4% with iterative reconstruction (p>0.05). The area under the receiver-operating characteristic curve on a per-segment level was 0.903 (95% confidence interval [CI], 0.875-0.932) and 0.888 (95% CI, 0.856-0.920) with FBP and iterative reconstruction, respectively (p = 0.290). Compared with FBP, iterative series showed no significant (p>0.05) differences in image quality parameters. Median effective radiation dose was 52% lower for the iterative reconstruction protocol compared with FBP (0.73 mSv [interquartile range, 0.55-1.18] vs. 1.53 mSv [1.15-2.42], p

CONCLUSION
Compared with a routine radiation dose FBP protocol, 50% reduced dose acquisition using iterative reconstruction preserves image quality and diagnostic accuracy at CCTA.

CLINICAL RELEVANCE/APPLICATION
Iterative CT image reconstruction techniques have potential to further reduce already low radiation requirements associated with CCTA.

SSJ22-06 • Quantifying the Spread in Deviation Index (DI) - An Initial Experience for a Tertiary Health Care Center and Its Affiliated Community Hospital

Jaydev K Dave PhD, MS (Presenter) ; Eric L Gingold PhD

CONCLUSION
Only 15%-18% of DI values fall within the target range of -0.5 to 0.5, and the SD ranged from 1.8 to 2.7. Thus, the range recommended in AAPM Report 116 is not being achieved in the current practice. This audit of DI values indicates the need for quality improvement projects and a re-evaluation of target values.

Background
Deviation Index (DI) expresses the deviation in image receptor dose utilized for a digital radiograph relative to a target value. The AAPM Report 116 recommends a desirable operating range of the DI to be between ±0.5. The goal of this work was to quantify the spread in the DI for radiographs under real-world clinical conditions.

Evaluation
IRB exemption was obtained. The DI values were evaluated for radiographs obtained using storage phosphor and flat-panel digital radiography systems at a tertiary medical center and an affiliated community hospital (Jan-2012 to Mar-2013). Descriptive statistics for the DI and percent cases within ranges listed in AAPM Report 116 were computed as a function of exam location and type.

Discussion
The mean ± standard deviation (SD) for all DI values (n=283,141) was 1.4±2.7. For neonatal (n=1,877) and adult (n=32,785) radiographs with mobile equipment and manual exposure parameters the mean±SD for the DI were -1.1±2.4, and 0.3±2.4, respectively. The most common radiographic exposure using manual technique was anterior-posterior chest for the neonatal (45%) and adult (60%) populations with mean±SD to be -1.2±2.2, and 0.1±1.8, respectively. For radiographs obtained with automatic exposure control (n=90,272) the mean±SD for the DI were 0.7±2.5; amongst these, radiographs of the chest were most frequent (58%) with a mean±SD for the DI of 0.9±2.2. The mean±SD of the DI for radiographs acquired with the flat-panel digital radiography system were 1.5±2.3. Only 15% to 18% of the cases were in the target exposure range for the entire data set and the subsets considered. Overall, 23% radiographs were in the underexposed category (5%: DI<-3.0 and 18%: DI from -3.0 to -0.6) and 62% radiographs were in the overexposed category (37%: DI from 0.6 to 3.0 and 25%: DI>3.0). The DI values followed a gaussian distribution for the subsets considered in this study.

SSJ23-01 • Imaging-task-Optimized, Source-detector Trajectory Design and Reconstruction in 3D Interventional Imaging

Joseph W Stayman PhD (Presenter) * ; Adam S Wang PhD * ; Wojciech Zbijewski PhD * ; Yoshito Otake * ; Jeffrey H Siewersden PhD *

PURPOSE
Interventional cone-beam CT differs greatly from diagnostic CT not only in highly flexible positioning of the source and detector, but also in that interventional imaging tasks typically involve well-posed detection and localization of targets which have been identified in pre-operative 3D imaging and planning. We propose to leverage this wealth of patient- and task-specific prior knowledge to design customized source-detector trajectories for subsequent intraoperative CBCT acquisitions to maximize imaging task performance.
METHOD AND MATERIALS
Task-based performance in 3D imaging is predictable using analytical models of the imaging chain. Task-based detectability index, for example, can be computed upon specification of a task function, acquisition geometry, trajectory, detector physics, reconstruction process; and the patient anatomy. Using a preoperative CT volume to integrate patient-dependence, we compute a marginal detectability index related to individual rotation angle/obliquity pairs of an interventional C-arm. A task-based trajectory is formed by successively finding the angle pair yielding the greatest detectability (e.g., the next best view) and adding it to a growing collection of angles. The trajectory design approach was applied to a simulated pulmonary nodule detection task where the data from a task-driven noncircular orbit was reconstructed using a model-based iterative approach.

RESULTS
The task-based trajectories designed for the pulmonary nodule detection task were largely continuous despite the lack of a constraint and tended to avoid long radiological path length (e.g., avoiding projections involving overlap of the nodule with bone or a surgical tool). Image reconstructions using the task-based orbit show excellent visualization of the nodule. By comparison, the nodule was obscured in reconstructions from sub-optimal orbits due to noise/limited spatial resolution.

CONCLUSION
Leveraging patient-specific information and analytical model for task-based imaging performance within the 3D image acquisition process allowed the design of customized orbits that maximize task performance in image-guided interventions.

CLINICAL RELEVANCE/APPLICATION
Task-based trajectories yield improved imaging performance over standard orbits and can potentially automatically overcome challenging imaging scenarios near high-density objects and bone.

SSJ23-02 • Bipolar Contrasts Generated by Microbubbles in Grating-based X-ray Phase Contrast CT

Xiangyang Tang PhD (Presenter) *; Yi Yang PhD

PURPOSE
We propose to utilize microbubbles as the contrast agent in grating-based x-ray phase contrast CT. Via a phantom study, we investigate the bipolar contrasts generated by microbubbles in grating-based x-ray phase contrast CT and its variation over the size of microbubble targets and detector cells.

METHOD AND MATERIALS
The phantom consists of seven targets that are clusters of microbubbles at diameters 2.5 μm. To simulate the small lesions in advanced clinical and preclinical applications, microbubbles are deployed along a spiral locus in each cluster with its outer dimension from the smallest to largest equal to 50, 75, 100, 250, 500, 1,000 and 2,500 μm. To assure a random deployment that mimics a chaotic distribution, half of the microbubbles in each cluster are randomly removed. The projection data are acquired at a 1° angular interval over 360° range. In data acquisition, a 31.6 keV monochromatic x-ray source with infinitesimal focal spot is assumed. At each angular position, grating shifts 8 steps, and the x-ray exposure is gauged as a summation over all the 8 steps of grating shifting and equal to 5.0x10^9 photon/cm². To investigate the contrast generated by microbubbles over spatial resolution, we conduct the study at detector cell sizes 48, 96, 128 and 256 μm, respectively.

RESULTS
The preliminary data show that the contrast generated by microbubbles in grating-based x-ray phase contrast CT is bipolar: the one generated by the differential phase contrast mechanism is negative, while that by the dark-field mechanism is positive. Moreover, the microbubbles bipolar contrasts in x-ray phase contrast CT are significantly larger than its counterpart in the conventional attenuation CT.

CONCLUSION
Using microbubbles as the contrast agent, the grating-based x-ray phase contrast CT may outperform the conventional attenuation CT significantly, especially in the scenarios where small lesions are to be detected at high spatial resolution.

CLINICAL RELEVANCE/APPLICATION
The preliminary results reported in this study may be of relevance to the preclinical and eventually clinical applications of grating-based x-ray phase contrast CT.

SSJ23-03 • Novel Results from a First Preclinical X-ray Phase-contrast CT Scanner

Astrid Velroyen (Presenter); Andre Yaroshenko; Arne Tapfer; Martin Bech; Mark Muller; Bart Pauwels; Jeroen Hostens; Peter Bruyndonckx; Xuan Liu; Alexander Sasov; Franz Pfeiffer

PURPOSE
In the last years, x-ray phase-contrast and dark-field imaging have been proven to provide superior soft-tissue contrast and complementary information in comparison to conventional attenuation-based imaging, thus great potential for medical imaging is anticipated. As a first step towards clinical implementation, we have developed a grating-based compact preclinical phase-contrast CT scanner with rotating gantry [1], from which we present novel results.

METHOD AND MATERIALS
Our preclinical phase-contrast CT scanner is the first one to comprise a laboratory x-ray source, a detector and a three-grating interferometer installed on a rotating gantry. The interferometer is used to transfer minimal, sample-induced directional changes of the x-rays into intensity variations on the detector. From those measurements, the two new contrast modalities, i. e. phase-contrast, which is based on the refraction of x-rays, and dark-field contrast, which indicates microstructured regions that scatter x-rays, are obtained in addition to the attenuation-based image. [2, 3]

By acquiring reference CT scans we studied thermal and rotation-induced instabilities that compromise the precise alignment and relative movement of the fine interferometric structures and thus cause image artifacts. Newly developed software tools are presented that allow to regain accurate images despite those instabilities. Also, technological advances that improve visibility and scanner performance in general are shown.

RESULTS
We show CT scans of several biological samples and phantoms to demonstrate the possibilities of the new system. First planar radiographic images of a living mouse in differential phase, dark-field and attenuation contrast are presented, as well as phase-contrast ex-vivo mouse CT images made possible by the software and hardware improvements introduced to the scanner.

CONCLUSION
Our measurements clearly show the improved soft-tissue contrast and complementary information that can be obtained by phase and dark-field imaging in comparison to the conventional attenuation image.


CLINICAL RELEVANCE/APPLICATION
By proving the feasibility of phase-sensitive imaging with a compact rotating gantry, this work represents an important milestone in translating phase-contrast from bench to bedside.
Artifact-suppressed, Low-dose C-arm CBCT Imaging of Low-contrast Cerebral Lesions

Xiao Han MSc (Presenter); Satoru Oishi PhD*; Tetsu Satow MD; Hiromichi Yokoyama RT; Masanobu Yamada RT; Michael Silver PhD*; Yu-Bing Chang; Emil Yi Sidky PhD; Xiaochuan Pan PhD*

PURPOSE
Three-dimensional images of a patient brain can be obtained by use of a C-arm-based CBCT system for clinical evaluation of cerebral lesions of low-contrast such as Intracranial Hemorrhage (IH) to surrounding soft tissues. Current CBCT systems employ FDK-based algorithms for yielding brain images, which require data acquired at a large number of projection-views and thereby incur a high level of radiation dose. In addition, FDK-based reconstructions may be susceptible to noise and shading artifacts, which can mimic or obscure low-contrast lesions. In this work, we develop an optimization-based algorithm for reconstructing C-arm CBCT brain images, with specific objectives of suppressing artifacts and significantly lowering radiation dose.

METHOD AND MATERIALS
A clinical C-arm CBCT system was used for collecting brain data of patients at 607 views over 200° in 20 seconds. We refer to the acquired data as the full-view data, from which we formed a half-view data set by removing one projection frame at every other view. An iterative algorithm, referred to as ASD-POCS, was adapted to fully incorporate calibration information characterizing the actual scan geometry, which deviates from a circular trajectory due to gantry wobble. We applied the adapted ASD-POCS algorithm to the half-view data, and compared the reconstructions to the FDK reconstructions from full- and half-view data sets.

RESULTS
The half-view ASD-POCS reconstructions show suppressed artifacts than both full- and half-view FDK reconstructions. The soft-tissue contrast of the half-view ASD-POCS reconstruction is superior to the half-view FDK reconstruction, and is visually comparable to that of the full-view FDK reconstruction.

CONCLUSION
Our new algorithm is capable of reconstructing from half-view data patient-brain images with reduced artifacts and comparable soft-tissue contrast than the full-view FDK reconstruction.

Clinical Relevance/Application
We have demonstrated a C-arm CBCT imaging technique with improved image quality at considerably lowered imaging dose for clinical evaluation of low-contrast lesions such as IH.

Dynamic Range Extension in Flat Detector CT Using a Compressed Sensing-based Multi-exposure Technique

Ludwig Ritschl (Presenter); Jan Kuntz; Michael Knaup PhD; Marc Kachelriess PhD

PURPOSE
To increase the dynamic range of flat detectors in CT without increasing dose or scan time.

METHOD AND MATERIALS
The dynamic range $R$ of x-ray detectors is the ratio between the highest detectable signal (just before overexposure) and the lowest detectable signal (where x-ray quantum noise = electronic noise). Achieving low contrast resolution (e.g. 5 HU contrast of 5 mm objects) in human beings requires $R = 10^5$ which includes two factors: the accuracy of attenuation measurements in each ray and the capturing of significant attenuation differences between different rays due to differences of ray position (peripheral vs. central rays). Flat detectors, however, operate at $R \approx 10^4$ and avoiding underexposure for central rays typically means accepting overexposure for peripheral rays and thus truncation artifacts. Dual or multi-exposure techniques could be a remedy if dose and scan time did not increase. We propose a new multi-exposure technique that performs dense sampling with high exposure levels interrupted from time to time by a sparse low exposure sampling (e.g. every 16th projection). We generalized the compressed sensing-based ITV algorithm [Phys. Med. Biol. 56:1545] to optimally combine the highly sampled high exposure data with the interleaved sparsely sampled low exposure data. The generalized ITV method was verified using simulated as well as measured data, acquired with a Varian flat detector, and was compared to a situation where two exposures were made in a conventional way and with the standard situation of having only one exposure while accepting overexposure in the peripheral patient areas (e.g. in the skin).

RESULTS
The images with extended dynamic range and generalized iTV reconstruction are nearly undistinguishable from those with double exposure. Minor differences are visible only in the peripheral areas where only very sparse information was available for iTV. Dose and scan time remain the same as with today's single exposure scans.

CONCLUSION
Sparsely sampling the low exposure CT scan and interleaving many high exposure projections combined with compressed sensing reconstruction is sufficient to provide images nearly equivalent to a CT scan with a high dynamic range detector.

Clinical Relevance/Application
Flat detector CT, in particular images in interventional CT and in image-guided radiation therapy, can significantly benefit from the
METHOD AND MATERIALS
A standard MR-compatible interventional device (DynaTRIM, Invivo) was modified to provide real-time feedback of the virtual needle path. Interventional instruments are tracked by a digitizer that measures the 3D offset between a set of reflective markers attached to the instrument tip and reference markers mounted in a fixed geometry to the MR table. Device-to-MRI transformation was determined in a one-time calibration step. Prior to the intervention, the device was registered by a custom-made 3D localization of reference MR markers. The navigation system (Localite, Germany) then provided MRI views centered at the position of the instrument tip and reformatted along either the axis or standard radiological planes. The accuracy was estimated in a 3-T MRI trial (Trio, Siemens) by targeting 30 invisible peas (mean diameter 8.5 mm) without any control imaging. Clinical application under IRB approval involved 18 patients (57-72 y.o., mean 65) that had negative biopsies under TRUS guidance. MRI intervention times and biopsy findings were documented.

RESULTS
The add-on components did not affect image quality or patient comfort. Device registration was successful and fast (< 30 s). Experimental biopsy samples contained pea material in 28/30 cases corresponding to a maximum 3D error of 4.3 mm in 93% of the cases. Median clinical intervention time was 55 (36-89) minutes and involved two lesions in 7/18 patients (39%). No procedure-related complications were observed. The obtained specimens were diagnostic in all cases. In 8 patients (44%), histopathology revealed prostate cancer of Gleason Score 6 and 7.

CONCLUSION
Virtual real-time MRI navigation was found to be feasible and accurate in combination with an existing interventional device for the prostate. Potential stereotactic errors, in particular from prostate motion, can be rapidly detected and corrected for by updating the 3D navigation dataset. The underlying technique can be modified to work with other devices, scanners models and clinical applications as well.

CLINICAL RELEVANCE/APPLICATION
The presented virtual real-time navigation solution is a convenient and accurate add-on option to facilitate interventional instrument guidance in organs like the prostate.

SSJ24-02 • 4D Flow MRI Assessment of Cerebral Blood Flow after Extracranial-intracranial Bypass
Tetsuro Sekine (Presenter); Yasuo Amano MD; Ryo Takagi MD; Yoshio Matsumura RT; Yuriko Suzuki BS *; Shinichiro Kumita MD

CONCLUSION
The hemodynamics after EC-IC bypass is assessed by 4D Flow comprehensively.

Background
Extracranial-intracranial (EC-IC) bypass is performed to maintain blood flow in the brain of patients with internal carotid artery (ICA) occlusion. However, hemodynamics after EC-IC bypass is not well known. The aim of this study was to comprehensively assess the hemodynamics in patients after EC-IC bypass using time-resolved 3D phase contrast MRI (4D Flow).

Discussion
4D Flow shows that the type of bypass affects flow direction and BFV, and that ?P correlates with ?BFV. 4D Flow can quantify BFV and ?P after EC-IC bypass as well as visualize flow direction.

SSJ24-03 • Diffusion Analysis with Triexponential Function in Liver Steatosis
Tatsuya Hayashi (Presenter); Toshiaki Miyati PhD; Junji Takahashi; Yoshinori Tsuji; Masakatsu Tano; Satoshi Saito

PURPOSE
Our previous study has shown that triexponential function analysis noninvasively obtains more detailed information on diffusion in liver; however, the influence of fat accumulation to liver quantitative diffusion analysis is not clear. The purpose of this study was to assess the influence of liver steatosis on diffusion and perfusion by using the triexponential function analysis.

METHOD AND MATERIALS
On a 1.5 T MRI, navigator-echo triggered single-shot diffusion echo planar imaging was used with multiple b-values of 0 to 1500 s/mm², TE of 77 ms, TR of 1 respiratory cycle, and an imaging matrix of 128×74. Thirty-three patients underwent diffusion-weighted magnetic resonance imaging (DWI) with multiple b-values to obtain perfusion-related diffusion, fast free diffusion, and slow restricted diffusion coefficients ($D_p$, $D_f$, $D_s$) and fractions ($F_p$, $F_f$, $F_s$) with triexponential function analysis. They also underwent dual-echo gradient echo imaging for measurement of hepatic fat fraction (HFF). Of these, 13 patients were included in the control group and 20 in the fatty liver group with HFF >5%. Parameters of two groups were compared using the Mann-Whitney U test. The relationships between each diffusion coefficient and HFF were assessed using the Pearson correlation.

RESULTS
Perfusion-related diffusion coefficient $D_p$ and fast free diffusion coefficient $D_f$ were significantly reduced in the steatotic liver group compared with in the control group ($D_p$ = 27.72 ± 6.61 × 10^{-3} mm²/sec vs. 33.33 ± 6.47 × 10^{-3} mm²/sec, P = .0072; $D_f$ = 1.70 ± 0.53 × 10^{-3} mm²/sec vs. 2.06 ± 0.40 × 10^{-3} mm²/sec, P = .0224). There were no significant differences in other parameters between both groups. Furthermore, $D_p$ and $D_f$ were correlated with HFF (P < .0001, r = -0.64 and P = .0008, r = -0.56, respectively).

CONCLUSION
Decreased liver perfusion in steatosis cause the reduction in $D_p$, and extracellular fat accumulation and intracellular fat droplets in steatosis lead to the reduction in $D_f$. Thus, the influence of hepatic steatosis should be taken into consideration when the triexponential function analysis is used to assess diffuse liver disease.

CLINICAL RELEVANCE/APPLICATION
Steatosis can act as a potential confounder in quantitative diffusion analysis and to know the influence of steatosis on diffusion and perfusion parameters is important.

SSJ24-04 • Quantitative Comparison of Varying Combinations of MRI Metal Artifact Compensation Techniques (HBW-TSE, VAT and SEMAC) for Hip Prosthesis Imaging
The goal of this study is to quantify and compare the reduction of metal artifacts using combinations of high transmit and receive bandwidth (HBW-TSE), View Angle Tilting (VAT) and Slice Encoding for Metal Artifact Correction (SEMAC) in order to derive an appropriate MRI protocol for hip prosthesis imaging that maximizes artifact reduction in a clinically realistic scan time.

**RESULTS**

As shown in the plot, the measured dimension of in-plane artifact initially decreases with the addition of VAT (p=0.004, 0.0003 for long and short axis) and SEMAC x2 (p=0.045, 0.16 for long and short axis). However, there is no further reduction with higher SEMAC steps increase the acquisition time without significant reduction of the artifact.

**CONCLUSION**

The combination of HBW STIR with VAT and SEMAC reduces metal artifact from a phantom hip prosthesis, but approaches a limit with VAT and SEMAC x2 where further increases of SEMAC steps increase the acquisition time without significant reduction of the artifact.

**CLINICAL RELEVANCE/APPLICATION**

In the presence of a hip prosthesis, VAT and SEMAC slice encoding steps of 2 should be applied on high bandwidth coronal STIR images for optimal metal artifact reduction and minimal scan time.

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**SSJ24-05 • Time-resolved Quantitative Ventilation and Perfusion Imaging in Free Breathing without ECG Triggering Using Non Contrast Enhanced DC Gated FLASH MRI Imaging**

**André Fischer** DiplPhys, PhD (Presenter); Christian O Ritter MD; Dietbert Hahn MD; Thorsten A Bley MD; Herbert Koestler PhD *

**CONCLUSION**

Quantification of time-resolved ventilation/perfusion datasets using DC gated 1H FLASH imaging is feasible and in accordance with literature. This technique offers high patient comfort since data are acquired without applying contrast agents in free breathing and without ECG triggering.

**Background**

Recently, a non contrast enhanced technique acquiring quasi-randomly MRI data of the human lung in free-breathing and without ECG triggering was introduced [1]. To prevent artifacts due to respiratory/cardiac motion, these data are simultaneously acquired with the DC self gating signal. The DC signal enables accurate determination of the respiratory/cardiac phase. Thereby, complete respiratory/cardiac cycles without motion artifacts can be reconstructed. From these datasets qualitative functional lung maps can be obtained [2]. In this abstract we describe a way to quantify the reconstructed time-resolved respiratory/cardiac cycles.

**Evaluation**

A quantification method for time-resolved ventilation data has been presented earlier [3]. For perfusion, the main task is to find a relationship between the FLASH signal equation in dependency on the number of applied excitation pulses and vE. Which is related to the perfusion rate. This concept is abbreviated AQUAPICSS (Absolute Quantification of Perfusion-Induced Changes in the Steady-state Signal). Using AQUAPICSS and [3], we successfully obtained quantitative time-resolved ventilation/perfusion maps of the human lung from 7 healthy volunteers (5m/2f, age 20-25). Imaging parameters:

3.0T R = 2.5ms, TE = 0.7ms, t = 8\( \cdot \)192x192, 450x450mm\(^2\), 10mm, tmeas = 4min. The quantitative perfusion maps were additionally compared to SEEPAGE [4]. Figure 1a demonstrates that perfusion values are in good accordance between SEEPAGE and AQUAPICSS. Figure 1b shows an exemplary quantitative ventilation map.

**Discussion**

The observed perfusion/ventilation values were in accordance with literature values [5,6]. Furthermore, the AQUAPICSS perfusion maps correspond well to quantitatively derived from additionally acquired SEEPAGE datasets. Since simultaneous quantification of ventilation and perfusion is feasible, this technique enables the determination of the V/Q ratio without applying contrast agents.

**SSJ24-06 • Evaluation of Short Term Reproducibility of Apparent Diffusion Coefficients for Diffusion-weighted Imaging of the Prostate**

**Meredith Sadinski** BA (Presenter); Milica Medved PhD; Ibrahim Karademir MD; Yahui Peng PhD; Gregory S Karczmar PhD *; Aytekin Oto MD *; Yulei Jiang PhD; Steffen Sammet MD, PhD *; Shiyang Wang PhD *

**PURPOSE**

To evaluate the short term reproducibility of DW-MRI imaging of the prostate through consistency in ADC maps between subsequent scans of the same patient using the same scanner and identical imaging parameters.

**METHOD AND MATERIALS**

14 patients with biopsy proven prostate cancer were evaluated under an IRB-approved protocol. Each patient underwent two, identical DW-MRI scans gathered back-to-back with the patient remaining on the table between acquisitions. ADC maps for each scan were generated using a least squares fit and a deformable registration was performed on the scan pairs using the Plastimatch software employing a Demons algorithm. The prostate and ROIs within cancer lesions were delineated on each scan per patient by two radiologists using the b-0 images. The prostate volume was divided into sextants (anterior apex, posterior apex, anterior medial, posterior medial, anterior base, posterior base) and absolute and magnitude percentage difference in ADC per voxel was calculated and compared across sextants. Voxel-based as well as ROI-based variation in ADC was also calculated for cancerous ROIs.

**RESULTS**

The absolute difference in ADC per voxel within the prostate ranged from 2.33x10\(^{-10}\) to 1.60x10\(^{-3}\) mm\(^2\)/sec (per voxel magnitude percentage difference of 0.00%-200%, mean 10.52%). Variation in ADC was found to be largest in the posterior apex (0.00%-200%, mean 11.55%) although difference between sextants was not statistically significant. Cancer ROIs showed a voxel-based percentage difference in ADC per voxel of 1.07x10\(^{-6}\) to 8.41x10\(^{-4}\) mm\(^2\)/sec (0.00%-67.37%, mean 11.16%). ROI-based analysis showed that the difference in mean ADC of a cancerous ROI between the two scans ranged from -4.22 x 10\(^{-4}\) to 4.63 x 10\(^{-4}\) mm\(^2\)/sec with mean absolute difference 3.63 x 10\(^{-5}\) mm\(^2\)/sec.

**CONCLUSION**

The absolute difference in ADC per voxel was significantly higher in the posterior apex compared to other sextants. Furthermore, the reproducibility of ADC values within the prostate was found to be highly reliable, with a lower range for ROI compared to Voxel-based analysis.
Both CRT for locally recurrent disease, whereas 8 (36%) were treated in the adjuvant setting, at initial diagnosis of locally advanced rectal cancer. The median age at treatment was 63 years, and 12 patients (56%) were males. Fourteen patients (64%) received post-operative chemotherapy (CT), two (5.4%) underwent chemotherapy, two (5.4%) chose urology, two (5.4%) chose ob/gyn, one (2.7%) chose dermatology, one (2.7%) chose pediatrics, and one (2.7%) chose orthopedic surgery.

Results: Of the 37 students tracked, 21 (56.8%) participated in the clinical mentorship program, ten (27.0%) in the research mentorship program, and six (16.2%) in both programs. In terms of specialty selection, 14 (37.8%) chose radiation oncology, seven (18.9%) chose internal medicine, four (10.8%) chose radiology, three (8.1%) chose general surgery, two (5.4%) chose ENT, two (5.4%) chose urology, two (5.4%) chose ob/gyn, one (2.7%) chose dermatology, one (2.7%) chose pediatrics, and one (2.7%) chose orthopedic surgery.

Conclusions: Early and active mentoring of medical students in radiation oncology will enhance general understanding of the field as well as improve its professional base to enhance patient care. While the sample size is too small to reach statistical significance, they seem to indicate that the involvement in formal clinical and research mentorships in radiation oncology is common among students pursuing this field. Furthermore, other studies have shown a statistically significant increase in medical student knowledge about cancer and radiation therapy following formal radiation oncology experiences in medical school. Given the large epidemiological impact of cancer on the population, physicians must be competent in understanding and addressing their cancer patients’ needs, regardless of chosen specialty.

Radiation Oncology Mentorship Program

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SSJ25-02 • Outcomes of Stereotactic Body Radiotherapy (SBRT) Treatment of Skeletal Muscle/Soft Tissue Metastases

Reed Cope (Presenter) ; Kenneth R Olivier MD ; Robert L Foote MD ; Paul D Brown MD

SSJ25-03 • Achieving Optimal Patient Setup Imaging and Treatment Workflow Configurations in Multi-Room Proton Centers via Monte Carlo Simulation

Hao H Zhang (Presenter) ; Karl Prado ; Katja M Langen PhD ; Minesh P Mehta MD * ; William F Regine MD ; Warren D D’Souza MD PhD

SSJ25-04 • Toxicity Associated with Intensity-modulated Pelvic Radiation Treatment in the Post-operative Setting

Carla Hajj MD (Presenter) ; Abraham J Wu MD ; Karyn A Goodman MD

ABSTRACT

Purpose/Objective(s): Preoperative chemoradiotherapy (CRT) is the recommended standard therapy for patients with locally advanced rectal cancer and is associated with reduced grade 3 or 4 toxicities compared with post-operative CRT. However, pre-operative staging studies may not correctly identify all patients with node positive or T3 disease, thus, some patients undergo upfront surgical resection and are found to have more advanced disease. In the small subset of rectal cancer patients who require post-operative CRT, the question of potential toxicity may affect the decision to offer therapy. The toxicity of post-operative CRT is primarily related to the large volume of small bowel that lies within the pelvis following rectal resection. The aim of this study was to evaluate the role of intensity modulated radiotherapy (IMRT) planning in reducing toxicity of CRT in the post-operative pelvis, either for adjuvant therapy or for a local recurrence.

Materials/Methods: We retrospectively reviewed records of 22 colorectal cancer patients treated between 2007 and 2012 who received CRT using IMRT after prior radical resection with a low anterior resection (LAR) or abdominoperineal resection (APR). We reviewed the patients’ characteristics and analyzed the clinicians’ reported toxicities (CTCAE v 3.0).

Results: The median age at treatment was 63 years, and 12 patients (56%) were males. Fourteen patients (64%) received post-operative CRT for locally recurrent disease, whereas 8 (36%) were treated in the adjuvant setting, at initial diagnosis of locally advanced rectal cancer. The median radiation dose was 50 Gy (range: 45 to 56 Gy). The median dose to the bowel was 2380 cGy, with a median in-field bowel volume of 621 cc. Grade 2 dermatitis, diarrhea, and proctitis occurred in 9%, 14%, and 45% of the patients, respectively. None of the patients had grade 3 or 4 toxicities. None of the patients experienced grade 2 nausea, vomiting, or cystitis.

Conclusions: In this small series, postoperative CRT with IMRT planning was associated with minimal acute GI or skin toxicity. While pre-operative CRT is preferable, if necessary, CRT in the adjuvant setting or for locally recurrent can be delivered safely using IMRT. While large prospective studies of IMRT in this setting are unlikely to be performed, retrospective studies can help clarify the role of IMRT planning for pelvic radiotherapy with the goal of reducing acute toxicity and ultimately minimizing late effects and long-term quality of life for these patients.
SSJ26-01 • Electromagnetically Navigated In situ Fenestration of Aortic Stent Grafts: In-vitro Experiments and Pilot Animal Study

Hong-Sik Na (Presenter) ; Philipp Bruners MD ; Peter Isfort MD ; Andreas H Mahnken MD * ; Thomas Schmitz-Rode MD ; Johannes Jansing DIPLENG ; Christoph Wilkmann DIPLENG ; Sabine Osterhuues DIPLENG * ; Andreas Besting DIPLENG * ; Catherine Disselhorst-Klug PhD ; Matias De La Fuente ; Christiane K Kuhl MD * ; Tobias Penzkofer MD *

PURPOSE
To evaluate the feasibility of electromagnetically navigated in-situ fenestration of aortic stent grafts to revascularize renal arteries in EVAR using a phantom and swine model.

METHOD AND MATERIALS
The proposed electromagnetic tracking system is operated by a custom-made navigation software working with a steerable EMT-guided catheter (BF) and a custom-made navigated guidewire (0.035") and being equipped with a gating algorithm to correct for breathing motion. In the phantom model of an abdominal aorta with a stent graft in place fenestration was performed 40 times on each side with 20 approaches from each iliac artery. Catheterization times, number of attempts and quality of fenestration were assessed and compared. Quality was measured on a scale from 1 to 3, judged by the distance from the ostial center. In the swine model a high porosity stent graft was placed in the abdominal aorta covering the two renal ostia. Successful reperfusion was documented by cone-beam CTA.

RESULTS
The phantom model average catheterization time was 88.6±79.8s (18-474 s) with 1.48±0.9 attempts. Mean quality of the fenestration was 2.0±0.7. In the in vivo setting reperfusion was successfully performed in 5 renal arteries. In one case a stent strut was placed in front of the renal ostium, so fenestration was possible only after introducing a Y-branch catheter. In the successful procedures, fenestration time was 8.4±4.9 min (catheter introduction to successful fenestration), stent placement time (catheter introduction to securing the branch with stent) was 32.0±27.1 min and average total stent-placement (aortic stent graft placement to placement renal stent) was 93.2±51.9 min. Problems delaying stent placement were attributable to the prototypical nature of the material (e.g. uncoated navigated guidewires, malfunctioning navigation coils).
CONCLUSION
Although the overall procedure times are currently not within acceptable ranges for renal ischemia time, the completion rates and short fenestration times warrant further development of the proposed procedure.

CLINICAL RELEVANCE/APPLICATION
Though EVAR is a valuable alternative to surgery nowadays it is still not suitable for emergency cases especially when side branches are involved. Our approach may allow EVAR even in those cases.

SSJ26-02 • Abdominal Aortic Aneurysm Follow-up after Endovascular Repair by Non-invasive Vascular Elastography: Feasibility in a Canine Model

Elie Salloum MSc, BEng (Presenter); Antony Bertrand-Grenier; Sophie Lerouge; Claude Kauffmann PhD; Guy Cloutier PhD; Gilles P Soulez MD *

PURPOSE
Non-invasive vascular elastography (NIVE) is a new ultrasonic technique enabling the measurement of tissue deformation. We aim to apply and optimize elastography of abdominal aortic aneurysm (AAA) after endovascular aneurysm repair (EVAR) with stent-graft (SG) in a canine model to detect endoleaks and characterize thrombus organization.

METHOD AND MATERIALS
SGs were implanted in a first group of 3 dogs with an aneurysm created in iliac arteries (6 aneurysms) and in a second group of 3 dogs in abdominal aorta. Type I endoleak was created in 6 iliac and 1 aortic aneurysms and type II in two aortic aneurysms. DUS (Supersonic Imaging) and elastography examinations (Sonix RP, Ultrasound) were performed at baseline, 1 week, 1 month, 3 month (first group) and 6 month (second group) follow-up. Angiography, CT-scan and histology were also performed at sacrifice. Ultrasonic raw radio frequency data were acquired on longitudinal and three axial planes (proximal, mid and distal part of the aneurysm) in order to generate time-varying strain images. Elastograms of zone of interest were computed using the Lagrangian Speckle Model Estimator (LSME). Area of endoleak, liquid thrombus (non-organized) and solid thrombus (organized) were identified and segmented by comparing the results of CT scan and histology. Strain values in area with endoleak, liquid and solid thrombus were compared.

RESULTS
Five iliac and one aortic aneurysms had type I endoleaks. A type II endoleak was observed in two aortic aneurysms whereas one iliac aneurysm was sealed. Maximal axial strain values in endoleak, liquid and solid thrombus areas were respectively estimated at 0.73 ± 0.14 %, 0.22 ± 0.035 %, 0.11 ± 0.035 %. Strain values were significantly different between endoleak and liquid or solid thrombus areas (p = 5.136E-09) and between solid and liquid thrombus areas (p = 0.00063). All endoleak areas were clearly identified on elastography examinations using axial or shear strain parameters.

CONCLUSION
The results show that NIVE is capable of detecting endoleak and characterize thrombus organization. Further development is needed to enable real time elastograms optimized for AAA follow-up after EVAR. It also has a potential to evaluate thrombus organization.

SSJ26-03 • Abdominal Aortic Aneurysm Follow-up by Dynamic Elastography after Endovascular Repair

Antony Bertrand-Grenier (Presenter); Elie Salloum MSc, BEng; Sophie Lerouge; Claude Kauffmann PhD; Guy Cloutier PhD; Gilles P Soulez MD *

PURPOSE
Supersonic Shear Wave Imaging (SSWI) measure the tissue elasticity in real-time. Our goal is to characterize the mechanical properties of abdominal aortic aneurysm (AAA) after endovascular aneurysm repair (EVAR) in a canine model (endoleaks, thrombus, walls) and correlate results with CT-Scan, Doppler Ultrasound (DUS) and pathologic findings.

METHOD AND MATERIALS
Stent Grafts (SGs) were implanted in 2 groups of dogs after creation of aortic or iliac aneurysms. The first group of 3 dogs (6 iliac arteries) had creation of type I endoleak and the second group of 3 dogs (3 aortic arteries) had creation of type I or type II endoleaks. DUS and elastography examinations (SSWI) were performed at implantation, 1 week, 1 month, 3 months (groups 1 and 2), 6 months (group 2). Angiography, CT-scan and histology were also performed at sacrifice to evaluate the presence, the size and the type of endoleak and characterize aneurysm thrombus organization. Areas of endoleak, liquid thrombus (non-organized) and solid thrombus (organized) were identified and segmented by comparing histology to others technics. Elasticity moduli values in area with endoleak, liquid thrombus and solid thrombus were compared on longitudinal and three axial planes (proximal, mid and distal part of the aneurysm).

RESULTS
Five iliac and one aortic aneurysms had type I endoleaks and one iliac and two aortic aneurysms had type II endoleaks. Elasticity moduli of 0.20 ± 0.30 kPa has been found in endoleak regions, 63.40 ± 66.28 kPa in solid thrombus and 2.97 ± 1.96 kPa liquid thrombus. Elasticity moduli values were significantly different between endoleak and solid thrombus areas (p = 0.0002), endoleak and liquid thrombus areas (p = 0.0009) and liquid thrombus and solid thrombus areas (p = 0.0003). All endoleak areas were clearly identified and significantly different of solid thrombus areas. Dynamic elastography detected endoleaks in which DUS failed (n = 3) and detected liquid thrombus (*possibility associated with type V endoleak).

CONCLUSION
The results show that SSWI is able to detect endoleaks and characterize thrombus organization. The next objective is to evaluate in a phase II clinical study the feasibility and efficacy this approach.

CLINICAL RELEVANCE/APPLICATION
SSWI has the potential to evaluate thrombus organization, detect endoleaks and possibly endotension, reducing the cost, the exposition to ionizing radiation and contrast agents of follow up of AAA after EVAR. It also has a potential to evaluate thrombus organization.

SSJ26-04 • Acute Limited Intimal Tears of the Aorta Diagnosed with ECG-gated CT Angiography: A 4-Year Single Center Experience

Anne S Chin MD (Presenter); D. Craig Miller; Gerry Berry; Dominik Fleischmann MD *

PURPOSE
Limited intimal tears (LIT) of the aorta presenting as acute aortic syndrome (AAS) are notoriously difficult to diagnose prospectively, reported to elude all cross-sectional imaging techniques. Although this entity has been included in the AHA classification of aortic dissection (class 3), this entity is thought to be rare and remains largely unknown to radiologists. We have observed his lesion at angiography and detected liquid thrombus (*possibility associated with type V endoleak).

METHOD AND MATERIALS
All CTAs from Jan 1, 2009 to Dec 31, 2012 in patients presenting to our institution for AAS were retrospectively reviewed. LITs were diagnosed on CTA according to AHA and Svensson’s original surgical description as subtle aortic wall contour bulges, without frank evidence of intimal flap or dissected intima-media. Five iliac and one aortic aneurysms had type I endoleaks and one iliac and two aortic aneurysms had type II endoleaks. Elasticity moduli values were significantly different between endoleak and solid thrombus areas (p = 0.0002), endoleak and liquid thrombus areas (p = 0.0009) and liquid thrombus and solid thrombus areas (p = 0.0003). All endoleak areas were clearly identified and significantly different of solid thrombus areas. Dynamic elastography detected endoleaks in which DUS failed (n = 3).
The use of low concentration of contrast media (iodixanol 270mgI/ml) combined with spectral CT imaging in abdominal CTA.

**RESULTS**

196 patients were diagnosed with AAS between Jan 2009-Dec 2012. The incidence of LIT was 8.1% (16 LITs, 115 classic dissection, 49 IMH, 11 penetrating atherosclerotic ulcer, and 5 rupturing aortic aneurysm). Of the 16 acute LITs, 14 were type A (ascending aorta), 1 was type B (descending aorta), and 2 were type C (one arch, one descending aorta). Of the nine patients who underwent urgent surgical repair, there was 100% concordance with CTA diagnosis. All type-A lesions were diagnosed prospectively, and only one type B LIT was missed on initial review.

**CONCLUSION**

Accurately and consistent detection of limited aortic tears is possible with ECG-gated CTA, although awareness of this lesion and meticulous review of the datasets is requisite; additional post-processing increases lesion conspicuity. To the best of our knowledge, this is a first report of the ability of CTA to detect LITs as well as the first to identify type B LIT lesions.

**CLINICAL RELEVANCE/APPLICATION**

Timely detection of acute limited intimal tears is critical for patient management, and can be accurately performed with ECG-gated CTA.
Injecting Contrast Media with Reduced Iodine Concentration at Higher Speed Results in Improved and Prolonged Arterial Enhancement in CT Angiography

**Toon Van Cauteren** MSc (Presenter) ;  **Gert Van Gompel** PhD ;  **Nico Buls** DSc, PhD * ;  **Koenraad H Nieboer** MD * ;  **Inneke Willekens** MD ;  **Guy Verfaillie** PhD, MD ;  **Daniel Jacobs Tulleneers Thevissen** MD ;  **Johan De Mey** MD

**PURPOSE**
To assess the impact of contrast media concentration on the height and length of arterial enhancement at constant iodine dose delivery rate (IDR) and total iodine dose (TID).

**METHOD AND MATERIALS**

**RESULTS**
Iodine concentration had a significant effect: the injection of lower concentrations at higher speed was associated with increased enhancement. Compared to 370 mg I/ml, all concentrations equal and below to 270 mg I/ml resulted in both a broader and higher arterial peak (all p values < 0.02). T>200HU increased from 7.3 ± 4.0 s at 370 mg I/ml up to 15.8 ± 4.0 s at 120 mg I/ml, whereas CTmax increased from 237 ± 33 HU to 271 ± 20 HU, respectively. Despite higher injection speed, only a marginal increase in injection pressure was observed for lower iodine concentrations due to their reduced viscosity.

**CONCLUSION**
Despite constant IDR and TID, injecting a reduced contrast media concentration at higher speed results in a higher arterial peak enhancement and improved time window above 200 HU compared to the administration of a high contrast media concentration at lower speed.

**CLINICAL RELEVANCE/APPLICATION**
At equal iodine burden, reduced contrast media concentration improves image quality and relaxes the timing of the acquisition in CT angiography studies.

Image Quality of Whole Aortic Angiography with Low Contrast Flow Rate and Dual-energy CT Non-linear Blending Technique

**Jie Liu** (Presenter) ;  **Jianbo Gao** MD

**PURPOSE**
To investigate the image quality of thoracoabdominal aortic angiography with a low contrast medium flow rate and DECT non-linear blending technique.

**METHOD AND MATERIALS**

**RESULTS**
The patient weight was 72.5 ± 12.6 kg. The contrast volume was 36.5 ± 6.3 ml. The flow rate was 3.2 ± 0.4 ml/s. The CT attenuation was significant higher in optimal contrast than simulated 120 kVp images (AA: 358.4 ± 35.9 vs. 276.7 ± 34.9 HU, p < 0.001; DA: 325.8 ± 41.1 vs. 258.1 ± 31.2 HU, p < 0.001; 350.7 ± 44.3 vs. 271.5 ± 29.5 HU, p < 0.001). The noise of optimal contrast was significantly higher than simulated 120 kVp group (AA: 358.4 ± 35.9 vs. 276.7 ± 34.9 HU, p < 0.001; DA: 325.8 ± 41.1 vs. 258.1 ± 31.2 HU, p < 0.001; 350.7 ± 44.3 vs. 271.5 ± 29.5 HU, p < 0.001). The volume CT dose index and dose-length-product were 7.7 ± 1.6 mGy and 526.2 ± 125.7 mGy*cm.

**CONCLUSION**
DECT non-linear blending technique can improve the image quality of whole aortic angiography and permit a low contrast medium volume and flow rate injection protocol.

**CLINICAL RELEVANCE/APPLICATION**
DECT permitted low contrast medium volume and flow rate which improve the patient care and maintain diagnostic image quality.

Validation of a Low Dose Simulation Method for Evaluation of Sub-mSv Computed Tomography

**Daniela Muenzel** MD (Presenter) ;  **Thomas Koehler** PhD * ;  **Kevin M Brown** MS * ;  **Stanislav Zabic** PhD * ;  **Alexander A Fingerle** MD ;  **Simone Waldt** MD ;  **Edgar Bendik** ;  **Tina Zahel** ;  **Ernst J Rummey** MD ;  **Martin Dobritz** MD ;  **Peter B Noel** PhD

**PURPOSE**
Evaluation of a new software tool for generation of simulated low-dose computed tomography (CT) images from an original higher dose scan.

**METHOD AND MATERIALS**

**RESULTS**
Image characteristics of simulated low-dose scans were similar to the original acquisitions. Mean overall discrepancy of image noise and CT values between original and simulated CT images was 0.2 % (range -0.6 % to 0.8 %) and -0.3 % (range -2.1 % to 0.8 %), respectively, p > 0.05. Subjective observer evaluation of image appearance showed no visually detectable difference.

**CONCLUSION**
Simulated low dose images showed excellent agreement with the original scan data concerning image noise, CT density values, and
subjective assessment of the visual appearance of the simulated images.

CLINICAL RELEVANCE/APPLICATION
An authentic low-dose simulation from actual CT examinations opens up important opportunities with regard to staff education, protocol optimization and introduction of new reconstruction techniques.

SSJ27-05 • Reduced Iodine Dose Single Source Dual-energy CT Angiography of Abdomen for Assessment of Aorto-Iliac Diseases: Is This the Killer Application for Dual-energy CT?

Mukta D Agrawal MBBS, MD (Presenter) *; Surabhi Bajpai MBBS, DMRD; George R Oliveira MD; Sanjeeva P Kalva MD *; Jorge M Fuentes MD; Koichi Hayano MD; Yasir Andрабi MD, MPH; Dushyant V Sahani MD

PURPOSE
To investigate the performance of ssDE-CTA using reduced iodine dose for abdominal angiography in comparison to currently applied iodine dose conventional single energy CT (SE-CTA) and to determine the energy level (kEV) that provide optimal imaging for vascular and extravascular evaluation.

METHOD AND MATERIALS
In a IRB approved ongoing clinical trial, 64 consecutive patients with AAA and prior SE-CTA exam using standard dose of iodine were enrolled. Their follow up CT exam was undertaken on ssDECT (GE Discovery CT750 HD) with reduced iodine dose (21-24gms instead of 33-55gms). Patients received iso-osmolar iodinated CM (Iodixanol, GE) of 270 mgI/ml (group A, n=32) or 320 mgI/ml (group B, n=32) concentration. The arterial phase DECT images were processed to generate virtual monochromatic images (VMC) of various energies (40 to 140 keV at an increment of 5 keV). Two-experienced radiologist independently evaluated VMC image sets for subjective image quality and noise. Readers also determined the diagnostic kEV range and the optimal kEV for vascular and extravascular assessments. The contrast to noise ratio (CNR) was calculated on VMC images at various energies and SE-CTA images. A paired student t-test was used to determine statistical significance.

RESULTS
All DE-CTA exams were considered diagnostic with an IQ score 4.2. Both readers observed a broad range of diagnostic kEV images from 40 to 75; and 40-45 kEV images were considered best for vascular assessment, whereas 60-65 kEV images were rated best for both vascular and extra-vascular assessment. In comparison to SE-CTA images, VMC images (40-60 kEV) provided significantly higher intravascular attenuation (200-20%) and CNR (40-20%) at 28% less iodine dose (p<.05). The arterial depiction and image quality were comparable between 240-80 and 370-120 groups and were greater with 300-80 group than with the other two groups in selected arteries (p<.05). Mean effective dose was higher with 370-120 group (2.8-5.4 mSv) than with 240-80 group (2.3-4.3 mSv) for the abdomen (<.05). Mean FOMs with 240-80 group (7.8-15.3) were greater for the abdomen (<.05) and tended to be greater for the thorax and pelvis (>.05). Mean FOMs with 240-80 group (7.8-15.3) were greater for the abdomen (P<.05) and tended to be greater for the thorax and pelvis than those with 370-120 group (4.8-9.2).

CONCLUSION
Use of 240 mgI/ml CM at 80 kEV seems appropriate for a routine whole-body CTA and beneficial to the reduction of iodine load and radiation dose, whereas the use of 300 mgI/ml CM may marginally improve the delineation of selected small arteries.

CLINICAL RELEVANCE/APPLICATION
ssDECT enables substantial reduction in the iodine dose for CTA exam while yielding 200-20% higher intravascular enhancement thereby providing an opportunity to lower renal risks in older patients.

SSJ27-06 • Whole-body 64-detector CT Angiography with Low-tube-Voltage (80 kVp) and Low-concentration (240 mgI/ml) Contrast Material to Reduce Radiation Dose and Iodine Load

Masayuki Kanematsu MD; Satoshi Goshima MD, PhD; Toshiharu Miyoshi RT; Hiroshi Kondo MD; Haruo Watanabe MD; Yukichi Tanahashi MD (Presenter); Yoshifumi Noda MD; Kyongtae T Bae MD, PhD *; Nobuyuki Kawai MD

PURPOSE
To prospectively evaluate contrast enhancement, vascular depiction, image quality, and radiation dose of low-tube-voltage whole-body computed tomographic angiograms (CTAs) with low-concentration iodinated contrast material (CM).

METHOD AND MATERIALS
This study was approved by our institutional review board and all patients provided informed consent. Whole-body CTAs were obtained in 109 patients (body weight range, 37-100 kg; mean, 61.2 kg) with a 64-detector CT (Discovery CT750 HD; GE Healthcare) using adaptive statistical iterative reconstruction algorithm (ASiR; GE Healthcare). Patients were randomized into three groups: CTA with 240 mgI/ml CM at 80 kEV (240-80 group), 300 mgI/ml at 80 kEV (300-80 group), and 370 mgI/ml at 120 kEV (370-120 group). CM was intravenously injected at 4 ml/sec and bolus tracking was used in all patients. Signal-to-noise ratio (SNR), arterial depiction, image quality, and radiation dose were assessed separately for the thorax, abdomen, and pelvis. A figure of merit (FOM) was computed to normalize the SNR, estimated effective dose, and iodine weight administered, using the following equation: FOM = SNR x effective dose/iodine weight.

RESULTS
Mean iodine weight administered was 21.6, 26.8, and 34.0 g, respectively, for 240-80, 300-80, and 370-120 groups (P<.05). Mean vascular enhancement in the thoracic aorta, abdominal aorta, and iliac arteries ranged 508-521, 546-593, and 435-442 HU with 240-80, 300-80, and 370-120 groups, respectively (P<.05). The arterial depiction and image quality were comparable between 240-80 and 370-120 groups and were greater with 300-80 group than with the other two groups in selected arteries (P<.05). Mean effective dose was higher with 370-120 group (2.8-5.4 mSv) than with 240-80 group (2.3-4.3 mSv) for the abdomen and pelvis (P<.05). Mean FOMs with 240-80 group (7.8-15.3) were greater for the abdomen (P<.05) and tended to be greater for the thorax and pelvis than those with 370-120 group (4.8-9.2).

CONCLUSION
Mean vascular enhancement in the thoracic aorta, abdominal aorta, and iliac arteries ranged 508-521, 546-593, and 435-442 HU with 240-80, 300-80, and 370-120 groups, respectively. The arterial depiction and image quality were comparable between 240-80 and 370-120 groups and were greater with 300-80 group than with the other two groups in selected arteries (P<.05). Mean effective dose was higher with 370-120 group (2.8-5.4 mSv) than with 240-80 group (2.3-4.3 mSv) for the abdomen and pelvis (P<.05). Mean FOMs with 240-80 group (7.8-15.3) were greater for the abdomen (P<.05) and tended to be greater for the thorax and pelvis than those with 370-120 group (4.8-9.2).

CLINICAL RELEVANCE/APPLICATION
Whole-body CTA with 240 mgI/ml CM and 80-kEV tube voltage may replace conventional CTA with 350-400 mgI/ml CM at 120-kEV tube voltage, contributing to a reduction of iodine load and radiation dose.

Breast Imaging (Digital Breast Tomosynthesis Screening Outcomes) Wednesday, 10:30 AM - 12:00 PM • Arie Crown Theater • Back to Top [OH] [PD] SSK01 • AMA PRA Category 1 Credit:™.1.5 • ARRT Category A+ Credit:1.5 Moderator Stephen L Rose MD *; Moderator Margarita L Zuley MD SSK01-01 • Breast Cancer Screening Pre and Post-tomosynthesis: Comparison of Recall Rate, Biopsy Positive Predictive Value, and Cancer Detection Rate

Marilyn A Barry-Brooks MD (Presenter); Ana P Lourenco MD; Martha B Mainiero MD

PURPOSE
To compare the recall rate, biopsy positive predictive value, and cancer detection rate prior to and following the implementation of screening tomosynthesis.

METHOD AND MATERIALS
This retrospective analysis was IRB approved and HIPAA compliant. Results from all digital screening mammography exams performed without tomosynthesis from March through December 2011 and results from all digital screening mammography exams performed with tomosynthesis from March through December 2012 were reviewed. Diagnostic cases were excluded. All studies were interpreted by radiologists with fellowship training in breast imaging. Recall rates, biopsy positive predictive values, and
cancer detection rates were determined. The biopsy positive predictive value was defined as the number of BI-RADS 4/5 biopsies positive for malignancy divided by the number of BI-RADS 4/5 cases that underwent biopsy. Cancer detection rate was calculated by dividing the total number of malignancies identified (including BI-RADS 3 cases undergoing biopsy that showed malignancy and high risk lesions at biopsy that were upgraded to malignancy at surgical excision) by the total number of screening exams. Statistical analysis was performed using a two-sample test of proportions.

RESULTS
A total of 11,818 patients underwent digital mammography screening and 11,794 patients underwent digital mammography plus tomosynthesis screening. The recall rate for the pre tomosynthesis group was significantly higher at 8.6%, compared with 6.0% for the tomosynthesis group (p=0.002). By reader, DM recall rates ranged from 15.32-5.72%; DBT recall rates ranged from 13.03-4.84%. 5 of the 6 readers decreased their recall rates; 1 reader had no change. Overall, the cancer detection rate increased from 3.51 to 5.24/1000 with DBT (p<0.05). 4 of the 6 readers increased their cancer detection rate; 2 readers had minimal decreases (both had decreases in recall). The one reader with an overall stable recall rate increased her cancer detection rate from 3.4 to 6.3/1000. The DM PPV1 for the readers ranged from 2.5 to 12.1%. With DBT, 5 of the 6 readers increased their PPV1 significantly (new range from 4.7 to 11.7%). 1 reader had no significant change in PPV1 but a slight drop in recall. The overall PPV1 increased for the group was from 4.1% to 6.0% (p=0.044).

CONCLUSION
The implementation of DBT in a large screening program demonstrated a reduction in recall rates and an increase in cancer detection rates that varied by reader. The balance of these outcomes for each reader, as measured by PPV1, showed significant improvements for 5 of 6 readers and stability for 1 reader.

CLINICAL RELEVANCE/APPLICATION
Screening outcomes as measured by PPV1 improved with DBT implementation in a large, prospective population.

SSK01-03 ● Recall Rates on Baseline Screening Mammography: Initial Experience Using Digital Breast Tomosynthesis (DBT)

Anabel M Scaranelo MD (Presenter); Karina Bukhanov MD; Hadas Moshonov PhD; Supriya R Kulkarni MD, DMRD; Pavel Crystal MD

PURPOSE
To determine differences in the recall rate between Digital Mammography with Breast Tomosynthesis (DBT) and standard 2D-view FFDM (2D) in baseline screening.

METHOD AND MATERIALS
REB approved study initiated March 2012 and lasting 362 days, informed consent obtained from all consecutive women scheduled for baseline mammography randomized to 2 clinical sites-teaching hospitals. One site performed DBT (Dimensions, Hologic, Bedford, MA) and the other 2D (Senograph 200D, GE Medical Systems, Milwaukee, WI). Certified DBT radiologists reported all exams at both sites without the knowledge of the study. Recall rates were calculated for each site and stratified by lesion type, breast density and age. Fisher’s exact tests used to determine statistically significant relationships

RESULTS
Thus far, outcome data for 15,633 women imaged with DBT have been compared to the prior year of 10,753 patients imaged with DM. The average recall rate for the group of 6 readers decreased from 10.40% to 8.78%. After generalized estimating equation based on adjustment to account for variability in the readers’ volumes over time, the recall rate was significantly higher under DM versus DBT with an OR = 1.23, 95% CI: [1.07, 1.40](p=0.002). By reader, DM recall rates ranged from 15.32-5.72%; DBT recall rates ranged from 13.03-4.84%. 5 of the 6 readers decreased their recall rates; 1 reader had no change. Overall, the cancer detection rate increased from 3.51 to 5.24/1000 with DBT (p<0.05). 4 of the 6 readers increased their cancer detection rate; 2 readers had minimal decreases (both had decreases in recall). The one reader with an overall stable recall rate increased her cancer detection rate from 3.4 to 6.3/1000. The DM PPV1 for the readers ranged from 2.5 to 12.1%. With DBT, 5 of the 6 readers increased their PPV1 significantly (new range from 4.7 to 11.7%). 1 reader had no significant change in PPV1 but a slight drop in recall. The overall PPV1 increased for the group was from 4.1% to 6.0% (p=0.044).

CONCLUSION
The implementation of DBT in a large screening program demonstrated a reduction in recall rates and an increase in cancer detection rates that varied by reader. The balance of these outcomes for each reader, as measured by PPV1, showed significant improvements for 5 of 6 readers and stability for 1 reader.

CLINICAL RELEVANCE/APPLICATION
Screening outcomes as measured by PPV1 improved with DBT implementation in a large, prospective population.

SSK01-04 ● Trends in Time to Interpretation of Tomosynthesis Based Screening Examinations with Increasing Experience

Per Skaane MD, PhD (Presenter); Ellen B Eben MD; Ingvild N Jebsen; Unni Haakenaasen MD; Mona Krager MD; Mina Izadi MD; Gunnar Jahn; Ulrika Ekseth MD

PURPOSE
An analysis of the time to interpretation of tomosynthesis-based screening examinations with increasing experience from 2012 to 2014.
SSK01-05 • ACRIN PA 4006: Comparison of Dose in Digital Breast Tomosynthesis and Standard Two-View Mammography for Prospective Breast Cancer Screening

Mathew Thomas BS (Presenter); Yohei Matsutani; Emily F Conant MD *; Andrew D Maidment PhD *

PURPOSE
To compare the cumulative mean glandular dose (MGD) in digital mammography (DM) and digital breast tomosynthesis (DBT) in a prospective breast cancer screening trial.

METHOD AND MATERIALS
This trial compared cumulative dose per breast from two imaging scenarios: standard of care DM versus an image set of low-dose 2-view DM combined with 2-view DBT (Hologic Selenia Dimensions). A paired design was used so that each patient underwent both types of imaging. Low-dose 2-view DM and DBT was conducted at 15% reduced dose. The cumulative MGD was calculated in 495 women from exposure parameters of 2262 standard-DM and 1980 low-dose DM/DBT acquisitions. Extra views in standard-DM were obtained in some cases at clinical discretion. No additional low-dose DM/DBT views were obtained. To adjust for additional views in the standard-DM group, the mean dose of all standard-DM views was used for cumulative dose comparison. The following screening paradigms were defined: Standard DM (CC/MLO) vs. low-dose ACRIN-Limited (DM/CC; DBT/CC), and low-dose ACRIN-Complete (DM/CC; DBT/CC). Comparison of MGD per breast between protocols was made by 2-sided paired t-test.

RESULTS
The ACRIN-Limited MGD at Site A and Site B were 4.94 mGy and 5.29 mGy, respectively. The ACRIN-Complete MGD was 6.35 mGy and 6.56 mGy at Site A and B, respectively. The standard-DM MGD was 4.81 mGy and 3.52 mGy at Site A and B, respectively. An additional 23.9% and 6.7% standard-DM views were obtained at site A and B, respectively. After adjusting for extra views, the standard-DM MGD was 3.85 mGy and 3.28 mGy at Site A and B, respectively. The ACRIN-limited MGD did not differ significantly from standard-DM at Site A (p=0.10) but was greater than standard-DM at Site B (p<0.05). Three-view, low-dose combination-DM/DBT screening is achievable at MGD comparable to the dose of routine screening mammography. The clinical use of additional standard-DM views significantly affects the cumulative MGD during routine breast cancer screening.

CLINICAL RELEVANCE/APPLICATION
Prospective 3-view combination DM/DBT screening can be achieved at cumulative mean glandular dose comparable to those in standard mammography screening.

SSK01-06 • Synthesized 2D Mammograms: A Review of Our First 100 Cases

Andres Alcazar Peral (Presenter); Olivia Benitez; Carmen Estrada; Slavina Mancheva; Alejandro Tejerina; Angeles Franco Lopez

PURPOSE
Retrospectively, we compare synthesized 2D Mammograms combined with Digital Breast Tomosynthesis versus combination-mode imaging which include 2D Digital Full Field Mammography (DFFM) combined with Tomosynthesis.

METHOD AND MATERIALS
Two expert radiologists assessed 100 mammograms retrospectively in two different ways. The first aspect of interpretation consisted in using 3D Digital Tomosynthesis combined with 2D DFFM and the second one included 3D Tomosynthesis combined with reconstructed synthetic 2D Mammography. In both cases previous mammograms were provided and reviewed. All 100 mammograms were positive for some kind of findings; 69 patients were placed under BIRADS 2 category which showed lesions stable for two years, the rest 31 patients were classified as BIRADS 3, 4 or 5 with a proper histological correlation.

RESULTS
In 97 cases nodules, microcalcifications and architectural distortions were diagnosed by both imaging techniques. - In 2 cases, the architectural distortion was the main finding and could only be detected with Digital 3D Tomosynthesis. - In 1 case, the architectural distortion was visualized on synthesized 2D Mammography and Tomosynthesis but not on conventional DFFM. - Most sites of architectural distortion, nodules, contours and calcifications were more visible with synthesized 2D Mammography than DFFM. - Our radiologists felt more confident in the detection of microcalcification and architectural distortion using the synthetic mode of imaging. - The use of synthesized 2D Mammography improves the characterization of the lesions compared to DFFM.

CONCLUSION
- Synthesized 2D Mammography has at least the same sensitivity as the conventional 2D mammography. - More clinical trials are needed to evaluate better the specificity of the synthesized 2D mammography in different kind of lesions. - As other studies show, Digital Breast Tomosynthesis combined with 2D Mammography has better sensitivity than 2D Mammography alone.

CLINICAL RELEVANCE/APPLICATION
Digital 3D Breast Tomosynthesis and Synthesized 2D Mammography increase the mammograms' sensitivity and decrease the radiation dose compared to conventional 2D mammography and Tomosynthesis.

SSK01-07 • Radial Scar: A Diagnostic Challenge in Breast Cancer Screening Using Tomosynthesis

Per Skaane MD, PhD (Presenter) *; Randi Gullien RT *; Ellen B Eben MD *; Unni Haakenaasen MD *; Ingvild N Jebsen *; Mona Krager MD *; Jon Lomo MD

PURPOSE
Radial scar is a benign lesion presenting with distortion or spiculations on mammography that mimic cancer. Diagnosis requires...
How Tomosynthesis Optimizes Patient Work Up, Throughput, and Resource Utilization

Liane E Philpotts MD (Presenter) *; Vivek B Kalra MD; Jacquelyn Crenshaw RT; Reni S Butler MD

PURPOSE
To examine patient throughput with 3D mammography (tomosynthesis) versus 2D mammography for screening and diagnostic exams in terms of number of images obtained per exam and room/resource utilization at a dedicated breast center.

METHOD AND MATERIALS
This study includes mammogram exams for a one year period prior to (8/1/10 - 7/31/11) and after (3/1/12 - 2/28/13) tomosynthesis introduction was retrospectively assessed. The number of screening and diagnostic exams performed on 3 digital mammography units (Selenia, Hologic, Bedford, MA) versus the same 3 digital mammography units plus one tomosynthesis unit (Dimensions, Hologic) were compared to determine volumes for individual units. Given that the number of views per screening case is similar, the number of images obtained per diagnostic case was retrospectively assessed over a one week period for the 2D cases (7/22/11-7/27/11) and the cases performed with tomosynthesis (2/4/13-3/9/13).

RESULTS
For the one year prior to tomosynthesis, 9462 screening and 4611 diagnostic exams were performed on three digital mammography units, for a total of 14,073 exams, or 4,691 exams per unit. After the incorporation of tomosynthesis, 11,101 screening and 5357 diagnostic exams were performed for an overall increase to 16,438 total exams. On the single tomosynthesis unit, 7,913 screening and 3594 diagnostic exams were performed, for a total of 11,507 exams. The remaining 3188 screening and 1763 diagnostic exams were performed on the 3 remaining 2D units. Therefore, the single tomo unit handled 2.5 times more exams than the individual 2D units previously. The total number of views per diagnostic patient decreased 11% with tomosynthesis compared to 2D, from 4.6 to 4.1 views per patient. Spot views decreased 57%, from 0.97 to 0.42 views per patient with tomosynthesis compared to 2D, with a decrease of 67% for bilateral exams and 49% for unilateral exams.

CONCLUSION
Tomosynthesis results in decreased number of images necessary per diagnostic case. Such expedited work up translates to better patient throughput and resource utilization. Such information is important in factoring equipment purchases and resource scheduling.
Breast Imaging: (Interventional Techniques and Radiology/Pathology Correlation) Wednesday, 10:30 AM - 12:00 PM

**E450A** Back to Top [SSK02] ● AMA PRA Category 1 Credit ™ ● ARRT Category A+ Credit:1.5 Moderator Susan P Weinstein, MD

**SSK02-01** Should Flat Epithelial Atypia Identified on Stereotactic Core Needle Biopsy of Calcifications Be Excised?

**Erin I Neuschler** MD (Presenter); **Alyssa Choate** MD; **Megan Sullivan**; **Ellen B Mendelson** MD *; **Elise E Saddleton** MD ; **Paula M Grabler** MD

**PURPOSE**
To assess the upgrade rate to malignancy for flat epithelial atypia (FEA) diagnosed on stereotactic core needle biopsy (SCNB) performed for calcifications and to determine if radiologic features or clinical history can be used to identify criteria for excision.

**METHOD AND MATERIALS**
An institutional review board-approved, HIPAA-compliant, retrospective review of 3919 consecutive SCNB procedures performed from January 2009 through December 2012 was performed. Pure FEA was present in 163 biopsies, with 146 biopsies included in the analysis. Biopsies excluded from the analysis comprised those from patients who did not have diagnostic mammography at our institution, calcifications associated with a mass or asymmetry or calcifications present in a patient with a known ipsilateral malignancy. Clinical data was collected from the patient's medical record. Mammographic imaging prompting biopsy was re-reviewed in a blinded fashion by two dedicated breast radiologists. The calculation and cluster morphology were assessed as well as stability of calcifications and extent of residual calcifications. Upgrade rate was determined by final excisional pathology. Correlation of clinical and mammographic characteristics with risk of upgrade was calculated using Chi-square and Fisher's exact tests.

**RESULTS**
98 out of 146 (67%) cases went to surgical excision at the study institution. Four of 98 cases of pure FEA demonstrated in-situ or invasive carcinoma upon excision, compatible with an upgrade rate of 4.1%. There was no significant association between personal history of breast cancer and upgrade. Likewise, there was no significant association between calcification and cluster morphology and upgrade.

**CONCLUSION**
The low upgrade rate of 4.1% for pure FEA demonstrated in this study suggests that mammographic follow-up may be a reasonable alternative to surgical excision for FEA diagnosed on SCNB for calcifications. To the authors' knowledge, this is the largest study evaluating upgrade of FEA detected on SCNB where all imaging prompting biopsy was re-reviewed.

**CLINICAL RELEVANCE/APPLICATION**
The low upgrade rate for pure FEA demonstrated in this study suggests that mammographic follow-up may be a reasonable alternative to surgical excision in patients with FEA detected on SCNB.

**SSK02-02** Is the Risk of Malignancy at Surgery Greater When Flat Epithelial Atypia (FEA) and Lobular Neoplasia (LN) Are Found in Association at Biopsy?

**Mona M El Khoury** MD (Presenter); **Isabelle Trop** MD, MPH; **Lucie Lalonde** MD ; **Maude Labelle** MD; **Julie David** MD

**PURPOSE**
1) To determine the frequency of malignancy at surgical excision of biopsy-proven pure FEA (2) to assess the significance of associated LN and residual microcalcifications at biopsy on the final upgrade at surgery.

**METHOD AND MATERIALS**
Retrospective review of 8907 core needle biopsies (CNB) (2009-2012) identified 110 cases of FEA (12%). Patients with associated atypical ductal hyperplasia (ADH) and ipsilateral breast cancer were excluded. Eighty-one women (mean age 54, range 38-80) of whom 5 had 2 biopsies were included. The 86 FEA lesions were pure or associated with LN in respectively 63/86 (73%) and 23/86 (27%). Overall, 63 (73%) lesions were excised and 23 (27%) were followed up (mean follow up 12 months).

**RESULTS**
Malignancy was documented at surgery in 9/63 (14%) patients (4 DCIS and 5 low-grade invasive cancers). The most frequent radiologic presentation was a cluster of microcalcifications (72/86 (84%) followed by a mass and distortion, in respectively 12/86 (14%) and 2/86 (2%). CNB was performed with a 10G vacuum-assisted device or a 14G spring-loaded needle in respectively 76/86 (88%) and 10/86 (12%) patients. The association of FEA with LN, the size of the cluster of microcalcifications and the presence of residual microcalcifications post biopsy were not significantly associated with final upgrade at surgery. There was a statistically significant association between the two parameters, needle size and radiologic presentation on one side and final upgrade at surgery on the other; FEA presenting as a mass was significantly more often upgraded to malignancy than microcalcifications (p= 0.0012) as was FEA diagnosed at biopsy with a 14G versus 11G vacuum assisted needle (p= 0.0015).

**CONCLUSION**
The 14 % upgrade rate of FEA was not significantly affected by concomitant LN at biopsy. Surgical excision of all FEA lesions, including the pure ones, is warranted. When FEA presented as a mass, it was more likely to be upgraded to malignancy. Careful re-review of all imaging findings is recommended when FEA and LN are detected together. Malignancy rate was not affected by presence of residual microcalcifications at biopsy.

**CLINICAL RELEVANCE/APPLICATION**
FEA is a risk lesion with no clear guidelines regarding its management. Our 14 % upgrade rate was not affected by concomitant LN or residual calcifications. We recommend excision of all FEA lesions

**SSK02-03** Impact of Biopsy Method and Tumor Localization on Sentinel Lymph Node Mapping

**Julia Krammer** MD (Presenter); **Anja Dutschke**; **Clemens G Kaiser** MD, BA ; **Andreas Schnitzer** MD; **Stefan O Schoenberg** MD, PhD *; **Klaus Wasser** MD

**PURPOSE**
This is the first study assessing the impact of both, method of biopsy (vacuum biopsy vs. core cut biopsy) and tumor localization on the evaluation of lymphscintigraphy for sentinel node biopsy in breast cancer patients.

**METHOD AND MATERIALS**
616 patients with lymphscintigraphy were included retrospectively from 2009 until 2012. 99mTc-labeled colloid was injected percutaneously, the sentinel lymph node was located by gamma camera. Depending on the signal intensity the scintigraphy was defined as excellent, adequate, weak or absent by two readers experienced in radiology and nuclear medicine. 44 patients had a preliminary stereotactic vacuum biopsy and 572 patients received ultrasound guided core cut biopsy for histological proof of the tumor.

**RESULTS**
Using vacuum biopsy 6 of 25 patients (24%) with a tumor localization in the upper outer quadrant showed a weak or absent lymphscintigraphic signal. Only one of 19 patients (5%) with a tumor in another localization showed a weak or absent signal after vacuum biopsy (odds ratio 5.7). In terms of ultrasound guided core cut biopsy 33 of 315 patients (10%) showed only weak or absent signal on lymphscintigraphy with a tumor localization in the upper outer quadrant. This was the case in 30 of 257 patients...
CONCLUSION
Using vacuum biopsy especially in the upper lateral quadrant could lead to a substantial reduction of quality in sentinel lymph node mapping with periareolar radionuclide injection. Further studies should consider the impact of the interval between biopsy and sentinel lymph node mapping.

CLINICAL RELEVANCE/APPLICATION
Using vacuum biopsy especially in the upper outer quadrant could lead to a substantial reduction of quality in following sentinel lymph node mapping with periareolar radionuclide injection.

SSK02-04 • Role of FDG PET-CT, Ultrasound and Ultrasound-guided Fine Needle Aspiration Biopsy in the Diagnosis of Axillary Lymph Nodes in Patients with Breast Cancer: Comparison of Their Diagnostic Performances

Yu Mee Sohn PhD (Presenter) ; Il Ki Hong MD ; Han Na Lee MD

PURPOSE
The aim of this study was to compare the diagnostic performance of FDG PET-CT and those of US and US-FNA in the preoperative evaluation of axillary lymph node (ALN) status and to evaluate the factors related to false negative results of PET-CT, US, and US-FNA in nodal staging of invasive ductal carcinoma (IDC).

METHOD AND MATERIALS
From March 2009 to July 2012, total 226 patients were diagnosed with primary breast cancer. Among them, 107 patients were composed of this study population after exclusion of transferred patients or patients with other breast cancer besides IDC. The diagnostic performances of FDG PET-CT, US and US-FNA were compared with a pathologic report regarding the presence and the number of ALN metastasis. The SUV of PET-CT to differentiate the metastatic lymph node were also evaluated. We assessed univariate and multivariate analysis to evaluate the relationship between the clinicopathologic factors (symptoms, T-stage, hormone receptor, histologic grade) and false negative results and true negative results of PET-CT, US, and US-FNA after review of medical and pathologic reports.

RESULTS
Among 107 patients, forty five patients (42.1%) showed positive results on final pathology. US-FNA had significantly higher specificity, PPV and accuracy than US and FDG PET-CT (p < 0.001). The area under the ROC curve value of US-FNA was also significantly higher than other modalities with specificity of 78.9 % and specificity of 75.0 %. Among three modalities, the false negative rate was highest in US (28.9 %) and the false positive rate was highest in PET-CT (25.8 %). And there was no significant clinicopathologic factors related to false negative results of three modalities.

CONCLUSION
US-FNA had the most excellent diagnostic tool for the preoperative evaluation of nodal status of IDC among three modalities. The cut off value of SUV of PET-CT to differentiate metastatic from benign lymph node was 1.6.

CLINICAL RELEVANCE/APPLICATION
Clinical relevance : US-FNA had the most excellent diagnostic tool for the preoperative evaluation of nodal status of IDC among FDG PET-CT, US and US-FNA.

SSK02-05 • Axillary Lymph Node Biopsy beyond Breast Cancer: What Are the Pathologic Findings of Suspicious Nodes Identified on Axillary Ultrasound?

Rakhee H Goel MD (Presenter) ; Alice S Rim MD ; Melanie Chellman-Jeffers MD

PURPOSE
The widespread use of multimodality imaging has lead to the discovery of findings of unknown clinical significance, such as the identification of hypermetabolic axillary lymph nodes on PET/CT. Clinicians are increasingly turning to breast imagers in order to assess abnormal axillary lymph nodes and obtain pathology. Our aim is to report the pathologic results for axillary lymph node biopsy in patients with otherwise normal mammograms.

METHOD AND MATERIALS
A retrospective review was performed for all patients who obtained an axillary lymph node needle biopsy with otherwise normal mammogram between 2009 - 2012. Data collected and analyzed was: Demographics, comorbidities, ultrasound lymph node characteristics, CT/MR imaging findings, needle biopsy results, and surgical excision results if performed.

RESULTS
88 patients with normal mammograms underwent ultrasound guided needle biopsy of suspicious axillary lymph nodes (mean age = 58). Forty four patients had either normal or benign proliferative pathologic results, of which 15 patients had known autoimmune diseases including rheumatoid arthritis, Churg-Strauss, and angio-edema. Six patients were diagnosed with breast cancer. Lymphoma was found on biopsy for 16 patients (18%) (for 8 patients the abnormal nodes were first noted on mammogram). Only 5 of the 16 lymphoma patients demonstrated bilateral axillary adenopathy. Additional diagnoses included polyclonal gamopathy (3 patients), granulomatous inflammation (sarcoid, BCG-related, and Cat-scratch) (5 patients), dermatopathic changes (6 patients), ovarian cancer metastatic disease (2 patients), and reactive nodes (ie associated with breast hiradenitis suppurativa) (6 patients).

CONCLUSION
A large number of ultrasound guided axillary lymph node biopsies lead to actionable pathologic diagnoses, including lymphoma, breast cancer, infection/inflammation, and newly diagnosed metastatic disease; emphasizing the importance of thorough evaluation of suspicious axillary lymph nodes.

CLINICAL RELEVANCE/APPLICATION
Axillary lymph node ultrasound with biopsy is valuable in the evaluation of non-breast cancer pathology, including malignancy, infection, and auto-immune diseases.

SSK02-06 • Cancer Detection Rate on Short-term, as well as Long-term Follow-up MRI after a Benign Concordant MRI-guided Breast Biopsy

Elana I Den MD (Presenter) ; Susan P Weinstein MD ; Susan G Roth MD

PURPOSE
To determine the cancer detection rate on short-term and long-term follow-up MRI after a benign concordant MRI-guided breast biopsy.

METHOD AND MATERIALS
A HIPAA-compliant, IRB-approved retrospective review of medical records at a large tertiary care institution was undertaken to identify all benign concordant MRI-guided breast biopsies performed from January 2005 to December 2011 that received follow-up MRI. All malignant and discordant cases were excluded. All longitudinal MRI follow-up (as well as mammographic and ultrasound follow-up) was reviewed through February 2013. Any subsequent core needle or excisional biopsies of the MRI-guided biopsy sites were also reviewed. The overall cancer detection rate was determined based on the follow-up MRI studies and electronic medical records.
RESULTS
A total of 802 MRI-guided breast biopsies were performed from 2005-2011, of which 172 had benign concordant results and MRI follow-up. The mean age at biopsy was 53.5 years (range 24-78 years). Longest follow-up times were as follows: 4 patients had up to 3 months follow-up, 33 had 6-12 months of follow-up, 37 had 1-2 years of follow-up, 31 had 2-3 years of follow-up, and 67 had greater than 3 years of follow-up. Only one patient who had a benign MRI-guided biopsy was diagnosed with ductal carcinoma in situ on follow-up; calcifications were detected at the MRI biopsy site on six-month mammography although the MRI remained negative, with only postbiopsy changes seen. No patients who had benign concordant MRI-guided biopsies were subsequently found to have pathology-proven invasive cancer.

CONCLUSION
The cancer detection rate on patients with MRI follow-up after a benign MRI-guided biopsy was 1/172 (0.6%). Our data suggests that there is low utility to either short-term or long-term MRI follow-up after a benign concordant MRI-guided biopsy.

CLINICAL RELEVANCE/APPLICATION
Short-term or long-term follow-up breast MRI does not appear to be useful for further cancer detection after a benign concordant MRI-guided breast biopsy.

SSK02-07 • Percutaneous Cryoablation (PCA) as Local Therapy for Patients with Breast Cancer and Bone Metastases (BCBM)
Claudio Pusceddu MD (Presenter) ; Luca Melis ; Sara Pilleri ; Barbara Sotgia ; Rosa Maria Fele ; Gianni Amucano ; Giovanni Battista Meloni
PURPOSE
The aim was to evaluate the safety and efficacy of PCA as local therapy for patients with breast carcinomas and bone metastases.

METHOD AND MATERIALS
PCA was used to treat fifteen breast lesions, mean size 2.4 (range 0.8-6.7 cm) in thirteen consecutive patients, mean age 52 (34-70) years with core-needle biopsy-proven breast carcinoma and bone metastases. 11 patients had one lesion and two patients had 2 lesions. The tumour and surrounding breast tissue were ablated with percutaneous CT-guided cryoablation under local anesthesia and mild conscious sedation. Cryoablation consisted of 2 cycles each of 10 minutes of freezing followed by a 4-min active thawing phase and a 4-min passive thawing phase for each one. Ten patients underwent one PCA session and two patients had 2 PCA sessions for different lesions. One patient was treated with two sessions for the same lesion.

RESULTS
All PCA sessions were successfully completed and all breast tumours were ablated. Morbidity consists in transient and mild ecchymotic changes and post-procedural oedema seen in six cases and alteration in skin pigmentation seen at the point of insertion of the cryoprobes in other two cases. The therapeutic outcomes were evaluated by contrast-enhanced CT or MRI at 1-, 3- and 6-month interval. The absence of contrast enhancement by the tumour on CT or MR image was considered complete tumour necrosis. During the mean follow-up of 11 months (3-24 months) none of the patients had shown local relapses. A patient died because of liver tumour progression after 16 months.

CONCLUSION
Our preliminary results suggest that cryoablation of breast carcinomas and bone metastases is a well-tolerated, safe and effective procedure. However, further follow up and a prospective controlled trial is necessary to validate the procedure.

CLINICAL RELEVANCE/APPLICATION
In patients with breast cancer and bone metastases cryoablation can be considered as a feasible and effective treatment as local therapy for the breast tumor.

SSK02-08 • Clinical Experience in Noninvasive Treatment of Focal Breast Cancer with Magnetic Resonance Guided High Intensity Focused Ultrasound (MRgFUS)
Luisa Di Mare MD (Presenter) ; Alessandro Napoli MD ; Federica Pediconi MD ; Michele Anzidei MD ; Vincenzo Noce MD ; Carlo Catalano MD
PURPOSE
To assess safety and feasibility of non-invasive high intensity 3T MR guided focused Ultrasound (MRgFUS) ablation of biopsy-proven invasive ductal breast cancer (IDC) (stage T1 M0 N0) before surgical resection and sentinel lymph node biopsy.

METHOD AND MATERIALS
Our retrospective study included 12 patients with unifocal biopsy-proven IDC, scheduled and consented to lumpectomy and sentinel lymph node biopsy. We use 3T MRI exam (Discovery 750, GE; Gd-BOPTA, Bracco) to confirm presence and treatable location of enhancing lesion (less than 2 cm). Patient underwent day-surgery single session MRgFUS treatment using ExAblate 2100 system (InSightec), under IRB approval. Post-surgery pathology evaluation test the efficacy of the treatment.

RESULTS
No significant complications were observed in all subjects during or immediately after the procedure. In 10 patients, multiparametric MRI no shows enhancement at breast treatment area. Post-surgery histological evaluation confirmed the absence of residual neoplastic foci in necrotic tissue area with at least 5 mm margins of normal breast tissue in all 10 patients. In 2 cases treatment failed due to transducer malfunction, and pathologist observed 15% of residual tumor. Results demonstrate excellent agreement between pathology and post-treatment MRI.

CONCLUSION
MRgFUS is a promise treatment to determines focal and noninvasive excision of unifocal breast cancer, according to histopathology findings.

CLINICAL RELEVANCE/APPLICATION
MRgFUS is an innovative incisionless technique to obtained reliable ablation of invasive breast cancer and successful clinical outcome.

SSK02-09 • Assessment of Breast Abscess Outcomes Following Ultrasound-guided Percutaneous Drainage
Christopher P Ho MD (Presenter) ; Sean Necessary MD ; Bhavika K Patel MD ; Rebecca L Seidel MD ; Kathleen R Gundry MD ; Michael A Cohen MD
PURPOSE
Breast abscesses have traditionally been managed surgically. There has been an increased role for minimally invasive management utilizing ultrasound-guided percutaneous drainage. We assessed those who received percutaneous drainage and examined outcomes to determine the efficacy and viability of managing breast abscesses with minimally invasive techniques.

METHOD AND MATERIALS
Consecutive patients with suspected breast abscesses were reviewed spanning a period from July 2011 to March 2013. Factors including abscess size, pre-existing patient conditions, volume of fluid aspirated, antibiotic use, and bacterial cultures were recorded. The procedure was termed successful if the abscess resolved following percutaneous drainage(s) and thus, surgery could be avoided.
RESULTS
81 patients had breast abscesses by imaging and underwent ultrasound-guided percutaneous drainage. The average age of the patients was 42.2 years, average maximal measured diameter of the abscess was 4.0cm and the average volume of fluid/pus aspirated was 22.3cc. Pre-disposing factors seen included: 7 patients with HIV, 4 smokers, 10 diabetic patients, 10 with history of previous breast surgical interventions. 65 (80.2%) of the 81 abscesses resolved following percutaneous drainage. Of the successful aspirations, 53 (81.5%) resolved after a single aspiration. 12 patients required additional drainages, ranging from 1 to 3 repeat examinations, however these abscesses did ultimately heal without surgery. 16 breast abscess required surgical intervention. Among the failures requiring surgical intervention, 4 patients had large volumes of fluid aspirated (range 500–290 cc) on initial aspiration and 3 patients had no fluid aspirated because the fluid was either too thick or predominantly solid/phlegmonous.

CONCLUSION
80% of breast abscesses can be managed with percutaneous drainage and antibiotics. The majority of patients require only a single aspiration. Large initial abscess size and the volume of fluid/pus aspirated appear to be factors that may predict percutaneous aspiration failure. Our experience would indicate that percutaneous drainage with concomitant antibiotics should be considered the first line of management for breast abscess.

CLINICAL RELEVANCE/APPLICATION
Given the successful management and patient outcomes of breast abscesses treated conservatively with percutaneous drainage, a shift in the traditional treatment paradigm should be considered.

Cardiac (Coronary CT/MR IV) Wednesday, 10:30 AM - 12:00 PM • SS04AB

Effect of Snapshot Freeze Motion Correction Algorithm on Image Quality of Prospective ECG-triggered Coronary CT Angiography

Lijuan Fan (Presenter); Jiwang Zhang; Donghai Fu; Liren Zhang MD

PURPOSE
We assessed Snapshot Freeze Motion Correction algorithm for its effect on image quality of coronary CT angiography (CCTA) with prospective ECG-triggered.

METHOD AND MATERIALS
Thirty consecutive patients undergoing coronary CTA with prospective ECG-triggered. We compared image quality and interpretability between standard (STD) and snapshot freeze motion correction (SSF) reconstructions. Coronary CTA images were interpreted with Likert 5-points score by two experienced radiologists. The image qualities and interpretability were respectively assessed on per-patient, per-artery and per-segment levels. Comparisons of variables were performed with Wilcoxon rank sum test and McNemar test.

RESULTS
A total of 130 study lesions were identified. Out of these, low reader confidence (less than 3) was found in 41 due to severe coronary calcification or stents. The use of coronary calcium image subtraction improved the reader confidence in 36% (13/36) of the segments with severe calcification and in 60% (3/5) of the segments with coronary stents. In 31 of the study lesions CAG found stenosis >50%. With conCCTA the false positive rate in study lesions was 18% (24/130) compared to 14% (19/130) with subCCTA.

CONCLUSION
Our initial experience with coronary calcium image subtraction suggests that it is feasible, and could lead to an improvement in reader confidence and diagnostic accuracy for identification of significant coronary artery disease.

CLINICAL RELEVANCE/APPLICATION
Coronary calcium subtraction may improve reader confidence and diagnostic accuracy in the presence of calcified plaques and stents, and thus may possibly improve overall diagnostic strength of CCTA.

Association of Calcium Score and Coronary Artery Disease on CCTA according to the Presence and the Degrees of Diabetic Retinopathy: Preliminary Results

Eun Young Kim (Presenter); Joon-Won Kang MD; Dong Hyun Yang MD; Tae-Hwan Lim MD, PhD

PURPOSE
To compare the difference of coronary artery calcium (CAC) score, plaque characterization and coronary artery disease in diabetes mellitus (DM) patients according to the presence and the type of retinopathy using coronary CT angiography (CCTA).

METHOD AND MATERIALS
From 1 February 2009 to 31 July 2011, 172 consecutive patients (89 men, 83 women mean age, 65.4±9.3 years) diagnosed with type 2 DM and CCTA taken were enrolled. The patients were categorized according to the presence of diabetic retinopathy (DR) and the types of DR. Differences in CAC score, plaque score, segment score and degree of stenosis were compared, simultaneously using
RESULTS
The study patients were divided into 3 groups; no retinopathy (n=37), non-proliferative (NPDR, n=91) and proliferative DR (PDR, n=44). The average of HbA1c (8.3±1.4, p=0.003), total cholesterol (163.0±42.3, p=0.014) and DM duration (20.7±6.5, p=0.000) were significantly high in PDR patients among three groups. Of 172 DM patients, 137 (80%) showed DR. There was statistically significant difference in CAC score (p=0.002) between the presence and absence of retinopathy. Segment score (p=0.01) and plaque score (p=0.04) was significantly higher in patients with DR as well. in patients with PDR, compared with NPDR, all of CAC score (p=0.012), the presence of significant stenosis (p=0.003) and multivessel disease (p=0.013), segment score (p=0.000) and plaque score (p=0.000) was significantly higher.

CONCLUSION
CAC score, plaque burden is significantly higher in DR and it becomes clear that in addition to that result, significant stenosis is more common in PDR patients. At least, proliferative diabetic retinopathy patients need to identify coronary artery disease with CCTA.

CLINICAL RELEVANCE/APPLICATION
This study suggested that PDR could be a predictor for CHD in asymptomatic type 2 diabetic patient and PDR patients need to start screening test for CHD through the CCTA.

SSK03-04 • Combined Assessment of MR Flow Measurement of Coronary Artery Bypass Graft and Stress Perfusion MRI in Detecting Graft Stenoses

Tatsuro Ito MD (Presenter) ; Masaki Ishida MD, PhD ; Kakuya Kitagawa MD, PhD ; Hiroshi Nakajima MD ; Kaoru Dohi ; Shinji Kanemitsu ; Hitode Shimpo ; Masaaki Ito ; Hajime Sakuma MD *

PURPOSE
Stress myocardial perfusion MRI is useful for the detection of flow-limiting coronary stenosis. However, reduced sensitivity of stress measurement MRI was reported in patients after coronary artery bypass grafts (CABG). MR flow measurement can provide functional assessment of CABG and permits noninvasive detection of significant graft stenoses. The purpose of this study was to evaluate the value of combined assessment of MR graft flow measurement and stress myocardial perfusion MRI for the detection of graft stenoses.

METHOD AND MATERIALS
Forty-eight patients (68±7 years) with CABG who had recurrent chest pain and underwent both coronary angiography and cardiac MRI including stress perfusion, late gadolinium enhancement (LGE) MRI and MR graft flow measurement within 3 months were studied. The observers recorded the presence or absence of myocardial ischemia using 4-point scale. The threshold of 24.8 ml/min, determined by ROC analysis, was used for identifying functional abnormality of the graft. Stenoses >70% in bypass grafts were considered significant.

RESULTS
Ninety-nine grafts were eligible for the analysis. MR graft flow measurement was inconclusive due to metal artifact in 6 (6%) grafts, whereas stress perfusion MRI was diagnostic in all patients. When 93 areas with successful flow measurements were evaluated, the diagnostic performance assessed by the area under the ROC curve (AUC) was significantly higher with MR graft flow measurement (AUC 0.92; sensitivity 90%; specificity 85%) than with stress perfusion MRI (AUC 0.73; sensitivity 70%; specificity 74%) (p=0.04) (Figure 1). In the analysis of all 99 areas with bypass grafts, stress perfusion MRI yielded a sensitivity of 70% and a specificity of 75% in detecting significant graft stenoses. These values were improved to 87% and 86% by combining MR graft flow measurement and stress perfusion MRI, using MR flow measurement as a primary determinant.

CONCLUSION
MR graft flow measurement combined with stress perfusion MRI can provide excellent diagnostic accuracy for the detection of graft stenoses in patients after CABG.

CLINICAL RELEVANCE/APPLICATION
MR graft flow measurement combined with stress perfusion MRI is highly valuable for the accurate detection of graft stenoses in patients after CABG.

SSK03-05 • Feasibility Study of the 100kVp and 400mA Coronary CTA

Kai Zhao (Presenter) ; Yuan Jiang ; Jian-Xing Qiu MD ; Xiaoying Wang MD

PURPOSE
To study the image quality and radiation dose of 100 kVp and 400 mA CT imaging in patients undergoing coronary CT angiography (CCTA).

METHOD AND MATERIALS
From September to December 2012, 101 patients suspected of coronary artery disease were scanned by GE CT 750HD with retrospectively ECG-gated reconstruct mode, whose weight was less than 80 kg. They were divided into 100 kVp group (n=65) and 120 kVp group (n=36). The patients in 100 kVP group were scanned with 100 kVp and ECG modulation tube current (peak current 400 mA), while 120 kVp group were scanned with 120 kVp and ECG modulation tube current (peak current 500 mA). Contrast medium injection rate and volume were personalized by patients' weight (370 mgI/ml, mean 40ml). CT image raw data sets were reconstructed with ASiR-FBP composite at 30%. The effective radiation dose (ED) and size specific dose estimate (SSDE) of each patient were calculated. CT attenuation of the main vessels were measured and the image quality (noise, CNR, SNR) were estimated.

RESULTS
Performing retrospective ECG-gated reconstruct mode, whose weight was less than 80 kg. They were divided into 100 kVp group (n=65) and 120 kVp group (n=36). The patients in 100 kVp group were scanned with 100 kVp and ECG modulation tube current (peak current 400 mA), while 120 kVp group were scanned with 120 kVp and ECG modulation tube current (peak current 500 mA). Contrast medium injection rate and volume were personalized by patients' weight (370 mgI/ml, mean 40ml). CT image raw data sets were reconstructed with ASiR-FBP composite at 30%. The effective radiation dose (ED) and size specific dose estimate (SSDE) of each patient were calculated. CT attenuation of the main vessels were measured and the image quality (noise, CNR, SNR) were estimated.

CONCLUSION
To those whose body weight is less than 80 kg, CCTA obtained by 100 kVp, may obtain diagnostic image quality with more than half of the radiation dose reduction.

CLINICAL RELEVANCE/APPLICATION
High radiation exposure for CCTA is a concern and a limitation for its use, 100kVp and 400mA provide a feasible way to solve the problem for most people.

SSK03-06 • Accuracy of Coronary Plaque Detection Using a Semiautomatic Plaque Analysis Software in Computed Tomography Coronary Angiography

Azien Laqmani (Presenter) ; Thorsten Klink MD ; Marcus Quitzke ; Domenique-Daniel Credner ; Gerhard B Adam MD ; Gunnar K Lund MD

PURPOSE
To assess the accuracy of coronary plaque detection with a semiautomatic plaque analysis software in computed tomography coronary angiography (CTCA) with a 256-MSCT scanner

METHOD AND MATERIALS
...
RESULTS
The software automatically identified 114 structures as plaques. 32 (28%) of the automatically marked lesions complied with plaques (true-positive). 82 (72%) of the lesions did not correspond with visually detectable plaques (false-positive). 20 plaques were manually detected by observers but not by the software (false-negative). For 82 false-positive detected plaques the following potential reasons were noticed by the observers: high density in pericoronary fat (59%), vessel ramification (24%), contrast in adjacent veins (6%), artery kinking (4%) and falsely contured vessel (7%).

CONCLUSION
The evaluated semiautomatic plaque analysis software demonstrates a very high false-positive detection rate of coronary plaques.

CLINICAL RELEVANCE/APPLICATION
Detection of coronary plaques with a semiautomatic plaque analysis software is not reliable. A revision of the software marked lesions as plaques is indispensable.

SSK03-07 • Restriction of Referral to CTCA by Clinical Evaluation Combined with Calcium Score

Anoeshka S Dharampali MD (Presenter); Alexia Rossi MD; Admir Dedic MD; Annick C Weustink MD, PhD; Mohamed Ouhlous MD, PhD; Filippo Cademartiri MD, PhD*; Eric H Boersma PhD; Koen Nieman MD; Pim Feyter MD, PhD; Gabriel P Krestin MD, PhD*

PURPOSE
To investigate the value of calcium score (CaSc) in addition to clinical evaluation to restrict referral to CTCA by reducing the number of patients with intermediate probability of CAD.

METHOD AND MATERIALS
We retrospectively included 2042 symptomatic stable patients who underwent clinical evaluation, unenhanced CT-scan for the calculation of CaSc and CTCA. Obstructive CAD (≥50% lumen diameter narrowing) assessed by CTCA was the outcome. We investigated 2 models, first, clinical evaluation consisting of chest pain typicality, female sex, age, risk factors and ECG) and second model consisting of clinical evaluation with CaSc. The model discrimination of CAD was compared by using area under the receiver operating characteristic curves. We assessed the net reclassification improvement (NRI) that allows both models to reclassify patients into low (

RESULTS
Discrimination of CAD was significantly improved by addition of CaSc to clinical evaluation (AUC: 0.80 vs. 0.90, p < 0.001). The NRI using both model to reclassify all patients was 56%. The clinical net reclassification improvement by model 2 of patients first classified by model 1 having intermediate risk was 66%. Unenhanced CT-scan and CTCA could be avoided in 12% using model 1 and an additional 32% of CTCA could be avoided using model 2 subsequently.

CONCLUSION
Calcium score provides incremental discrimination of CAD compared to clinical evaluation. Implementation of calcium score model can reduce referral to CT coronary angiography by 44%.

CLINICAL RELEVANCE/APPLICATION
Risk stratification of stable angina patients can be improved by using the calcium score model.

SSK03-08 • Effect of a Novel Motion Correction Algorithm (SSF) on the Image Quality of Coronary CTA with Higher Heart Rates: In Comparison with Bi-sector Reconstruction

Qianwen Li (Presenter); Xiangying Du MD; Peng-Yu Li; Xiaoguang Yang; Kuncheng Li MD

PURPOSE
SnapShotFreeze (SSF) is a novel vendor-specific motion correction algorithm based on non-rigid registration in coronary CTA. The purpose of this study is to assess the effect of SSF algorithm on image quality in comparison with bi-sector reconstruction in higher heart rates.

METHOD AND MATERIALS
Retrospective ECG-gated coronary CTA was performed on 15 patients with higher heart rates (65-75 bpm, mean 69.7±3.2 bpm) using a 64-row CT scanner (GE Discovery CT750 HD). The optimal SSF images were generated following the reconstruction protocol for SSF. Multi-phase bi-sector images were reconstructed as well and the optimal phase was selected for comparison with SSF images. The images were interpreted in an intent-to-diagnose fashion by 2 experienced readers using a 5-point scale with 3 point as diagnostically acceptable.

RESULTS
SSF algorithm can provide superior image quality than bi-sector reconstruction in coronary CTA of patients with higher heart rates.

CONCLUSION
For higher heart rates patients, bi-sector reconstruction may be neglected by using the motion-correction algorithm, avoiding the higher radiation dose related to small pitch required by bi-sector.

CLINICAL RELEVANCE/APPLICATION

SSK03-09 • Role of an Intracycle CT Motion Correction Algorithm in the Coronary CT Angiography Accuracy

Patricia M Carrascosa MD (Presenter)*; Carlos Capunay MD; Alejandro Deviggiiano MD; Gaston Rodriguez Granillo; Jorge M Carrascosa MD

PURPOSE
The purpose of this study is to demonstrate that coronary CT angiography (CCTA) employing a novel intracycle motion compensation algorithm (SnapShot Freeze [SSF]) will be superior to CCTA without intracycle motion compensation algorithm (�conventional�� CCTA) for diagnostic accuracy and image quality.

METHOD AND MATERIALS
Twenty patients with known or suspected coronary artery disease were studied with MSCT and ICA. CCTA were performed on a 128-slice CT scanner (Discovery CT750 HD, GE Medical Systems). Studies were done using prospective or retrospective ECG-gating depending on the heart rate of the patients. In the prospective scan a padding of 100 msec was used, while in the retrospective scans, cardiac x-ray modulation was performed (centered 45 % to 75% of the R-R interval).

First images were analyzed without the motion compensation algorithm and 2 weeks later in a random and blinded way with the algorithm. The per-vessel and per-segment diagnostic interpretability and image quality of CCTA with and without motion compensation algorithm was calculated.

RESULTS
From the 20 patients studied, 299 segments were analyzed.
In 215 of 299 segments, the motion compensation algorithm showed similar evaluation than conventional CCTA. In 84 segments, the motion compensation algorithm allowed a better evaluation. In relation to vessel analysis, SSF showed improvement of vessel visualization in 30% of DA, 75% of CX and 40% of RCA.
SSF had only 1 segment non evaluable whereas conventional CCTA 15. The assessability was 99.6% versus 95 % for both modalities.

CONCLUSION
SSF allowed better visualization of the coronary arteries as well as lesser non evaluable segments in comparison to conventional CCTA.

CLINICAL RELEVANCE/APPLICATION
Correction of coronary arterial motion on coronary CTA using an Intracycle CT Motion Correction Algorithm would be of clinical significance.

**Chest (Diffuse Lung Disease)** Wednesday, 10:30 AM - 12:00 PM • S404CD

**Back to Top**

**SSK04 • AMA PRA Category 1 Credit:1.5 • ARRT Category A+ Credit:1.5**

**Moderator David A Lynch**, MBBCh *

**Cristopher A Meyer** MD *

**SSK04-01 • Dynamic Contrast-enhanced CT Quantification of Fractional Extracellular Space Correlates with Pulmonary Fibrosis Severity in a Bleomycin Mouse Model**

**Wilbur Wang** BA (Presenter) ; **Yanjun Fu** PhD ; **Dongwei Gao** MD ; **Margaret J Wong** MENG, BS ; **Kevin Tan** ; **Hal Chapman** MD ; **Kirk D Jones** MD ; **Michael D Hope** MD ; **Benjamin M Yeh** MD *

**PURPOSE**
To evaluate whether dynamic contrast-enhanced CT measurements of the pulmonary fractional extracellular space (fECS) can be used to quantify the severity of pulmonary fibrosis in a mouse model.

**METHOD AND MATERIALS**
A range of early pulmonary fibrosis was induced in twenty-one C57BL6/N mice by intratracheal bleomycin. Mice were then scanned with dynamic contrast-enhanced CT using iohexol. Lungs were then excised and collagen was quantified using the Sircol assay in a blinded fashion. Histopathologic peribronchiorial/alveolar ductal fibrosis was graded qualitatively from 0 = none to 3 = severe. Severity of pulmonary fibrosis was graded by a thoracic radiologist from 0 = none to 2 = severe. Pulmonary fECS was calculated at each time point (every minute after contrast injection for 35 minutes) using the following equation: (precontrast – postcontrast lung attenuation) x (1 – hematocrit) / (postcontrast – precontrast blood pool attenuation). Final pulmonary fECS values for each mouse were determined as the average of the calculated fECS reached an asymptote, representing equilibrium of the contrast material. Findings were correlated to collagen concentration and histopathological fibrosis grade.

**RESULTS**
Calculated fECS measurements in the mouse lungs ranged from 12.4 to 76.1%. Collagen concentrations ranged from 15.0 to 84.6 g collagen / mg dry lung tissue. Histopathologic pulmonary fibrosis grade ranged from 0 to 3. CT measures of fECS correlated strongly with pulmonary collagen concentrations (R² = 0.647, P < .001) and histopathologic fibrosis grade (R² = 0.578, P < .001). Visual radiologic findings of lung disease correlated moderately with collagen concentration (R² = 0.325, P < .01) but not with histopathological fibrosis grade (R² = 0.033, P = .43). Multivariate regression analysis showed fECS and visual findings are independent predictors of collagen concentration, with an adjusted-R² = 0.62 (P < .001, P < .05, respectively).

**CONCLUSION**
Quantitative contrast-enhanced CT measurements of fECS more accurately estimates pulmonary fibrosis than does visual scoring of CT images in a mouse model, and complements visual scoring.

**CLINICAL RELEVANCE/APPLICATION**
Contrast-enhanced CT measurements of fECS may potentially be a useful quantitative marker for pulmonary fibrosis for noninvasive monitoring of pulmonary disease severity.

**SSK04-02 • Idiopathic Pulmonary Fibrosis: Comparison of a Quantitative Fibrosis Score and CT Indexes from Histogram as Biomarkers of Disease Severity and Surrogate Endpoints in Assessing Change**

**Hyun J Kim** PhD (Presenter) ; **Matthew S Brown** PhD * ; **Daniel Chong** BS ; **Peyun Lu** ; **Heidi Coy** ; **Jonathan G Goldin** MBBChB, PhD

**PURPOSE**
To be a useful Quantitative Imaging Biomarker (QIB) of treatment efficacy, it should be capable of assessing severity and change of time of the disease process. CT quantitation can be based on histogram analysis of lung density or a classifier-model derived score from a set of texture features. The purpose of the study is to compare two published approaches, kurtosis of histogram analysis and the Quantitative Fibrosis Score based on a classification model to assess baseline severity and change over time in patients with idiopathic pulmonary fibrosis (IPF).

**METHOD AND MATERIALS**
From imaging database of standardized CT scans obtained on patients with well characterized IPF, 60 patients (29 Male with mean of Forced Vital Capacity (FVC) 63%±12) with at least baseline and paired follow-up scans were selected. After semi-automated lung segmentation, indexes of kurtosis, mean lung attenuation, variance, and skewness were derived from histogram at whole lung. Quantitative Lung Fibrosis (QLF) and Quantitative Interstitial Lung Disease (QILD) scores and volumes were calculated from a classification algorithm with denoise technique. Spearman rank correlations were used to assess associations between CT indexes and quantitative scores comparing with FVC (percent predicted) at baseline and change in FVC on follow-up.

**RESULTS**
At baseline, mean (±SD) of kurtosis, mean lung attenuation, variance, and skewness were 2.43 (±1.83), -760HU (±54), 44220 (±15048), and 1.48 (±0.45), respectively. Mean (±SD) of QLF and QILD were 20.7% (±13.4) and 43.3% (±20.0) for scores and were 0.71L (±0.42) and 1.52L (±0.64) in volumes. All baseline histogram indexes and QLF and QILD scores were correlated with the baseline FVC (e.g. P = 0.57; p < .01) but not with histological fibrosis grade (R² = 0.033, P = .43). Multivariate regression analysis showed fECS and visual findings are independent predictors of collagen concentration, with an adjusted-R² = 0.62 (P < .001, P < .05, respectively).

**CONCLUSION**
Kurtosis is associated with physiological measure of baseline severity but not useful for assessing change over time. A classifier-model derived score based on a set of texture features is associated with both baseline disease extent and a sensitive measure of change over time.

**CLINICAL RELEVANCE/APPLICATION**
For patients selection based on extent of disease and for measuring longitudinal changes in patients with IPF, a quantitative score derived from a classification algorithm can be used as a QIB.

**SSK04-03 • Atypical UIP: Prevalence and Genetic Associations**

**Jonathan H Chung** MD (Presenter) * ; **Ashish Chawla** MD, MBBS ; **David Mckean** ; **Steve Groshong** MD ; **Carlyne Cool** MD ; **David A Lynch** MBBCh * ; **Anna Peljto** ; **Janet Talbert** ; **Marvin I Schwarz** MD ; **David Schwartz**

**PURPOSE**
To determine the frequency of atypical UIP and to evaluate whether there was an association between atypical UIP and the MUC5B promoter site SNP (rs35705950), which has been strongly associated with IPF and familial PF.

**METHOD AND MATERIALS**
HRTC scans of 1,764 subjects with known idiopathic lung interstitial disease were scored. Of these subjects, 250 subjects had both histologic...
and rs35705950 SNP data (GG, GT, TT). Atypical UIP was defined as subjects in whom UIP was not considered present on the imaging differential diagnosis but was scored as definitely present on histology. Typical UIP was defined as subjects in whom UIP was considered possible, probable, or definite on imaging diagnosis and was scored as definitely present on histology. A two-tailed Fisher's exact test and t-test were used to compare proportions and means, respectively.

RESULTS
There were 25 atypical UIP cases and 52 typical UIP cases. The rate of atypical UIP relative to all subjects in whom UIP was not considered was 22.7%. Though the total extent of fibrosis was similar in typical and atypical UIP (19.6% +/-17.7% vs 11.7% +/-12.2%, p=0.019) a lower rate of honeycomb (20% compared to 53.8%), and less subpleural preponderance (20% compared to 58%, p=0.032). The extent of honeycomb on CT is an important to predict the median survival time in a symptomatic CPFE subject.

CONCLUSION
Atypical UIP cases had a significantly higher prevalence of ground-glass opacity (19.6% +/-17.7% vs 11.7% +/-12.2%, p=0.019) a lower rate of honeycomb (20% compared to 53.8%), and less subpleural preponderance (20% compared to 58%, p=0.032). A substantial percentage of subjects with an imaging pattern inconsistent with UIP have a high-confidence diagnosis of UIP on histopathology. Atypical UIP cases most commonly mimic NSIP and chronic HP. The prevalence of the rs35705950 SNP is substantially higher in typical UIP than atypical UIP.

CLINICAL RELEVANCE/APPLICATION
Exclusion of a pathologic UIP diagnosis cannot be made accurately based purely on chest CT. Optimal treatment and prognosis may differ between atypical and typical UIP patients.

SSK04-04 • Combined Pulmonary Fibrosis and Emphysema: What Are the Prognostic Factors of Survival in Symptomatic Subjects Compared with Asymptomatic Subjects?

Yong Seek Kim (Presenter); Kum Ju Chae; Gong Yong Jin MD, PhD; Young Min Han MD; Su Bin Chon; Young Sun Lee; Keun Sang Kwon

PURPOSE
The aim of this study was to identify prognostic predictors among pulmonary function tests, clinical and CT features in symptomatic combined pulmonary fibrosis and emphysema (CPFE) compared with asymptomatic subjects.

METHOD AND MATERIALS
The study was approved by the institutional review board. We reviewed the 1,339 asymptomatic subjects (male smoker, aged 40 years or older) who performed low-dose CT in 2004 and 2010 for lung cancer screening. 3,176 respiratory symptomatic patients (male smoker, aged 40 years or older) who performed HRCT scan between 2004 and 2009 were also reviewed to find symptomatic CPFE patients. 49 asymptomatic (3.7%) and 113 symptomatic CPFE patients (2.6%) were included in this study. The extent of emphysema and honeycomb on CT was visually assessed using six and five point scale, respectively. We compared those with asymptomatic to those with symptomatic subjects for age, smoking, pulmonary function tests, and CT findings (extent of emphysema and fibrosis) using an unpaired t-test or a Chi-square with Fisher's exact test. Multivariate Cox proportional hazards regression analysis was performed to determine the prognostic factors of symptomatic patients in pulmonary function tests and CT findings. Median survival time differences in symptomatic patients according to fibrosis scoring on CT were calculated from Kaplan-Meier analysis.

RESULTS
FVC and FEV1/FVC of symptomatic patients were lower than those of asymptomatic subjects; 87.8 ± 16.7 vs. 95.7 ± 23.6, p=0.032, 72.2 ± 10.2 vs. 77.6 ± 4.1, p=0.032. The overall survival of patients with UIP was considered possible, probable, or definite on imaging diagnosis and was scored as definitely present on histology. A two-tailed Fisher's exact test and t-test were used to compare proportions and means, respectively.

CONCLUSION
The measure of extent of honeycomb on CT is an important to predict the median survival time in a symptomatic CPFE subject.

CLINICAL RELEVANCE/APPLICATION
Because honeycomb on CT is a prognostic factor to estimate survival rate in CPFE subjects, quantification of honeycomb on CT is useful for the prognosis prediction of a symptomatic CPFE subject.

SSK04-05 • Performance and Interobserver Variability in Diagnosis of Idiopathic Pulmonary Fibrosis (IPF)

Hriday Shah MD (Presenter); David M Naeger MD; Joyce Lee; Harold Collard MD; Brett M Elicker MD

PURPOSE
To determine the performance and interobserver variability of radiologists with different levels of experience for the high-resolution CT (HRCT) diagnosis of Idiopathic Pulmonary Fibrosis according to ATS/ERS/JRS/ALAT criteria.

METHOD AND MATERIALS
HRCT scans of 219 randomly selected patients from the UCSF interstitial lung disease database were analyzed by a senior attending radiologist, a junior attending radiologist and a 1st year radiology resident according to ATS/ERS/JRS/ALAT criteria. Each case was interpreted as 'definite UIP', 'possible UIP' or 'inconsistent with UIP.' In cases that were 'inconsistent with UIP', the inconsistent criteria were identified. Agreement was assessed with a Kappa statistic and a 1-tail test against the null (p-value of 0.05 considered significant).

RESULTS
33% of patients in the total cohort had a final multidisciplinary diagnosis of IPF. Overall agreement for 'definite UIP' was 0.639 (p < 0.001). The overall sensitivity and specificity, respectively, of each reader for the diagnosis of IPF was as follows: senior attending radiologist (48%, 96%), junior attending radiologist (81%, 84%) and 1st year radiology resident (73%, 85%). Similar results were obtained when subset analysis only included patients with HRCT signs of fibrosis or patients =50 years of age. 6 false positive interpretations were made by the junior attending radiologist whereas 22 false positive interpretations were made by the junior attending radiologist, including 14 connective tissue disease, 4 hypersensitivity pneumonitis, 1 drug toxicity and 3 idiopathic nonspecific interstitial pneumonia patients. The senior radiologist described mosaic perfusion/air trapping more often and honeycombing less often than the other two readers.

CONCLUSION
The radiologist with greater experience had a lower sensitivity and greater specificity in the HRCT diagnosis of IPF according to ATS/ERS/JRS/ALAT criteria. Most false positives in the radiologists with less experience were in patients with connective tissue disease and hypersensitivity pneumonitis.

CLINICAL RELEVANCE/APPLICATION
Because honeycomb on CT is a prognostic factor to estimate survival rate in CPFE subjects, quantification of honeycomb on CT is useful for the prognosis prediction of a symptomatic CPFE subject.

SSK04-06 • Radiographic Interstitial Lung Abnormalities in Advanced NSCLC Patients during Platinum-based Chemotherapy: A Systematic Study in a Cohort with Wild-type EGFR, ALK, BRAF, and KRAS

Mizuki Nishino MD (Presenter); Stephanie Cardarella; Tetsuro Araki MD; Christine Lydon; Michael S Rabin MD *; Hiroto Hatabu MD, PhD *; Bruce E Johnson

PURPOSE
Investigate the frequency of radiographic interstitial lung abnormalities (ILA) during first-line platinum-based chemotherapy in advanced NSCLC patients who are genomically characterized as wild-type for EGFR, ALK, BRAF, and KRAS, and provide reference data to assess lung toxicity of newer agents targeting specific mutations of lung cancer.
RESULTS
A total of 311 chest CT scans in 65 patients were scored. On baseline CT before therapy, 9 of 65 patients (14%) were positive for ILA (score 2 in 7, score 3 in 2 patients). Six patients developed ILA during therapy (score 2 in all 6 patients), accounting for 11% of 56 patients without baseline ILA. The median time from the initiation of therapy to the first scan showing ILA was 5.0 months (range 0.1 to 14 months). Time from the initiation of therapy to the last CT did not differ between patients who developed ILA and those who did not (median: 7.1 vs. 5.0 months, respectively, Wilcoxon p=0.17). Clinical variables including age, gender, stage, smoking, and pathology was not associated with baseline ILA (P>0.07), or development of ILA (P>0.2).

CONCLUSION
ILA was present at baseline in 14% of the total population. 11% of the patients without baseline ILA developed ILA during platinum-based chemotherapy in genomically characterized advanced NSCLC patients. The data serve as a reference for the frequency of ILA in newer anti-cancer agents developed for lung cancer.

CLINICAL RELEVANCE/APPLICATION
Frequency of ILA during chemotherapy in advanced NSCLC patients negative for 4 well-studied genomic abnormalities is reported, providing reference to assess lung toxicity of newer anti-cancer agents.

SSK04-07 • Ultra-low-Dose (ULD) Chest CT in Immunocompromised Patients - A Prospective and Intraindividual Evaluation regarding Detection of Infiltrates

Niklas Lutzen (Presenter) ; Tobias Baumann MD ; Jonas Burk ; Stefan Bulla MD ; Markus Wilhelm ; Isabelle Dorr ; Gregor Pache MD ; Mathias F Langer MD, PhD

PURPOSE
Pneumonia is a potentially fatal complication in immunocompromised patients. Therefore, low-dose (LD) CT of the chest is widely applied in these patients. It is unclear, however, to what extent radiation exposure can be lowered while still maintaining diagnostic accuracy. Thus, it was the aim of this study to evaluate the diagnostic properties of an ULD CT protocol by intraindividual comparison with an established LD CT protocol.

METHOD AND MATERIALS
102 immunocompromised patients with an hematologic disease underwent 118 paired ULD and LD CT examinations with the following scan parameters. Tube voltage 120 kV, reference tube current for LD: 75mAs, fixed tube current for ULD: 10 mAs (BMI < 25kg/m²) or 15 mAs (BMI > 25kg/m²). Four experienced radiologists, blinded to patient data and scan parameters, prospectively rated the presence of macronodules, nodules with halo-sign, grouped micronodules, ground-glass opacity, consolidations and cavities on a five-point Likert scale for each examination and side separately. Variance and mean of the four ratings were calculated for each side, patient, and dose. These values were subjected to generalized linear model (mean) and logistic regression (variance=0 or variance>0) with dose as fixed effects and patient as random effect.

RESULTS
Mean effective dose was 3.38±0.81 mSv for LD examinations and 0.44±0.09 mSv for the ULD approach, corresponding to dose reduction of 87% with ULD. All studies were considered as diagnostic. With an effect size of 0.09 and a t-value of 2.94 the mean rating for ground-glass opacities was slightly but significantly lower in the ULD group. Logistic regression demonstrated a significantly increased interreader variance for grouped micronodules in ULD studies. Dose settings revealed no significant effect for all other imaging criteria and parameters.

CONCLUSION
The proposed ultra-low-dose chest CT protocol allows for a considerable decrease in radiation exposure even compared to existing low-dose approaches. Despite this decrease, the diagnostic properties could largely be maintained, yet with an increased interreader variance for the detection of micronodules and a slightly lower sensitivity for ground glass opacities.

CLINICAL RELEVANCE/APPLICATION
Immunocompromised patients are commonly subjected to repeated chest CTs, Ultra-low-dose CTs might allow for a considerable decrease in radiation exposure without demise in the diagnosis of pneumonia.

SSK04-08 • Probable UIP Is Still a Necessary Diagnostic Category on HRCT in Fibrosing Interstitial Pneumonia

Jonathan H Chung MD (Presenter) * ; Ashish Chawla MD, MBBS ; Steve Groshong MD ; Carlyne Cool MD ; David Mceann ; David A Lynch MBCh * ; Janet Talbert ; Anna Peljto ; Gregory Cosgrove MD ; Kevin K Brown MD ; Marvin Schwarz ; David Schwartz

PURPOSE
Recent international guidelines support 3 classes of UIP diagnosis on CT: Definite UIP, possible UIP, and inconsistent with UIP; the probable UIP class is not included in this diagnostic scheme. The purpose of this study was to evaluate the importance of the probable UIP imaging classification, using histological correlation.

METHOD AND MATERIALS
HRCT scans from 1,764 subjects in a large multicenter database of subjects with known or suspected interstitial lung disease were scored by two thoracic radiologists. CT findings and UIP diagnosis with level of confidence (not UIP, possible, probable, definite) were recorded. Definite UIP was defined as peripheral predominant, basal predominant reticular abnormality with honeycombing. Probable UIP was defined as peripheral predominant, basal predominant reticular abnormality without honeycombing. Possible UIP was defined as reticular abnormality with features not sufficiently characteristic to reach definite or probable levels. 258 subjects had histological scoring. Histological findings and UIP diagnosis with level of confidence were recorded by two pulmonary pathologists. Two-tailed Fisher exact test was used to compare proportions of histological scores for each UIP category.

RESULTS
In those with probable UIP on CT, UIP was histologically scored as definite, possible/probable, and not considered in 48.8% (20/41), 41.5% (17/41), and 9.8% (4/41) of subjects, respectively, compared with 30.7% (23/75), 37.3% (28/75), and 32.0% (24/75) for those with possible UIP on CT (p = .0154). Corresponding histologic diagnoses for those with definite UIP on CT were 46.4% (13/28), 39.3% (11/28), and 14.3% (4/28) of subjects, respectively, very similar to the distribution of diagnoses in probable UIP (p=.883). The proportions of histological scores for probable UIP and not UIP on CT were significantly different (p < 0.05). In those with probable UIP on CT, the distribution of histological diagnoses is significantly different from those with possible UIP, but very similar to those with definite UIP.

CONCLUSION
In those with probable UIP on CT, the distribution of histological diagnoses is significantly different from those with possible UIP, but very similar to those with definite UIP.

CLINICAL RELEVANCE/APPLICATION
Patients with a probable UIP diagnosis on CT should not be categorized as possible UIP.

SSK04-09 • The Definition of Traction Bronchiectasis on CT Remains Unclear: Evaluation by 48 Observers with Various Specialties and Countries
RESULTS
In the first session, agreement for the scores varied from poor to excellent (?w: 0.06 to 0.81, median: 0.56). In the second session, agreement for the scores was fair to excellent (?w: 0.36 to 0.89, median: 0.65). The ?w increased for 41 (85%), and decreased for seven (15%) observers. A statistically significant difference in ?w was found between the two sessions (P < 0.001). In the first session, there was agreed presence for 11, agreed absence for 12, disagreement for 19, and eight undecided cases. Ten (91%) of the agreed presence cases had chronic interstitial pneumonia with reticular opacity/honeycombing. Ten (83%) of the agreed absence cases had airway disease on CT. The mean costs for additional evaluation were $2 (95% CI: $1.3-$3.0) per participant and $101 (95% CI: $78-$126) per individual with detected high/moderate ECFs. Detection of important ECFs was not related to patient gender (P=0.31) and age (P=0.13). However, important ECFs were more likely to be detected in positive screening results vs. negative screening results (ORs, 4.1; 95% CI: 1.8-8.1; P<0.001). Any ambiguity regarding clinic significance of ECFs was resolved with meeting consensus. ECFs assigned to E4 or E3 category were referred for additional workup. Costs of diagnostic procedures (mean, $2 per participant).

CONCLUSION
Although the definition of traction bronchiectasis in chronic interstitial pneumonia appears to be congruent between observers, disagreement is often seen in cases with acute/subacute interstitial lung diseases.

CLINICAL RELEVANCE/APPLICATION
To improve interobserver agreement, traction bronchiectasis should be used as a finding of dilated bronchi only in areas with radiological evidence of interstitial fibrosis.

Gastrointestinal (CT Colonography) Wednesday, 10:30 AM - 12:00 PM • E351

CT Colonography (CTC): Extracolonic Findings in a Public Organized Screening

Gabriella Iussich MD (Presenter) *; Loredana Correale PhD *; Carlo Senore MD *; Nereo Segnan; Cesare Hassan; Daniele Regge MD; Paolo Falco *; Stefania Montemezzi MD; Alberto Bert PhD *

PURPOSE
To evaluate the frequency and costs of additional diagnostic workup for extracolonic findings (ECFs) detected at CTC in a public organized screening program.

METHOD AND MATERIALS
CTC cases performed within a randomized multi-center screening trial were included in this study. The trial enrolled asymptomatic persons aged 58-60 years undergoing low-dose CTC screening without contrast material. CTCs were prospectively read by experienced radiologists; positive patients (ie, polyps >5-mm) were referred for colonoscopy. All ECFs reported in the initial report were reviewed by two radiologists and were classified as being of high/moderate significance (E4 or E3) vs. minor (E2). Any ambiguity regarding clinic significance of ECFs was resolved with meeting consensus. ECFs assigned to E4 or E3 category were referred for additional workup. Costs of diagnostic procedures due to these ECFs were evaluated. Regression analysis was also performed to assess the related factors in ECF detection.

RESULTS
Of the 1652 (851 men) included subjects, 71 ECFs were found in 68 (4.1%) patients, with 31 (1.9%) of minor significance; 26 (1.5%) moderate and 11 (0.7%) high. The most common E4 findings were ovarian mass (n=2), urinary tract mass (n=2) and, pulmonary nodule >9mm (n=2). Further diagnostic workup was recommended in 37 (2.2%; one per 45 patients) of patients, including 9 patients having previously identified ECFs. Additional tests having previously identified ECFs. Additional tests included: ultrasound (n=19); CT scan (n=6) and other diagnostic imaging (n=8). The mean costs for additional evaluation were $2 (95% CI: $1.3-$3.0) per participant and $101 (95% CI: $78-$126) per individual with detected high/moderate ECFs. Detection of important ECFs was not related to patient gender (P=0.31) and age (P=0.13). However, important ECFs were more likely to be detected in positive screening results vs. negative screening results (ORs, 4.1; 95% CI: 1.8-8.1; P

CONCLUSION
About 2% of asymptomatic subjects participating in a public organized CTC screening program will present important ECFs (one per 45 examinations). Early detection of important diseases may add benefit to screening intervention outweighing the incremental costs for diagnostic procedures (mean cost, $2 per participant).

CLINICAL RELEVANCE/APPLICATION
Our results provide information regarding the estimate of important ECFs rate in an organized CTC screening program and should be considered carefully to evaluate ECFs related costs and benefit.

SSK05-02 • Initial Endoscopy Following Screening CT Colonography: Confirmed versus Discordant Polyps

Bryan D Pooler MD (Presenter); Perry J Pickhardt MD *; David H Kim MD *

PURPOSE
Endoscopy (optical colonoscopy or flexible sigmoidoscopy) with polypectomy is recommended following significant findings at CT colonography (CTC). Our purpose was to analyze the difference between colon polyps detected at screening CTC that were subsequently confirmed at initial endoscopy and those that were discordant (not found).

METHOD AND MATERIALS
We collected data from 7157 consecutive adult patients (mean age 56.6±7.2 years, M:F 3285:1051) undergoing first-time screening CTC over an eight-year period at a single academic center. A total of 1051 patients were positive for polyps =6 mm at CTC. Of these, 751 patients with a total of 1272 polyps =6 mm went to endoscopy. Characteristics of all polyps detected at CTC—including size, location, morphology, and diagnostic confidence—were recorded, and those polyps confirmed at endoscopy were compared against those that were discordant.

RESULTS
Of 12/72 colon polyps =6 mm in diameter that went to endoscopy, 115/3 (89.7%) were confirmed and 119 (10.3%) were discordant. Polyps confirmed were more likely to be sessile (63.1% vs 46.2%), 
P
CONCLUSION
For polyps detected at screening CTC, there were significant differences seen in polyp morphology, polyp location, and diagnostic confidence between those confirmed at initial endoscopy versus those that were discordant.

CLINICAL RELEVANCE/APPLICATION
Discordant polyps at initial endoscopy following screening CTC are more likely to be flat lesions, right-sided, and called with low diagnostic confidence.

SSK05-03 • Post-surgery Follow-up Colonoscopy of the Colon Proximal to an Occlusive Cancer, Which Was Found Negative on Pre-surgery CT Colonography
Bohyun Kim MD (Presenter); Seong Ho Park MD *; Jong Seok Lee; Ah Young Kim MD; Hyun Kwon Ha MD

PURPOSE
To suggest the optimal timing for follow-up colonoscopy of the proximal colon after surgical resection of an occlusive cancer when pre-surgery CT colonography (CTC) was negative in the proximal colon.

METHOD AND MATERIALS
461 consecutive patients with occlusive colorectal cancer underwent CTC for proximal colonic evaluation, of which 304 patients were negative in the proximal colon on adequately performed CTC. Excluding those who underwent surgical removal of the proximal colon or palliative ostomy (n=88) and those whose post-surgery colonoscopy was absent (n=42), 174 patients (M:F; 86:88; age, 58±11 years) operated on between January 2006 and March 2010 constituted the cohort for this study. Results of all post-surgery colonoscopic examinations were reviewed. Pathology, size, and the time from CTC to colonoscopic identification of proximal colonic lesions were collected. The time from CTC to the first discovery of any clinically relevant lesions (i.e. adenoma 6 mm or greater, advanced adenoma, or cancer) in the proximal colon was analyzed using Kaplan-Meier method and the cumulative risk of the clinical relevant lesions across the follow-up time was calculated.

RESULTS
Length of the colonoscopy was 3.81 months (median; 33), during which 1-8 colonoscopies per patient (median; 2) were performed (a total of 5444 patient months and 368 colonoscopies). The probability (standard error) of not having any clinically relevant lesions in the proximal colon at 6 months and at 1.5, and 2 years was 97.8% (1.2%), 96.4% (1.5%), 91.2% (2.3), and 89.5% (2.6%), respectively. 152 patients did not develop any clinically relevant lesions for 3-76 months (median; 31). 15 patients were found having nonadvanced adenomas 6 mm or greater at 4-68 months (median; 18). 7 patients presented with advanced adenomas at 6-43 months (median; 13). None was post-surgically identified as having cancers in the proximal colon.

CONCLUSION
If the colon proximal to an occlusive cancer was negative on adequately performed CTC, the probability of finding clinically relevant lesions in the proximal colon post-surgically was fairly low until 1 year after the CTC (cumulative risk of 3.6%) although advanced adenoma was found as early as at 6 months.

CLINICAL RELEVANCE/APPLICATION
Additional colonoscopy at 3-6 months post surgery for evaluating the colon proximal to occlusive cancer currently recommended may not be necessary if preoperative CTC was well performed and negative.

SSK05-04 • Feasibility of Ultra-low kVp CT Colonography: Effect of Different Iterative Reconstruction Algorithms on Radiologists’ Performance Using Anthropomorphic Colon Phantoms
Cheong-II Shin MD (Presenter); Se Hyung Kim; Eun Sun Lee MD, PhD; Dong Ho Lee MD; Eui Jin Hwang; Se-Yeong Chung; Jeong-Min Lee MD *; Joon Koo Han MD; Byung Ihn Choi MD, PhD *

PURPOSE
To analyze the effect of a decrease in tube voltage from 100–120 kVp to 80 kVp in CT colonography (CTC) on dose, image noise, and diagnostic performance using anthropomorphic phantoms and to assess the effect of two different iterative reconstruction algorithms on radiologists’ performance.

METHOD AND MATERIALS
Seven colon phantoms with 68 simulated polyps =6 mm were scanned at different kVp settings (80, 100, and 120 kVp) and 10 mAs. Images were reconstructed using filtered back projection (FBP), statistical model-based iterative reconstruction (iDOSE®), and knowledge-based iterative reconstruction algorithm (IMR). Nine datasets for each phantom according to 3 kVp settings and 3 reconstruction algorithms yielded 63 CTC datasets. Volume CT dose index (CTDI vol) and image noise were recorded and compared. Two readers blinded to kVp and reconstruction algorithm independently reviewed CTC using primary 3D method. Per-polyp sensitivity was compared among the datasets.

RESULTS
Decreasing tube voltage from 120 and 100 to 80 kVp resulted in 70.7% and 50.5% significant reduction in CTDI vol, respectively (P=0.014). Effective radiation dose of 80 kVp CTC was 0.17 mSv. With FBP reconstruction, image noise in 80 kVp was significantly lower than those in 100 kVp (P=0.014) and 120 kVp (P=0.014), respectively (P=0.014) and per-polyp sensitivity (14.7%, 7.4%) was significantly lower than those in 100 kVp (57.4%, 39.7%) and 120 kVp (85.3%, 83.8%) (P=0.018 but, per-polyp sensitivity (79.4%, 66.2%) in 80 kVp was still significantly lower than those of 100 kVp (95.6%, 86.8%) and 120 kVp (98.5%, 89.7%). IMR was not significantly different from those in 100 kVp (95.6%, 95.6%) and 120 kVp (95.6%, 95.6%) for both readers (P>0.05).

CONCLUSION
A decrease in tube voltage to 80 kVp results in a significant reduction of radiation dose to 0.17 mSv at a cost of significant deterioration in image noise and diagnostic performance. With application of knowledge-based iterative reconstruction algorithm, radiologists’ performance of 80 kVp CTC is acceptable and is on par with 100 or 120 kVp CTC.

CLINICAL RELEVANCE/APPLICATION
Ultra-low kVp CT colonography with 80 kVp can be feasible with an application of knowledge-based iterative reconstruction algorithm, significantly lowering the radiation dose with sub-mSv.

SSK05-05 • Reduce CT Colonography (CTC) Radiation Dose Using Model Based Iterative Reconstruction (MBIR) while Maintaining Image Quality
Patrick Miller MD (Presenter); Wendy L Stiles MD; C. Daniel Johnson MD *; Jeffrey T Lund MD; Robert G Paden; Qiu Wu; Amylou Dueck PhD; Amy K Hara MD *

PURPOSE
Reduce CT colonography (CTC) radiation dose using model based iterative reconstruction (MBIR) while maintaining image quality.

METHOD AND MATERIALS
After colon prep w/ stool tagging, 20 patients (11M/9F; 40-95 yrs, Ave. BMI=31.6) underwent CTC standard dose (SD) and reduced dose (RD). 2 acquisitions at SD in supine and prone positions: 120 kVp, Auto mAs (m/M 30/450), Noise index (NI)=65, yield ave. dose 4 mSv. Additional single supine acquisition at RD: NI=92, other parameters unchanged, expected 50% reduced radiation dose. All
images reconstructed with 3 algorithms: filtered back projection (FBP), adaptive statistical iterative reconstruction (ASIR), MBIR. Image noise quantified using ROI to measureHU standard deviation at 5 locations (liver, kidney, both psoas muscles, aorta) in each patient. Also, images reviewed by 2 experienced radiologists (>500 CTC cases) blinded to scan technique. Observers independently scored image quality and noise at 3 sites (cecum, rectosigmoid, splenic flexure). Image noise was graded on a scale from 0 to 4 (nondiagnostic to no perceptible noise). Image quality was scored from 0 (nondiagnostic) to 4 (high confidence of detecting =5 mm lesion).

RESULTS
Average CTDI decreased 60% from 6.7 mGy on SD to 2.7 mGy on RD. As expected, measured average image noise level increased from SD (FBP 58.6, ASIR 35.8, MBIR 16.6) to RD (FBP 97.2, ASIR 60.6, MBIR 21.9); all algorithms improved measured noise levels. Importantly, noise was less on RD MBIR compared to SD ASIR images (p < 0.001).

CONCLUSION
60% RD 2D and 3D CTC reconstructed with MBIR had less visual noise both objectively and subjectively compared to SD ASIR. Image quality on RD MBIR 2D and 3D CTC was not perceived to be significantly different compared to SD ASIR, but RD MBIR images were slightly better quality than comparable ASIR.

CLINICAL RELEVANCE/APPLICATION
Image quality was not compromised on RD MBIR images. Thus, CTC image quality can be maintained with 60% radiation dose reduction.

SSK05-06 • Effect of Different Reconstruction Algorithms on Computer-aided Diagnosis (CAD) Performance in Ultra-low Dose CT Colonography

Eun Sun Lee MD, PhD (Presenter) ; Se Hyung Kim ; Jong Pil Im ; Sang Gyun Kim ; Cheong-Il Shin MD ; Joon Koo Han MD ; Byung Ihn Choi MD, PhD *

PURPOSE
To assess the effect of different reconstruction algorithms on computer-aided diagnosis (CAD) performance in ultra-low dose CT colonography (CTC).

METHOD AND MATERIALS
Twelve patients who underwent same-day CTC and colonoscopy were prospectively enrolled. Non-contrast CTC was performed with 120kVp/10mA in supine and 100kVp/10mA in prone. Fecal tagging was done with 50ml of iodinated contrast agent (gastrografin). CTC images were reconstructed with three different reconstruction algorithms: filtered back projection (FBP), 80% adaptive statistical iterative reconstruction (ASIR80), and model-based iterative reconstruction (MBIR, VEO) algorithm. Commercial CAD (ColonCAD, Philips Medical Systems) was applied to CTC dataset. Per-polyp sensitivity and the number of false-positives (FP) were recorded and compared among the reconstruction algorithms using McNemar test and Friedman test, respectively.

RESULTS
Mean effective radiation dose of CTC was 1.02 mSv (range, 0.94 ~ 1.12 mSv). Forty-seven polyps were detected and removed by colonoscopy. Of them, 27 polyps were detected in each supine and prone CTC dataset. Therefore, 24 CTC datasets of 12 patients contain 54 visible polyps (8 polyps per-polyp sensitivity of CAD was not acceptable in ultra-low dose CTC with FBP reconstruction. However, it can be improved with an application of iterative reconstruction algorithm with insignificant increase in false-positive. Between the two iterative reconstruction algorithms, ASIR might be more beneficial than MBIR on CAD performance in terms of both per-polyp sensitivity and the number of false-positives.

CLINICAL RELEVANCE/APPLICATION
With application of hybrid-iterative reconstruction algorithm, CAD can show acceptable per-polyp sensitivity for polyps =10mm and number of false-positive even in ultra-low dose CT colonography.

SSK05-07 • Computer-aided Detection for Laxative-free Non-cathartic CT Colonography: Standalone Performance in a Screening Population

Janne J Nappi PhD (Presenter) * ; Minh Phan ; Michael E Zalis MD * ; Hiroyuki Yoshida PhD *

PURPOSE
To evaluate the standalone detection performance of a fully automated computer-aided detection (CAD) scheme in a laxative-free (non-cathartic) CT colonography (ICTC) screening population.

METHOD AND MATERIALS
A total of 605 asymptomatic men and women (age: 50-85 years) were prepared for an ICTC examination (3.75-mm maximum slice thickness, 120 kVp, and 50 mAs effective) at 4 medical centers with two-day dietary fecal tagging by non-ionic iodine. The precise spatial locations of lesions that were confirmed by segmentally unblinded colonoscopy were identified in the CTC data prospectively and retrospectively. A fully automated CAD scheme was trained to detect polyps by use of an independent set of 204 cathartic and non-cathartic CTC cases with 263 lesions. The CAD scheme was tested with the 605 ICTC cases. The per-lesion and per-patient sensitivities were evaluated by use of bootstrap analysis. The maximum number of CAD detections was limited to 15 per patient to avoid indication fatigue.

RESULTS
There were 21 (61) biopsy-confirmed retrospectively visible carcinomas or adenomas =10 mm (6=9 mm) in size in 21 (54) patients, and there were 6 hyperplastic lesions =10 mm. The CAD detected 95% (95% CI: 81-100%) of =10 mm lesions/patients at a median/average of 7 false-positive (FP) detections per patient. The CAD detected all cancers (n=3) and all but one of the hyperplastic lesions. For 6=9 mm lesions, the average per-lesion sensitivity was 61% (46-73%) and the per-patient sensitivity was 63% (50-78%). The principal source of FP CAD detections was poorly tagged feces mimicking soft-tissue lesions.

CONCLUSION
CAD provided high detection sensitivity for =10 mm lesions in an ICTC screening population, but for 6=9 mm lesions the detection sensitivity was relatively low.

CLINICAL RELEVANCE/APPLICATION
CAD could be used to realize an effective laxative-free CTC examination for improving patient adherence to colorectal screening, but its performance has not been evaluated in a screening population.

SSK05-08 • Computer-aided Detection of Non-polypoid Flat Lesions in CT Colonography: Observer Performance Study

Yasuji Ryu MD (Presenter) ; Janne J Nappi PhD * ; Minh Phan ; Wenli Cai PhD ; Daniele Regge MD ; Hiroyuki Yoshida PhD * ; Yin Wu

PURPOSE
To evaluate the effect of optimized computer-aided detection (CAD) on the performance of human readers in the detection of non-polypoid flat lesions in asymptomatic patients from a large multi-center CT colonography (CTC) clinical trial.

METHOD AND MATERIALS
A total of 200 cathartic CTC cases including colonoscopy-confirmed, morphologically flat lesions and normal examinations were
DSC-MR depicts kinetic differences in perfusion parameters among the different common type of benign and malignant liver lesions, benign lesions and malignant lesions.

252,9 sec for colangiocarcinoma. A statistical difference (p < 0.05) was achieved in all the perfusion parameters calculated between RLE 17.3%, ME 295.0%, MRE 26.6%, TTP 149.2 sec for HCC; RAE 20.3%, RVE 51.4%, RLE 62.7%, ME 367.4%, MRE 62.7%, TTP 15.1%, RLE 38.8%, ME 123.4%, MRE 29.9%, TTP 181.8 sec for abscesses. Perfusion mean values calculated in malignant lesions sec for angiomas; RAE 79.82%, RVE 93.28%, RLE 81.99%, ME 1100.66%, MRE 98.28%, TTP 181.8 sec for FNH; RAE 5.6%, RVE 123.4%, RLE 138.8%, ME 29.9%, MRE 29.9%, TTP 181.8 sec for colangiocarcinoma. A statistical difference (p < 0.05) was achieved in all the perfusion parameters calculated between benign lesions and malignant lesions. 

CLINICAL RELEVANCE/APPLICATION
Colorctal flat lesions were difficult to be found by reader. CAD may improve sensitivity for flat lesion.

SSK05-09 • Reproducible Quantitative Assessment of Colonic Morphology Using Novel CTC Software: Men versus Women

Charles N Weber MD (Presenter); Anna S Lev-Toaff MD; Jason Poff MD; Andrew S Wilmot MD; Hanna M Zafar MD; Marc S Levine MD; Sandra Sudarsky *; Luiz Guendel *; Bernhard Geiger *

PURPOSE
We developed novel CTC software for the purpose of performing reproducible quantitative analysis of colonic morphology. Using this method, our aim was to determine if there are significant differences between genders which may explain higher rates of incomplete optical colonoscopy among women.

METHOD AND MATERIALS
CTC datasets from 20 men and 20 women with incomplete optical colonoscopies and no acute symptoms were compared using software to determine total and segmental colonic length, volume, tortuosity (number of acute angles with 8cm limbs), compactness (boxed volume containing colon or segments divided by respective lengths), and height of the sigmoid apex relative to the lumbosacral junction. Quantitative assessment of the datasets was performed twice each by two different readers on different occasions. Statistical analyses were performed using the unpaired two-tailed student T-test. Intra-reader and inter-reader reliabilities were evaluated using the concordance correlation coefficient.

RESULTS
Women had greater tortuosity (turns) of the total colon (10.60 vs 7.53, p < 0.05). Differences were also evidenced for compactness, volumes, and sigmoid apex height. Statistical significance was observed between the genders in tortuosity, compactness, volumes, and sigmoid apex height which may explain differences in optical colonoscopy performance. This software may have other beneficial applications for CTC.

CLINICAL RELEVANCE/APPLICATION
Detailed quantitative assessment of colonic morphology is both feasible and reproducible, and may help us to identify patient groups who are at increased risk for incomplete optical colonoscopy.

Gastrointestinal (Focal Liver Lesions and Metastases) Wednesday, 10:30 AM - 12:00 PM • E350 Back to Top

SSK06 • AMA PRA Category 1 Credit™:1.5 • ARRT Category A+ Credit:1.5 Moderator Claude B Sirlin, MD *

Moderator Mark E Lockhart, MD

Moderator Kathryn J Fowler, MD *

SSK06-01 • Detection and Characterization of Focal Liver Lesions: Added Value and Diagnostic Accuracy of Dynamic Contrast Magnetic Resonance Perfusion Imaging

Maddalena Colombo MD (Presenter); Davide Ippolito MD; Pietro A Bonaffini MD; Davide Fior MD; Orazio Minutolo MD; Sandro Sironi MD

PURPOSE
To assess the diagnostic accuracy of dynamic susceptibility contrast-enhanced perfusion images in differentiation between benign and malignant focal liver lesions by the assessment of tumoural perfusion kinetics.

METHOD AND MATERIALS
A total of 73 patients with known focal liver lesions including 45 benign (16 FNH, 27 angiomas, 2 abscesses) and 28 malignant ones (17 metastases, 9 HCCs, 2 colangiocarcinoma) underwent 1.5 T MRI (Achieva, Philips) upper abdominal study with a phase array multi-coil and with standard protocol that included dynamic study. On dedicated workstation, time-intensity curves were created in order to generate color permeability maps, showing perfusion of enhancing tumors. ROIs were manually drawn inside the focal liver lesions and on the normal hepatic parenchyma. Perfusion data, as relative arterial, venous and late enhancement (RAE, RVE, RLE%), maximum enhancement (ME%), relative enhancement (RE%), time to peak (TTP, sec) were statistically analyzed.

RESULTS
All the diagnosis were established either by histopathology or imaging follow-up (size increase of over a period of time). Perfusion mean values calculated in benign lesions were: RAE 15.98%, RVE 89.17%, RLE 121.12%, ME 1103.94%, MRE 130.64%, TTP 169.4 sec for angiomas; RAE 79.82%, RVE 93.28%, RLE 81.99%, ME 1100.66%, MRE 98.28%, TTP 89.62 sec for FNH; RAE 5.6%, RVE 123.4%, RLE 138.8%, ME 29.9%, MRE 29.9%, TTP 181.8 sec for abscesses. Perfusion mean values calculated in malignant lesions were: RAE 38.43%, RVE 55.11%, RLE 62.57%, ME 683.94%, MRE 60.24%, TTP 149.28 sec for metastases; RAE 8.1%, RVE 15.1%, RLE 17.3%, ME 295.0%, MRE 26.6%, TTP 149.2 sec for HCC; RAE 20.3%, RVE 51.4%, RLE 62.7%, ME 367.4%, MRE 62.7%, TTP 252.9 sec for colangiocarcinoma. A statistical difference (p < 0.05) was achieved in all the perfusion parameters calculated between benign lesions and malignant lesions.

CONCLUSION
DSC-MR depicts kinetic differences in perfusion parameters among the different common type of benign and malignant liver lesions, by offering information about the tumour supply and microvascular tissue characteristics.

CLINICAL RELEVANCE/APPLICATION
DSC perfusion MRI is a feasible technique for the assessment of focal liver lesions, offering quantitative information related to biological characteristics of different tumour tissue.

SSK06-02 • Feasibility of Blood Oxygenation Level-Dependent MR Imaging at 3 T in the Characterization of Hepatic Tumors

Young Kon Kim MD, PhD; Hyun Jeong Park (Presenter); Dongil Choi; Won Jae Lee MD
SSK06-03 • Characterization of Benign Liver Lesions with Ultrasound Quantitative Supersonic Shear Wave Elastography

Maxime Ronot MD (Presenter) ; Sara Di Renzo ; Bettina Gregoli MD ; Simon Lambert ; Rafaela Duran MD ; Valerie Vilgrain MD

PURPOSE
To prospectively assess the stiffness of a consecutive series of benign focal liver lesions (FLL), using supersonic shear wave elastography (SWE).

METHOD AND MATERIALS
Between January 2012 and March 2013, all focal liver lesions (FLL) fortuitously discovered during an ultrasound (US) examination were prospectively included. Patients with underlying chronic liver disease and malignant lesions were excluded. On all patients and for each lesion a quantitative elastography image was acquired. The largest possible region of interest was placed in the lesion to quantitatively assess its stiffness, measured in kPa. Characterization of the lesion relied either on a combination of MR imaging, CT, and contrast enhanced US features, or on biopsy. Tumor elasticity was analyzed using ANOVA and non-parametric Mann-Whitney tests.

RESULTS
112 FLL in 76 patients were analyzed. For 10 lesions (9%) in 6 patients (8%), SWE data could not be obtained due to patient motion (n=4), major steatosis (n=2) or a deep lesion (n=2). 102 lesions were successfully evaluated in 70 patients (61 women, 87%) with a mean age of 44.8 (range: 20-75). The mean stiffness was 33.3 +/- 12.7 kPa for the 60 nodal hyperplasia (FNH), 19.7 +/- 9.8 kPa for the 17 hepatocellular adenomas (HCA), 17.1 +/- 7 kPa for the 20 hemangiomas, and 11.3 +/- 4.3 kPa for the 5 focal fatty sparing tumors for patients who cannot receive gadolinium-based contrast agents.

CONCLUSION
Liver BOLD MR imaging at 3 T is feasible to predict hypervascularity and vascular pattern of various hepatic tumors because T2* and R2* values are different among hepatic tumors according to tumor vascularity and color map of T2* values also well reflect tumor vascularity when compared to contrast-enhanced MR imaging, particularly in hepatic tumors > 2.0 cm.

CLINICAL RELEVANCE/APPLICATION
Liver BOLD MR imaging at 3 T could be an alternative tool to gadolinium-enhanced MR imaging to predict vascularity of hepatic tumors for patients who cannot receive gadolinium-based contrast agents.

SSK06-04 • Role of Acoustic Radiation Force Impulse Elastography in Characterization of Focal Solid Hepatic Lesions: Feasibility, Imaging Considerations and Preliminary Experience

Harshavardhan Nagolu MBBS (Presenter) ; Sudhakar Katloju DMRD, MD ; Meera Krishnakumar DMRD, MD ; Chidambaranathan Natesan MD, PhD

PURPOSE
1. To analyze if focal liver lesions can be characterized as benign and malignant based on their appearance on ARFI elastogram images in relation to conventional grayscale ultrasonography images. 2. To assess the accuracy of ARFI Elastometry in characterization of solid liver lesions based on differences in their shearwave velocities.

METHOD AND MATERIALS
In this prospective study, 52 patients with 60 focal solid liver lesions were single blindedly analyzed on ARFI Elastography, which included 25 benign (21 hemangiomas, 2 abscesses, 1 adenoma and one granuloma), 27 malignant (22 HCCs, 3 adenocarcinomas of gall bladder, one fibrolamellar carcinoma and one leiomyoma), and 8 metastases (from colon, adenocarcinoma, one each from adenocarcinoma stomach, liver, gallbladder, rectum and transitional cell carcinoma of ureter). 30 age and sex matched controls were analyzed for normal shearwave velocity. Both qualitative and quantitative elastography were performed in these patients using Siemens ACUSON S 2000 US machine. The size and stiffness of the lesions were analyzed with respect to grayscale US images. The shearwave velocities were quantified in these lesions. All the findings were correlated with histopathology of the lesions.

RESULTS
Malignant liver lesions were found to be predominantly stiffer (88%) and larger (74%), while benign lesions were predominantly similar in stiffness to background liver (44%) or softer (40%) and were similar in size (88%). The shearwave velocities were: benign lesions 1.3 +/− 0.35 m/s; malignant lesions 2.93 +/− 0.74 m/s; metastatic lesions 2.77 +/− 0.90 m/s. Statistically significant differences exist between the shearwave velocities of benign and malignant groups of lesions.

CONCLUSION
ARFI elastography can be useful addition to conventional US in improving the characterization of benign and malignant solid liver lesions. Further studies with larger population and diverse pathologies is necessary to prove its clinical implication in their characterization.

CLINICAL RELEVANCE/APPLICATION
As conventional US features are non specific in characterization of solid liver lesions, addition of ARFI elastography might help in early and accurate characterization of focal solid liver lesions.

SSK06-05 • Correlation between Size and ADC Value in Liver Metastasis

Maria Luiza Testa MD (Presenter) ; Rubens Chojniak MD, PhD ; Letícia S Sene MD
PURPOSE
To prospectively study the influence of the size of liver metastases in the quantitative value of the apparent diffusion coefficient (ADC) obtained through DW-MRI. This technique has been studied for detection, characterization and even to assess therapeutic response, but few studies have evaluated the factors affecting the quantitative analysis of ADC and no studies have correlated the variation of the ADC with the dimensions of metastatic liver lesions.

METHOD AND MATERIALS
We analyzed 262 hepatic metastatic lesions identified in 58 adult patients who underwent upper abdominal MRI with diffusion technique. Lesions with at least 5 mm or greater in diameter were evaluated. The sequence of diffusion was performed with normal breathing, two values of b (200 and 600 sec/mm²) for detection and characterization of liver lesions. The apparent diffusion coefficient (ADC) of each lesion was obtained using the ROI (Region of Interest) positioned centrally and occupying about 50% of the lesion. Quantitative evaluation was performed by measuring the ADC value of each lesion. ADC values were correlated with the size of the lesion.

RESULTS
The average ADC of all metastatic liver lesions analyzed (n=262) was 1.1 x 10⁻³ mm²/sec [standard deviation (SD) = 0.1]. [confidence interval (CI) 95%: 1.01-1.2 x 10⁻³ mm²/sec]. The average size of metastatic liver lesions was 19.8 mm (SD = 13.6) and a median of 16.5 mm, with a minimum of 5.0 mm and a maximum of 104.8 mm. In our study we observed that the mean ADC of metastatic liver lesions smaller than the median of 16.5 mm (n=130) was 1.0 x 10⁻³ mm²/sec ± 0.1 CI 95%: 0.9-1.1 x 10⁻³ mm²/sec while lesions with dimensions equal or superior than 16.5 mm (n=132), the ADC value was 1.2 x 10⁻³ mm²/sec ± 0.1 CI 95%: 1.1-1.4 x 10⁻³ mm²/sec, with statistical significance (p<0.05).

CONCLUSION
Larger metastatic liver lesions have higher ADC values. The increase in the size of lesions is normally associated with progression of disease but could be paradoxically accompanied by increased the ADC value, usually associated with reduced cellularity and response to therapy.

CLINICAL RELEVANCE/APPLICATION
The ADC value increases with the size of the liver metastases. It may have an impact on the utilization of DW-MRI for lesion characterization and for monitoring of therapeutic response.

SSK06-06 • ‘Extended Washout’-A New Sign for Distinguishing Hepatic Metastases from Hemangiomas on Gadoxetate Disodium-enhanced MRI

Sheela Agarwal MD, MS (Presenter) ; Seyed Mahdi Abtahi MD ; Azadeh Elmi MD ; Jason J Carroll MD ; Mukesh G Harisinghani MD ; Peter F Hahn MD, PhD *

PURPOSE
To describe the enhancement pattern of hemangiomas with gadoxetate disodium and propose a new sign—the ‘extended washout sign’ to diagnose hemangiomas on hepatobiliary phase imaging.

METHOD AND MATERIALS
In this retrospective study, quantitative and qualitative image analysis of 45 hemangiomas and 37 metastases in 77 patients who performed, Gadoxetate-enhanced MR imaging was obtained during arterial and portal-venous phase, and delays of 3, 8, and 20 min to describe enhancement characteristics. During each phase, signal intensities were measured for the lesion, liver, and aorta, and were normalized using paraspinal musculature. Quantitatively, extended washout was defined as a 10% change in signal intensity from 8 to 20 minutes. Statistical analysis was performed using paired Student t-test. Qualitative analysis was also performed by one blinded reader, who assessed the appearance of all lesions on T2-weighted images alone, dynamic images alone, and combined early (8 min) and late (20 min) hepatobiliary phase images. ROC analysis was used to estimate the diagnostic accuracy of the various sequences to distinguish hemangioma from metastasis.

RESULTS
On quantitative analysis, 84% of hemangiomas demonstrated a positive extended washout sign while only 18% of metastases did. Hemangiomas demonstrated a mean change in signal intensity of 18.4% as compared to 4.1% for metastases (p<0.001). Majority of hemangiomas demonstrate a positive extended washout sign, which is not seen with most metastases. This sign, particularly when combined with T2 signal intensity, can be used to increase accuracy of differentiating hemangiomas from metastases on gadoxetate-enhanced MRI.

CONCLUSION
Majority of hemangiomas demonstrate a positive extended washout sign, which is not seen with most metastases. This sign, particularly when combined with T2 signal intensity, can be used to increase accuracy of differentiating hemangiomas from metastases on gadoxetate-enhanced MRI.

CLINICAL RELEVANCE/APPLICATION
Extended washout sign, particularly when used in conjunction with T2 signal intensity, can be used to increase accuracy of differentiating hemangiomas from metastases on gadoxetate-enhanced MRI.

SSK06-07 • Diagnostic Dilemma: Hepatic Angiomyolipoma versus Hepatocellular Carcinoma in Non-cirrhotic Liver on Gd-EOB-DTPA-enhanced MR

So Jung Lee (Presenter) ; So Yeon Kim MD ; Kyoung Won Kim MD ; Jin Hee Kim MD ; Yong Moon Shin ; Moon-Gyu Lee MD

PURPOSE
To describe imaging characteristics of hepatic angiomyolipoma (AML) on Gd-EOB-DTPA-enhanced MR and to identify imaging features helpful to differentiate it from hepatocellular carcinoma (HCC) in non-cirrhotic liver

METHOD AND MATERIALS
We retrospectively identified 18 patients with pathologically proven hepatic AML who underwent Gd-EOB-DTPA-enhanced MR. We randomly chose 36 patients from 91 patients who had single HCC in non-cirrhotic liver on Gd-EOB-DTPA-enhanced MR during the same period. Two readers in consensus reviewed all the images to assess the size, the presence of fat component, enhancement profile, tumor capsule, tumoral vessels and early draining veins. For the quantitative analysis, contrast enhancement ratio (CER) and SI ratio of lesions were measured on the dynamic and hepatobiliary phases. These features and measurements were compared between the AML and HCC groups.

RESULTS
No significant difference in the size between AML (3.4 cm) and HCC (4.5 cm) (P=0.15). Intratumoral fat component was more common in AML (44.4 %) than HCC (22.2%) but not statistically significant (P=0.11). Dynamic enhancement profile was similar between the two groups: in particular, arterial hypervascularity and wash-out on theportal or delayed phases were common in both HCC (97.2%) and AML (83.3%) (P=0.10). Almost all AML (100%) and HCC (94.4%) were hypointense on the hepatobiliary phase (P=0.04). However, they differed significantly for tumor capsule on the delayed phase (no tumor capsule: AML vs. HCC, 94.4 vs. 83.3%, P=0.04) and early draining vein (38.8% vs. 11.1%, P=0.03). In the quantitative analysis, arterial enhancement for AML was stronger than that of HCC (CER, 140.1% vs. 89.6%, P=0.03). However, they differed significantly for tumor capsule on the delayed phase (no tumor capsule: AML vs. HCC, 94.4 vs. 83.3%, P=0.10). Almost all AML (97.2%) and HCC (83.3%) were hypointense on the hepatobiliary phase (P=0.04). They differed significantly for tumor capsule on the delayed phase (no tumor capsule: AML vs. HCC, 94.4 vs. 83.3%, P=0.04) and early draining vein (38.8% vs. 11.1%, P=0.03).

CONCLUSION
On Gd-EOB-DTPA-enhanced MR of non-cirrhotic liver, it is often difficult to differentiate AML from HCC, since they share similar enhancement characteristics. However, AML is more commonly without tumor capsule but contains intratumoral vessel and early draining vein. Qualitative analysis can facilitate the differentiation of AML from HCC.

CLINICAL RELEVANCE/APPLICATION
On Gd-EOB-DTPA-enhanced MR of non-cirrhotic liver, AML is often indiscernible from HCC with the enhancement characteristics alike. Capsule, tumoral vessel and early draining vein can be helpful clues.
SSK06-08 • Rapidly Enhancing Hemangioma versus Hypervascular Hepatocellular Carcinoma Showing Washout Appearance on Gadoxetic Acid-enhanced Hepatic MRI: Usefulness of Diffusion-weighted Imaging for Differential Diagnosis

**Sejin Nam MD (Presenter) ; Jeong-Sik Yu MD ; Eun-Suk Cho ; Jae-Joon Chung MD ; Joo Hee Kim ; Ki Whang Kim MD**

**PURPOSE**
To validate the diffusion-weighted imaging (DWI) in the differential diagnosis of rapidly enhancing hemangiomas showing washout appearance on gadoxetic acid-enhanced hepatic MRI from hypervascular hepatocellular carcinomas (HCCs).

**METHOD AND MATERIALS**
For 54 hemangiomas (0.3 to 1.9 cm, mean 0.7 cm; in 44 consecutive patients) showing homogeneous enhancement on the arterial dominating dynamic phase images during the gadoxetic acid MR imaging, DWI (b=50 and 800 s/mm2) with apparent diffusion coefficient (ADC) map were retrospectively analyzed and compared with 113 hypervascular HCCs (0.4 to 2.0 cm, mean 0.9 cm; in 66 consecutive patients) showing similar pattern of contrast enhancement. In addition to measurement of mean ADC by drawing region-of-interest in each lesion on the ADC map, qualitative analysis of DWI was performed using a five-grade scale by two independent observers.

**RESULTS**
Mean ADC of hemangioma was significantly larger than HCC (1.94 versus 1.00 x 10-3 mm2/s, p < .0001) on both 1.5T and 3T scanners. In particular, both the moderate and severe CP groups had significantly lower SIR than those in the normal group (p < .0001). The four groups (mild/moderate/severe CP and normal) showed significant differences in SIR (p < .0001) on both 1.5T and 3T scanners. In particular, both the moderate and severe CP groups had significantly lower SIR than those in the normal group (p < .0001).

**CONCLUSION**
For the small rapidly enhancing hemangiomas showing washout appearance during dynamic gadoxetic acid-enhanced MRI, DWI can provide a determinative information to exclude small hypervascular HCCs.

**CLINICAL RELEVANCE/APPLICATION**
Quantitative and qualitative analysis of diffusion-weighted imaging can provide a determinative information to characterize these atypical hemangiomas distinguished from small hepatocellular carcinoma

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SSK06-09 • Delayed Enhancement of Colorectal Metastases with MR Hepatobiliary Contrast Agent

**Rahul A Sheth MD (Presenter) ; Mukesh G Harisinghani MD ; Sheela Agarwal MD, MS**

**PURPOSE**
Hepatobiliary contrast agents provide accurate detection of hepatic metastases particularly on hepatobiliary phase owing to the high level of enhancement of the background hepatic parenchyma. Parenchymal uptake is mediated by a family of cell surface transporters known as OATPs that were previously believed to be expressed only by hepatocytes. Recently, however, the overexpression of these transporters has been demonstrated in up to 80% of colorectal cancers. The purpose of this study was to evaluate for delayed enhancement within hepatic colorectal cancer (CRC) metastases following the administration of a hepatobiliary contrast agent.

**METHOD AND MATERIALS**
We performed a single institution, retrospective study of all patients with pathologically proven hepatic metastases who underwent MRI with gadoxetic acid (Eovist, Bayer, NJ) between 2010-2012. Gadoxetate-enhanced MR imaging was obtained during arterial phase, portal-venous phase, and delays of 3 minutes, 8 minutes, and 20 minutes. During each phase, signal intensities were measured for the lesion, adjacent liver parenchyma, and spleen, and were normalized using signal intensity of the paraspinal musculature. Delayed enhancement was determined by calculating the percent relative enhancement between the 3 minute and 20 minute time points.

**RESULTS**
A total of 35 patients were identified, of which 24 (69%) had CRC metastases and 11 (31%) had non-CRC metastases including pancreatic, breast, neuroendocrine, or sarcoma metastases. There was a statistically significant difference in the percent relative enhancement within CRC metastases than non-CRC metastases (p < .05), with 42% (10/24) CRC metastases demonstrating > 10% percent relative enhancement compared to 0% of non-CRC metastases.

**CONCLUSION**
CRC metastases can demonstrate delayed hyperintensity with gadoxetate. This may reflect extracellular accumulation; however, given that OATP overexpression has been shown in CRC, this finding may indicate specific intracellular uptake.

**CLINICAL RELEVANCE/APPLICATION**
Metastases may demonstrate hyperintensity on delayed imaging with hepatobiliary agents. This should not be misinterpreted as a specific finding for a benign lesion such as focal nodular hyperplasia.

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Gastrointestinal (Pancreas Benign Disease) Wednesday, 10:30 AM - 12:00 PM • E353B

**SSK07 • AMA PRA Category 1 Credit ™ • ARRT Category A+ Credit:1.5 Moderator Kevin J Chang , MD**

**Douglas S Katz , MD**

**Moderator Desiree E Morgan , MD.**

**SSK07-04 • Gradient Echo T1-weighted Signal Intensity Changes of the Chronic Pancreatitis**

**Temel Tirkes MD (Presenter) ; Chen Lin PhD * ; Chenkun Wang ; Hans Mouser MD ; Bharat Kakarala MD ; Fatih Akisik MD * ; Evan Fogel MD ; Gregory A Cote MD, MSc * ; Alex M Aisen MD * **

**PURPOSE**
To determine if there is any correlation between the chronic pancreatitis and the signal intensity of the parenchyma on pre-contrast fat suppressed gradient echo GRE images

**METHOD AND MATERIALS**
A retrospective analysis was performed on 84 patients with chronic pancreatitis (CP) and 27 normal patients as the control group. Gastroenterologists established the diagnosis of CP with Endoscopic Retrograde Cholangiopancreatography (ERCP) using the combination of characteristic imaging findings of a pancreatic duct as mild (n=24), moderate (n=28), or normal, MR Cholangiopancreatiography (MRCP) was performed on either 1.5T (n=68) or 3T (n=43) machines. A volume interpolated 3D GRE sequence was used to acquire pre-contrast T1-weighted images with TR of 5.0±0.17 ms and flip angle of 12 for 1.5T and TR of 4.24±0.16 ms and flip angle of 9 for 3T scanners. Two reviewers independently performed region of interest (ROI) measurements (~1cm2) from the head, body and tail of the pancreas as well as the spleen. Analyses of covariance (ANCOVA) models were used to compare the differences in SIR among the four patient groups, readers and magnet strength.

**RESULTS**
The four groups (mild/moderate/severe CP and normal) showed significant differences in SIR (p < .0001) on both 1.5 and 3T scanners. In particular, both the moderate and severe CP groups had significantly lower SIR than those in the normal group (p < .0001).

**CONCLUSION**
Moderate and severe chronic pancreatitis patients have lower parenchymal signal on pre-contrast fat-suppressed T1-weighted GRE images

**CLINICAL RELEVANCE/APPLICATION**
Decrease in the pancreas to spleen signal ratio in T1-weighted GRE images can be used as an indicator of chronic pancreatitis.
SSK07-02 • Accuracy of a Novel Noninvasive MRI Severity Scoring System for Chronic Pancreatitis: Correlation with EUS

Daniel A Souza MD (Presenter); Gyanprakash A Ketwaroo; Mandeep Sawhney MD; Koenaad J Mortele MD

PURPOSE
To evaluate the accuracy of a novel noninvasive scoring system, the MRI Chronic Pancreatitis Severity Index (CPSI), in the diagnosis and grading of patients with suspected chronic pancreatitis (CP), as compared to endoscopic ultrasound (EUS).

METHOD AND MATERIALS
In this IRB-approved, HIPAA-compliant retrospective study, 32 patients (20 female [age 25-86 yrs, average 55.5]) with known or suspected CP were evaluated with both EUS and MRI/MRC. Of these, 12 patients underwent secretin-stimulated MRCP (sMRCP). Blind review of the MRI findings was performed, and CP severity was graded using the novel 10-point-scale, CPSI scoring system. Correlation between MRI CPSI and EUS, which was considered as the gold standard, was performed. Comparative evaluation of test performance was obtained using ROC analysis.

RESULTS
On EUS, 12 patients were diagnosed with CP, 15 patients were rendered normal, and 5 patients had equivocal findings. There was no statistically significant correlation (r = 0.357) between the CPSI score derived from the MRCP studies without secretin administration and EUS. Excellent correlation, however, between sMRCP and EUS was present. ROC analysis demonstrated an area under the curve of 0.983 (p = 0.008), with a cutoff value of 3.5 having sensitivity of 83% and specificity of 100% for the diagnosis of CP.

CONCLUSION
There was excellent correlation between the novel 10-point-scale, CPSI score derived from sMRCP and EUS for the diagnosis of CP. However, the score performance was poor when MRCP was performed without the use of secretin.

CLINICAL RELEVANCE/APPLICATION
The MRI Chronic Pancreatitis Severity Index (CPSI) can be used as a noninvasive alternative to EUS for the diagnosis of chronic pancreatitis, with comparable results when secretin is used.

SSK07-03 • Correlation between Secretin-enhanced MRCP Findings and Histopathologic Severity of Chronic Pancreatitis in a Cat Model

Tingting Zhang (Presenter); Li Wang; Dengbin Wang MD, PhD; Zhijun Huang; Yuhua Li; Jianping Lu MD

PURPOSE
Secretin-enhanced magnetic resonance cholangiopancreatography (S-MRCP) is a noninvasive medical imaging technique that has been successfully used to evaluate pancreatic exocrine function in patients with chronic pancreatitis (CP). However, no detailed description of how S-MRCP findings relate to the severity of CP as determined by histopathology is currently available in the literature. The purpose of this study was to characterize this association in a cat model of CP.

METHOD AND MATERIALS
Thirty-two cats were divided into control (n = 8) and experimental (n = 24) groups. Cats in the experimental group underwent ligation of the pancreatic duct to induce CP, while the control group received a sham operation. MRCP was performed prior to, and 5 and 15 min after, secretin stimulation in all cats. All cats were then euthanized and pancreatic samples were processed for Hande and Sirius red staining to evaluate histopathological changes. The cats were then divided into four groups depending on the severity of CP as determined by histopathology: normal, minimal, moderate, or advanced. The S-MRCP parameters, consisting of the increasing degree of fluid volume (IDFV) at 15 min in the region of interest (which encompassed the pancreas, stomach, and small bowel) and the pancreatic duct caliber change (PDC) at 5 min, were measured and compared with the results of histopathology.

RESULTS
Significant differences were observed in both IDFV and PDC between sham-operated (control) cats and those with either moderate or advanced CP (IDFV: P = 0.001, 0.000, respectively; PDC: P = 0.013, 0.001). There were no significant differences in the two parameters between the controls and those whose CP was minimal (IDFV: P = 0.195; PDC: P = 0.964), although the minimal CP did show a downward trend.

CONCLUSION
IDFV and PDC measured with S-MRCP correlated with the histopathological severity of induced CP. S-MRCP could be used to evaluate the severity of CP, although it is somewhat insensitive for depicting very early disease.

CLINICAL RELEVANCE/APPLICATION
The assessment of exocrine pancreatic function by S-MRCP can contribute to select the appropriate medical treatment for chronic pancreatitis.

SSK07-04 • Fibrosis and Postoperative Fistula of the Pancreas: Correlation with MR Imaging Findings-Preliminary Results

Haruo Watanabe MD (Presenter); Satoshi Goshima MD, PhD; Hiroshi Kondo MD; Yoshifumi Noda MD; Masayuki Kanematsu MD

PURPOSE
To assess the potential value of magnetic resonance (MR) imaging to help assess pancreatic fibrosis and predict development of postoperative pancreatic fistula (POPF).

METHOD AND MATERIALS
This retrospective study had institutional review board approval, and the requirement for informed consent was waived. MR images obtained in 29 consecutive patients (15 men, 14 women; mean age, 64.9 years; range, 21-80 years) who underwent ligation of the pancreatic duct to induce CP, while the control group received a sham operation. MRCP was performed prior to, and 5 and 15 min after, secretin stimulation in all cats. All cats were then euthanized and pancreatic samples were processed for Hande and Sirius red staining to evaluate histopathological changes. The cats were then divided into four groups depending on the severity of CP as determined by histopathology: normal, minimal, moderate, or advanced. The S-MRCP parameters, consisting of the increasing degree of fluid volume (IDFV) at 15 min in the region of interest (which encompassed the pancreas, stomach, and small bowel) and the pancreatic duct caliber change (PDC) at 5 min, were measured and compared with the results of histopathology.

RESULTS
Multiple regression analysis showed that the pancreas-to-muscle SI ratio on T1-weighted images and ADC value were significantly correlated with pancreatic fibrosis (r = 0.66, P < .001) and with activated PSC expression (r = 0.67, P < .001). The mean pancreas-to-muscle SI ratio on T1-weighted images was higher (P = .002) for patients with POPF (1.6 ± 0.2) than for those without (1.2 ± 0.2).

CONCLUSION
The pancreas-to-muscle SI ratio on T1-weighted images of the pancreas may be a potential biomarker for assessment of pancreatic fibrosis and prediction of POPF.

CLINICAL RELEVANCE/APPLICATION
The pancreas-to-muscle SI ratio on T1-weighted images may be a potentially useful biomarker for preoperatively predicting the progression of pancreatic fibrosis and development of POPF.

SSK07-05 • Single Centre Experience of Extending Indications for Percutaneous Intra-portal Islet Auto-transplantation
RESULTS
PIPIAT was performed in 7/41 patients (4 for inadequate islet mass, 2 for hemodynamic instability, 1 for islet culture contamination), while it was successfully performed in 34/34 patients. PIPIAT-related complications occurred in 8 patients (23.5%): 4 bleedings (2 requiring transfusions), 3 portal thromboses (1 complete, 2 partial), 1 sepsis. Median follow-up duration was 546 days. Insulin independence was achieved in 15/34 patients (44%), partial graft function in 16/34 patients (47%), no function in 3/34 patients (6%). Seventeen patients had malignancy; none of them developed liver metastases during follow-up.

CONCLUSION
PIPIAT, performed under a combined US and fluoroscopy guidance and not requiring immunosuppression, is feasible, with a relatively low complication rate and a better metabolic outcome than allo-transplantation.

CLINICAL RELEVANCE/APPLICATION
PIPIAT indications can be extended to selected patients with neoplasm, both benign and malignant. An increased islet mass may lead to the improvement of the metabolic outcome.

SSK07-06 • Feasibility and Reproducibility of Pancreatic Iron Overload Measurement Using Direct MR T2* Evaluation in B-Thalassemia Population
Carlo Liguori (Presenter), Francesca Pitocco, Ilenia Di Giampietro, Aldo Eros De Vivo, Francesco Sorrentino, Bruno Beomonte Zobel MD

PURPOSE
To assess feasibility of pancreatic iron accumulation in Thalassemia patients in course of MRI using T2* technique. To establish preferential patterns of overload among head, body and tail of the pancreas. To quantify intra-interobserver and interstudy variability in course of pancreatic T2* assessment. To assess normal ranges of pancreatic T2* values in Thalassemia subjects compared to non transfusion dependent population.

METHOD AND MATERIALS
In a setting of 210 TM patients we performed T2* MRI using gradient multi-echo sequences (12 echo range: 0.99–16.5 ms; slice thickness 10 mm) on pancreatic head, body and tail using three different acquisitions. Image analysis was performed using a dedicated software (CMR Tools, London, UK) and truncation method was used to account for background noise. Images were examined by two observers (obs) to assess interobserver variability and obs1 performed a double evaluation of same dataset for intraobserver variability.

RESULTS
Mean pancreatic T2* in normal subjects was 41±8.8 and significant difference (p Mean pancreatic T2* in TM value was 24.9±15.6 and significant difference (p Measurement in all three portions of the gland showed good intra-observer (p Image quality score resulted superior for pancreatic head (mean score 4.2) compared to body (3.6) and tail (2.8).

CONCLUSION
Direct assessment of pancreatic iron overload is feasible and can be considered a robust technique in terms of inter-observer and inter-study reproducibility. These data allow routinely gland assessment in Thalassemia subjects compared to non transfusion dependent population.

CLINICAL RELEVANCE/APPLICATION
Despite growing interest in to endocrine evaluation in thalassemia patients, Pancreatic iron overload assessment is still not widely adopted. Present study clarifies technical aspects in this field.

SSK07-07 • Free Breathing Dynamic Contrast MR Imaging with Navigator Technique for the Evaluation of the Pancreas
Takayuki Masui (Presenter), Motoyuki Katayama, Kimihiko Sato MD, Yuji Iwadate*, Kazuma Terauchi, Kei Tsukamoto, Kenichi Mizuki, Masayoshi Sugimura, Hirokazu Katabawa, Harumi Sakahara MD

PURPOSE
In elderly patients who cannot hold their breaths, information of dynamic contrast study may be limited. Navigator technique can be utilized for dynamic contrast studies with repeated acquisitions. The purpose was to evaluate feasibility of dynamic contrast study during free-breathing with navigator technique for evaluation of pancreatic lesions.

METHOD AND MATERIALS
The study was approved by IRB. 48 patients (23 men, 25 women, mean 73 years old), who underwent contrast MR imaging for pancreas at 3T between March 2011 and November 2012 were included. Pathologies were IPMN in 25 cases, other cystic in 7, solid in 2, and others in 14. After T2WI and MRCP, with navigator technique, pre and 5 phases of dynamic contrast images (Gd-chelate 0.1mm/kg, slice thickness 3/4mm) in axial plane were obtained using 3DFSPGR (LAVA) under free-breathing followed by imaging without navigator. Image quality, blurring, recognition of each organ and lesions were evaluated using a five-point scale (1=undiagnostic–5=excellent).

RESULTS
Image time tended to be prolonged in postcontrast phases (38–46sec). The enhancement was observed initially in the aorta followed by the spleen and pancreas. All images in dynamic phases with navigator technique were diagnostic (Image quality: 4.4–4.7, Blurring 4.5–4.7, Lesion recognition 4.5–4.6). On images without navigator, blurring was prominent. Cystic (73 lesions in 35 cases, Fig), and solid lesions (2 lesions) were identified (mean diameter 15.5mm from 1mm to 57mm). Five lesions were missed and one serious cystic tumor was falsely recognized as solid. Septa in cysts were recognized in 31 of 45 cases. There was no nodule in cystic lesions.
RESULTS
Pancreatic parenchymal attenuation showed a linear decrease in HU with increase in patient body habitus (Normal: 44.2±6HU vs morbid obesity: 22±1 HU, p

CONCLUSION
Pancreatic parenchymal attenuation decreases with increasing body weight and is a predictor for occurrence of impaired glucose tolerance and occurrence of diabetes.

CLINICAL RELEVANCE/APPLICATION
Excess pancreatic fat have negative correlation to beta cell function, leading to glucose intolerance and diabetes. Imaging can be a potential screening biomarker for detection of pancreatic fat.

SSK07-09 • Whole-organ CT Perfusion of the Pancreas: Impact of Iterative Reconstruction on Image Quality, Perfusion Parameters and Radiation Dose in 256-slice CT-preliminary Findings

Qian Xie (Presenter) ; Zonghui Liang ; Juan Wu ; Yafang Dou ; Ying Tang ; Xiaoyuan Feng MD ; Feijia Xu

PURPOSE
This study was to assess whether iterative reconstruction algorithm can reduce the radiation dose while maintaining acceptable image quality, and to investigate whether perfusion parameters vary from conventional filtered back projection(FBP) at the low-tube-voltage(80kVp) during whole-pancreas perfusion examination using a 256-slice CT.

METHOD AND MATERIALS
76 patients with known or suspected pancreatic mass underwent whole-pancreas perfusion by a 256-slice CT. High- and low-tube-voltage CT images were acquired. 120-kVp image data(protocol A) and 80-kVp image data(protocol B) were reconstructed with conventional FBP algorithm, and 80-kVp image data were reconstructed with iDose4(Protocol C) iterative reconstruction technique. The image noise; contrast-to-noise ratio(CNR) relative to muscle for the pancreas, liver, and aorta; and effective dose of each protocol were assessed quantitatively. Overall image quality was assessed qualitatively. Among 76 patients, 23 were eventually proven to have normal pancreas. Nine of 23 patients received 120-kVp CT perfusion scans and 14 of 23 received 80-kVp CT perfusion scans. Perfusion parameters of normal pancreas in each protocol including blood volume(BV), blood flow(BF), and permeability-surface area product(PS) were measured.

RESULTS
In the quantitative study, protocol C reduced image noise by 36.8% than protocol B(P

CONCLUSION
Low-tube-voltage and iDose4 iterative reconstruction technique can dramatically decrease radiation dose with acceptable image quality during whole-pancreas CT perfusion and have no significant impact on the perfusion parameters of normal pancreas compared to the conventional FBP reconstruction in the use of 256-slice CT scanner.

CLINICAL RELEVANCE/APPLICATION
iDose4 iterative reconstruction technique yields a significant improvement in image quality, decrease in radiation dose and appears not to impede calculation of healthy pancreas perfusion parameters.
SSK08-02 • Quantitative Shear Wave Ultrasound Elastography for Prostate Cancer Imaging: Correlation to Pathology

Jean-Michel Correas MD *, Ahmed Khairoune *; Anne-Marie Tissier MD; Olivier Helenon; Richard G Barr MD, PhD (Presenter) *

PURPOSE
To prospectively evaluate in two independent centers the diagnostic performance of real-time quantitative Shear Wave Elastography (SWE) in detecting and characterizing prostate lesions in patients with increased PSA and/or abnormal digital rectal examination, by using histologic biopsy results scoring system as the reference method. Correlation between elasticity and Gleason Score (GS) was also performed to analyse the relation between tumor stiffness and pathology.

METHOD AND MATERIALS
The IRB approved this prospective, HIPAA-compliant study in both institutions. Written informed consent was obtained from 184 men undergoing ultrasound guided systematic and targeted biopsies. Two blinded radiologists independently measured stiffness of prostate lesions and lesions depicted in ultrasound imaging. Biopsy core pathology analysis (GS) of corresponding sextants and lesions constituted the reference standard. The diagnostic performance at the sextant level and lesion detection sensitivity for lesions was calculated. The correlation between GS and tissue stiffness was investigated using Student T-test and Pearson’s correlation coefficient.

RESULTS
A total of 184 patients were enrolled in the study, providing a total of 1176 peripheral zone regions including 1039 sextants and 137-targeted lesions. A total of 188 foci of cancer (size=2mm and GS=6) were detected in 65 patients. On the basis of the ROC curve analysis and to maximize the negative predictive value, a cutoff value of 35 kPa for the elasticity or 3.42 m/s for the shear wave velocity was chosen to differentiate benign and malignant regions (p

CONCLUSION
SWE might provide additional information for the biopsy guidance and differentiation of aggressive prostate cancers.

CLINICAL RELEVANCE/APPLICATION
Prostate tissue stiffness using Shear Wave Elastography could be used to guide prostate biopsy and significantly improve prostate positive biopsy rate.

SSK08-03 • Comparison of 1.5T vs. 3.0T Multiparametric MR Imaging in the Detection of High Grade Prostate Cancer

Daniel A Moses MBBS, FRANZCR (Presenter); Ronald C Shnier MBBS; James Thompson MBBS; Lee E Ponsky MD; Phillip Brenner MBBS; Warick Del Prado; Andrew Hayen PhD; Phillip Stricker MBBS

PURPOSE
Compare the efficacy of 1.5T and 3.0T mp-MRI in the detection/exclusion of high grade prostate cancer.

METHOD AND MATERIALS
A prospective study (for 300 men) was approved by the ethics board. 122 men had been randomised for mp-MRI at either 1.5T or 3T before a planned transperineal biopsy. The MR protocol included high resolution T2-weighted, diffusion and perfusion sequences without the use of an endorectal coil. Two uroradiologists used the PI-RADS reporting system independently for each scan. A combined score was attained by taking the average.

RESULTS
A total of 91/122 men received a average PI-RADS score of 2.5 or greater (intermediate to high risk of significant PCa), with 47/54 of men on the 1.5T MRI, and 44/68 of men on the 3T MRI being classified in the same way. On biopsy 48/122 [28/54 on 1.5T and 20/68 on 3T] had Gleason 7 or greater prostate cancer. 11/122 [6/54 on 1.5T and 5/68 on 3T] had greater than Gleason 8 prostate cancer. The following results were achieved using a threshold of Gleason 7 disease and above as positive for significant disease an average PI-RADS score of 2.5 and above or suspected clinically significant disease: 1.5T: TPR 100%, FPR 73%, NPV 100%, PPV 60% 3.0T: TPR 100%, FPR 50%, NPV 100%, PPV 45% Combined: TPR 100%, FPR 58%, NPV 100%, PPV 53% Using a threshold of Gleason 8 disease and above as positive for significant disease and average PI-RADS score of 4 and above for suspected clinically significant disease: 1.5T: TPR 100%, FPR 29%, NPV 100%, PPV 30% 3.0T: TPR 100%, FPR 16%, NPV 100%, PPV 33% Combined: TPR 100%, FPR 22%, NPV 100%, PPV 31% [True positive rate (TPR), False positive rate (FPR), Negative predictive value (NPV), Positive predictive value (PPV)]

CONCLUSION
MP-MRI, without an ER coil, can achieve very high NPV for significant prostate cancer (in our case 100%). There was no difference between the NPV when using a 1.5T or 3T MR system. The positive predictive value was higher for 1.5T (60%) vs 3T (45%) when choosing a threshold of Gleason 7 disease for significant disease. This equalised [1.5T 30% vs 3T 33%] with a threshold of Gleason 8. The false positive rate was higher at 1.5T vs 3T for both Gleason thresholds.

CLINICAL RELEVANCE/APPLICATION
Given the different costs and availability, knowing the relative strengths and limitations of assessment on 1.5T and 3.0T scanners allows planning in thier use in the diagnosis of prostate cancer.

SSK08-04 • The Cost-effectiveness of MR-guided Targeted Biopsy versus Systematic TRUS-guided Biopsy in Diagnosing Prostate Cancer: A Modeling Study

Maarten De Rooij MD (Presenter); Simone Crienen; Fred Witjes MD, PhD; Jelle O Barentsz MD, PhD; Maroeska M Rovers PhD; Janneke P Grutters PhD

PURPOSE
To develop and apply a decision analytic model to determine whether multiparametric magnetic resonance imaging (mp-MRI) and targeted magnetic resonance guided biopsies (MRGB) are cost effective in the diagnosis of prostate cancer compared with standard systematic transrectal ultrasound guided biopsies (TRUSGB).

METHOD AND MATERIALS
A combined decision tree and Markov model was used to evaluate the quality-adjusted life years (QALYs) and healthcare costs of the MRI strategy (mp-MRI and targeted MRGB) compared with the standard strategy of systematic TRUSGB for a cohort of patients with clinical suspicion of prostate cancer. Input data were derived from systematic literature searches, including meta-analyses, and expert opinion. Probabilistic and threshold analyses were performed to assess uncertainty.

RESULTS
Expected costs of the MRI strategy per patient (●2349) were similar to those for the TRUSGB strategy (●2356). The corresponding QALYs were higher for the MRI strategy (6.97 versus 6.74). Threshold analysis revealed MRI is the dominant strategy (less costly and more effective) when the sensitivity of MRGB is 60% or higher. Probabilistic sensitivity analysis showed that in 92% of simulations, the MRI strategy was most effective. In 52% of the simulations MRI was more effective and less costly. The probability that the MRI strategy is cost effective is 90% at willingness to pay thresholds over ●1,000/QALY.
**RESULTS**
Higher T2-weighted, Dynamic Weighted Imaging and Dynamic Contrast Enhanced ESUR scores were observed in areas yielding cancer-positive cores. The proportion of positive cores increased with the ESUR sum of scores aggregated in five increments from less to more suspicious (percentage and 95%CI): 2.3%(1.2-3.3), 5.8%(3.5-8.0), 24.7%(18.3-31.1), 51.8%(42.4-61.1) and 72.1%(66.2-77.9) for increasing increments of ESUR-S, p for trend p < 0.05.

**CONCLUSION**
In primary prostate biopsies, the ESUR score system was shown to provide clinically relevant stratification of the risk of showing prostate cancer in a given location.

**CLINICAL RELEVANCE/APPLICATION**
MRI-TRUS fusion technology could provide optimal method to sample the prostate gland, reduce the number of cores needed to demonstrate cancer.

**SSK08-05 • Validation of the European Society of Urogenital Radiology Score System for Prostate Cancer Diagnosis on Multiparametric MRI in a Cohort of Primary Biopsy Patients**

**Raphaële M Renard Penna (Presenter); Pierre Mozer MD; Daniel Portalez MD; Francois Cornud MD; Eva Comperat; Bernard Malavaud PhD, MD**

**PURPOSE**
To assess the ESUR score system in the context of primary biopsies.

**METHOD AND MATERIALS**
IRB-approved, bicentric prospective study. 119 consecutive patients referred for primary prostate biopsies with normal DRE but elevated PSA (≥4.0ng/ml). Transfer of mpMRI suspicious areas on 3D-transrectal ultrasound images by three-dimensional elastic surface registration (Koelis, UroStation, France) random systematic and targeted cores followed by core-by-core analysis of pathology and mpMRI characteristics. Relationships between ESUR scores and biopsy results were assessed by the Mann-Whitney U test. A teaching set was randomly drawn to construct the ROC curve of the ESUR sum of scores (ESUR-S). The threshold to recommend additional biopsy was obtained from the Youden J-statistics and tested in the remaining validation set in terms of predictive characteristics.

**RESULTS**
The inter-observer agreement for detection at the sextant level was in perfect agreement. In detecting pathologic cancer volume of 0.5cm3, DW MRI and DCE MRI had a higher accuracy than T2W MRI. The accuracy of detection for cancers volume > 1cm3 or Gleason grade = 7 was significantly higher than cancers of volume 0.5 to 1cm3 or Gleason grade = 6, and multi-parametric MRI had a significantly higher diagnostic performance than T2W+DW MRI and T2W+DCE MRI. The multi-parametric MRI was more accurate with high-pathologic cancer volume and Gleason grades. For lesions of cancer volumes > 1cm3 and Gleason grades = 7, the accuracy was significantly higher than with cancers of volume 0.5 to 1cm3 and Gleason grade = 6 (82.3% vs. 90.2%, P = 0.05).

**CONCLUSION**
In clinically low-risk cancer, the detection of multi-parametric MRI is significantly dependent on cancer volumes and Gleason grades. The higher cancer volumes and Gleason grades have high sensitivity, specificity and accuracy in detection.

**CLINICAL RELEVANCE/APPLICATION**
In clinically low-risk cancer, the detection of multi-parametric MRI is significantly dependent on cancer volumes and Gleason grades.

**SSK08-06 • The Role of Multi-parametric MRI for Assessment of Detection in Patients with a Low-risk Prostate Cancer**

**Jin Young Kim (Presenter); See Hyung Kim**

**PURPOSE**
To assess the diagnostic performance of multi-parametric MRI in cancer detection categorized by cancer volume and Gleason grade in clinically low-risk prostate cancer.

**METHOD AND MATERIALS**
One hundred consecutive patients with clinically low-risk cancer received multi-parametric MRI before radical prostatectomy, including T2-weighted (T2W), diffusion-weighted (DW) and dynamic contrast enhanced (DCE) MRI. By using scoring systems, two radiologists independently assessed likelihood of cancer per sextant on multi-parametric MRI. Cancer lesions of = 0.5cm3 identified on whole-mount step-section were correlated with multi-parametric MRI. The diagnostic performance of multi-parametric MRI was assessed for cancer volumes and Gleason grades.

**RESULTS**
The inter-observer agreement for detection at the sextant level was in perfect agreement. In detecting pathologic cancer volume of = 0.5cm3, DW MRI and DCE MRI had a higher accuracy than T2W MRI. The accuracy of detection for cancers volume > 1cm3 or Gleason grade = 7 was significantly higher than cancers of volume 0.5 to 1cm3 or Gleason grade = 6, and multi-parametric MRI had a significantly higher diagnostic performance than T2W+DW MRI and T2W+DCE MRI. The multi-parametric MRI was more accurate with high-pathologic cancer volume and Gleason grades. For lesions of cancer volumes > 1cm3 and Gleason grades = 7, the accuracy was significantly higher than with cancers of volume 0.5 to 1cm3 and Gleason grade = 6 (82.3% vs. 90.2%, P = 0.05).

**CONCLUSION**
In clinically low-risk cancer, the detection of multi-parametric MRI is significantly dependent on cancer volumes and Gleason grades. The higher cancer volumes and Gleason grades have high sensitivity, specificity and accuracy in detection.

**CLINICAL RELEVANCE/APPLICATION**
In clinically low-risk cancer, the detection of multi-parametric MRI is significantly dependent on cancer volumes and Gleason grades.


**Matthias J Elber MD (Presenter); Matthias Heck; Michael Souvatzoglou; Tobias Maurer; Markus Schwaiger MD; Ernst J Rummery MD; Bernd Krause**

**PURPOSE**
Computed tomography is of limited value for lymph node (LN) staging in prostate cancer (PCa) patients scheduled for radical prostatectomy (RP). To prospectively compare computed tomography (CT), diffusion-weighted magnetic resonance imaging (DWI) and [11C]choline positron emission tomography/computed tomography ([11C]choline PET/CT) for LN staging in PCa patients undergoing RP and extended pelvic lymph node dissection (ePLND).

**METHOD AND MATERIALS**
Between June 2010 and May 2012, we preoperatively performed CT, DWI and [11C]choline PET/CT in 33 intermediate and high risk PCa patients without neoadjuvant treatment. All patients underwent open RP and ePLND including the LN-fields obturator fossa, external, internal and common iliac vessels. Patient- and field-based performance characteristics for all 3 imaging techniques in comparison with histopathology are reported. Imaging techniques were compared by AUC-analyses (area under the curve).

**RESULTS**
LN metastases were detected in 92 of 1012 (9%) LNs from 14 of 33 (42%) patients. ePLND achieved a median of 30 dissected LNs per patient (range 9-61). On a patient-based analysis, sensitivity for CT, DWI and [11C]choline PET/CT were identical (57.1%, 57.1% and 57.1%, respectively), but specificity was best for [11C]choline PET/CT (68.4%, 78.9% and 89.5%, respectively). On a LN-field-based analysis, sensitivity was best for [11C]choline PET/CT followed by DWI and CT (61.8%, 55.9% and 47.1%, respectively) whereas specificity was similar for all 3 imaging techniques (96.5%, 96.0% and 94.3%, respectively). However, neither DWI nor [11C]choline PET/CT performed better than CT in a pair-wise comparison of AUCs of patient- and field-based results (p>0.05, respectively).
CONCLUSION
Neither DWI nor [11C]choline PET/CT perform statistically significant better than CT for preoperative detection of LN-metastases in PCa patients scheduled for RP and ePLND. All 3 imaging techniques have a low sensitivity with less than two thirds of LN metastases being detected on a patient- or LN-field-based analysis.

CLINICAL RELEVANCE/APPLICATION
Our data indicate that neither [11C]choline PET/CT nor DWI can be recommended to replace adequate ePLND for determining a patient's LN status or to define the extent of a PLND on an individual basis.

SSK08-08 • Dynamic Contrast Enhanced MR Imaging Features of the Normal Central Zone of the Prostate
Barry G Hansford MD (Presenter) ; Ibrahim Karademir MD ; Yahui Peng PhD ; Yulei Jiang PhD ; Gregory S Karczmar PhD * ; Stephen Thomas MD ; Ambereen Yousef MBBS ; Tatjana Antic ; Scott Eggener * ; Aytekin Oto MD *

PURPOSE
Evaluate qualitative dynamic contrast enhanced magnetic resonance imaging (DCE-MRI) characteristics of normal central zone (CZ) based on recently described CZ MR imaging features.

METHOD AND MATERIALS
Retrospective, HIPAA compliant study with Institutional Review Board approval. Evaluated 82 patients with prostate cancer (PCa) who underwent pre-operative, multi-parametric endorectal MR before radical prostatectomy. 19 patients with tumor involving portions of the CZ or prostate base on histopathology were excluded, as were four patients with MR artifacts. Final cohort of 59 patients: mean age, 59.9 years; age standard deviation (SD), 7.0; and age range, 43-72; average serum prostate-specific antigen (PSA) level, 8.7 m/L; PSA SD, 8.0; and PSA range, 1.7-40.9. Two readers independently reviewed T2-weighted images and ADC maps to identify normal CZ based on its low signal intensity and characteristic location. Next, two readers drew bilateral CZ regions of interest on DCE-MRI images in consensus and then independently recorded enhancement curve types as: type 1 (progressive enhancement), type 2 (plateau) and type 3 (wash-out). Identification rates of normal CZ and enhancement curve type were recorded and compared for each reviewer.

RESULTS
CZ identified in 92% to 93% of patients on T2-weighted images and 78% to 98% on ADC maps without a significant difference between identification rates (p=0.63 and p=0.15 and Inter-reader agreement, κ=0.64 and 0.29, for T2-weighted images and ADC maps, respectively). All CZs rated as either curve type 1 or 2 by both radiologists. Type 1, progressive enhancement (24/104 or 23% of curve types), type 2, plateau enhancement (80/104 or 77% of curve types) and type 3, wash-out (0/104 or 0% of curve types). No statistically significant difference between the two radiologists (p=0.19) and inter-reader agreement was κ=0.37.

CONCLUSION
Normal CZ demonstrates type 1 or type 2 enhancement curves on DCE-MRI which can potentially be useful to differentiate CZ from PCa which classically demonstrates a type 3 (wash-out) curve. CZ identified in majority of patients based on characteristic location and low signal on T2-weighted images and ADC maps.

CLINICAL RELEVANCE/APPLICATION
Our study shows that the normal CZ demonstrates either type 1 or type 2 enhancement time-curves on DCE-MRI, which can be potentially used to differentiate the CZ from PCa.

SSK09-01 • Anatomical and Functional Volume Concordance between FDG-PET, T2 and Diffusion Weighted MRI for Cervical Cancer: A Hybrid PET/MRI Study
Hongzan Sun (Presenter) ; Jun Xin MD ; Shaomin Zhang ; Qiyong Guo MD

PURPOSE
To evaluate the concordance of imaging by [18F] fluorodeoxyglucose (FDG) - positron emission tomography (PET), T2 weighted imaging (T2WI) and apparent diffusion coefficient (ADC) maps with diffusion-weighted imaging (DWI) in cervical cancer using hybrid whole-body PET/MRI.

METHOD AND MATERIALS
Cervical cancer patients (N=35) were prospectively recruited to undergo pretreatment 18FDG-PET/MRI. 18FDG-PET and MRI images were fused using standard software. The percent of the maximum standardized uptake value (SUVmax) was used to contour tumors on PET images and volumes were auto calculated. Tumor volumes measured by T2WI and DWI were calculated with standard techniques of tumor area multiplying slice profile. Data analysis used parametric statistics.
RESULTS

CONCLUSION

Hybrid PET/MRI showed strong concordance between FDG-PET, T2WI and DWI in cervical cancer. Cutoff at 35% or 40% of SUVmax is recommended during 18FDG PET-MRI SUV-based tumor volume estimation. Tumor subvolumes with increased metabolic activity on FDG-PET also have greater cell density by DWI.

CLINICAL RELEVANCE/APPLICATION

Hybrid PET/MRI was demonstrated a reliable method in cervical cancer imaging, and will benefit its clinical decision making by combining accordant anatomical and functional information together.

SSK09-02 ● Radiologists’ Adherence to the 2010 Society of Radiologists in Ultrasound Guidelines for the Management of Incidental Adnexal Cysts Imaged at Ultrasound: Frequency and Associated Factors

Andrea S Kierans MD (Presenter) ; Andrew B Rosenkrantz MD

PURPOSE

To evaluate adherence to the 2010 Society of Radiologists in Ultrasound (SRU) guidelines for management of incidental adnexal cysts imaged at ultrasound.

METHOD AND MATERIALS

398 adnexal cysts initially detected at ultrasound were included; all studies had been performed after publication of the SRU guidelines and guideline review at departmental conferences. The ultrasound reports were retrospectively reviewed to determine whether the management recommendations were adherent to the guidelines. Non-adherent cases were categorized as over-management, under-management, or as incomplete in their recommendation. Impact of categories determining appropriate recommendation (menopausal status, cyst size, and other cyst imaging features) was assessed via the chi-square test, and the primary cause for non-adherence (over- vs. under-management) in each sub-category was identified.

RESULTS

Among all 398 adnexal cysts, the frequency of adherence was 55%, over-management was 27%, under-management was 12%, and incomplete recommendation was 6%. Menopausal status, cyst size, and other cyst imaging features all significantly impacted adherence rate (all p < 0.05). Lesions adherent in most instances were simple cysts (55%), para-ovarian cysts (71%), corpus luteums (88%), and cysts suggestive of, but not classic for, a hemorrhagic cyst, endometrioma, or dermoid (57%). Lesions with under-management in most instances were cysts with multiple thin septations (83%), thick irregular septations (33%), or an avascular nodule (67%), and dermoids (78%). Lesion with over-management in most instances was cyst with one thin septation (64%).

CONCLUSION

Radiologists at our institution adhered to the SRU guidelines for incidental adnexal cysts at ultrasound in 55% of cases. Non-adherence was greater in post-menopausal patients, larger cysts, and cysts with greater complexity.

CLINICAL RELEVANCE/APPLICATION

Our findings will be used to direct future efforts to improve adherence to the SRU guidelines, which in turn will improve patient care. Causes of both under- and over-management will be addressed.

SSK09-03 ● Early Response Assessment to Concurrent Chemoradiotherapy in Cervical Cancer: Value of Diffusion-weighted and Dynamic Contrast-enhanced MR Imaging

Sohee Song (Presenter) ; Chan Kyu Kim MD, PhD ; Jung Jae Park MD ; Sung Yoon Park ; Byung Kwan Park MD ; Seung Jae Huh PhD

PURPOSE

To prospectively investigate the value of diffusion-weighted (DWI) and dynamic contrast-enhanced MR imaging (DCEI) as early and reproducible response predictors in cervical cancer patients who received concurrent chemoradiotherapy (CCRT).

METHOD AND MATERIALS

Sixteen consecutive patients with biopsy-proven cervical cancer who treated with CCRT were evaluated with MR imaging at 3T, including DWI and DCEI. Four serial MR examinations were performed before CCRT (preTx), after 1 week of therapy (postTx1), after 4 weeks after therapy (postTx2), and after 1 month after the end of therapy (postTx3). At each time point, apparent diffusion coefficient (ADC) and DCEI parameters were calculated in the tumor, gluteus muscle and normal uterus and the results were compared. Tumor response at postTx2 or postTx3, as determined by changes in tumor size or volume using MRI was correlated with tumor ADC or DCEI parameters at preTx and postTx1, or correlated with changes in tumor ADC and DCEI parameters between preTx and postTx1. For reproducibility of ADC and DCEI parameters measurement, 10 patients had two separate pretreatment DWI and DCEI at an interval of < 2 weeks.

RESULTS

At each time point, ADC and DCEI parameters (i.e., Ktrans and Vep) in the tumors showed consecutive increase (all P < 0.05), while those of gluteus muscle and normal uterus did not reveal a significant difference (all P >0.05). At postTx1 tumor ADCs showed a significant correlation with tumor size response at postTx2 (P = 0.003). Changes in tumor ADCs between preTx and postTx1 had a significant correlation with tumor size (P = 0.001) and volume response (P = 0.021) at postTx2. At preTx, tumor Ktrans showed a significant correlation with tumor volume response at postTx3 (P = 0.033); tumor Ktrans and Vep had a significant correlation with tumor size response at postTx2 (P = 0.043 and P = 0.019, respectively). Reproducibility of ADC versus DCEI parameters measurements in the tumor, gluteus muscle and normal uterus was confirmed with a mean difference of 0.3% versus 0.6% ± 16.6%, 1.7% versus 0.5% ± 12.3%, and 2.2% versus 0.9% ± 17.8% in sequence, respectively.

CONCLUSION

DWI and DCEI, as early and reproducible biomarkers, have the potential to evaluate therapeutic response to CCRT in patients with cervical cancer.

CLINICAL RELEVANCE/APPLICATION

As imaging biomarkers, ADC and DCEI parameters may aid in the development of more individualized, effective therapy regimens for the patient group.

SSK09-04 ● Clinical Application of Diffusion-weighted MR Imaging in Uterine Cervical Cancer

Ying Liu (Presenter) ; Zhao Xiang Ye

PURPOSE

To investigate the application value of apparent diffusion coefficient (ADC) values in evaluating the histological type as well as pathologic grade of uterine cervical cancer; and to investigate whether ADC values could reflect tumor cellularity density.

METHOD AND MATERIALS

Ninety-eight patients with histopathologically proven uterine cervical cancer were included in this prospective study. All of them received conventional MRI and DWI examinations before surgery or concurrent chemoradiation. Mean ADC value and minimum ADC value of the tumor were measured. Tumor cellularity density was counted using CMIAS (colored multifunction imaging analyzing system).
RESULTS
Both mean ADC value and minimum ADC value of squamous cell carcinoma were significantly lower than that of adenocarcinoma (P=0.001; P=0.000). Using mean ADC criteria (=0.965×10^{-3} mm²/s) and minimum ADC criteria (=0.844×10^{-3} mm²/s), the sensitivity and specificity for differentiating squamous cell carcinoma from adenocarcinoma were 83.5% and 76.9%, 77.6% and 92.3%, respectively. The Az of mean ADC was not statistically greater than minimum ADC P=0.990). Tumor cellularity density, mean ADC value and minimum ADC value of different pathological grade varied significantly (P=0.000, P=0.000, P=0.000). There was a significant positive linear correlation between tumor cellularity density and the pathological grade of tumor (P=0.000). Both mean ADC value and minimum ADC value correlated negatively with cellularity density (P=0.000, P=0.000) and the pathological grade of tumor (P=0.000, P=0.000). Comparisons of correlation coefficients showed no significant differences (P=0.656, P=0.631).

CONCLUSION
DWI has a potential ability to indicate the histologic type of uterine cervical cancer. ADC measurements of uterine cervical cancer can represent tumor cellularity density, thus providing a new method for evaluating the pathological grade of tumor. Mean ADC value instead of minimum ADC value was recommended to fully reflect the whole tumor.

CLINICAL RELEVANCE/APPLICATION
DWI with ADC measurement may be helpful for the noninvasive and preoperative prediction of the histologic type and degree of differentiation of uterine cervical cancer.

SSK09-05 • Tumor ADC Value Is Associated with Depth of Myometrial Invasion and Is Negatively Correlated to Tumor Volume in Endometrial Carcinomas

Jenny A Husby MD (Presenter) ; Inger J Magnussen ; Jone Trovik MD ; Oyvind Salvesen ; Line Bjorge ; Helga Salvesen MD, PhD ; Ingrid S Haldorsen MD

PURPOSE
Explore possible correlations between tumor apparent diffusion coefficient (ADC) values, morphological imaging findings and clinical and histological patient and tumor characteristics in endometrial carcinomas. To investigate interobserver agreement between readers on preoperative staging by MRI, including diffusion weighted imaging (DWI).

METHOD AND MATERIALS
RESULTS
CONCLUSION
Low tumor ADC value is associated with absence of deep myometrial invasion and the ADC value is negatively correlated to tumor volume in endometrial carcinomas. Preoperative staging by MRI with DWI is prone to considerable interobserver variability. Calculation of tumor ADC values may aid in the prediction of deep myometrial invasion in endometrial carcinomas.

CLINICAL RELEVANCE/APPLICATION
Low tumor ADC value is associated with presence of deep myometrial invasion, and DWI may aid in the prediction of deep myometrial invasion in endometrial carcinomas.

SSK09-06 • Temporal Changes of Imaging Parameters of MRI and FDG-PET/CT during Treatment in Cervix Cancer

Saba N Elias MSc (Presenter) ; Guang Jia PhD ; Nina A Mayr MD ; William T Yuh MD ; Jun Zhang PhD ; Michael V Knopp MD, PhD ; Nathan C Hail MD, PhD *

PURPOSE
To prospectively assess the temporal changes of multi-imaging parameters from MRI and PET/CT, including ADC, tumor size, and standardized uptake value (SUV) for early therapy monitoring in cervix cancer patients.

METHOD AND MATERIALS
RESULTS
CONCLUSION
 Imaging parameters from the MR and PET/CT, standard modality for the assessment of treatment response in cervical cancer, correlate significantly and our limited data suggest both modalities are efficacious during early treatment. Our research establishes an opportunity to further investigate the comparative effectiveness of each parameter at different treatment time points and further augment the potentials of these parameters for the early responsiveness assessment and long-term outcome prediction.

CLINICAL RELEVANCE/APPLICATION
Current research paves the foundation for cost-effective analysis of the presumed expensive MR and PET/CT and potential augmentation efficacy from the combined-modality approach.

SSK09-07 • Blood Oxygenation Level-Dependent MR Imaging: Early Changes to Concurrent Chemoradiotherapy in Cervical Cancer

Jungmin Bae (Presenter) ; Chan Kyo Kim MD, PhD ; Seung Hee Choi ; Sung Yoon Park ; Byung Kwan Park MD

PURPOSE
To investigate the feasibility of blood oxygenation level-dependent (BOLD) MR imaging (MRI) in assessing early changes to concurrent chemoradiotherapy (CCRT) in patients with cervical cancer.

METHOD AND MATERIALS
This prospective study was approved by our institutional review board. 15 consecutive patients with biopsy-proven cervical cancer who treated with CCRT were evaluated with MRI at 3T, including BOLD MRI. Three serial MR examinations were performed before CCRT (preTx); after 1 week of therapy (postT1); and after 4 weeks after therapy (postT2). BOLD MRI was performed using a multiple fast field echo (mFFE) sequence with 8, 12, 16 and 20 gradient echoes. At each time, the rate of spin dephasing (R2*) was calculated. At 4 different gradient echoes were measured in the tumor and normal uterus using manufacturer-supplied software (PRIDE Relaxation Maps Tool, version 2.1.1, philips Healthcare), and the results were compared. For reproducibility of R2* measurements, 8 patients had two separate pretreatment MRI at an interval of < 1 week. Repeated measures analysis of variance with a Bonferroni correction and Altman-Bland test were used for statistical analyses.
RESULTS
The mean R2* values of the tumors from preTx to postT2 tended to have consecutive increase at 8 echoes (20.7, 22.4 and 34.1), 12 echoes (20.9, 22.7 and 32.1), 16 echoes (21.3, 22.5 and 34.1) and 20 echoes (20.9, 22.8 and 33.3); however, compared with preTx, postT2 showed a significant increase in R2* values (P < 0.001), while postT1 had no significant difference (P > 0.05). At each time, the mean R2* values of the normal uterus were not significantly different at 4 different gradient echoes (P > 0.05). At 4 different gradient echoes, the reproducibility of R2* measurements in the tumor and normal uterus was confirmed with a mean difference of 0.1% ± 2.8% and 0.2% ± 7.6%, respectively.

CONCLUSION
BOLD MRI is a feasible, reproducible technique and may demonstrate early physiologic changes to CCRT in patients with cervical cancer.

CLINICAL RELEVANCE/APPLICATION
As a noninvasive, reproducible biomarker, BOLD MRI can be used to evaluate early therapeutic response to CCRT in patients with cervical cancer.

SSK09-08 • Diagnostic Accuracy of PET/MRI in Gynaecological Malignancies: Initial Results
Patrick Veit-Haibach MD (Presenter) *; Nik Hauser MD; Bianca Chilla MD; Gustav K Von Schultess MD, PhD *; Rahel A Kubit-Huch MD

PURPOSE
To assess and to compare the diagnostic accuracy of PET/CT and PET/MRI in primary and metastatic gynaecological malignancies.

METHOD AND MATERIALS
13 patients (13 female, mean age: 64, range 55-76 years) with different primary and recurrent gynaecological diseases underwent a contrast-enhanced tri-modality PET/CT-MRI examination (PET/CT D 690 and 3T MRI 750W, GE Healthcare). Patients were first injected with an average of 320 MBq F18-FDG and then rested for 30 minutes. Then, a full diagnostic, contrast-enhanced MRI of the abdomen and pelvis, based on the current guidelines, was acquired with the following sequences: coronal T2 SSFSE pelvis, axial T2 SSFSE liver, axial T1 Laveflex whole abdomen, axial diffusion pelvis, sagittal/axial T2 propeller pelvis, sag/axial T1 LavaFlex post contrast whole abdomen. After the MRI, patients were transferred on a dedicated shuttle to the PET/CT. Here, a standard PET/CT with/without intravenous contrast media was acquired (FOV mid-thigh to the vertex of the skull. CT: 50-79 mAs/slice, automated dose modulation 3D (100 kVp, 3.75 mm slice thickness. PET: 3D mode, 2 minutes/bed, iterative reconstruction with 3 iterations, 18 subsets). All data were evaluated on a commercially available workstation and can be displayed as PET, CT, PET/CT and PET/MRI.

RESULTS
Acquisition of PET/CT-MRI and PET/CT vs. PET/MRI evaluation was feasible in all patients. Concerning the primary tumour, the PET/CT was superior in 2 cases, PET/MRI in 5 cases, concerning lymph nodes PET/CT was superior in 2 cases, PET/MRI in 2 cases, in abdominal metastases PET/CT was superior in 2 cases, PET/MRI in none, PET/CT overall showed additional relevant information in 9 cases mainly concerning distant metastases, while PET/MRI showed relevant additional information in 3 cases concerning the primary tumour.

CONCLUSION
PET/MRI is well feasible within a tri-modality PET/CT-MRI system. The PET/MRI shows mainly advantages concerning the evaluation of the primary tumour/local pelvic situation while the PET/CT has advantages concerning distant metastases.

SSK09-09 • 18F-FDG PET/MRI versus MRI Alone for Whole Body Staging of Patients with Recurrent Malignancies of the Female Pelvis
Karsten J Beiderwellen MD (Presenter) ; Johannes Grueneisen ; Verena Hartung ; Philipp Heusch MD ; Rainer Kimmig ; Thomas C Lauenstein MD ; Lale Umutlu MD *

PURPOSE
To evaluate the diagnostic benefit of integrated 18F-FDG PET/MRI for whole-body staging of female patients with recurrent pelvic malignancies compared to MRI alone.

METHOD AND MATERIALS
RESULTS
In 10 of 13 patients malignant lesions were present. A total of 41 lesions, comprising 29 malignant and 12 benign lesions were detected. PET/MRI offered correct and respectively superior identification of all 10 patients with cancer lesions, compared to MRI (without DWI, 6/10; including DWI 8/10). Additionally, 18F-FDG PET/MRI exhibited higher conspicuity (PET/MRI: median: 4, range: 3-4; MRI: median: 4, range 1-4; MRI + DWI: median: 4, range 2-4) and diagnostic confidence (PET/MRI: median: 3, range 2-3; MRI: median: 2, range 1-3, MRI +DWI: median: 3, range 1-3) in the detection of malignant lesions (P < 0.001).

CONCLUSION
Our results demonstrate the superiority of 18F-FDG PET/MRI in detecting malignant lesions compared to MRI alone. Thus, whole body PET/MRI may be utilized as a stand-alone imaging technique for staging of patients with suspected pelvic malignancies, allowing for significant time reduction due to omission of T2w and DWI MRI.

SSK010-01 • Health Service, Policy and Research Keynote Speaker: Pragmatic Trials-Real World Research for Real World Problems
Jeffrey G Jarvik MD, MPH (*)

PURPOSE
Whole-body 18F-FDG PET/MRI may be applied as a stand-alone staging technique for patients with suspected pelvic malignancies.
This retrospective study included patients who underwent abdominal CT scans for evaluation of hematuria or nephrolithiasis between January 2008 to October 2011. An independent reader evaluated the CT reports for documentation of hepatic steatosis, nature of reporting (body of report vs impression), presence of recommendations and physician contact at the time of reporting. The patient medical records were then reviewed for diagnosis of steatosis, alcohol use, medications, diagnosis of hypertension, hyperlipidemia, and diabetes. The laboratory values were also examined prior to and after CT scanning.

RESULTS
Out of a total of 12,000 CT scans, 356 patients had hepatic steatosis on CT reports. Out of these, 127 patients (M:F, mean age-, age range- ) were included in final analysis due to availability of follow up data. On evaluation of CT reports, hepatic steatosis was documented in the impression in 83/127 (65%) patients and in the body of report in 44/127 (35%) patients. HCV screening was performed in 6.3% of patients and 59% underwent insulin resistance screening and over 80% of patients underwent LFT and lipid screening. There was a significant difference in the rate of follow up when radiology reports commented on fatty liver in the impression vs the body (30.1% vs. 9.1%, p = 0.007). On follow up evaluation at 14 months, steatosis was commented in the PCP follow up notes in only 23% of patients. New cases of insulin resistance were identified in 36% of patients (12% diabetes, 24% pre-diabetes) who underwent screening within 14 months of imaging.

CONCLUSION
Structured radiology reporting practices for incidentally detected hepatic steatosis on CT scans significantly impacts PCP documentation rates, and our data suggest that steatosis should be recorded in impression section of reports.

CLINICAL RELEVANCE/APPLICATION
Structured reporting of incidentally detected hepatic steatosis in CT scans will enable the treating physician to take decisive action allowing significant impact on patient care and management.

SSK10-03 • Assessing Competence of Non-physician Providers Trained in Point-of-Care Obstetrical Ultrasound in Under-resourced Settings of Western Kenya

H. B Harvey MD, JD (Presenter) ; Daniel Price MD ; Roy Ahn MPH ; Garry Choy MD, MS ; Giles W Boland MD ; Thomas Burke MD *

PURPOSE
Hand-held ultrasound machines have the potential to positively impact infant and maternal mortality in the developing world by identifying patients with high risk conditions that should deliver in a hospital setting. However, due to the paucity of radiologists in the developing world, training of non-radiologist clinicians in point-of-care ultrasound is essential. We trained a select group of nurse midwives in resource-limited areas of Western Kenya and empowered them to implement antenatal ultrasound screening programs in their hospitals and clinics. At least six months after training, we evaluated their retained obstetrical ultrasound skills.

METHOD AND MATERIALS
From February 2011 through August 2012, nine nurse midwives underwent an intensive one-week training course to perform and interpret point-of-care ultrasound examinations followed by a few weeks of supervised on-the-job training. Approximately six months after completion of training, fellowship trained sonographers subjected the providers to an objective structured clinical examination (OSCE) on two patients. The OSCE graded their ability to assess gestational number, gestational age, fetal heart rate, fetal position, placental position, and amniotic fluid index on a 3 point scale (0 = inadequate, 1 = adequate, 2 = excellent). The maximum score for the OSCE was 12.

RESULTS
The ultrasound screening programs were set up in three hospitals and six clinics. The average age of the providers was 36.9 yrs (28-60yrs, stdev 12.9 yrs). The providers performed an average of 9.3 scans per month (4-15, stdev 4.6) in their home clinics and hospitals. All of the providers achieved at least a score of 1 (adequate) on all the assessed OSCE measures with an average per skill score of 1.6. The average total OSCE score per provider was 9.9 (8-12, stdev 1.3).

CONCLUSION
The findings suggest that non-physician clinical providers retain basic skills in point-of-care maternal ultrasound after one week of intensive training. Confident with the quality of the service provided, we next hope to begin the process of evaluating the potential longitudinal impact of these maternal ultrasound screening programs on patient management and maternal and infant outcomes.

CLINICAL RELEVANCE/APPLICATION
Non-physician clinical providers can be trained to reliably perform and interpret point-of-care obstetrical ultrasound examinations in resource-limited areas of the developing world.

SSK10-04 • Radiologist Compliance with Institutional Guidelines for Use of Non-routine Communication of the Results of Radiologic Examinations

H. B Harvey MD, JD (Presenter) ; Tarik K Alkasab MD, PhD ; Gloria M Salazar MD ; Daniel I Rosenthal MD ; G. Scott Gazelle MD, PhD *

PURPOSE
Failure to appropriately communicate the results of radiologic examinations in urgent or non-routine clinical situations is a common source of medical malpractice liability in radiology. In 2009, the Departments of Radiology across our large integrated health system came together and developed guidelines for non-routine communication of diagnostic imaging findings based on the urgency of the findings and in view of existing guidelines and requirements. We study radiologist compliance with the guidelines nearly three years after implementation.

METHOD AND MATERIALS
From July 2012 through March 2013, 6,716 randomly selected radiology reports with images across all sections were reviewed in a peer-review conference format by at least three radiologists. The reviewing radiologists were asked to reach a consensus on two questions relating to non-routine communication: (1) Does the report describe a finding which requires non-routine communication to the patient’s physicians? and (2) if so, Were departmental guidelines for non-routine communication followed? Consensus judgments were subsequently aggregated and analyzed based on section, level of acuity per the guidelines (i.e. Level 1, 2 or 3), and type of communication employed.

RESULTS
Of the 6,716 studies reviewed, 718 (10.7%) were deemed to require non-routine communication of results and 17 (0.3%) resulted in no consensus as to whether non-routine communication was required. Out of the 718 studies deemed to require non-routine communication, 10 cases (3%) resulted in a consensus that the guidelines were not followed: 4 of these were level 1 findings, 4 were level 2 findings, and 12 were level 3 findings. Neurological imaging accounted for the majority of the failures of non-routine communication with 60% of the cases and all of the cases involving level I findings (e.g. new ventricular entrapment, subarachnoid hemorrhage, and new acute cortical infarction). Cases in which no consensus could be reached primarily involved Level 3 findings.

CONCLUSION
Guidelines for non-routine communication are appropriately applied in the vast majority of clinical cases at our large academic medical institution years out from their introduction.

CLINICAL RELEVANCE/APPLICATION
Non-routine communication of radiologic results is an important aspect of the radiology quality and safety landscape and efforts to ensure that it occurs consistently and effectively remain essential.
SSK10-06 • The Effect of Increasing Imaging Volumes on Radiologist Fatigue: The eFatigue Phenomenon

Robert J McDonald MD, PhD (Presenter) ; Kara M Schwartz MD ; Felix E Diehn MD ; Laurence J Eckel MD ; Christopher H Hunt MD ; Bradley J Erickson MD, PhD * ; David F Kallmes MD *

PURPOSE
Cross-sectional imaging utilization has dramatically increased over the past two decades. Driven by technical innovations that have improved anatomic resolution, acquisition time, and applicability of CT and MRI, cross-sectional modalities have supplanted use of conventional radiographs in many clinical practice guidelines. Rising utilization coupled with innovation has increased Radiologists’ workload with respect to the total number of studies and images that must be interpreted. In the current study, we quantify changes in imaging workload over time as a surrogate measure of fatigue.

METHOD AND MATERIALS
Monthly counts of CT and MRI studies performed at our institution from 1999-2010 were identified. Total numbers of images per exam were also extracted from the associated studies. Imaging workload data were normalized to the number of dedicated CT and MRI daily work assignments to determine the average radiologist workload assuming a 255-work day calendar and 8-hour workday. Temporal trends in institutional and individual workload were assessed by Sen’s slope analysis (Q) using a normal Z-test statistic.

RESULTS
From 1999-2010, a total of 1,517,149 cross-sectional imaging studies (CT=994,471; MRI=522,678) comprised of 539,210,581 images (CT=339,830,947; MRI=199,379,634) were evaluated at our institution. Total numbers of annual cross-sectional studies steadily increased from 84,469 in 1999 to 147,336 in 2010, representing a two-fold increase in workload (Q=6465/yr, Z=4.2, p<0.0001).

CONCLUSION
Imaging volumes have grown at a rate out of proportion to increasing imaging utilization at our institution. The average radiologist workload must now interpret 1 image every 2-3 seconds in a given 8-hour workday to keep up with workload demands.

CLINICAL RELEVANCE/APPLICATION
Growing imaging volumes, and to a lesser extent increasing utilization, are likely major contributors to Radiologist fatigue.

SSK10-07 • Tension between Quality Metrics: The Case of Radiation Dose and Diagnostic Yield in Suspected Chronic Stable Angina

Saurabh Jha MD (Presenter)

PURPOSE
Radiation dose and proportion of negative coronary catheter angiograms (CCA) are potential quality metrics in the management of patients with suspected chronic stable angina. The tension between achieving the metrics when using various gatekeeper tests for coronary artery disease (CAD) is explored.

METHOD AND MATERIALS
Decision model capturing the diagnostic strategies utilizing various gatekeeper tests, either singly or in combination, in a cohort of patients suspected of chronic stable angina was constructed. CCA was assumed to be the gold standard. Patients with positive and non-diagnostic tests were assumed to receive CCA. The outcomes included total radiation dose in the diagnostic pathway and the proportion of negative catheter angiograms.

RESULTS
The typical patient in the cohort is a 55 year old female with atypical chest pain who has 30 % pre-test probability of obstructive CAD, achieved one of the lowest negative CCA rate of 33 % (desirable) but the highest radiation dose of 15.04 msv (undesirable). Exercise ECG led to the highest negative CCA rate (undesirable) of 54 % but one of the lowest radiation doses (desirable) of 3.36 msv.

CONCLUSION
A strategy employing stress echo and cardiac CT achieved the lowest negative CCA rate and relatively low radiation exposure; both outputs are plausible quality metrics. The scenario highlights that quality metrics can sometimes be oppositional, even if united by a singular underlying goal of improved patient care.
S501-08 • Abdominopelvic MRI for Lesion Characterization: Factors Associated with Likelihood of Added Value
Andrew B Rosenkrantz MD (Presenter) ; Laura Heacock MS, MD ; James S Babb PhD

PURPOSE
To evaluate factors associated with the likelihood that abdominopelvic MRI examinations performed for characterization of lesions identified on other imaging modalities will provide information with potential to add value to patient management.

METHOD AND MATERIALS
1,132 abdominopelvic lesions in 863 patients in which MRI was performed for further characterization following detection by an alternate imaging modality were included in this retrospective study. Reports of the MRI examinations and of the prior studies were reviewed to classify cases in terms of patient, examination, and lesion related factors. The MRI reports were also classified in terms of various measures reflecting inclusion of content with potential to add value to patient management. Data was analyzed using logistic regression for correlated data.

RESULTS
MRI provided a definitive diagnosis (DD) for 79.2% (897/1132) of lesions, upgraded the severity of the favored diagnosis in 6.2% (70/1132) of lesions, downgraded the severity of the favored diagnosis in 34.5% (390/1132) of lesions, and showed an absence of the suspected lesion in 12.0% (136/1132) of lesions. Provision of a DD was significantly associated with the organ containing the lesion (p = 0.02).

CONCLUSION
Abdominopelvic MRI examinations performed for further lesion characterization may add value to clinical management in a high fraction of cases, the likelihood of which is influenced by factors related to the given examination.

S501-09 • Improved Accuracy of Gadoxetate Disodium-Enhanced MRI Using a Double Reading Paradigm for Detection and Characterization of Liver Lesions
Sheela Agarwal MD, MS (Presenter) ; Sandeep S Hedge MD ; Elkan F Halpern PhD * ; Mukesh G Harisinghani MD ; Pari Pandharipande MD, MPH ; Debra A Gervais MD * ; Peter F Hahn MD, PhD * ; Sanjay Salni MD

PURPOSE
To evaluate the incremental clinical value of double reading gadoxetate liver MRIs for detection and characterization of liver lesions and incidental findings.

METHOD AND MATERIALS
During the 6 month period from 8/1/2012-1/31/2012, 489 patients underwent 544 liver MRIs with the relatively new contrast agent gadoxetate disodium. Each study was read primarily by a fellowship trained staff abdominal radiologist and over-read by a second abdominal radiologist. Change in diagnosis was confirmed by characteristic radiologic findings with consensus review (74%), imaging follow-up (12%), or histopathology (14%). Any interpretive changes were classified by clinical significance and potential change in patient management. Rates of change in diagnosis were analyzed with logistic regression analysis, including reader factors (experience level, percent of workload dedicated to MRI), exam factors (indication, scanner brand, magnet strength) and work related factors (weekend vs weekday read, presence of preliminary read by trainee).

RESULTS
Changes in interpretation occurred on 50 examinations (9.2%) with 23 (4.2%) leading to a potential change in clinical management. On multivariate logistic regression analysis, weekend interpretation was an independent predictor increasing likelihood of a change in interpretation (p < 0.01). In step-wise logistic analysis, reading the study alone (without the preliminary read of a trainee) was also found to be a predictor of an interpretive change (p < 0.02). On univariate logistic analysis, less experience with liver MRI as measured by a smaller percentage of one's workload dedicated to MRI was a significant factor predicting a miss (p < 0.05). Common interpretative discrepancies included omission of one metastasis in the setting of multiple metastases (13), misinterpretation of HCC (9), misinterpretation of hemangiomas (6) and misinterpretation of FNH and adenomas (8).

CONCLUSION
Double reading of gadoxetate-enhanced liver MRI results in improved detection and characterization of liver lesions, with a significant effect on clinical management of patients. This may be considered for better clinical practice in divisions with varying levels of reader experience with hepatobiliary contrast agents.

S501-10 • Crying 'Wolf' about Unsatisfactory Study Quality: A Potential Rift in Communication between Radiologists and Referring Clinicians
Shahine Baghai MD (Presenter) ; Amy Kunce ARRT ; William W Olmsted MD ; Eliot L Siegel MD *

PURPOSE
Technically unsatisfactory imaging quality (TUIQ) impacts patient care, but there is wide variability in whether and how TUIQ is identified in radiology reports. The purpose of this study was to determine the relative frequency in which TUIQ is explicitly identified in reports of various modalities, how often recommendations for follow up are made, and whether these recommendations are heeded by clinicians.

METHOD AND MATERIALS
Using software to search 330,733 radiology reports (Montage, Philadelphia, PA), we retrospectively identified studies (CR, US, and CT) describing TUIQ. Search terms included: limited, suboptimal, sub-optimal, and poor. Study date, modality, radiologist, indication, number of cases, the rate of TUIQ was 1.7 times higher for CT and 3.7 times higher for US. 52% of all TUIQ cases underwent no follow up imaging; 29% had a follow up study for clinical reasons other than technical quality and only 19% of cases had follow up imaging.
The conclusion establishes the significance of the findings. It highlights the variations in radiation dose delivery across different CT protocols and the importance of controlling for patient-specific factors.

CLINICAL RELEVANCE/APPLICATION

This study is of interest to all radiologists seeking to improve communication with referring clinicians regarding the diagnostic quality of imaging studies and need for repeat imaging.

SSK11-03 • Updating Radiation Dose Rate in Fukushima Two Years after Severe Accident of Fukushima Nuclear Power Plant

Shoichi D Takekawa MD (Presenter); Takahiro Kato PhD

CONCLUSION

The RDR in Fukushima residential area is decreasing by the effort of eradication by removing the surface soil and leaves of trees contaminated by radioactivity. However, some radiation is still remaining and further observation and effort to remove contaminated materials in the residence areas are necessary.

CLINICAL RELEVANCE/APPLICATION

This study is of interest to all radiologists seeking to improve communication with referring clinicians regarding the diagnostic quality of imaging studies and need for repeat imaging.

SSK11-04 • Evaluation of Non Commercial DICOM De-identification Tools Freeware

K. Y. E. Aryanto; Matthys Oudkerk MD, PhD; Peter M Van Ooijen (Presenter)

PURPOSE

To compare freeware DICOM toolkits for their ability to de-id sensitive elements in the DICOM header that may contain patient personal health information (PHI).

METHOD AND MATERIALS

Ten non commercial DICOM toolkits were selected and tested to be compared for their de-identification utility. The selection was made through an internet search to get as many tools as possible. The tests were performed in two scenarios. First, de-identification was performed using tools default setting and then by using the best possible customized settings. The toolkits were also examined for their de-identification profiles and how the configuration could be customized.

RESULTS

The DICOM toolkits were tested to eliminate fifty elements in the DICOM header which are considered to contain private information that may be used to reveal the identity of a patient. Not all of the toolkits provide a full customizable de-identification profile. Two tools use a fixed configuration. In the other eight tools, changes can be made by giving input through user interface, manually into a configuration file, or providing the appropriate command arguments or options. Using the first scenario, there was only one tool which, by default, was configured to de-identify all selected elements. In the second scenario, three other DICOM toolkits could perform the task after manual adjustment.

CONCLUSION

Only four out of ten selected free DICOM toolkits could de-identify the defined DICOM elements properly. Free DICOM toolkits should therefore be used with extreme care when de-identifying sensitive data since they can have a high risk of disclosing PHI, especially when using the default configuration. In case optimal security is required, one of the four toolkits is proposed.

CLINICAL RELEVANCE/APPLICATION

Guidance to select the proper tool to de-identify DICOM data is important to ensure the security and confidentiality of patient personal health information in order to prevent patient data breach.

SSK11-05 • CT Dose Variability for Patients Undergoing Repeat Identical CT Scans: A Retrospective Analysis of 2606 Patients Undergoing 12,632 CT Scans

Douglas G Larson MD (Presenter); Daniel T Boll MD *; Olav Christianson; Rendon C Nelson MD *

PURPOSE

To evaluate the intrinsic variability in radiation dose delivery of CT scanners in clinical use, independent of patient-specific factors.

METHOD AND MATERIALS

We identified colon cancer, lung cancer, and renal stone patients who underwent the same CT protocol at least twice between 1/2007 and 2/2013. Evaluating patients undergoing multiple scans with identical protocols allowed us to control for any patient- and protocol-specific factors which could affect CT dose. Patient and dose data was taken from DICOM headers and dose sheets in PACS.

RESULTS

2606 patients underwent 12,632 repeat CT scans (mean 4.8, range 2-33 repeat scans/patient). There were 875 A/P, 4620 C/A/P, 1053 Renal Stone, and 6084 Chest CT scans. The per-patient dose variation was identified, then normalized using coefficients of variation, and ratios of maximum dose to minimum dose. In both cases, a higher value indicates higher dose variability. There was statistically significant variation across all patients and protocols (p
There is a statistically significant variation in the radiation dose delivered to a single patient undergoing repeat identical CT scans, which varies by scanner and is higher in large patients. The data suggests that there are opportunities to reduce this variability by careful monitoring of key factors, CT table height being one example.

**CLINICAL RELEVANCE/APPLICATION**

Evaluation and scrutiny of CT dose delivery in clinical practice allows for determination of the intrinsic and controllable variability in an attempt to achieve more consistent patient care.

**SSK11-06 • Simulation of Adverse Contrast Reactions - An Educational Tool for Team Training**

_Taj Kattapuram MD (Presenter) ; Gloria M Salazar MD ; Elkan F Halpern PhD * ; Preston D Stingley MA, MBA ; Shawn Bonk ; Emily Hayden ; Margaret Sande ; James Gordon MD ; Bethany L Niell MD_

**PURPOSE**

Successful management of a serious adverse reaction to contrast media requires prompt recognition and treatment, as well as effective team dynamics among radiologists, technologists, and nurses. Our radiology department implemented an educational simulation in which teams of nurses, technologists, and physicians are required to manage simulated adverse contrast reactions. This study evaluates whether simulation training emphasizing team dynamics improved an individual's self-actualization of the management of an adverse contrast reaction.

**METHOD AND MATERIALS**

Following IRB approval, 56 physicians, 7 nurses, and 56 technologists worked in interprofessional teams of four to manage two cases of simulated adverse contrast reactions. A standardized debriefing occurred immediately following each simulated case, focusing on medical management of adverse contrast reactions, an institutional adverse contrast reaction kit, and team dynamics including role clarity, communication, event managers, etc. Participants individually completed pre- and post-simulation questionnaires which included knowledge-based questions regarding the appropriate management of contrast reactions, as well as questions about participants' perception of their ability to manage adverse contrast reactions. Self-actualization was measured with a 6-point Likert scale. Statistical significance was calculated using McNemar's test with a p value.

**RESULTS**

Following completion of simulation training, radiologists, technologists, and nurses reported a statistically significant improvement in their ability to function as a team during a medical emergency, including an adverse contrast reaction (p-value).

**CONCLUSION**

This simulation training program with its emphasis on team training and adverse contrast reaction management was perceived by the participants as an effective tool to improve the self-actualization of radiology personnel managing adverse contrast reactions.

**CLINICAL RELEVANCE/APPLICATION**

Simulation training is recommended to educate radiology personnel on effective team dynamics in the management of adverse contrast reactions.

**SSK11-07 • Comparison of Image Quality and Lesion Detectability between Knowledge Based Iterative Reconstruction (IMR-L1) and iDose4 with 50% and 70% Reduced-dose CT Scan in Evaluation of Small Abdominal (≤3cm) Lesions**

_Yuying Gao (Presenter)_

**PURPOSE**

To compare the image quality and lesion detectability of a new reconstruction algorithm IMR-L1 and iDose4 iterative reconstruction technique on a 256-slice CT in low-dose abdomen scans, with focus on small (=3cm) lesions detection and evaluation.

**METHOD AND MATERIALS**

Two sets of images were obtained during arterial phase scanning: standard-dose filtered back projection (FBP) for each, and low-dose scans were performed randomly on 24 patients (10 male and 14 female; mean age 51.3 years) with acknowledged small lesions. (Group 1, 50% dose reduction for 11 patients), (Group 2, 70% dose reduction for 13 patients). Image quality of the iDose and IMR L-1 (L1) images was evaluated according to these features: lesion sharpness, low contrast detectability, overall diagnostic confidence (1 [poor] to 5 [excellent]). The CNRs for lesions were measured in CT images reconstructed by iDose4 and IMR, and compared using the paired-t test.

**RESULTS**

Group 1 (50% reduction), IMR L1 was better than iDose4 in lesion sharpness and low contrast detectability (P<0.05; 3.04±0.59, 2.98±0.65, P>0.05). In group 2 (70% reduction), IMR L1 was better than iDose4 in lesion sharpness and low contrast detectability (P<0.05).

**CONCLUSION**

IMR-L1 enhances lesion's sharpness, and thus improves small lesion's detectability both in 50% and 70% dose-reduced group.

**CLINICAL RELEVANCE/APPLICATION**

IMR does enhance the interface contrast between different tissues and Sharpen the edges of Small lesions, thus improved the low contrast lesion's detectability.

**SSK11-08 • CT Protocol Optimization Using an Automated IT Solution Provided Size Specific Patient Doses, Automatic Tube Current Modulation Information, and Radiologist Feedback**

_Timothy P Szczytkowicz PhD (Presenter) * ; Frank N Ranallo PhD ; Walter W Peppler PhD * ; Richard J Bruce MD * ; Myron A Pozniak MD *_

**CONCLUSION**

Monitoring the radiation dose and image quality of CT examinations is essential to ethical patient care. This work represents a large stride in giving an institution's CT protocol optimization team the tools it needs to carry out that task.

**Background**

CT protocol optimization for a large multi center institution is complex due to: variations in CT architecture; the wide array of clinical sections using CT; the large number of required protocols to service each clinical section; and highly varied patient populations (i.e. size and age). To aid in this process, our institution has developed an automated system that collects information about patients, the scanner output and configuration for each patient, and a radiologist quality assessment report. All of this information is gathered digitally, and is fully automated. Patient information is taken from DICOM headers. Scanner output information is extracted from structured dose reports and the configuration of the scanner is taken from the DICOM images from individual image series. Patient sizes are measured using the scout images and every axial image slice. All of this information is used to guide protocol development, monitor the function of the automatic mA control, and identify outliers in terms of low or high dose, which may help identify reoccurring errors in patient scanning.

**Evaluation**

Prior to using the automated system, small subsets of patients were examined individually by medical physicists. This was a laborious task in which patient sizes, DICOM data, the maximum and minimum mA values, and dose information were manually recorded. This older method was more involved and required little to no user input. The automated patient sizing information was found to agree to the manual method within the uncertainty of the manual method.

**Discussion**
We found that RIT was able to specifically kill ART-treated lymphocytes and to reduce HIV p24 to undetectable levels. ART and RIT

purposes and methods

To describe a new digital radiography (DR) national database registry using standardized, automated data collection methods.

method and materials

The Dose Index Registry (DIR) DR pilot project collects and compares exposure indices across both adult and children’s facilities nationwide. The new International Electrotechnical Commission exposure index standard for digital x-ray systems (IEC 62494-1) is used, eliminating proprietary indices. Elements from DICOM Structured Reporting (SR) are extracted by the American College of Radiology (ACR) Triad software. Captured elements include age, gender, body part, technique factors (kVp, tube current), Exposure Index, Target Exposure Index, and Deviation Index. The information is de-identified and automatically transmitted to the ACR.

results

Three vendors (Agfa, Fujifilm, and Siemens) currently have equipment that uses the IEC terminology and the DICOM SR with more vendors adding equipment in the near future. Six adult and three children’s facilities are participating in the pilot project. To avoid the problems associated with individual institutional examination naming convention, each study is mapped to the new RadLex Digital Radiography Lexicon Playbook. Experiences learned from the DIR CT are used to overcome problems associated with the new DIR DR.

clinical relevance/application

A DIR DR national database using standard methods of data collection to monitor changes in exposure indices over time is urgently needed. The ability to track trends in exposure indices is useful to individual practices wishing to compare their own exposure indices against established benchmarks or national practice patterns. This data is useful to advisory radiation safety bodies. The data can be used to document exposure and variability for common examinations nationally and to create diagnostic reference levels for DR.

radiolabeled antibody to gp41 HIV glycoprotein kills ART-treated lymphocytes from HIV patients and HIV-infected monocytes in the CNS.

Purpose

To describe a new digital radiography (DR) national database registry using standardized, automated data collection methods.

Method and Materials

The Dose Index Registry (DIR) DR pilot project collects and compares exposure indices across both adult and children’s facilities nationwide. The new International Electrotechnical Commission exposure index standard for digital x-ray systems (IEC 62494-1) is used, eliminating proprietary indices. Elements from DICOM Structured Reporting (SR) are extracted by the American College of Radiology (ACR) Triad software. Captured elements include age, gender, body part, technique factors (kVp, tube current), Exposure Index, Target Exposure Index, and Deviation Index. The information is de-identified and automatically transmitted to the ACR.

RESULTS

Three vendors (Agfa, Fujifilm, and Siemens) currently have equipment that uses the IEC terminology and the DICOM SR with more vendors adding equipment in the near future. Six adult and three children’s facilities are participating in the pilot project. To avoid the problems associated with individual institutional examination naming convention, each study is mapped to the new RadLex Digital Radiography Lexicon Playbook. Experiences learned from the DIR CT are used to overcome problems associated with the new DIR DR.

CONCLUSION

A DIR DR national database using standard methods of data collection to monitor changes in exposure indices over time is urgently needed. The ability to track trends in exposure indices is useful to individual practices wishing to compare their own exposure indices against established benchmarks or national practice patterns. This data is useful to advisory radiation safety bodies. The data can be used to document exposure and variability for common examinations nationally and to create diagnostic reference levels for DR.

CLINICAL RELEVANCE/APPLICATION

Exposure creep is common with DR. By participating in national registries, a practice can monitor their DR exposures, monitor trends, and compare their exposures with other centers.

Molecular Imaging (Oncology II) Wednesday, 10:30 AM - 12:00 PM • SS04CD

P PURPOSE

The aim of this study was to investigate the use of targeted contrast-enhanced high-frequency ultrasonography for molecular imaging to determine the expression levels of endoglin, βv integrin and vascular endothelial growth factor receptor 2 (VEGFR2) biomarkers in murine melanoma tumor models.

METHOD AND MATERIALS

Melanoma-bearing nude mice (B16F10) were explored using dynamic contrast-enhanced ultrasonography with a VEVO2100 imaging system (Visualsonics, Canada). Microvasculature and expression levels of biomarkers were investigated at 20 MHz using specific contrast agents (CA) (MicroMarkerTM, Visualsonics). The lyophilized CA were conjugated with biotinylated rabbit anti-mouse endoglin, βv integrin and VEGFR2 monoclonal antibodies. Specificity of these functionalized CA was evaluated in comparison with an isotope control antibody (immunoglobulin G) which was bounded on the surface of the CA. Boluses injections of each targeted CA were performed and ultrasound signal intensity from bounded CA was evaluated on the different groups of mice. Two groups of mice were evaluated, control and treated with sorafenib with a daily dose of 62 mg/kg. Tumor samples were harvested for analysis of endoglin, integrin and VEGFR2 expression levels by immunohistochemisty.

RESULTS

The mean ultrasound signal intensity amplitude caused by backscatter of the retained endoglin/integrin/VEGFR2-targeted ultrasound CA after fixation into the vasculature was assessed. Endoglin biomarkers were more expressed than βv integrin and VEGFR2 in the tumor model. Endoglin tend to increase with time in the control group whereas a decrease in the level expression was observed in the sorafenib group between D0 and D3. These differences in biomarkers expression were also observed by immunostaining.

CONCLUSION

Targeted ultrasound CA coated with antibodies enable in vivo molecular imaging of biomarkers expression on the tumor vascular endothelium and may be used for noninvasive evaluation of tumor angiogenesis during growth or therapeutic treatment in preclinical studies. Endoglin protein which plays an important role in angiogenesis seems to be a target of interest for detecting cancer and for predicting therapy efficacy.

CLINICAL RELEVANCE/APPLICATION

Being able to propose to most appropriate therapy depending on biomarkers expression

radiolabeled antibody to gp41 HIV glycoprotein kills ART-treated lymphocytes from HIV patients and HIV-infected monocytes in the CNS.

Purpose

Eliminating virally infected cells is an essential component of HIV eradication strategy. In addition, many patients on antiretroviral therapy (ART) suffer from HIV-associated neurocognitive disorders as the brain becomes a reservoir for infection. Thus, the drugs that can enter into the CNS and eradicate the infection are needed.

Method and Materials

Radioimmunotherapy (RIT), a clinically established method to kill cells using radiolabeled monoclonal antibodies (mAbs), was recently used to target the HIV gp41 glycoprotein expressed on the surface of infected cells. As gp41 expression by the infected cells is downregulated in patients on ART, we evaluated the ability of RIT to kill infected cells treated with ART in vitro using patients lymphocytes. We also tested the ability of the same radiolabeled mAb 2556 to gp41 to cross the blood brain barrier (BBB) and kill HIV infected monocytes in the CNS.

RESULTS

We found that RIT was able to specifically kill ART-treated lymphocytes and to reduce HIV p24 to undetectable levels. ART and RIT
worked in concert to decrease viral production when compared to ART or RIT alone, indicating that expression of gp41 under ART was still sufficient to allow 2556 mAb binding and killing infected cells. A 4 Ci dose of 213Bi-2556 successfully killed over 80% of PBMCs (97 compared to isotype control 1418 mAb pl of 8. 213Bi-2556 killed significantly more HIV infected than uninfected monocytes on the astrocyte side of the BBB in dose response manner (p CONCLUSION

In conclusion, RIT in concert with ART eliminated infected cells. Co-treatment was effective in both Atripla and tenofovir/emtricitabine/azacavir cohorts. We demonstrated the unique ability of 213Bi-2556 mAb to cross the BBB and specifically kill HIV infected monocytes. These findings demonstrate the feasibility of an RIT-based strategy for use with ART to achieve HIV eradication systemically and in CNS.

CLINICAL RELEVANCE/APPLICATION

HIV/AIDS remains an incurable disease. Our goal is to develop RIT-based strategies for therapy of systemic and CNS HIV for use with other anti-retroviral strategies to achieve complete HIV eradication.

SSK12-04 • Early Multi-modal Tumor Perfusion Monitoring upon Anti-vascular tTF-NGR Therapy by USPIO-MRI, CE-US, SPECT, and FRI

Thorsten Persiengil MD (Presenter); Janine Ring; Sven Hermann; Wolfgang E Berdel; Walter L Heindel MD; Rolf Mesters; Christoph B Bremer MD; Christian Schwoppe

PURPOSE

The purpose of this study was to investigate multi-modal USPIO-enhanced MR imaging (MRI), contrast-enhanced Ultrasound (CE-US), 123I-tTF-NGR-SPECT, and Fluorescence Reflectance Imaging (FRI) for early monitoring of anti-vascular treatment effects of the thrombogenic tTF-NGR protein with a specific binding to CD13 on tumor endothelial cells.

METHOD AND MATERIALS

Fibrosarcoma (HT1080) bearing nude mice (n=12/12/14) were injected with the thrombogenic tTF-NGR with and without earlier blocking of CD13 by pure NGR peptide (GNRRAHA), or saline as control respectively. USPIO-enhanced MRI for determination of the relative blood volume (RBV), 123I-tTF-NGR-SPECT, and FRI for fluorescence imaging of Alexa-Fluor647-labelled fibrinogen were acquired about 4-8 hours after treatment initiation. CE-US was performed during and within 30 minutes after tTF-NGR application. Treatment response and blocking effectiveness were analyzed by histological grading of vascular thrombosis and/or necrosis (score: 0-5).

RESULTS

CONCLUSION

Multi-modal USPIO-MR, CE-US, SPECT, and FRI imaging allow an early complementary assessment of treatment efficacy of the thrombogenic vascular targeting agent tTF-NGR.

CLINICAL RELEVANCE/APPLICATION

This study demonstrates the feasibility of a complementary early multi-modal monitoring of anti-vascular therapies for better understanding of the molecular mechanism of action.

SSK12-05 • Whole-body Diffusion-weighted MRI with ADC Mapping in Patients with Diffuse Large B Cell and Hodgkin Lymphoma at Staging and during Treatment

Sarah M Toledano-Massiah (Presenter); Emmanuel Itti MD; Alain Luciani MD, PhD *; Violaine Safar; Sandrine Katshian; Chieh Lin MD; Bertrand Bresson; Anais Charles-Nelson; Karim Behadj; Jehan Dupuis; Pierre Zerbib; Benhalima Zegai; Julien Moroch; Michel Meignan MD, PhD; Corinne Haioun MD; Alain Rahmouni MD

PURPOSE

Evaluation of whole body diffusion weighted MRI (WB-DW-MRI) using apparent diffusion coefficient (ADC) parametric images for staging and response assessment in diffuse large B-cell lymphoma (DLBCL) and Hodgkin lymphoma (HL) by comparison with PET/CT as the reference standard.

METHOD AND MATERIALS

27 consecutive patients presenting with newly diagnosed DLBCL (n=15) and HL (n=12) prospectively underwent both WB-DW-MRI and 18-F FDG-PET/CT at staging, after 2 cycles of chemotherapy (26 patients at interim) and at the end of treatment (23 patients at closure). WB-DW-MRI analysis included size and visual ADC analysis - more or less restricted than muscle-, for the 23 defined nodal regions and the 6 defined organs allowing Ann Arbor staging at baseline and for response assessment. PET/CT data were analyzed using Deauville international criteria. WB-DW-MRI and PET/CT images were both independently analyzed by a junior and a senior reader. The baseline stages and the interim and closure responses based on WB-DW-MRI and PET/CT were compared. Agreement between junior and senior readings were compared on a per-site basis (Kappa).

RESULTS

At baseline, Ann Arbor stages were concordant between WB-DW-MRI and PET/CT in 22 patients: 4 patients were understaged on WB-DW-MRI because of overlooked lung (n=2), iliac node (n=1), and bowel involvement (n=1); one was overstaged (bone marrow involvement). Using size criteria, WB-DW-MRI and PET/CT showed concordant responses in 12/26 patients at interim and in 18/24 patients at closure: with combined size and visual ADC analysis, WB-DW-MRI was concordant with PET/CT in 19/26 patients at interim and in 21/23 patients at closure. At closure, only 1 patient had persistent low ADC with no abnormal uptake on PET/CT, and 1 patient had abnormal FDG uptake not detected on MRI (mediastinal mass). Interobserver agreement for PET/CT reading ranged 0.63-0.70 (good) while for WB-DW-MRI reading the range was 0.86-0.96 (excellent).

CONCLUSION

WB-DW-MRI with ADC mapping is a potentially valuable technique for initial staging, interim and final response assessment, with excellent interobserver agreement.

CLINICAL RELEVANCE/APPLICATION

Our study opens a path towards the use of WB-DW-MRI with ADC mapping complementary to PET/CT in lymphoma patient care; these results should be confirmed in a larger population.

SSK12-06 • A Hybrid Radioactive and Fluorescent Tracer for Sentinel Node Biopsy in Melanoma Patients

Nynke S Van Den Berg MSc; Gijs Kleinjan MD; Martin Klop; Omgio Nieweg; Renato Valdes Olmos; Fijis Van Leeuwen (Presenter)

PURPOSE

The purpose of this study was to explore the value of the hybrid tracer indocyanine green (ICG)-99mTc-nanocolloid for the sentinel biopsy in a large cohort of melanoma patients. A comparison was made with optical detection of blue dye (conventional approach).

METHOD AND MATERIALS

One-hundred-and-four patients with melanoma of the head and neck (n=53), trunk (n=33) or an extremity (n=18) were evaluated. Lymphoscintigraphy with subsequent SPECT/CT was performed after intradermal administration of ICG-99mTc-nanocolloid. The operation was performed 3-27 hours after tracer injection. Patent blue dye was injected prior to the start of surgery, except in patients with a melanoma in the face (n=35). Intraoperatively, sentinel nodes were pursued via gamma ray tracing, followed by optical verification using fluorescence and/or blue dye. A portable gamma camera was used to confirm removal of all radioactive sentinel nodes.
RESULTS
Preoperative imaging revealed at least one sentinel node in all patients. Intraoperatively, in 17 patients (16%) a sentinel node could only be localized using fluorescence imaging; these sentinel nodes were mainly located near the injection site or in the parotid area. Of all harvested sentinel nodes (n=300), 97% of sentinel nodes exhibited fluorescence intraoperatively. In the patients in whom blue dye was used, only 60% of sentinel nodes were stained blue at the time of excision (p=0.001).

CONCLUSION
ICG-99mTc-nanocolloid allowed for preoperative lymphoscintigraphy and SPECT/CT imaging as well as intraoperative radio- and fluorescent sentinel node detection in all 104 included patients. Optical fluorescence-based identification of the sentinel node was particularly useful in head and neck melanoma with nodes located close to the injection site and/or in the parotid area.

CLINICAL RELEVANCE/APPLICATION
Fluorescence imaging, in addition to the conventional radioguided approach, may allow the accuracy with which sentinel nodes can be removed, possibly improving the false-negative rates.

SSK12-07 • Novel Fluorescent Nanoparticle Imaging Allows Non-invasive Assessment of Immune Cell Modulation within the Esophageal Tumor Microenvironment

Peiman Habibollahi MD (Presenter) ; Todd Waldron ; Pedram Heidari MD ; Hoon Sung Cho ; David Alcantara PhD ; Timothy C Wang ; Anil Rustgi ; Omar Mahmoud MD, PhD

PURPOSE
Repeat endoscopic imaging combined with administration of fluorescent nanoparticles highly phagocytized by subpopulations of immune cells in the tumor microenvironment allows for their temporal evaluation. We employed this approach to understand changes in the myeloid derived suppressor cell (MDSC) immune cell subpopulation, a central modulator of tumor initiation and progression.

METHOD AND MATERIALS
A novel imaging probe (FH-CyAL5.5) was developed based on Feraheme, a monocrystalline dextran coated iron oxide nanoparticle, conjugated to a near infrared (NIR) fluorochrome, CyAL5.5. Two groups of L2Cre;p120cnflox/flox mice (n=5 each), a transgenic mouse model of esophageal squamous cell carcinoma, were imaged simultaneously for white light and fluorescent NIR signal using a custom-built dual channel upper GI endoscope 3 hrs after receiving the imaging probe, with or without dexamethasone (dex) pretreatment. Immune cell modulation was quantified by means of immunophenotyping (FACS), confocal microscopy and compared to the signal intensity during fluorescent endoscopy.

RESULTS
A high level of uptake of the fluorescent nanoparticles was observed in the esophageal lesions of L2Cre;p120cnflox/flox mice which significantly decreased after dex treatment (TBR 2.65±0.15 vs. 1.98±0.09, p<0.001) in both groups. These observations suggest that FH-CyAL5.5 is highly taken up by the MDSC immune cell component of the esophageal tumor microenvironment and can be used for assessment of specific immune cell modulation in response to targeted or non-targeted therapies.

CONCLUSION
This translatable technology may be used for the early detection of dysplastic changes as well as the serial assessment of immune-modulatory therapy in the esophageal tumor microenvironment.

SSK12-08 • 18F-fluorocholine PET/CT Detecting Prostate Cancer Recurrence: Is Dual-phase Imaging Really Beneficial?-Singapore Experience

Aaron K Tong MBBS, MRCP ; Zoe X Zhang PhD ; Sean X Yan MD (Presenter)

PURPOSE
In the last decade, choline PET/CT scan has been evaluated in diagnosing prostate cancer, particularly recurrence. The ability of choline PET/CT to detect prostate cancer recurrence may be enhanced by dual-phase acquisition presumably due to the different kinetics of choline in cancer tissue and in benign tissues. However, for this young imaging modality, the optimal protocol and the added value of performing dual-phase scan are still debatable. This study aimed to better define the imaging protocol for 18F-fluorocholine PET/CT.

METHOD AND MATERIALS
A total of 34 patients with suspected prostate cancer recurrence were scanned during the period of 04/2010 to 02/2013 in our hospital and were followed up for an average of 16 months. Final diagnosis was made on biopsy, correlating with other imaging modalities, PSA trend and clinical course. Each patient was given 5-10 mCi 18F-fluorocholine. Immediate acquisition (early phase, 2h post injection) of the pelvis and subsequently whole body acquisition (late phase, 30h post injection) were performed. Two blinded physicians read the scans independently with final consensus achieved in all cases. Standard Uptake Value (SUV) in the dominant lesions was recorded. Statistical analysis was done by SPSS program.

RESULTS
The accuracy of 18F-fluorocholine PET/CT for diagnosing prostate cancer recurrence was 85% with sensitivity of 81% and specificity of 100%. Uptrend change of SUV on the late phase vs early phase was significantly associated with recurrent cancer (P<0.05). The PSA level is closely associated not only with the likelihood of a positive scan (P=0.001), but also with the SUV (R=0.51, P=0.000) and the change in SUV between two phases (R=0.25, P=0.014).

CONCLUSION
18F-fluorocholine PET/CT is a useful imaging modality in evaluating prostate cancer recurrence. The dynamic change of SUV between early and late phase images facilitates differentiating malignancy from benignity. The value of dual-phase imaging in improving the performance of 18F-fluorocholine PET for detecting prostate cancer recurrence is confirmed.

CLINICAL RELEVANCE/APPLICATION
Dual-phase 18F-fluorocholine PET/CT scan is more accurate than single phase scan and is recommended in detecting prostate cancer recurrence.

SSK12-09 • [18F]-FLT PET to Predict Early Response to Neoadjuvant Therapy in Rectal Cancer

Eliot McKinley (Presenter) ; Ronald C Walker MD ; Anuradha Bapsi Chakravarthy MD * ; M. Kay Washington ; Robert J Coffey ; H. C Manning PhD

PURPOSE
Effective implementation of personalized medicine in oncology requires tailoring an individualized therapeutic regimen for a given patient based upon the molecular characteristics of their disease, and deploying effective biomarkers that predict responses early in the course of therapy. In this pilot study, we evaluated [18F]-FLT PET, a non-invasive molecular imaging biomarker of thymidine salvage pathway activity, as a means to predict response to neoadjuvant therapy that included cetuximab in wild-type KRAS rectal cancer patients.

METHOD AND MATERIALS
Baseline [18F]-FLT PET was collected prior to treatment initiation. Followup [18F]-FLT was collected after three weekly infusions of cetuximab, and following a combined regimen of cetuximab, 5-FU, and radiation. Imaging-matched biopsies were collected...
RESULTS

Diminished [18F]-FLT PET was observed in 3/4 of patients following cetuximab treatment alone and in all patients following combination therapy. Reduced [18F]-FLT PET following combination therapy predicted disease free status at surgery. Overall, [18F]-FLT PET imaging agreed with Ki67 immunoreactivity from biopsy samples and surgically resected tissue and was predictive of treatment-induced p27 levels.

CONCLUSION

To our knowledge, this study represents the first clinical evaluation of [18F]-FLT PET to predict response to neoadjuvant therapy that included EGFR blockade with cetuximab in patients with rectal cancer. Our results suggest that [18F]-FLT PET is a promising imaging biomarker of treatment response in this setting.

CLINICAL RELEVANCE/APPLICATION

This study reports the utilization of [18F]-FLT PET to predict early response to neoadjuvant therapy in patients with rectal cancer. Early detection of therapeutic efficacy can improve clinical outcomes.

SSK13-01 • Musculoskeletal Keynote Speaker: Update in Cartilage Imaging

Christine B Chung MD (Presenter)

SSK13-02 • T2 Mapping of Articular Cartilage in Patients of Meniscus Transplantation: A Prospective Study over 1 Year

Sun-Young Park MD (Presenter); Sang Hoon Lee; Min Hee Lee MD; Hye Won Chung MD; Myung Jin Shin MD

PURPOSE

To evaluate changes of T2 value of articular cartilage in patients of meniscus transplantation on serial follow up images.

METHOD AND MATERIALS

From 2010 to 2011, 26 patients (mean age, 29.6±10.3) who underwent meniscus allograft transplantation of lateral meniscus were prospectively evaluated by using a 3T MR imaging at 2 days, 6 weeks, 3, 6 and 12 months after the surgery. All patients showed no aggravation in the transplanted meniscus and no aggravation of chondromalacia. Quantitative T2 maps of femoral condyle and tibial plateau were obtained at the operation compartment. Mean T2 values were calculated at the deep and superficial layers of three allocated areas in femoral condyle and tibial plateau (the anterior and posterior meniscal coverage areas, and the weight bearing area). T2 value in each area was measured twice at the sagittal slice 6mm medially and laterally away from the central articulation (12 points). The grading of the chondromalacia was evaluated at each location with reference to the arthroscopic grading. All images were quantified using Relaxation Maps Tool. Statistical software (SAS® Version 9.2; SAS institute Inc., Cary, NC) was used.

RESULTS

The T2 values in both femoral and tibial articular cartilage were significantly decreased after meniscal transplantation on the serial follow-up MR scans for up to 1 year in both superficial and deep layers (p < 0.05).

CONCLUSION

T2 quantification showed the subclinical changes of articular cartilage after meniscus allograft transplantation over time and demonstrated the differences of T2 value according to the chondromalacia grade on serial follow up MR.

CLINICAL RELEVANCE/APPLICATION

T2 quantification is a useful tool in monitoring the treatment response of mesniscus allograft transplantation.

SSK13-03 • MRI T2-mapping with Clinical Correlation after Treatment of Knee Osteoarthritis with Autologous Mesenchymal Stem Cells: A Pilot Study

Joan C. Vilanova MD, PhD (Presenter); Marina Huguet MD; Ana Sanchez; Javier Garcia-Sancho; Lluis Orozco; Robert Soler

PURPOSE

To asses the feasibility of osteoarthritis treatment with mesenchymal stromal cells (MSCs) in humans, and to demonstrate its efficacy on MRI and clinical outcome.

METHOD AND MATERIALS

Twelve patients with clinical and radiologic diagnosis of osteoarthritis of the knee (graded according to the ICRS (International Cartilage Repair Society) were treated with autologous MSCSs by intrarticular injection on a phase I-II trial. Clinical outcomes were followed for 1 year (including pain, disability, and quality of life). Cartilage assessment was performed using MRI T2-mapping at 88 pre-determined anatomical regions previous to treatment, at 6 months and 12 months after treatment; by determining the T2 relaxation values (RV) in each region of the knee. Inter, intraobserver and equipment errors were calculated for reproducibility, and plateau were obtained at the operation compartment. Mean T2 values were calculated at the deep and superficial layers of three allocated areas in femoral condyle and tibial plateau (the anterior and posterior meniscal coverage areas, and the weight bearing area). T2 value in each area was measured twice at the sagittal slice 6mm medially and laterally away from the central articulation (12 points). The grading of the chondromalacia was evaluated at each location with reference to the arthroscopic grading. All images were quantified using Relaxation Maps Tool. Statistical software (SAS® Version 9.2; SAS institute Inc., Cary, NC) was used.

RESULTS

A positive correlation was identified between the baseline mean T2 RVs and the pain score (r=0.42; p < 0.05). The T2 values in both femoral and tibial articular cartilage were significantly decreased after meniscal transplantation on the serial follow-up MR scans for up to 1 year in both superficial and deep layers (p < 0.05).

CONCLUSION

The T2 values in both femoral and tibial articular cartilage were significantly decreased after meniscal transplantation on the serial follow-up MR scans for up to 1 year in both superficial and deep layers (p < 0.05). The grading of the chondromalacia was evaluated at each location with reference to the arthroscopic grading. All images were quantified using Relaxation Maps Tool. Statistical software (SAS® Version 9.2; SAS institute Inc., Cary, NC) was used.

CLINICAL RELEVANCE/APPLICATION

MSC therapy could be a valid alternative treatment for knee osteoarthritis and MRI T2-mapping might be a useful tool for its cartilage assessment follow up.

SSK13-04 • The Value of T2 Color Maps in the Patellar Cartilage Grading Injury

Qian Cui (Presenter); Shao Wu Wang; Yue Dong; Shaowei Zheng; Qingwei Song BS, BEng

PURPOSE

To investigate value of T2 color maps in assessment of patellar cartilage injury grading.

METHOD AND MATERIALS

62 patients who underwent knee MR and arthroscopic surgery patients were collected, including 32 males and 30 females, aged 30-51 years, mean 40.7 years. GE Company Signa3.0T MR was used. The scan sequence include: FSE-T1WI, FSE-T2WI, FS-FSE-PDWI and T2 mapping. T2 mapping images were sent to the GE-ADW 4.3 workstation to generate T2 color maps of patellar cartilage. Arthroscopic patellar cartilage grading standards, to explore T2 color maps value of the patellar cartilage grading injury.

RESULTS

T2 color maps would be reliable in classification of patellar cartilage damage assessment.
Purpose
MRI of the knee is increasingly applied in population-based studies, particularly on osteoarthritis (OA). Little is known on incidental knee MRI findings in an unselected ageing population. Our purpose was to describe the prevalence and clinical relevance of incidental findings on knee MRI in females of the Rotterdam Study, an ongoing open population-based study of middle-aged and elderly.

Method and materials
891 female participants aged 45-60 (mean 55) from the Rotterdam Study underwent MRI of both knees (1.5 T scanner (GE)) independent of OA status. All participants gave written informed consent, including a section on incidental findings. Incidental findings were assessed by trained researchers, reviewed with an experienced musculoskeletal radiologist and classified into findings that did or did not require referral, based on clinical relevance, expected health benefit and evidence based therapeutic consequences. Age-related changes were not considered findings that needed referral because these were primary study outcomes. In accordance with informed consent, findings that required referral were reported to participants and their GP.

Results
In 1782 MRI scans we identified 54 incidental findings (3.0%) in 52 participants, 17 of which (1.0%) in 17 participants required referral: 16 lesions suspicious of a chondroid lesion with uncertain benign characteristics and 1 large atypical cystic intraosseous abnormality. In all referrals, additional dynamic contrast-enhanced MRI was performed. Although this did neither demonstrate malignant tumor characteristics nor necessitated specific treatment in any, all referred participants were still followed-up clinically and radiologically. Among findings that did not require referral were 37 chondroid lesions in 35 participants with unequivocal benign features (central metadiaphysial lesion).

Conclusion
Our findings suggest that in the general middle-aged female population incidental findings are present in 3% of knee MRI scans. While referral and additional MRI was deemed necessary in 1% of MRIIs, this demonstrated that incidental findings virtually all consist of chondroid tumours with low suspicion of high tumour grade.

Clinical relevance/application
Incidental findings are present on 3% of knee MRI scans in the general middle-aged female population and virtually all consist of chondroid tumours with low suspicion of high tumour grade.

SSK13-06 • Comparison of Quantitative Magnetization Transfer Parameters of Patellar Cartilage in Asymptomatic Volunteers and Patients with Early Osteoarthritis
Nadee Sritanyaratana (Presenter); Pouria Mossahebi MS; John Wilson MD, MS; Alexey A Samsonov PhD; Walter F Block PhD*; Richard Kijowski MD

Purpose
Quantitative magnetization transfer (qMT) imaging utilizes the magnetization transfer effect to probe macromolecular tissue composition typically inaccessible by conventional magnetic resonance (MR) techniques. qMT can be used to measure the fraction of protons bound to macromolecules (f), the exchange rate between mobile protons and macromolecular bound protons (k), and the T2 relaxation time of macromolecular bound protons (T2b). This study was performed to compare qMT parameters of patellar cartilage in young asymptomatic volunteers and patients with early patellofemoral osteoarthritis (OA).

Method and materials
An MRI examination through the patellofemoral joint was performed in the axial plane at 3.0T on 14 young asymptomatic volunteers and 11 patients with Kellgren-Lawrence grade 1 (N=6) and grade 2 (N=5) patellofemoral OA. Nine spoiled gradient recall-echo (SPGR) volumes were acquired with different MT offset frequencies and MT powers, 2 SPGR volumes were acquired for B1 error correction, and 24 additional actual flip angle imaging (AFI) and 4 SPGR volumes were acquired for T1 mapping using variable flip angle imaging (VFI). Total scan time was 25 minutes. The qMT parameters f, k, and T2b were iteratively fitted in MATLAB using a previously described model and then measured in regions of interest placed around the entire patellar cartilage. (SPGR) volumes were acquired with different MT offset frequencies and 2 SPGR volumes were acquired for B1 error correction, and 11 patients with Kellgren-Lawrence grade 1 (N=6) and grade 2 (N=5) patellofemoral OA. Nine spoiled gradient recall-echo (SPGR) volumes were acquired with different MT offset frequencies and MT powers, 2 SPGR volumes were acquired for B1 error correction, and 24 additional actual flip angle imaging (AFI) and 4 SPGR volumes were acquired for T1 mapping using variable flip angle imaging (VFI). Total scan time was 25 minutes. The qMT parameters f, k, and T2b were iteratively fitted in MATLAB using a previously described model and then measured in regions of interest placed around the entire patellar cartilage. Mann-Whitney-Wilcoxon tests were used to compare qMT parameters between groups of subjects.

Results
Mean f, k, and T2b within patellar cartilage for asymptomatic volunteers were 14.00±0.71%, 6.51±0.71sec^{-1}, and 6.53±0.15s respectively. Mean f, k, and T2b within patellar cartilage for patients with OA were 14.30±0.85%, 5.63±0.80 sec^{-1}, and 6.83±0.14s respectively. Patients with OA had similar f (p=0.26), significantly lower k (p=0.006), and significantly higher T2b (p=0.00006) within patellar cartilage than asymptomatic volunteers.

Conclusion
Patients with early patellofemoral OA have lower k and higher T2b within patellar cartilage than asymptomatic volunteers. Additional studies are needed to investigate the mechanisms behind the observed changes in k and T2b with early cartilage degeneration.

Clinical relevance/application
qMT imaging is a new quantitative MR technique which has high sensitivity for detecting changes in macromolecular tissue composition associated with early cartilage degeneration.

SSK13-07 • Magnetic Resonance Imaging of Knee Changes in Psoriatic Patients without Arthritic Symptoms
Yasser Ragab MBCh, MSc (Presenter); Yasser F Emad MD, PhD; Hosny M Hamza MD, FRCR

Purpose
To evaluate magnetic resonance imaging (MRI) findings of knee joints in patients with psoriasis without clinical peripheral or axial joint involvement, and to correlate MRI findings with disease and demographic variables

Method and materials
In total 48 patients with psoriasis and no clinical evidence of synovitis or enthesitis in any peripheral or axial joints were enrolled. A random sample of 20 healthy subjects without knee or other joint complaints and matched for age and sex served as controls. All patients and controls underwent enhanced MRI studies of both knee joints, and MRI findings were compared.

Results
Among 48 patients (96 knees), a total of 90 entheseal lesions were detected, with no enthesitis in 2 cases (6.3%). Signs of continuing inflammation bilaterally were frequently found: soft tissue edema (STE; n = 52), bone marrow edema (BME; n = 20), perienthesal BME (n = 3), cartilage erosions (n = 42), and bone erosions (n = 27). In controls, 2 (10%) subjects had BME and another 5 (25%) showed cartilage erosions. None showed evidence of enthesitis. Significant correlations were observed between the number of entheseal lesions of both knees vs STE (present vs absent; r = 0.314, p = 0.030) and STE (number of lesions; r = 0.351, p = 0.014). Enthesitis (unilateral vs bilateral) was significantly and positively correlated with STE (r = 0.304, p = 0.036), cartilage erosions (r = 0.304, p = 0.036) and villous projections (r = 0.347, p = 0.016)
CONCLUSION
Subclinical synovitis and enthesis are frequently found in the knee joint of patients with psoriasis. These may be an early sign of psoriatic arthritis.

CLINICAL RELEVANCE/APPLICATION
In psoriatic patients the knees could be the seat of enthesis and synovitis changes even without symptoms of artheritis. Those changes may be depicted by MRI.

SSK13-08 • Semiquantitative MRI-based Predictors of Quantitative Cartilage Thickness Loss in Knee Osteoarthritis: Data from the MOST Study
Ali Guermazi MD, PhD (Presenter) *; Felix Eckstein MD *; Daichi Hayashi MBBS, PhD; Frank W Roemer MD *; Jingbo Niu MD, PhD; David T Felson MD, MPH *

PURPOSE
Although several pathological MRI and radiographic features of knee osteoarthritis (OA) have been associated with subsequent structural disease progression, no study has compared these features within the same study. We aimed to determine which of these features are most predictive of quantitative cartilage thickness loss measured by MRI.

METHOD AND MATERIALS
196 subjects from the Multicenter OA Study subcohort had baseline and 30-month knee MRIs, quantitative cartilage thickness measurement, and semiquantitative scoring (Whole Organ MRI Score) of cartilage, bone marrow, meniscus, effusion synovitis, and Hoffa synovitis at both time points. Presence of radiographic joint space narrowing (JSN) was noted at baseline. Knees were classified into progressors (those who lost cartilage thickness above thresholds) and non-progressors (those who did not). All MRI predictors were dichotomized into present (score=2 for cartilage, =1 for others) or absent. Differences in baseline scores of ipsocompartmental predictor variables were compared between progressors and non-progressors by logistic regression adjusting for covariates. Odds ratios (OR) and 95% CIs were calculated for medial (MFTC) and lateral femorotibial compartment (LFTC) cartilage loss, respectively. We combined MFTC and LFTC to calculate ORs of ipsocompartmental cartilage loss across compartments using Generalized Estimating Equations.

RESULTS
Of 196 knees (mean age 59.8±6.3, BMI 29.2±4.6), 46 knees had radiographic OA at baseline. Compared to non-progressors (n=149), progressors (n=47) had higher adjusted OR (aOR) for having baseline medial meniscal damage (aOR 2.4 [95%CI 1.2-5.1]), medial meniscal extrusion (aOR 2.5 [1.2-5.3]) and effusion synovitis (aOR 3.2 [1.2-8.2]) in MFTC. In LFTC, baseline JSN (aOR 7.0 [1.8-27.1]), lateral meniscal damage (aOR 8.1 [2.5-26.6]) and lateral meniscal extrusion (aOR 4.1 [1.4-12.5]) predicted cartilage loss. For analysis combining MFTC and LFTC, results were similar to those of LFTC, with baseline compartment specific JSN, meniscal damage and extrusion predicting cartilage loss.

CONCLUSION
Among MRI and radiographic features, meniscal damage/extrusion and effusion synovitis most strongly predict quantitatively assessed cartilage thickness loss over 30 months.

CLINICAL RELEVANCE/APPLICATION
Knees with meniscal damage and extrusion are likely to have cartilage thickness loss over time in the same FTC and should be a therapeutic target in knee OA.

SSK13-09 • Osgood-Schlatter Disease and Patella Alta on MRI: Is There Any Association?
Olavo K Nakamura MD (Presenter); Yves Costa MD; Juliana F Guimaraes MD; Luciana S Timbo MD; Luiz Guilherme Hartmann MD; Durval D Santos MD; Carlos H Longo MD; Lercio A Rosenberg MD; Marcelo B Funari MD

PURPOSE
To evaluate the association between Osgood-Schlatter disease and patella alta using MRI.

METHOD AND MATERIALS
A retrospective case-control study included patients evaluated by MRI of the knee performed in the period from January 2009 to December 2011 at our hospital. We included 103 patients with late sequel of Osgood-Schlatter disease (94 males and 9 females, average 37 years-old) and 393 controls without Osgood-Schlatter disease (326 males, and 67 females, average 41 years-old). Patients with Osgood-Schlatter disease in acute phase, patients younger than 15 years, prior surgery, fracture and bone deformities of the knee, and quadriceps and patellar tendon injuries were excluded. Patellar height was calculated using Insall-Salvati index technique and reference indexes on MRI were based in Shabshin et al published study. All case and control exams were independently evaluated by two radiologists. The used statistical methodologies were scatter and Bland Altman plots, intraclass correlation and kappa coefficients, and Fisher’s exact tests.

RESULTS
The study was approved by the institutional review board of our institution and written consent was obtained from all patients. From January 2012 to March 2013, 24 consecutive patients with suspicious bone tumors underwent radiography, tomosynthesis, and CT within 3 days. Two radiologists analyzed about the presence or absence of periosteal reaction, space occupying lesion (SOL), mineralization and fracture on each three imaging modality.

RESULTS
In the comparison between cases and controls, there was association with statistical significance between Osgood-Schlatter disease and patella alta (p<0.05). As demonstrated in the study, there was a statistical significant association between Osgood-Schlatter disease and patella alta and a good interobserver concordance. This fact highlights the importance of the evaluation for patellar height by Insall-Salvati index technique on MRI of the knees in patients with sequelae of Osgood-Schlatter.

CONCLUSION
In patients with Osgood-Schlatter disease, radiologists must be aware to the presence of patella alta, which can be important to the therapeutic decision and detection of associated lesions.

Musculoskeletal (Tumor II) Wednesday, 10:30 AM - 12:00 PM • E451A Back to Top MR CT RO MK SSK14 • ANA PRA Category 1 Credit ™:1.5 • ARRT Category A+ Credit:1.5 Moderator Kambiz Motamedi, MD
Moderator Mark J Kransdorf, MD
SSK14-01 • Diagnostic Performance of Tomosynthesis for Evaluation of Suspicious Bone Tumors: Comparison with Radiography and CT
Jihyun Bae MD (Presenter); In Sook Lee; You Seon Song; Jeung Il Kim MD, PhD; Jong Woon Song

PURPOSE
To compare tomosynthesis with radiography for evaluation of suspicious bone tumors, using multidetector computed tomography (CT) as the reference method.

METHOD AND MATERIALS
The study was approved by the institutional review board of our institution and written consent was obtained from all patients. From January 2012 to March 2013, 24 consecutive patients with suspicious bone tumors underwent radiography, tomosynthesis, and CT within 3 days. Two radiologists analyzed about the presence or absence of periosteal reaction, space occupying lesion (SOL), mineralization and fracture on each three imaging modality.

RESULTS
Fourteen patients had benign bone tumors, nine had malignant bone tumors and one had only cortical fracture. The overall sensitivity, specificity, and accuracy of tomosynthesis were, respectively, 88.9%, 100%, and 95.8% about the periosteal reaction, all 100% about the SOL and mineralization, and 87.5%, 100% and 91.7% about the fracture. Those of radiography were, respectively, 88.9%, 100%, and 95.6% about the periosteal reaction, 81.8%, 100% and 83.3% about the SOL, 83.3%, 100%, and 97.8% about the mineralization, and 43.7%, 100%, and 62.5% about the fracture. The degrees of agreement between CT and tomosynthesis were 0.909 about periosteal reaction, 1 about the SOL and mineralization and 0.824 about the fracture (p < 0.05). Those between CT and radiography were respectively 0.909, 0.429, 0.882, and 0.341 (p < 0.05).

CONCLUSION
The diagnostic performance of tomosynthesis for evaluation of suspicious bone tumors was significantly greater than radiography and comparable to CT.

CLINICAL RELEVANCE/APPLICATION
The imaging qualities of tomosynthesis in the cases of suspicious bone tumors may comparable to those of CT images, with relatively lower radiation dose.

SSK14-02 • Treatment Response Evaluation of Patients with Malignant Bone Tumors; Correlation of ADC from 3.0T MR Imaging and SUV from FDG PET/CT
So-Yeon Lee MD (Presenter) ; Won-Hee Jee MD ; Joon-Yong Jung MD ; Jin-Kyeong Sung MD ; Soo Ah Im ; Jin Hyoung Kang ; Je Ryung Yoo

PURPOSE
To retrospectively determine whether the apparent diffusion coefficients (ADC) at 3T diffusion-weighted MR imaging (DWI) correlate with the standardized uptake values (SUV) at positron emission tomography (PET)/computed tomography (CT) for evaluating treatment response in malignant bone tumors.

METHOD AND MATERIALS
The institutional review board approved this HIPAA-compliant study and informed consent was waived. Twenty-two patients with 27 malignant bone tumors underwent 3T MR imaging including DWI with b value of 0, 800 sec/mm² and whole-body fluorine 18 fluorodeoxyglucose PET/CT before and after treatment. Minimum ADC (ADCmin) of the tumor was measured by two independent musculoskeletal radiologists and correlated the maximum SUV (SUVmax) of the tumor. The percentage changes of ADCmin and SUVmax were calculated by the difference between the initial and follow-up values divided by the initial value. The change ratios of ADCmin and SUVmax were defined as the ratio of the follow-up value to the initial value. The Spearman rank correlation were obtained for statistical analysis.

RESULTS
There was significant correlation between the differences between the initial and follow-up values of ADCmin and SUVmax (r = 0.573 for reviewer 1 and r = 0.597 for reviewer 2, P < .005), the change ratios of ADCmin and SUVmax (r = 0.457, r = 0.491, P < .05), and percentage changes of ADCmin and SUVmax (r = 0.457, r = 0.491, P < .05). DWI and PET CT showed treatment response in 14 lesions of the ADC was increased by 105% (interquartile range, 61-166) and SUVmax was decreased by 56% (37-83). The ADCs of two responded lesions returned to the range of normal bone marrow and resulted in a decrease of the ADCmin (65% and 32%, respectively) with decrease of SUVmax (71% and 87%, respectively). There was no response in six lesions: the ADC was decreased by 23% (13-30) and SUVmax was increased by 53% (26-90). There was one lesion with a discrepancy in changes of ADCmin (decreased by 29%) and SUVmax (decreased by 13%).

CONCLUSION
There was significant correlation between the ADC and SUV for evaluating treatment response in malignant bone tumors.

SSK14-03 • Negative Relationship between CT Attenuation Values and ADC Values in Densely Sclerotic Bone Metastases from Prostate Cancer
Usman Bashir MBBS (Presenter) ; Nina Tunariu MD ; David J Collins BSC, BA ; Diletta Bianchini ; Andrea Zivi ; Dow-Mu Koh MD, FRCR

PURPOSE
To investigate relationship between CT attenuation and ADC value of skeletal metastasis in prostate cancer.

METHOD AND MATERIALS
26 patients of prostate cancer with bone metastases, who underwent contemporaneous whole body diffusion-weighted MRI (WB-DWI) and CT were retrospectively reviewed. WB-DWI was performed on a 1.5T system using b-values 50, 900 s/mm². CT of chest, pelvis and pelvis was acquired at 65s post-contrast. Slice-by-slice synchronization was obtained between CT and MRI data-sets by careful use of anatomic landmarks. A lucent and a sclerotic metastasis were chosen on CT, when present, at each of the following skeletal sites: thoracic spine, lumbar spine, sacrum, right pelvis and left pelvis. A maximum of 10 lesions were evaluated per patient. Lesion signal intensity on b900 image was recorded as hyperintense or iso/hypointense to skeletal muscle. A region of interest (ROI) was drawn on CT around each lesion to record the mean CT value (HU) and copied on the matching b900 image to derive lesion’s mean ADC value (x 10-3 mm²/s). The relationship between lesion CT HU and ADC values was evaluated by Spearman’s correlation. The mean CT HU and ADC values of hyperintense versus iso/hypointense lesions were compared using t-test. A p-value of <0.05 was considered statistically significant.

RESULTS

212 lesions were evaluated. The mean CT HU was 481 (33-1152); the mean ADC value was 0.91 (0.18-2.13). 140/212 (66%) lesions appeared hyperintense; 73/212 (34%) were iso/hypointense on DWI. The mean CT HU of hyperintense metastases was significantly lower than iso/hypointense lesions (371 vs 681, p = 650 HU; n = 57), a highly significant negative correlation was observed between CT HU and ADC (r = -0.60, p < 0.005). In 18 lesions: the ADC was increased by 105% (interquartile range, 61-166) and SUVmax was decreased by 56% (37-83). The SUVmax was increased by 53% (26-90). There was one lesion with a discrepancy in changes of ADCmin (decreased by 29%) and SUVmax (decreased by 13%).

CONCLUSION
There was significant correlation between the ADC and SUV for evaluating treatment response in malignant bone tumors.

CLINICAL RELEVANCE/APPLICATION
Quantitative DWI is comparable to PET/CT for evaluating treatment response in malignant bone tumors.

SSK14-04 • Differentiation of Osteogenic Bone Metastases and Bone Islands Using Conventional Single-energy CT Value and Monochromatic CT Value from Spectral CT in Patients with Bronchogenic Carcinoma
Yue Dong (Presenter) ; Shaowei Zheng ; Bing Wang ; Ruxin Wang ; Lifei Sun

PURPOSE
To evaluate the diagnostic efficacy of single-energy CT and single-source Dual-energy CT in the identification of osteogenic bone metastases and bone islands in patients with bronchogenic carcinoma.

METHOD AND MATERIALS
49 cases of osteogenic metastases in patients with pathologically proven bronchogenic carcinoma and 43 cases of bone islands were confirmed via MRI, single-photon emission computed tomography (SPECT) and one year follow-up. All subjects underwent
SSK14-05 • Can IDEAL-MR Imaging of Multiple Myeloma Be Used as a Biomarker for Predicting Symptomatic Myeloma?  
Miyuki Takasu MD (Presenter); Yoko Kaichi; Miho Ishikawa MD; Shuji Date; Yuji Akiyama; Kazuo Arai MD *; Yoshiaki Kuroda; Akira Sakai

PURPOSE
Asymptomatic multiple myeloma is an asymptomatic plasma-cell proliferative disorder associated with a high risk of progression to symptomatic multiple myeloma. Predictive factors for the progression of this disease are unclear. This study was performed to evaluate the effectiveness of the iterative decomposition of water and fat with echo asymmetric and least-squares estimation (IDEAL) MRI to predict symptomatic myeloma in patients without visible focal lesions.

METHOD AND MATERIALS
The lumbar spine was examined with 3T-MRI in 47 patients with multiple myeloma (asymptomatic myeloma, 23; symptomatic myeloma, 24). The fat-signal fraction (FSF) obtained by IDEAL sequence was calculated as the mean value from three vertebral bodies. We evaluated factors predictive of symptomatic myeloma. They included sex, age, FSF, MR signal intensity pattern (MR pattern), bone marrow plasma cell percentage (BMPC%), obtained from a biopsy specimen, presence of IgA monoclonal protein, serum monoclonal protein level (M protein), serum albumin level, serum ?2-microglobulin (?2m) level, the ratio of ?2m/albumin, reductions in levels of uninvolved immunoglobulins, and the kappa/lambda ratio. For data analysis, univariate and multivariate logistic regression analyses, as well as receiver operating characteristic curves, were used. A difference with P < .05 was considered significant.

RESULTS
Univariate analysis demonstrated that MR pattern, FSF, BMPC%, M protein, the reduction in uninvolved immunoglobulins, ?2m, and their ratio were significantly associated with symptomatic myeloma. Results of multivariate analysis demonstrated that ?2m, FSF, and the reduction in uninvolved immunoglobulins had significant effects in differentiation between asymptomatic and symptomatic myeloma. The area under the curve was 0.805 for FSF, 0.844 for ?2m, and 0.793 for BMPC%.

CONCLUSION
Fat quantification results using the IDEAL sequence in MRI were significantly different in patients with symptomatic- and asymptomatic myeloma. The FSF and ?2m facilitated the discrimination of symptomatic- from asymptomatic myeloma.

CLINICAL RELEVANCE/APPLICATION
Predictive factors for the progression to symptomatic myeloma included FSF and ?2m. The discriminative performance of FSF is comparable to that of BMPC% obtained from biopsy specimen.

SSK14-06 • Magnetic Resonance Imaging Differentiation between Malignant Marrow Replacing Lesion and Benign Red Marrow Deposition of Vertebra Using T2*-corrected Fat Fraction Map Imaging Based on Three-point Dixon-VIBE Sequence

Yong Pyo Kim (Presenter); Sungjun Kim MD; Tae Sub Chung; Yaena Kim MD; Munyoung Paek; Choon Sik Yoon MD; Young Han Lee MD; Ho-Taek Song MD; Jin-Suck Suh MD

PURPOSE
To assess feasibility of T2*-corrected fat fraction map using three-point Dixon-VIBE sequence as a tool for differentiation between malignant marrow replacing lesion and benign red marrow deposition of vertebra.

METHOD AND MATERIALS
From Mar. 2012 to Feb. 2013, magnetic resonance imaging was performed for consecutive 33 patients who were referred for vertebral marrow abnormality assessment. Twenty two pathologically confirmed malignant marrow replacing lesions and 11 benign red marrow lesions from the patients were subjects of this study. Three sequences were applied using a 1.5-T MR imaging scanner like follows: three-point Dixon-volume interpolated breath-hold GRE sequence (VIBE) for fat fraction (FF) measurement; conventional T1 weighted imaging (T1WI), pre- and post-contrast enhanced fat-suppressed T1WI (CE). To measure fat fraction or signal intensity (SI), region of interest (ROI) was placed at the target lesions. Average measurements from consecutive three slices of the target lesions were used for data analysis. Three parameters from the measurements were obtained like follows for each lesion: FF from VIBE; LDR (lesion-disc ratio; SI of marrow lesion / SI of disc)*100 for T1WI; CER (contrast enhancement ratio; [LDR of post-contrast T1WI-LDR of pre-contrast T1WI]*100 / LDR of pre-contrast T1WI) for CE. To evaluate diagnostic performance of the three parameters, receiver operating characteristic (ROC) curves were obtained and areas under curves (AUCs) of the parameters were compared to each other. The sensitivity and specificity at the most ideal cut off values for the parameters were obtained.

RESULTS
AUCs of FF, LDR, CER were 0.96, 0.83, 0.74. FF showed superior AUC than CER with statistical significance. The optimal cut-off value and the corresponding sensitivity/specificity in percentage were like follows: 16, 0.81/1 in FF; 116, 1/63.6 in LDR; 93.4, 0.68/0.81 in CER.

CONCLUSION
T2*-corrected fat fraction measurement using a three-point Dixon-VIBE sequence showed superior diagnostic performance than contrast enhanced T1WI, and it showed excellent specificity in differentiation between malignant marrow replacing lesion and benign red marrow deposition of vertebra.

CLINICAL RELEVANCE/APPLICATION
T2*-corrected fat fraction measurement using a three-point Dixon-VIBE sequence is expected to play an important role to differentiate benign red marrow from malignant marrow lesion.

SSK14-07 • Diagnostic Efficacy of Whole-body Ultra Low Dose CT (WBULDCT) in Comparison with Spinal Magnetic Resonance Imaging (SMRI) in the Assessment of Disease in Patients with Multiple Myeloma (MM)

Valeria Besostri MD (Presenter); Davide Ippolito MD; Pietro A Bonaffini MD; Valentina Bartolo; Alessandra Cuccia; Sandro Sironi MD

PURPOSE
Dual-energy spectral CT imaging using a high definition CT (Discovery CT750 HD, GE). The means, standard deviation (SD) and coefficient variation (CV) of 140kvp-quality check (QC) CT values and virtual monochromatic (40-140 keV) CT values of osteogenic metastases and bone islands were measured and compared with independent-samples t-test. The lesion center was selected as ROI (20-30mm2). ROC curves were used to compare the diagnostic efficacies of conventional single-energy CT and monochromatic CT in the identification of osteogenic bone metastases and bone islands.

RESULTS
The mean mono-energy CT values (40-140 keV) and QC CT value of osteogenic bone metastases were all significantly lower than that of bone islands (p < .05).

CONCLUSION
Both conventional single-energy CT and monochromatic CT were reliable for differential diagnosis of osteogenic bone metastases and bone islands. SD of monochromatic CT value at higher keV has better diagnostic efficacies.
To compare the diagnostic value of Whole-Body Ultra Low-Dose CT (WBULDCT) with dedicated Spinal Magnetic Resonance Imaging (SMRI) in the identification of bone marrow involvement of patients with Multiple Myeloma (MM).

METHOD AND MATERIALS
A total of 30 patients (17 males and 13 females; mean age 68 years, range 52-83 years), with histologically proven MM, undergoing WBULDCT and a dedicated SMRI (9/30 for staging, 21/30 during follow-up), were evaluated in our study. Unenhanced WBULDCT was performed on a 256-slice scanner (ICT, Philips), with the following parameters: tube voltage 120 kV, tube current time product 40 mAs, collimation 128x0.65. Spine MRI was performed on a 1.5T magnet (Achieva, Philips), with the following protocol: T1 TSE and T2 STIR acquired on sagittal plane. WBULDCT was compared to spine MRI in terms of lesion detection, pattern of bone marrow involvement and risk fractures.

RESULTS
In 21/30 patients (70%), WBULDCT and SMRI were concordant, detecting (14/21) or excluding (7/21) involvement of the axial skeleton. In 9/30 patients (30%) WBULDCT and SMRI were discordant in terms of axial skeleton involvement: in 2/9 patients SMRI was positive and WBULDCT was negative, while in 7/9 patients only WBULDCT was positive. The corresponding sensitivity for lesion detection in the spine was 73% for WBULDCT and 53% for SMRI, respectively. Only one patient with a negative WBULDCT scan showed multifocal lesions on SMRI. Moreover, in 22/30 of cases (73%) WBULDCT detected additional osteolytic lesions in other extra-assial districts (skull, sternum and ribs, pelvis, upper and lower limbs).

CONCLUSION
WBULDCT demonstrated superior capability as compared to SMRI, for the detection of disease in the axial skeleton and also offers detailed information about extra-assial involvement, which could be potentially missed with dedicated SMRI alone.

CLINICAL RELEVANCE/APPLICATION
WBULDCT imaging appears to be helpful in detecting spinal involvement in patients with MM, reserving SMRI in case of negative results in asymptomatic patients.

SSK14-08 • Appearance of Monoclonal Plasma Cell Diseases in Whole-body MRI and Correlation with Parameters of Disease Activity

Jost Kloth (Presenter) ; Jens Hillengass MD ; Karin Listl MD ; Stefan Delorme MD ; Hans-Ulrich Kauczor MD * ; Marc-Andre Weber MD * ; Hartmut Goldschmidt MD

PURPOSE
To examine a possible association of the presence of focal lesions (FL) or a diffuse infiltration pattern of bone marrow in whole-body MRI (WB-MRI) with the disease stage and established markers of disease activity in patients with monoclonal plasma cell disease.

METHOD AND MATERIALS
Institutional review board approval was obtained. We examined the WB-MRI scans in 547 consecutive, unselected and untreated patients with monoclonal gammopathy of undetermined significance (MGUS, n=138), smoldering multiple myeloma (SMM, n=157) and multiple myeloma (MM, n=252) on two identical 1.5 Tesla MRI-scanners with body array coils. Assessment was done by two experienced radiologists blinded to the diagnosis of the patients in consensus.

RESULTS
We found focal lesions in 23.9% (MGUS), 34.4% (SMM) and 81.3% (MM), respectively. A diffuse infiltration pattern was detected in 38.4%, 45.9%, and 71% of the corresponding patients. Infiltration patterns were significant (p<0.05). The frequency of focal or diffuse bone marrow abnormalities as well as the severity of diffuse signal changes in bone marrow are significantly associated with the stage of plasma cell disease as well as established markers of disease activity.

CLINICAL RELEVANCE/APPLICATION
Considering nearly riskless application and non-invasiveness of wb-MRI its future application in the prognostic evaluation of MM and its asymptomatic precursors MGUS and SMM is promising.

SSK14-09 • Whole-body MRI for Diagnosing Multiple Myeloma and Evaluating Treatment Efficacy

Min Zong MD, PhD (Presenter) ; Dehang Wang MD ; Si-Guang Zhu MD ; Li-Juan Chen

PURPOSE
To investigate the initial diagnostic value and treatment efficacy of the whole-body MRI for Multiple Myeloma.

METHOD AND MATERIALS
Forty-seven Multiple Myeloma patients confirmed with histopathology were enrolled in the study. All patients underwent whole-body MRI before chemotherapy, and follow up scans at 3 and 6 months after the first and second rounds of chemotherapy treatment, respectively. The lesions found by whole-body MRI of each patient were counted at different time points and compared by one-way ANOVA statistic analysis.

RESULTS
Five imaging patterns were identified on whole-body MRI, which were smoldering type (5 patients), diffuse type (7 patients), focal type (25 patients), mixed type (3 patients), and salt-and-pepper type (7 patients). Out of the 47 patients, there were 42 patients with visible lesions on follow up whole-body MRI scans during chemotherapy. The mean number of lesions was 113.90±45.71 on WB-MRI before chemotherapy and decreased to 28.00±22.49 and 10.04±9.02 at the third and sixth month on follow-up whole-body MRI. Statistically significant differences were confirmed between either two of the three groups (P<0.05).

CONCLUSION
Whole-body MRI is a valuable tool for initial Multiple Myeloma diagnosis and monitoring treatment efficacy after chemotherapy.

CLINICAL RELEVANCE/APPLICATION
Whole-body MRI is a valuable tool for initial Multiple Myeloma diagnosis and monitoring treatment efficacy after chemotherapy.

Neuroradiology/Head and Neck (Head and Neck Tumors) Wednesday, 10:30 AM - 12:00 PM • N229

SSK15 • AMA PRA Category 1 Credit ™:1.5 • ARRT Category A+ Credit:1.5 Moderator Yoshimi Anzai , MD

SSK15-00 • Ultrasound (SRU) Recommendations for Workup of Imaging-detected Incidental Thyroid Nodules: What Types of Cancers Would We Miss?

Manisha Bahl MD, MPH (Presenter) ; Julie A Sosa MD ; Hasan A Hobbs MD ; Nathan Wnuk MSc, BSc ; Rendon C Nelson MD * ; Jenny K Hoang MBBS *

PURPOSE
To apply the Society of Radiologists in Ultrasound (SRU) recommendations to incidental thyroid cancers detected on imaging and to describe cancers that do not meet the workup criteria.

METHOD AND MATERIALS
We performed a retrospective review of 1721 patients who underwent thyroidectomy or lobectomy from 2003 to 2012 to identify thyroid cancers that were detected incidentally on imaging. Imaging-detected incidental cancer was defined as cancer in asymptomatic patients presenting with incidental thyroid nodules (ITN) on imaging with no other risk factors. The SRU
RESULTS
Of 1721 patients who underwent surgery, 578 (34%) patients had thyroid cancer and 86 (5%) patients had thyroid cancer first detected incidentally by imaging studies. Incidental cancers were first detected on ultrasound in 21 patients. Other cancers were seen incidentally on CT, MRI, PET, octreotide scan, echocardiogram, and radiographs. The SRU recommendations were applied to 724 patients, of which 21 had ultrasound-detected ITN and an additional 51 who had ultrasound workup of ITN detected on other imaging modalities. 15/72 (21%) patients did not meet SRU recommendations for workup and would not have undergone FNA if the recommendations had been used at the time of diagnostic ultrasound. The SRU- group represented 3% of all malignancies. SRU-cancers had a mean size of 1.1 cm (range 0.9-1.4 cm) compared to 2.4 cm (range 1.0-7.6 cm) for SRU+ cancers. Histology was papillary in 3/15 SRU- and 50/57 SRU+ cancers. 5/15 SRU- patients had nodal metastases (all micrometastases detected on central compartment neck dissection). 16/57 SRU+ patients had nodal metastases (11 confined to central compartment).

CONCLUSION
Imaging-detected incidental thyroid cancer is uncommon. 3% of malignancies would be missed using the SRU recommendations for workup of ITN. SRU- tumors were more likely to be papillary carcinoma and less likely to have nodal metastases.

CLINICAL RELEVANCE/APPLICATION
SRU recommendations could reduce the biopsy rate of imaging-detected ITN. Missed malignancies would be uncommon (3%) and more likely to be nonaggressive papillary carcinoma.

SSK15-02 • Thyroid Nodules: A Total Malignancy Score (TMS) for Ultrasound (US) - A Validation Pilot Study
Giovanni G Pompoli MD (Presenter) ; Silvia Tresoldi MD ; Alessandra Primolevo ; Stefania Rossi ; Gaetano Bulfamante PhD ; Gianpaolo Cornalba MD

PURPOSE
The aim of our study was to validate a malignancy score of thyroid nodules (Total Malignancy Score — TMS) based on their ultrasound features. Pilot study

METHOD AND MATERIALS
Based on a retrospective analysis of 102 patients with follicular pattern at US we recently suggested an US score for the characterization of thyroid nodules (a score from 0 (most likely benign) to 2 (most likely malignant) was assigned to each nodule feature — number, margins, colour-flow, structure, echogenicity, halo, calcifications, dimensional increment — leading to a total score (TMS) ranging from 0 to 11). The malignancy score system is shown in Figure 1. In the present study we prospectively apply that score to all the patients undergoing a thyroid nodule fine needle aspiration cytology (FNAC) at our Institution. The score results are then compared to the cytological diagnosis.

RESULTS
between September 2012 and April 2013 59 consecutive patients entered the study. Among patients with TMS 3 (20/59) 8 had non-negative cytological results. Patients with non-negative cytological results (n=9) were diagnosed with malignancy (TMS 4 n=3; TMS 6 n=1); follicular proliferation (n=2; both follicular adenomas at surgery; TMS 5 and 3 respectively) or high cellularity lesion (TMS 4 n=1; TMS 5 n=2).

CONCLUSION
The preliminary results of this pilot study confirms what previously suggested: the identification of a predictive US score would allow a more accurate estimation of risk. Nodules with a TMS≥3 should undergo FNAC, nodules with a score ≤2 should be reassessed in the clinical setting.

CLINICAL RELEVANCE/APPLICATION
Our US-TMS, when validated, will be useful in the management of patients with thyroid nodules avoiding useless FNAC when benign features are recognized, and suggesting cytology in potential malignancy.

SSK15-03 • Can Ultrasound Features of Thyroid Nodules Predict Outcomes after a Non-diagnostic Fine Needle Aspiration?
Thomas J Anderson MD (Presenter) ; Michael K Atalay MD, PhD ; David J Grand MD ; Michael D Beland MD

PURPOSE
Ultrasound characteristics of thyroid nodules are notoriously poor predictors of malignancy. The purpose of this study was to identify reproducible ultrasound characteristics that could indicate benignity to avoid repeat biopsies when the initial FNA is non-diagnostic.

METHOD AND MATERIALS
We identified 5399 nodules that were biopsied under ultrasound guidance in our radiology department between 2004 and 2012. Of these, 454 were initially non-diagnostic and met inclusion criteria with adequate cytological, surgical, or ultrasound follow up. Three independent, board-certified radiologists who were blinded to outcomes scored the ultrasound features of each nodule. Nodule size, composition, border, calcifications, comet tail, and central vascularity were recorded. Outcomes data were collected through review of the medical record.

RESULTS
Of the 454 initially non-diagnostic thyroid FNAs, 10 malignancies (2.2%; 3 follicular, 7 papillary) were diagnosed by subsequent FNA (3, 0.7%) or surgery (7, 1.5%). There were no cancers detected in nodules with a spongiform or cystic composition, with a comet tail, or with eggshell or indeterminate calcifications. The minimum diameter of any malignant nodule was 0.8cm, with an average of 2.2cm, compared to 0.3cm and 1.5cm in the benign group (p=0.049).

CONCLUSION
The incidence of malignancy after initial non-diagnostic FNA is very low (0.7%), particularly when the nodule is cystic, spongiform, or in the presence of a comet tail, or eggshell or indeterminate calcifications. In the setting of a non-diagnostic FNA with these features, clinical and ultrasound follow up are more appropriate than repeat FNA, particularly in smaller nodules.

CLINICAL RELEVANCE/APPLICATION
Clinical and ultrasound follow-up may be more appropriate than repeat FNA in thyroid nodules with a non-diagnostic result and reassuring ultrasound characteristics.

SSK15-04 • Is Repeat FNA after a Non-diagnostic Thyroid Nodule FNA Necessary?
Thomas J Anderson MD (Presenter) ; Michael K Atalay MD, PhD ; David J Grand MD ; Michael D Beland MD

PURPOSE
Fine needle aspirates (FNA) of thyroid nodules have a diagnostic yield of 85-90%, but optimal management of non-diagnostic results is unknown. The aim of this study was to identify demographic features predictive of malignancy after an initially non-diagnostic FNA and the role of subsequent FNA.

METHOD AND MATERIALS
We identified 5399 nodules that were biopsied under ultrasound guidance in our radiology department between 2004 and 2012. Of these, 454 were initially non-diagnostic and met inclusion criteria with adequate cytological, surgical, or ultrasound follow up. Demographic and laboratory data were correlated with outcomes through review of the medical record.
RESULTS
Of the 454 initially non-diagnostic thyroid FNAs, 10 malignancies (2.2%; 3 follicular, 7 papillary) were diagnosed by subsequent FNA (3, 0.7%) or surgery (7, 1.5%). 373 (82.2%) were benign at subsequent FNA (279, 61.5%) or surgical pathology (94, 20.7%), and 71 (15.6%) were stable or decreased in size by serial ultrasound examinations (mean follow up: 2.7 years). In 77 males (17%), 4 (5.2%) cancers were detected; in 377 females (83%), 6 (1.6%) cancers were detected (p=0.02). No malignancies were detected in patients less than 47 years of age, 27 (5.9%) patients were noted to have a papillary cancer elsewhere in the thyroid either at the time of surgery or by FNA of a separate nodule.

CONCLUSION
The likelihood of a malignant FNA after a non-diagnostic FNA is very low (0.7%), and therefore clinical and ultrasound follow up may be more appropriate than repeat FNA, particularly in female patients under the age of 45.

CLINICAL RELEVANCE/APPLICATION
Clinical and ultrasound follow up of non-diagnostic thyroid FNAs may be more appropriate than repeat FNA, particularly in younger female patients, due to the very low rate of malignancy.

SSK15-05 • Repeat Fine Needle Aspiration Biopsy for Nondiagnostic Thyroid Nodules with Short Interval Does Not Increase Atypical Cytologic Result

Ha Young Lee (Presenter) ; Jung Hwan Baek ; Hyunkyung Yoo MD ; Young Hye Kang MD ; Myung Kwan Lim MD

PURPOSE
To evaluate which factors affected atypia with undetermined significance (AUS) results of thyroid nodules with initial nondiagnostic (ND) result and to determine whether repeat fine needle aspiration biopsy (FNAB) with short interval increases AUS result.

METHOD AND MATERIALS
A retrospective review of 128 nodules from 126 patients with initial ND results was performed from January 2009 to December 2012. Demographic and clinical factors: age, sex, and time interval of FNAB, and ultrasonographic factors: size, location, consistency, suspicious malignant finding and thyroiditis were recorded. Time interval was subdivided into < or = 5, 10, 15, and 20 weeks after initial FNAB. Their effects on AUS result were analyzed using Fisher's exact test and Mann-Whitney U test.

RESULTS
None of the demographic, clinical, and ultrasonographic variables was significantly related with AUS result of repeat FNAB. Time interval of repeat FNAB was not related with AUS result (p=0.63, 0.57, 0.23, 0.48 for 5, 10, 15, 20 weeks, respectively).

CONCLUSION
Timing of repeat FNAB for the ND nodules did not influence the AUS result of repeat FNAB, and other clinical and US characters were not correlated with AUS result. Repeat FNAB for ND nodules could be performed without waiting for 3 months following to the need of patients and referring clinicians.

CLINICAL RELEVANCE/APPLICATION
1. To determine the recommended waiting period of 3 months is neccessary or not.
2. To provide clinical evidence for management of thyroid nodules with initial nondiagnostic results.

SSK15-06 • Thyroglobulin Measurement in Fine Needle Aspirates from Neck Lesions after Total Thyroidectomy: Is It a Reliable Tool for Post-surgical Follow-up Regardless of TSH Stimulation?

Youngheon Lee MD (Presenter) ; Hyung Suk Seo ; Nan Hee Kim ; Soon Young Kwon ; Gil Soo Son

PURPOSE
Thyroglobulin (Tg) measurement in needle washout fluid has been reported to increase diagnostic accuracy of fine needle aspiration for sonographically suspicious neck lesions encountered in postoperative follow-up. Although TSH stimulation is needed to improve the diagnostic accuracy of serum Tg for detection of recurrence, it is not clear whether stimulated or suppressed TSH status affect FNA-Tg.

METHOD AND MATERIALS
A total of 104 consecutive patients with papillary thyroid carcinoma initially treated by total thyroidectomy followed by remnant iodine ablation were retrospectively enrolled. They were sonographically evaluated for cervical recurrence by FNA-Tg and cytology during recent 5 years. Final diagnoses were confirmed by histopathologic results or follow-up examination at least 3 years. We evaluated the diagnostic performances of their FNA-Tg and cytology, serum Tg, anti-Tg antibodies, depending on the TSH stimulated or suppressed.

RESULTS
Of 104 lesions, 30 were confirmed as recurrences and 74 were non-recurrence. On TSH stimulated condition, both serum Tg and FNA-Tg levels in recurrent group were significantly higher in those of non-recurrent group (p<0.05).

CONCLUSION
On TSH-suppressed condition, FNA-Tg measurement may be sufficient postoperative follow tool for cervical recurrence in patients with thyroid cancer.

CLINICAL RELEVANCE/APPLICATION
On TSH-suppressed condition, FNA-Tg measurement may be sufficient postoperative follow tool for cervical recurrence in patients with thyroid cancer.

SSK15-07 • Head and Neck Squamous Cell Carcinoma: Predicting Treatment Response to Induction Chemotherapy with Standard- and High-b-value Diffusion Weighted MR Imaging

Inseon Ryoo MD (Presenter) ; Ji-Hoon Kim MD ; Soo Chin Kim MD ; Tae Jin Yun MD ; Seung Hong Choi MD, PhD ; Chul-Ho Sohn MD ; Jisang Park MD ; Koung Mi Kang ; Eun Kyong Lee MD

PURPOSE
Recent publications reported the contradictory results of pretreatment diffusion-weighted MR imaging (DWI) for the prediction of chemoradiotherapeutic response in primary head and neck squamous cell carcinomas (HNSCC). The purpose of this study was to evaluate the diagnostic performance of DWI with both standard (b=1000 s/mm2) and high (b=2000 s/mm2) b-values for predicting treatment response to induction chemotherapy in primary HNSCC.

METHOD AND MATERIALS
Twenty seven patients with primary HNSCC who underwent DWI with both b=1000 and 2000 s/mm2 prior to treatment were included in this study, and corresponding apparent diffusion coefficient (ADC) maps were calculated. Regions of interest containing the tumor were drawn on every section of ADC map and summated to make volume based data of the entire tumor. Histogram parameters were correlated with treatment response using unpaired student t-test.

RESULTS
Among 27 patients, 14 showed good response (complete remission or partial response) and 13 showed poor response (stable disease or progressive disease) to induction chemotherapy. The mean ADC values of good responders (125.2±79.14 s/mm2 at b=1000 and 625.3±26.9 s/mm2 at b=2000) were higher than those of poor responders (129.1±19.5 s/mm2 at b=1000 and 746.5±41.8 s/mm2 at b=2000). But statistically significant difference was achieved at only high-b-value ADC map. (p=0.039) The
CONCLUSION
Pretreatment DWI with high-b-value may facilitate and be better in predicting treatment response to induction chemotherapy than DWI with standard-b-value in primary HNSCCs.

CLINICAL RELEVANCE/APPLICATION
Based on our study results, high-b-value DWI has the potential to facilitate pretreatment prediction of the response to induction chemotherapy in primary head and neck squamous cell carcinomas.

SSK15-08 • Improved Zoomed EPI-DWI of the Head and Neck Using Two-dimensional Spatially-selective Radiofrequency Excitation Pulses

Philipp Riffel MD (Presenter); Stefan Haneder MD; Josef Pfeuffer PhD *; Stefan O Schoenberg MD, PhD *; Henrik J Michaely MD *

PURPOSE
Diffusion-weighted MR imaging (DWI) in the head and neck is challenging especially because of susceptibility artifacts. Two-dimensional spatially-selective radiofrequency (RF) excitation pulses for single-shot echo-planar imaging (EPI) combined with reduced FOV i.e. zooming in the phase-encoding direction lead to a decreased number of acquisition k-space lines and significantly shorten the length of the EPI echo train. This can potentially reduce susceptibility artifacts. The purpose of this study was to evaluate the feasibility of a zoomed DW EPI (z-EPI) sequence in the head and neck in a healthy volunteer population. The approach was compared to conventional single-shot EPI (c-EPI).

METHOD AND MATERIALS
The necks of 9 healthy volunteers were examined in this prospective IRB-approved study. All examinations were performed on a 3T whole-body MR system (MAGNETOM Skyra, Siemens Healthcare, Erlangen, Germany) equipped with a two-channel fully dynamic parallel imaging (DPI) gradient coil and a 16-channel transmit array, termed TimTX TrueShape. In all subjects, the experiment consisted of a conventional EPI sequence and two zoomed EPI sequences. Therefore the excitation of the standard DW EPI sequence was extended by the two-dimensional spatially-selective RF pulse using an echo-planar transmit trajectory. For quantitative assessment of distortion artifacts, DW images were merged with T2 TSE. Maximum misregistration of DW images with T2 TSE images was assessed in the cervical myelon. For qualitative assessment two readers ranked c-EPI and z-EPI sequences in terms of susceptibility artifacts, image blur and overall scan preference.

RESULTS
CONCLUSION
Zoomed DW EPI in the head and neck leads to substantial image quality improvements and has the potential to exhibit markedly reduced susceptibility artifacts and image distortion especially in regions close to major air cavities.

CLINICAL RELEVANCE/APPLICATION
Due to significantly reduced susceptibility artifacts zoomed DW EPI in the head and neck could have a potential value for identification of small malignant lymph nodes prior to neck dissection.

SSK15-09 • Role of Sonoelastography in Differentiating Benign and Malignant Salivary Gland Tumors: A Systematic Review and Meta Analysis

Mahsa Ghajarzadeh MD, MPH (Presenter); Mehdi Mohammadifar; Kamran Azarkhish MD; Seyed Hassan Emami-Razavi MD, PhD *

PURPOSE
to evaluate accuracy of sonoelastography in differentiating benign and malignant salivary gland tumors

METHOD AND MATERIALS
A highly sensitive search for sonoelastography and salivary glands tumors was performed in MEDLINE, Cochrane Library, ACP Journal Club, EMBASE, Health Technology assessment, and ISI web of knowledge for studies published prior to December 2012. The criteria for eligibility were:
1. Studies evaluated diagnostic accuracy of sonoelastography in differentiating malignant and benign salivary glands tumors. 2. Using appropriate reference standard test such as Fine-Needle Aspiration (FNA), histological assessment of specimens obtained by surgery. 3. Diagnostic measures on sonoelastographic evaluation results such as sensitivity, specificity, positive and negative predictive values. Articles which evaluated role of sonoelastography in differentiating malignant and benign salivary glands tumors considered for more evaluation.

SPSS version 18 used for descriptive analysis and meta-disc version 1.4 applied for meta analysis. Forest plots for pooled estimates and summary of ROC plots for different cut-offs were produced.

RESULTS
CONCLUSION
Sono-elastography has high accuracy in differentiating benign and malignant salivary gland tumors.

CLINICAL RELEVANCE/APPLICATION
applying sonoelastography for differentiating benign and malignant salivary glands.
METHOD AND MATERIALS
The SPARE-AD index, a previously characterized imaging biomarker capturing spatial patterns of brain atrophy, was first tested for sensitivity and specificity as a biomarker of Alzheimer’s disease (AD), in a training set of 411 participants. SPARE-AD, and a related mild cognitive impairment (MCI)-specific index called SPARE-MCI, were then evaluated at baseline in 212 MCI patients who either converted to AD within 18 months or remained stable for at least 3 years. Baseline predictive value of SPARE-AD, SPARE-MCI, CSF biomarkers (total and phosphorylated tau and Aβ), MMSE, ADAS-Cog, and APOE genotype were then evaluated using a support vector machine classifier.

RESULTS
SPARE-AD offered excellent diagnostic accuracy of AD (AUC between 0.96-0.98). Excluding CSF biomarkers, MRI-derived SPARE score offered the highest predictive power for MCI conversion to AD (AUC=0.76); followed by ADAS-Cog (AUC=0.74). Their combination offered the best accuracy (AUC=0.76). Other cognitive and APOE4 markers did not add any predictive power beyond them. In a subset (112 MCI patients) who also had CSF biomarkers, SPARE had the best predictive power (AUC=0.73), being enhanced by CSF biomarkers (AUC=0.76), which by themselves were relatively poorer predictors (AUC=0.68). In amyloid-negative MCI patients, SPARE-AD had high predictive power.

CONCLUSION
MRI patterns of atrophy, quantified via advanced pattern analysis methods, offer the highest predictive power of conversion from MCI to AD, but are slightly better than ADAS-Cog. Combination of MRI and CSF biomarkers improves predictive power. High predictive value of SPARE in negative amyloid MCI is not expected under the amyloid hypothesis and merits further investigation.

CLINICAL RELEVANCE/APPLICATION
A highly sensitive and specific imaging biomarker of AD is evaluated as an earlier predictor of clinical progression from MCI to AD, which can become an AD-specific marker for diagnosis and treatment.

SSK16-02 • MR Elastography of Alzheimer’s Disease and Frontotemporal Dementia
John Huston MD (Presenter); Matthew C Murphy PhD; Kevin J Glaser *; Clifford R Jack MD *; Richard L Ehman MD *

PURPOSE
Several MR imaging biomarkers exist to measure various disease processes associated with Alzheimer’s disease (AD) and frontotemporal dementia (FTD). Patterns of hippocampal and whole brain atrophy, MR spectroscopy, perfusion, diffusion and functional MRI have been reported. Magnetic resonance elastography (MRE) is a noninvasive technique to measure tissue stiffness, akin to manual palpation. Our purpose was to investigate the effect of AD and FTD on brain stiffness.

METHOD AND MATERIALS
We examined 59 subjects with brain MRE including 39 age and gender matched cognitively normal controls (NC), 15 subjects with AD and 5 subjects with behavioral variant FTD. MRE data were collected with a modified spin-echo EPI pulse sequence on a 3.0T MR imaging system including full head coverage in just less than 7 minutes. Shear waves were introduced with a soft pillow-like vibration source operating at 60 Hz using a pneumatic actuator. The wave data underwent a curl operation to remove contributions of the longitudinal waves and a 3D direct inversion algorithm calculated the elastogram. In subjects with 3 mm isotropic sampling we measured age adjusted global brain stiffness (entire brain excluding cerebellum), in 8 regions.

RESULTS
Global stiffness was decreased in AD subjects (2.20 kPa) compared to NC (2.37 kPa). Group-wise differences in stiffness were demonstrated within the lobes of the brain that contain association cortices (p<0.005). We have demonstrated that AD and FTD alter the mechanical properties of the brain in a way that can be measured in vivo by MRE, following the known topography of the diseases. Measures of brain elasticity have the potential to offer insights into the ultrastructural alternations of brain tissue that occur with AD and FTD, how these change with time and the clinical expression of the diseases.

CLINICAL RELEVANCE/APPLICATION
MR Elastography demonstrates Alzheimer’s disease and frontotemporal dementia alter the mechanical properties of the brain by decreasing brain stiffness, following the known topography of the diseases.

SSK16-03 • Different Post Label Delay Cerebral Blood Flow Measurements in Patients with Alzheimer’s Disease Using 3D Arterial Spin Labeling
Ying Liu MD (Presenter); Huishu Yuan MD; Xiangzhu Zeng MD; Zheng Wang MS

PURPOSE
To evaluate cerebral blood flow (CBF) and find out differences in patients with Alzheimer’s disease (AD) and healthy control group (HC) using 3D Arterial Spin Labeling (ASL) on 3.0T MR. Changing the label time in 3D ASL in order to obtain two CBF maps. To observe the analysis of different label time for CBF map result and explore the 3D ASL in the display of brain perfusion factor and its clinical significance.

METHOD AND MATERIALS
Thirteen AD patients (5 men and 8 women; age range, 58-88 years, mean age 75.00±7.36 years) and fifteen healthy control subjects (4 men and 11 women; age range, 56-84 years, mean age 71.20±7.89 years) were recruited. All MRI examinations were performed using a 3.0T scanner, pseudo-continuous ASL scanning was conducted with 36 label/control images acquired on a GE750 imager including full head coverage in just less than 7 minutes. Shear waves were introduced with a soft pillow-like vibration source operating at 60 Hz using a pneumatic actuator. The wave data underwent a curl operation to remove contributions of the longitudinal waves and a 3D direct inversion algorithm calculated the elastogram. In subjects with 3 mm isotropic sampling we measured age adjusted global brain stiffness (entire brain excluding cerebellum), in 8 regions.

RESULTS
Global stiffness was decreased in AD subjects (2.20 kPa) compared to NC (2.37 kPa). Group-wise differences in stiffness were demonstrated within the lobes of the brain that contain association cortices (p<0.005). We have demonstrated that AD and FTD alter the mechanical properties of the brain in a way that can be measured in vivo by MRE, following the known topography of the diseases. Measures of brain elasticity have the potential to offer insights into the ultrastructural alternations of brain tissue that occur with AD and FTD, how these change with time and the clinical expression of the diseases.

CLINICAL RELEVANCE/APPLICATION
MR Elastography demonstrates Alzheimer’s disease and frontotemporal dementia alter the mechanical properties of the brain by decreasing brain stiffness, following the known topography of the diseases.

SSK16-04 • The Correlation of Hippocampal T2-mapping with Neuropsychology Test in Patients with Alzheimer’s Disease
Zhu-Ren Luo (Presenter); Xiong-Jie Zhuang

PURPOSE
1) To deduce T2, the inverse of the transverse relaxation rate (R2), in the hippocampus of healthy adults; 2) to investigate the brain iron deposition in Alzheimer’s disease (AD) patients and age-matched healthy controls using T2-values.
METHOD AND MATERIALS

T<sub>2</sub>-weighted data from the bilateral-hippocampi of ten AD patients and sixty healthy controls were collected using multi-slice multi-echo turbo spin echo (MSME-TSE) imaging on a 3.0T MR-scanner, followed by the neuropsychological testing. The correlations between T<sub>2</sub>-values and Mini-Mental-State-Examination (MMSE) score were investigated on group-wise basis (gender, age, side and healthy/AD).

RESULTS

There were no significant differences in hippocampal T<sub>2</sub>-values on intra-gender and inter-gender basis (P > 0.05). Hippocampal T<sub>2</sub>-values of both sides were similar (right: 85.17±2.44 milliseconds; left: 85.28±2.51 milliseconds). The bilateral hippocampal T<sub>2</sub> values correlated moderately with age (right: r = -0.59; left: -0.58; P < 0.001). Mean hippocampal T<sub>2</sub>-values from ten controls correlated strongly (r = -0.90, P < 0.001) with reference brain iron concentrations for healthy adults. The AD-group had significantly lower T<sub>2</sub>-values in the hippocampus when compared to normal controls (P < 0.001) and had a strong positive correlation with the MMSE score (R<sup>2</sup> = 0.97; P < 0.05).

CONCLUSION

Patients with AD showed significantly iron depositions in the hippocampus resulting in the decreased T<sub>2</sub> values. A positive correlation between T<sub>2</sub>-values and cognition/ memory scores, suggests that quantitative T<sub>2</sub> can be used in the early diagnosis of AD and monitoring of the treatment response.

CLINICAL RELEVANCE/APPLICATION

In vivo proton transverse relaxation rate imaging is capable of quantitatively measuring the iron deposition in the hippocampus in AD patients, consistent with incipient AD pathogenesis.

SSK16-05 • GABA-edited Magnetic Resonance Spectroscopy in Alzheimer’s Disease at 3T

Xue Bai BA (Presenter); Guangwong Wang MD

PURPOSE

Gamma-aminobutyric acid (GABA) is the essential inhibitory neurotransmitter in human brain. It is considered that reduced neuronal GABA concentration and neurotransmission results in cognitive impairments in Alzheimer’s disease (AD). However, few in vivo studies have directly certified this hypothesis. In this study, we used magnetic resonance spectroscopy at high field to measure GABA levels, aiming to investigate whether there is a regional GABA level decline in AD.

METHOD AND MATERIALS

Twelve untreated AD patients (5 males and 7 females; range 56-79, mean = 67.6±8.4 years) and twelve age-and sex-matched healthy control subjects were recruited. AD patients were diagnosed according to National Institute of Neurological and Communicative Disorders and Stroke and the Alzheimer’s Disease and Related Disorders Association. 1H-MRS was performed in a 3-tesla MR scanner (Philips Achieva TX, Best, The Netherlands). The voxel size was set (3 cm x 3 cm x 3 cm) in the frontal lobe and the parietal lobe (Fig 1), using high resolution T1-weighted three-dimensional TFE images as a localizer. The GABA concentration was measured using a MEGA-PRESS sequence (TR = 2000ms; TE = 68 ms; 320 averages; acquisition bandwidth = 1000 Hz; scan duration 11 minutes). All the metabolite quantitation was performed with time-domain fitting algorithm AMARES by jMRUI v.4.0. Each pixel in the brain images was segmented as to gray matter, white matter, or cerebrospinal fluid using the FSL package.

RESULTS

According to the result of segmentation result, there was no significant difference in the proportions of each part between AD patients and controls. Fig 2 shows the typical GABA-edited spectra from the MEGA-PRESS sequence in the frontal lobe of an AD patient. Significant differences of GABA/Cr ratio were found in parietal lobe between AD patients and Controls (t=-2.212, p=0.038), but not found in frontal lobe (t= 0.799, p>0.05).

CONCLUSION

In this study, GABA-edited MRS technique was successfully applied in AD patients to assess GABA level in vivo, and the brain GABA level in parietal lobe is decreased in AD. GABA may be a potential biomarker for early detection of AD, and could be used to assess the prognosis after treatment.

CLINICAL RELEVANCE/APPLICATION

GABA-edited MRS technique was useful to assess GABA level in vivo, GABA may be a potential biomarker for early detection of AD, and could be used to assess the prognosis after treatment.

SSK16-06 • Relationships between the Structural Connectome and Amyloid Burden in Alzheimer’s Dementia

Jeffrey W Prescott MD, PhD (Presenter); Arnaud Guidon PhD; P. M Doraismwamy MD *; Chunlei Liu PhD; Jeffrey R Petrella MD *

PURPOSE

The hypothesis of the current study is that relationships between the structural connectome and cortical amyloid burden may provide complementary information about pathologic changes in Alzheimer’s Disease (AD).

METHOD AND MATERIALS

Subjects were those newly enrolled in the ADNI2 study. Baseline data was used. T1 anatomical images were parcellated using FreeSurfer. DTI scans were registered to the T1 images using FSL. Structural connectomes were created using the Connectome Mapper Toolkit. Node degree, local efficiency, and clustering coefficient were calculated for the precuneus, posterior cingulate, and superior frontal connectome nodes. The FreeSurfer parcellations were registered to the florbetapir PET scans. The global SUVR and four local SUVRs (frontal, cingulate, parietal, and temporal) were calculated. Clinical cognitive assessments included MMSE, ADAS-Cog, and Rey AVLT. Statistical analyses were performed between structural connection metrics, amyloid status, and clinical cognitive scores.

RESULTS

There were 102 ADNI2 subjects (64 males, 38 females) available at the time of the analysis. There were 37 normal control, 19 early mild cognitive impairment (MCI), 25 late MCI, and 21 AD subjects. All global and local AV45 amyloid burden measures were significantly associated with RAVLT, MMSE, and ADAS-Cog (p < 0.05). The strongest associations between amyloid burden and structural connection metrics were in the posterior cingulate and precuneus (node degree; p < 0.05). The strongest associations between structural connection metrics and clinical dementia scores were in the precuneus, superior parietal, and superior temporal regions (node degree vs. MMSE and ADAS-cog; p < 0.05).

CONCLUSION

Brain amyloid burden has significant associations with clinical cognitive status in all regions analyzed, consistent with globally increased amyloid burden as an important condition for AD. The strongest associations between amyloid burden and structural connection metrics were in the posterior cingulate and precuneus (node degree; p < 0.05), suggesting that these regions are most likely to have structural changes related to amyloid deposition in AD.

CLINICAL RELEVANCE/APPLICATION

The combination of quantitative amyloid PET and DTI tractography can provide information about global and local structural changes in AD, aiding in diagnosis and disease tracking.

SSK16-07 • Voxel-based Analysis of Quantitative Susceptibility Data Obtained from Subjects with AD and MCI
To investigate quantitative susceptibility in three groups of subjects with cognitive normal (CN), mild cognitive impairments (MCI) and Alzheimer's disease (AD). Because AD is expected to have the most iron plaques, we expected that the AD brains would produce the least signals in comparison to the CN and MCI brains.

METHOD AND MATERIALS
Subjects of 20 CN, 21 MCI, and 21 AD participated after informed consent. A fully first-order flow-compensated three-dimensional (3D) gradient echo sequence ran to obtain magnitude and phase images, which were later used to produce final quantitative susceptibility mapping (QSM). Furthermore, 3D T1-weighted images were acquired for the brain tissue segmentation, image registration, and masking-out of non-brain tissues, including CSF and vessels. The QSM images were produced by implementing the Morphology Enabled Dipole Inversion (MEDI) method. After the QSM images were smoothed using isotropic 4 mm Gaussian kernel, the differences of QSM data among the three groups were investigated by performing a voxel-based statistical analysis using a one-way analysis of variance (ANOVA) test with subject age and gender as covariates.

RESULTS
QSM values would decrease from CN to MCI and to AD. Compared with MCI subjects, QSM values in CN subjects were high in the left superior frontal gyrus and the left superior temporal gyrus. The lower signals were also found in the left superior frontal gyrus and the right superior temporal gyrus. Compared with the AD group, the QSM values in CN subjects were high in the left parahippocampal gyrus and the left inferior frontal gyrus, but low in the right cingulate gyrus. Compared with AD patients, QSM values in CN subjects were high in the right superior temporal and the left superior temporal, but low in the left middle frontal gyrus.

CONCLUSION
We were able to identify the brain regions in which the susceptibility changes occurred among the different groups. More differences were found when CN and AD groups were compared than when CN and MCI groups were compared.

CLINICAL RELEVANCE/APPLICATION
The local variations in amyloid plaque can cause local magnetic susceptibility variations. Quantifying iron concentrations in vivo is instrumental for understanding the role of iron in CN and AD.

SSK16-08 • Quantitative MRI Discrimination of Alzheimer’s Dementia, Mild Cognitive Impairment, and Other Memory Disorders Using Volumetric MRI

Zachary T Berman BA (Presenter) ; Shamseldien Y Mahmoud MD ; Alexander Rae-Grant MD ; Jennifer Bullen MSc ; Nancy A Obuchowski PhD ; Stephen E Jones MD, PhD

PURPOSE
To investigate whether automated quantitative MRI may be useful in discriminating AD, MCI, and other memory disorders in a cognitive disorders clinic.

METHOD AND MATERIALS
The clinical records were reviewed of 669 consecutive patients at the Lou Ruvo Center for Brain Health who underwent quantitative MRI using NeuroQuant (Cortech Inc), which computes the brain volumes of 48 regions. These numbers were compared with the presence and type of dementia, whose gold standard was the clinical diagnosis made by neurologists, geriatricians, or general practitioners. Other clinical data collected included factors such as age, age of onset, and various test scores. These data were used to form a library to compare future patients whose dementia diagnosis is unknown. Specifically, a new patient’s quantitative MRI is compared with the library of prior scans, and probabilities are provided associating the patient to either the presence of dementia or dementia type.

RESULTS
The 669 patients scanned with volumetric MRI were divided into three diagnoses: 328 were with Alzheimer’s dementia, 262 with mild cognitive impairment, and 79 with age-related non-neurodegenerative memory loss. The attached figure shows the distribution of hippocampal volume for the three diagnoses. Using such data, including from other regions of the brain, probabilities are easily derived for any new patient with a quantitative volumetric MRI but without a diagnosis. These probabilistic maps may be useful in determining if a patient fits the profile for one of these three diagnostic categories given a specific set of MRI measures. We plan to apply this analysis prospectively to a cohort of patients seen in our cognitive disorders clinic to test the clinical utility of this procedure and analysis.

CONCLUSION
A center specific library of quantitative MRI measures may be useful in categorizing patients with cognitive disorders. We review the initial results of our quantitative analysis and probabilistic maps generated during this analysis.

CLINICAL RELEVANCE/APPLICATION
Using institution specific libraries, quantitative volumetric MRI can be used to distinguish different cognitive disorders.

SSK16-09 • The Pattern of Metabolic Heterogeneity in the Hippocampus by 3T Multi-voxel Proton Spectroscopy in Alzheimer’s Disease

Fei Chen MS (Presenter) ; Bing Zhang PhD ; Ming Li ; Xin Zhang MD, MS ; Yun Xu ; Bin Zhu ; Weibo Chen MSc

PURPOSE
We explore the metabolic changes in the head, body and tail of hippocampal in Alzheimer’s disease (AD) compared with normal control. We also investigate the distribution rules of metabolites concentration among different parts of the hippocampus for more accurate clinical diagnosis of AD.

METHOD AND MATERIALS
Thirty patients with AD and 30 cognitively normal person (CN) were scanned by a 3.0 T magnetic resonance (MR) by Multivoxel proton spectroscopy (Achieva, Philips Medical Systems, Netherlands). The 8channels-HEAD coil was employed. The data was processed by commercially available postprocessing workstation (Extended Workspace (EWS), Philips Medical Systems, Netherlands). The hippocampus was divided equally into three parts (head, body and tail). N-acetylaspartate (NAA)/creatinine (Cr), myoinositol (MI)/Cr and MI/NAA ratio were calculated separately from each part. We compared with each metabolites concentration data of AD and CN groups and analyzed the anteroposterior metabolic profile in hippocampus.

RESULTS
The mean value of NAA/Cr is decreased and that of MI/Cr, MI/NAA are elevated in the bilateral hippocampi and hippocampal body and tail in AD group (p < 0.01). MI/NAA in the head of left hippocampus is also increased statistically (p < 0.01). Fig.1 shows NAA/Cr in the bilateral hippocampi from head to tail have the gradually rising trend (p < 0.01) and MI/NAA gradually declines in CN group (p < 0.01). MI/Cr in CN group and each metabolite concentration in AD group have no anteroposterior metabolic heterogeneity in bilateral hippocampi. (Fig.1).

CONCLUSION
The anteroposterior metabolic heterogeneity is dismissed in AD, which might be helpful on the early clinical diagnosis of AD.

CLINICAL RELEVANCE/APPLICATION
Simultaneous PET/MR imaging depends on MR-derived attenuation maps (mu-maps) for accurate attenuation correction (AC) of the PET data. MRI Contrast agents (MRCA) have the potential to affect obtained mu-maps and in turn reduce the quantitative accuracy of the PET measurements. Currently, the effects of i.v. administered ferumoxytol, which is FDA approved for iron replacement and is a MRCA belonging to the class of ultrasmall superparamagnetic iron oxides (USPIO), are unknown. The purpose of this study is to study the possible effects of ferumoxytol on simultaneously obtained PET/MR data.

**METHOD AND MATERIALS**

An agarose phantom was constructed with homogeneous concentrations of ferumoxytol (Feraheme®, AMAG Pharmaceuticals, Inc.) ranging from 0-20 mg/kg. The phantom was scanned on a Siemens Biograph mMR PET/MR scanner, using a 2-point Dixon 3-D (VIBE) sequence. The default algorithm for reconstruction of the mu-map was used, including selection of thelung compartment option. In addition, repeated in-vivo PET/MR 18F-FDG studies were performed in a 13.2 kg male baboon, in an animal committee approved protocol, at four different time points: baseline (before and after injection of 10mg/kg ferumoxytol i.v.), 1, 3 and 5 weeks after the baseline scan. All studies were performed using a body Matrix coil and the built-in spine coil as the receiving coil elements.

**RESULTS**

Phantom experiment: Misclassification was observed in the mu-maps of the phantom regions with ferumoxytol concentrations of 10 mg/kg and higher. Baboon imaging: In data obtained later than 5 minutes after the i.v. ferumoxytol injection, significant signal loss was observed in the mu-maps, particularly in the liver, resulting in liver tissue being misclassified as lung. This translated in a persisted over the next 5 weeks (SUV 0.48, -61% compared to baseline).

**CONCLUSION**

Our data suggests that ferumoxytol, when used as an MRCA (at FDA approved clinical doses (e.g. 10 mg/kg Fe)) in simultaneous PET/MR imaging, has the potential to cause misclassification of tissues on AC maps resulting in >50% changes in observed SUV.

**CLINICAL RELEVANCE/APPLICATION**

Ferumoxytol has good vascular, lymph node and macrophage activity, however, our data suggests that PET/MR AC algorithms and dose response need improvement prior to its utilization for cancer staging.

**SSK17-03 • FDG PET/MR for the Assessment of Lymph Node Involvement in Lymphoma: Preliminary Results and Role of Diffusion Weighted MR**

Ivan Platzek MD (Presenter) ; Bettina Beuthien-Baumann MD ; Jens Langner PhD ; Michael Laniado MD ; Jorg Van Den Hoff PhD

**PURPOSE**

The purpose of this study was to evaluate the sensitivity and specificity of PET/MR (positron emission tomography/magnetic resonance imaging) with FDG (18F-fluorodeoxyglucose) for nodal involvement in malignant lymphoma and to assess the additional value of DWIBS (diffusion weighted MR imaging with background supression) as a part of the PET/MR examination.

**METHOD AND MATERIALS**

Eighteen patients with malignant lymphoma (10 m, 8 f, mean age 44 y) were included in this retrospective study (Hodgkin’s disease: n=10; non-Hodgkin lymphoma: n=8). The patients underwent FDG PET/ MR on a whole-body hybrid system after intravenous injection of FDG (176 – 357 MBq FDG, 276 MBq on average). The PET/MR examination included DWIBS images of the neck, thorax, abdomen and pelvis. Ten patients underwent PET/MR FDG for initial staging, while 8 patients had PET/MR for assessment of therapy response. Lymph node involvement was documented according to the scheme introduced by the German Hodgkin Study Group. Follow-up imaging and histology served as the standard of reference. The sensitivity and specificity of FDG PET/ MR and DWIBS were calculated and compared using the McNemar test. In patients referred for initial staging, disease stage according to the Ann Arbor classification was determined with FDG PET/MR and DWIBS.
RESULTS

Ninety out of 468 lymph node stations were rated as having lymphoma involvement based on the standard of reference. No evidence for organ involvement was found. Eighty-four lymph node stations were rated as positive by PET/MR and 78 by DWIBS. The sensitivity and specificity of FDG PET/MR for nodal involvement was 93.3% and 99.5%, while DWIBS had a sensitivity of 89.6% and a specificity of 97.4%. Both the sensitivity (p=0.03) and specificity (p=0.008) of FDG PET/MR were significantly better in comparison to DWIBS. In patients referred for initial staging, Ann Arbor stage determined by PET/MR and DWIBS was identical in nine cases and differed in one case (p=0.81).

CONCLUSION

FDG PET/MR allows for lymphoma staging with high sensitivity and specificity for nodal involvement. The use of DWIBS is not recommended as a part of FDG PET/MR examinations in lymphoma, because it does not provide relevant additional information.

CLINICAL RELEVANCE/APPLICATION

FDG PET/MR is a promising method for lymphoma staging which allows for metabolism evaluation in analogy to PET/CT, while ionising radiation associated with CT is eliminated.

SSK17-04 • PET/MRI in the Detection and Characterization of Pulmonary Lesions: Technical and Diagnostic Evaluation in Comparison to PET/CT

Isabel Rauscher (Presenter) ; Matthias J Eiber MD * ; Sibylle Ziegler * ; Ernst J Rummeny MD ; Markus Schwaiger MD * ; Ambros J Beer MD *

PURPOSE

PET/MRI differs substantially from PET/CT concerning PET-detector technology and attenuation correction, which might be of special relevance in the lung. We thus compared PET/MRI and PET/CT for evaluation of pulmonary lesions.

METHOD AND MATERIALS

Forty patients (23 men, 17 women; mean age 53.2 years) underwent a single injection dual imaging protocol with [18F]FDG PET/CT (Siemens Biograph 64) and PET/MRI (Siemens Biograph mMR). Pulse sequences for the lung included T1-weighted VIBE Dixon for attenuation correction and contrast-enhanced VIBE pulse sequences. All patients had a diagnostic CT of the chest in deep inspiration. Two blinded readers assessed in consensus all images randomly concerning quality, detection, standardized uptake value (SUV) and size of pulmonary nodules. Correlations were performed using linear correlation.

RESULTS

All scans together revealed 47 pulmonary lesions (mean size 10.0±11.4mm; range 2-60mm) in 25/40 patients. The PET datasets of PET/MRI and PET/CT revealed both 22/47 pulmonary lesions with focal [18F]FDG uptake. SUV-values of lung lesions in PET/MRI and PET/CT correlated significantly (r=0.9; p=0.0001) with a tendency for higher SUVs in PET/MRI. There was a significantly lower image quality comparing Dixon and VIBE sequence with CT whereas PET from PET/CT and PET from PET/MRI showed similar results. Dixon images detected 15/47 lung lesions while VIBE images detected 32/47 lesions, respectively. The detection rates for small lung lesions < 1 cm diameter (n=33) of CT and MR imaging was significantly lower with a detection rate of 9/33 for Dixon sequence and 15/33 for VIBE sequence. There was a high correlation of pulmonary lesion size of CT versus VIBE (r=0.97; p

CONCLUSION

PET image quality and detection rate of [18F]FDG positive lung lesions in PET/MRI is equivalent to PET/CT despite differences in attenuation correction techniques. Additionally, a high linear correlation coefficient in the SUV mean for the PET images form PET/CT and PET/MR was found. The detection rate of lung lesions can be significantly improved by adding a diagnostic contrast-enhanced VIBE sequence to the PET/MRI protocol. However, the detection rate of small lung lesions is still inferior compared to PET/CT with diagnostic CT of the chest.

CLINICAL RELEVANCE/APPLICATION

Also for lung evaluation the PET part of PET/MRI is equivalent to PET/CT.

SSK17-05 • Whole-body PET/MRI: The Effect of Ignoring Bone during MR-based Attenuation Correction in Oncology Imaging

Thomas Beyer PhD (Presenter) * ; Rachida Sersar ; Julie Sabyee ; Johan Lofgren ; Claes Ladefoged ; Flemming L Andersen MSc, PhD ; Rasmus Larsen ; Marianne C Aznar MS

PURPOSE

Standard PET attenuation correction (AC) in integrated PET/MRI is based on tissue segmentation following in- and opposed phase MR imaging (ACin_op) and does not account for bone tissue. We evaluate PET quantification in whole-body (WB)-PET/MRI following MR-AC without and with accounting for bone tissue using separate CT.

METHOD AND MATERIALS

20 oncology patients referred for a PET/CT were injected with [18F]-FDG or [18F]-NaF and scanned on PET/CT (mCT, Siemens) followed by a PET/MR scan (mMR, Siemens) following clinical WB-protocols. PET/MR images were reconstructed using standard MR-AC and four modified attenuation maps. These were created by co-registering (b-spline) the CT images to (ACin_op) and adding CT bone mask values representing cortical bone: 1200HU (ACcortCT), spongiosa bone: 350HU (ACspongCT), average CT value (ACmeanCT) and original CT values (ACorgCT). PET images were reconstructed after MR-AC using AW-OSEM (3 iterations, 21 subsets, 4mm Gaussian) on 344-matrices. Relative difference images of PET following modified MR-AC and MR-AC using ACin_op (ACmeanCT) and original CT values (ACorgCT). PET images were reconstructed using standard imaging (ACin_op) and does not account for bone tissue. We evaluate PET quantification in whole-body (WB)-PET/MRI following PET/CT correlated significantly (r=0.9; p=0.0001) with a tendency for higher SUVs in PET/MRI. There was a significantly lower image quality comparing Dixon and VIBE sequence with CT whereas PET from PET/CT and PET from PET/MRI showed similar results. Dixon images detected 15/47 lung lesions while VIBE images detected 32/47 lesions, respectively. The detection rates for small lung lesions < 1 cm diameter (n=33) of CT and MR imaging was significantly lower with a detection rate of 9/33 for Dixon sequence and 15/33 for VIBE sequence. There was a high correlation of pulmonary lesion size of CT versus VIBE (r=0.97; p

RESULTS

All scans together revealed 47 pulmonary lesions (mean size 10.0±11.4mm; range 2-60mm) in 25/40 patients. The PET datasets of PET/MRI and PET/CT revealed both 22/47 pulmonary lesions with focal [18F]FDG uptake. SUV-values of lung lesions in PET/MRI and PET/CT correlated significantly (r=0.9; p=0.0001) with a tendency for higher SUVs in PET/MRI. There was a significantly lower image quality comparing Dixon and VIBE sequence with CT whereas PET from PET/CT and PET from PET/MRI showed similar results. Dixon images detected 15/47 lung lesions while VIBE images detected 32/47 lesions, respectively. The detection rates for small lung lesions < 1 cm diameter (n=33) of CT and MR imaging was significantly lower with a detection rate of 9/33 for Dixon sequence and 15/33 for VIBE sequence. There was a high correlation of pulmonary lesion size of CT versus VIBE (r=0.97; p

CONCLUSION

Ignoring bone tissue during MR-AC causes an average underestimation of (10-14)% in reference tissues, bone and soft tissue lesions, which is visually insignificant but considerable during follow-up.

CLINICAL RELEVANCE/APPLICATION

Standard MR-AC appears acceptable in clinical routine for now but mandates improvements in accuracy and reliability for quantitative follow-up examinations.

SSK17-06 • 18-FDG PET/CT Compared with 18-FDG PET/CT and Whole Body MRI for Lesion Detection, Confidence and Radiation Dose in the Evaluation of Metastatic Breast Cancer

Amy N Melsaether MD ; Akshat C Pujara MD (Presenter) ; Rajan Rakheja ; Mohammed B Shaikh MD ; Eric Sigmund PhD ; Sungeheon Kim ; Christian Geppert * ; Linda Moy MD

PURPOSE

PET/CT is often used to evaluate for systemic breast cancer (BC), but provides low contrast at a relatively high radiation dose. Whole-body (WB) MRI is also being investigated in this role. Simultaneous PET/MRI scanners are recently available. We therefore evaluated PET/MRI performance for lesion detection, reader confidence and radiation dose as compared with PET/CT and contrast
METHOD AND MATERIALS
For this HIPPA compliant, IRB approved prospective study, 26 women (age 37-76 mean 56) with n=1 newly diagnosed T2 BC or n=25 history of metastatic disease underwent WB simultaneous 18-FDG PET/MRI on an integrated 3T PET/MR scanner (Siemens Biograph mMR), after PET/CT.

RESULTS
In patients with lymphoma, FDG PET-CT is critical in the initial staging with early interim PET CT being a strong independent predictor of progression free survival. Diffusion weighted MRI is also a biomarker of malignancy with an uncertain role in lymphoma. The goal of this work was to evaluate the diagnostic performance of simultaneous PET/MR compared to PET/CT in patients with lymphoma.

METHOD AND MATERIALS
15 subjects with lymphoma underwent an IRB approved, single-injection/dual-imaging protocol, consisting of a PET/CT and subsequent PET/MR scan. PET-images of both modalities were reconstructed iteratively. Attenuation, decay and scatter correction and regional allocation was performed using low dose CT data for PET/CT and Dixon-MR sequences for PET/MR. Whole body DWI was performed using a respiratory gated SSePIE (T/TE/TR 220/68/7800ms) with 3 b-values (0,50,800). ADC was calculated using a mono-exponential fit. SUVmax for FDG-avid lesions were measured and compared using ROI analysis by a single radiologist and OsiriX (OsiriX ©, Lausanne, Switzerland) for each imaging modality. ROI analysis was performed as well comparing ADC fused to FDG-PET/MR SUVmax. Strength of correlation between variables was measured using the Spearman rank correlation coefficient (rs).

RESULTS
Of the 15 subjects, 4 had Hodgkin's and 11 had non-Hodgkin's (NHL) lymphoma. The mean age was 53 +/- 16 years. Thirty-seven FDG-avid lesions were identified. The mean difference in time between PET/CT and PET/MR acquisitions was (209.9 +/- 43.9 min). SUVmax from FDG-PET/MR (mean 8.5 +/- 4.6) versus FDG-PET/CT (mean 4.6 +/- 2.7) was on average higher and demonstrated a strongly positive correlation (rs=0.84 (0.71, 0.92); p < 0.001).

CONCLUSION
FDG-PET/MR offers an equivalent whole body staging examination as compared with PET/CT with an improved radiation safety profile (negating the CT component) in lymphoma patients. Correlation of ADC to SUVmax was weak understating the potential importance of both biomarkers in this disease process.

CLINICAL RELEVANCE/APPLICATION
The equivalence of PET/MRI both qualitatively and quantitatively offer a provocative, future clinical staging and surveillance option in patients with lymphoma with dramatic savings in radiation dose.

SSK17-08 • Utility of a Dedicated [18F]-FDG-PET/MRI Protocol for Thoracic Staging in Lung Cancer: Comparison to [18F]-FDG-PET/CT

Philipp Heuscher MD (Presenter); Jens Kohler; Christian Buchbender; Felix Nensa MD; Verena Hartung; Till A Heusner MD

PURPOSE
Therapeutic decisions in non-small cell lung cancer (NSCLC) patients depend on the tumor stage. Positron emission tomography/computed tomography (PET/CT) with [18F]-FDG is widely accepted as the diagnostic standard of care. The feasibility of pulmonary tumor staging with simultaneous [18F]-FDG-PET/MRI has recently been proven, but no state-of-the-art lung MRI protocol was used in this early study. The purpose of this study was to compare a dedicated pulmonary [18F]-FDG-PET/MRI protocol to [18F]-FDG-PET/CT for thoracic staging in NSCLC patients.

METHOD AND MATERIALS
36 patients (23 male, 15 female, mean age 63.9±10.5 years) with histopathologically confirmed NSCLC underwent [18F]-FDG-PET/CT followed by a [18F]-FDG-PET/MRI (including a dedicated pulmonary MRI protocol). The TNM stage was determined in separate sessions for PET/CT and PET/MRI by two readers in consensus. The mean and maximum standardized uptake values (SUVmean; SUVmax) and the maximum diameter of the primary tumor were measured. TNM stages, SUVmean/max and tumor size obtained from PET/CT and PET/MRI were compared and Pearson correlation analysis and Bland-Altman plots were performed for quantitative parameters.

RESULTS
PET/MRI and PET/CT agreed on T-, N- and thoracic M-stages in 33/38 (87%), 32/38 (84%) and 35/38 (92%) of patients. Compared to PET/CT, N-stages and thoracic M-stages were staged down by PET/MRI in 3 (8%), 3 (8%) and 3 (8%) and were staged up in 2 (5%), 3 (8%) and 6 (16%) patients, respectively. Pearson correlation coefficients for the primary tumors SUVmean, SUVmax and maximum diameter in PET/CT and PET/MRI were 0.89, 0.90 and 0.98, respectively. Using Bland-Altman analysis, the lower and upper limits of agreement between PET/CT and PET/MRI were -3.45 to 3.15 for SUVmean, -7.43 to 6.55 for SUVmax and -0.86 to 0.96 for the tumor size, respectively.

CONCLUSION
PET/MRI using a dedicated pulmonary MRI protocol and PET/CT generally show a good agreement on thoracic TNM- stages in NSCLC patients. Comparability of primary tumor sizes measured in PET/CT and PET/MRI is substantial and is very well for quantitative measures of [18F]-FDG uptake.

CLINICAL RELEVANCE/APPLICATION
In NSCLC the choice of therapeutic options is based on the individual tumor stage. Hence, comparability of thoracic TNM- stages and primary tumor sizes assessed by PET/CT and PET/MRI is essential.
Abusive head trauma (AHT) represents a leading cause of death in infants. The significance of traumatic subdural hygromas (SDHy) in AHT, especially in shaken baby syndrome, is not well understood and still a matter of debate. The present study investigates the origin and characteristics of SDHy by modern imaging techniques.

METHOD AND MATERIALS

The image material of all children between 0 and 2 years, who were suspected to have a craniocerebral injury and had an initial cranial computer tomography at the University Hospital Essen, were analyzed retrospectively from the years 1999 to 2012. In cases where additional MR examinations existed, these MR images were also analyzed. First, the demographic and anamnestic data were collected. Second, the radiological co-findings were analyzed. Third, we searched for criteria indicating AHT as origin of SDHy.

RESULTS

The inclusion criteria detailed above were met by 136 cases. In 33 cases an AHT was assumed from the total of clinical, forensic, and criminalistic findings. 17 cases showed evidence of SDHy. In only one SDHy case, there was adequate accidental trauma anamnesis. The demographic data and the radiologic findings in cCT and cMRI will be presented. The classification scheme by Zanini et al. (2008) is not suitable. Instead, for indicating AHT as cause of SDHy, the presence of bridging vein thromboses appears to indicate a high degree of violence and thus, in the absence of adequate accidental trauma, the presence of AHT.

CONCLUSION

There are different SDHy appearances which allow for conclusions to the mechanism of causation. Therefore, neuroradiologists should be aware of the possible presentations of AHT. The presence of bridging vein thromboses indicates AHT.

CLINICAL RELEVANCE/APPLICATION

Although difficult to investigate, understanding of SDHy’s may allow for new insights into the pathogenesis of phenomena such as the shaken baby syndrome.
Heike E Daldrup-Link  MD

PURPOSE
MRI is the modality of choice for local staging of many solid malignancies in pediatric patients. 18F FDG-PET/CT is often
correlated for whole body staging. Integrated PET/MR can combine local and whole body staging in one imaging exam while
eliminating the CT portion of a PET/CT. The purpose of this study was to determine the need for administering contrast for local
tumor staging with PET/MR by comparing tumor areas of increased 18-FDG metabolic activity with areas of Gd-enhancement.

METHOD AND MATERIALS
We retrospectively evaluated imaging studies of 35 children (age 1-18 years, mean 9.9 years) with small round blue cell tumors, who
had undergone an 18F-FDG PET/CT and gadopentetate-enhanced MRI with an interval of less than three weeks. Patients in remission
or with brain tumors were excluded. 18F-DG PET and Gd-enhanced MR scans were color encoded and fused using Osirix software. A
pediatric radiologist and nuclear medicine physician evaluated the concordance or discordance of 18F-FDG and Gd-tumor
enhancement in consensus. Results were compared using the McNemar’s Test.

RESULTS
29/35 patients had regions of tumor that demonstrated avid contrast enhancement that correlated with regions of significant FDG
avidity (83%). 6/35 patients had areas of contrast enhancement that was discordant with regions of FDG avidity (17%). The
McNemar’s Test demonstrated a significant correlation between 18F-FDG and Gd-tumor enhancement.

CONCLUSION
PET/MR as a combined imaging modality is highly effective for staging and restaging of pediatric malignancies when used as a
combined imaging modality and would allow for one stop shop tumor staging. There is a high concordance between areas of
increased 18-FDG avidity on PET with areas of Gd-enhancement on MRI in small cell tumors. Thus, MRI contrast agent administration
cannot be needed and should be assessed on a patient-by-patient basis.

CLINICAL RELEVANCE/APPLICATION
PET-MR as a combined imaging modality is highly effective for staging and restaging of pediatric malignancies which allows one
stop shop tumor staging and significantly reduces radiation exposure.

SSK18-04 • Comparison of Multivoxel MR Spectroscopy and I-123 MIBG Findings in Neuroblastoma

Zakir Sakci MD (Presenter) ; Yonca Anik MD ; Ahmet Akca ; Mehmet Gencturk MD ; Ali Demirci MD ; Hakan Demir ; Gozde Da?l?oz Gorur ; Funda Corapcio?lu

PURPOSE
In neuroblastoma patients who have tumor residue after treatment the use of convenional MRI provides limited information
regarding the maturity of the tumor. For this reason, we use I-123 Metaiodobenzylguanidin (MIBG) to evaluate the tumor for
maturity before prescribing further treatment. We can learn about the current membrane turnover by looking at the MR Spectroscopy maturity levels along with the peak of cholin. We can analyze the cholin peaks at finer detail with the use of multivoxel MR spectroscopy. The aim of our study was to evaluate tumor activation with MRS and compare the findings with that of I-123 MIBG.

METHOD AND MATERIALS
We included twenty patients diagnosed pathologially proven with neuroblastoma. MR imaging was done via 3T MR device before
treatment and during treatment intervals. Multivoxel spectroscopy was performed with TE: 140. Cholin peak and choline/creatine
ratio were measured. I-123 MIBG was also performed. Uptake was graded as 4 grade onI-123 MIBG. Time interval between both
modalities was at most 10 days. In all patients primary tumor was imaged and in three patients metastatic lesions were also
imaged. Cholin peak and choline/creatine ratio and MIBI grade were correlated.

RESULTS
We demonstrated choline peak in all I-123 MIBG active tumors. Correlation among cholin peak and choline/creatine ratio and MIBI
grade revealed significant correlations both in primary tumors and metastatic lesions.

CONCLUSION
I-123 MIBG has radiation exposure and is repeated several times during treatments, takes a long time to perform. On the contrary
MRS lack radiation, can be performed in about twenty minutes. MRS can provide tumor activation information. MRS may be an
alternative technique for I-123 MIBG in near future. Further analysis with larger number of patients is required.

CLINICAL RELEVANCE/APPLICATION
MRS may be an alternative technique for MIBG in near future. MRS lack radiation, can be performed in about twenty minutes.
Advantages to MIBI.

SSK18-05 • Evaluation of Whole Body MRI including Diffusion-weighted and Conventional Unenhanced and Contrast Enhanced Imaging as the Sole Staging and Follow-up Imaging Procedure in Pediatric Tumors Compared to Other Imaging Modalities

Guenther K Schneider MD, PhD (Presenter) * ; Alexander Massmann MD ; Stefan R Rick ; Arno Buecker MD * ; Jonas Stroeder MD ; Peter Fries MD

PURPOSE
In 36 pediatric pts with suspected malignant tumors prediagnosed by other imaging modalities whole body MRI was evaluated as the
sole staging procedure including evaluation of the lungs. MRI was compared with established staging procedures such as PET,
MIBG or bone scintigraphy, CT and ultrasound. Furthermore findings in follow-up whole body MRI were used for evaluation of tumor
response and tumor recurrence, again compared against conventional imaging.

METHOD AND MATERIALS
167 whole body exams in 36 pts were performed for staging / follow-up of different benign and malignant tumors confirmed by
histology and/or surgical exploration. In 9 pts benign tumors incl. mature teratoma, liver abscess, hemorrhage, mesothelial cysts,
hemangioma, angiomyolipoma and myofibromatosis were diagnosed. In the remaining 27 pts 8 lymphoma and 19 solid tumors
(renal, hepato- and nephroblastoma, different sarcomas) were found. MR protocol incl. T1w dynamic GRE sequences of the
abdomen post CM (0,05 mmol/kg BW Gd-BOPTA (MultiHance) and during the liver specific phase. DWI was acquired during free
breathing and transversal T2w TSE sequences with navigator triggering and a composed whole-body STIR-sequence in coronal
orientation were acquired.

RESULTS
MRI correctly differentiated between malignant and benign tumors in 35/36 pts. In one patient infantile myofibromatosis was
misinterpreted as rhabdomyosarcoma without metastases. In malignant tumors one rhabdoid tumor was misinterpreted as
nephroblastoma but correctly staged, and one case of Hodgkin lymphoma was misinterpreted as PNET, again with correct staging.
Differences between MRI and CT were seen regarding the number of small lung metastases (< 3mm), however relevant lesions for
staging were correctly diagnosed. Recurrent tumors and restaging was correctly facilitated by MRI, sensitivity for detection of small
abdominal mets (< 10 mm) was better for MRI as compared with PET imaging. No differences in staging of neuroblastoma were
seen between MRI and scintigraphy.

CONCLUSION
Whole body MRI performed with the described technique can correctly stage and diagnose a variety of malignant tumors and
further large scale studies have to prove if MRI can finally replace at least some of the actually established staging procedures.
SSK18-06 • Intussusception Revisited: Is On-site Surgeon Presence at the Time of Radiologic Reduction Necessary?

Haithuy N Nguyen MD (Presenter) ; J. H Kan MD ; R. Paul Guillerman MD ; Christopher I Cassady MD

PURPOSE
The ACR-SPR clinical practice guidelines recommend that fluoroscopic-guided intussusception reduction be performed with a surgeon readily available. At many institutions, this may not be feasible. The purpose of this study is to assess the utilization of immediate surgical services at the time of radiologic intussusception reduction.

METHOD AND MATERIALS
All radiologic intussusception reductions at a tertiary care children’s hospital from 11/07-8/12 were reviewed to determine method, complications, clinical status of the child, and time interval between unsuccessful reduction and operative intervention.

RESULTS
433 intussusceptions were referred for fluoroscopic reduction. 86.1% (N=373) were successful and 13.9% (N=60) were unsuccessful, with 5 perforations representing 8.3% (5/60) of unsuccessful and 1.2% (5/433) of total reduction attempts. Six patients became hemodynamically unstable during attempted reduction (4 perforations, 2 unsuccessful reductions without perforation), representing 10% (6/60) of unsuccessful and 1.4% (6/433) of total reduction attempts. Percutaneous needle decompression and cardiorespiratory resuscitation restored hemodynamic stability in all cases. The mean time to surgery after perforation, unsuccessful reduction complicated by hemodynamic instability, and unsuccessful radiologic reduction without complication was 1.3, 2.2 and 4.3 hours, respectively.

CONCLUSION
In our series, complications requiring immediate medical or surgical attention were rare, occurring in 1.6% of cases (5 bowel perforations and 2 hemodynamically unstable cases without perforation). On-site surgeon presence may not be necessary at the time of radiologic-guided reduction attempts, provided that the radiologist is facile with percutaneous needle decompression and management of hemodynamic instability, and ultimate surgical care can be arranged expeditiously.

CLINICAL RELEVANCE/APPLICATION
The ACR-SPR guidelines should continue to reflect the need for emergent on-call surgical back-up for intussusception reduction attempts, but surgical attendance is not required during the procedure.

SSK18-07 • Prevalence of Developmental Dysplasia of the Hip in Breech Infants after Normal Screening Ultrasound: Is Follow-up Radiography Really Necessary?

Booth Aldred MD (Presenter) ; Henry J Baskin MD ; Brett Weitzel MD

PURPOSE
DDH is a prevalent source of morbidity seen within pediatric orthopedics. A significant amount of discrepancy exists in the literature regarding selective screening and follow-up imaging for the patient at risk for DDH. Current protocol at our institution dictates that all normal ultrasounds in breech infants be followed-up with radiography at four to six months. Yet, the data is conflicted on the value-added by these follow-up radiographs. We evaluate the utility of follow-up radiography in breech infants with normal ultrasound findings and determine if radiographs add significant value, justifying their use.

METHOD AND MATERIALS
We performed a systematic review of all breech infants born since 2009 collected from our institution’s database. All infant ultrasounds were performed by accredited sonographers utilizing standard techniques. Breech infants with a negative ultrasound at around 6 weeks were included if a follow-up radiograph was performed at approximately 6 months. Then, using standard departmental criteria, we evaluated whether the infant had radiographic findings of DDH or remained normal.

RESULTS
Preliminary screening of approximately 200 breech infants demonstrated 125 infants that met out inclusion criteria. Of these 125 infants, there were 5 infants with radiographic findings of DDH. We expect another 200 to 250 infants to meet inclusion criteria for this study.

CONCLUSION
Preliminary data suggests that breech infants with negative US at 6 weeks have a small but significant risk of DDH diagnosed with radiograph by 6 months of age. Given the severe morbidity of delayed diagnosis of DDH, we suggest radiographic follow-up of breech infants who had normal screening hip ultrasound in the newborn period.

CLINICAL RELEVANCE/APPLICATION
Morbidity associated with DDH in the infant is significant. Our center recently began follow-up imaging in breech infants who had a negative initial ultrasound. Is this imaging necessary?

SSK18-08 • Iterative CT Image Reconstruction Allows Sub-0.1 mSv Effective Dose for the Diagnosis of Craniosynostosis

Caroline Ernst MD ; Tine Huulstaert (Presenter) ; Dries Belsack MD ; Nico Buils DSc, PhD * ; Gert Van Gompel PhD ; Koenraad H Nieboer MD * ; Johan De Mey *

PURPOSE
To evaluate diagnostic quality of markedly lowered dose cranial computed tomography (CT), reconstructed by full model based iterative reconstruction (MBIR), in the diagnosis of craniosynostosis.

METHOD AND MATERIALS
During 2009-2012 48 patients, aged 0-35 months, underwent cranial 3D CT on a 64 Multidetector CT to assess cranial sutures. In 2009-2010 24 patients were scanned on a Philips system (Brilliance CT 64) with a standard acquisition protocol (120 kVp; 276 mA,fixed) and reconstructed by FBP. In 2011-2012 the other 24 patients underwent a lowered dose CT (80 kVp; 10 mA, fixed) on a Discovery 750HD (GE Healthcare) system using MBIR reconstruction (Veo). CT-DVol and DLP were obtained from the dose report and effective doses were estimated conform current ICRP guidelines. Objective image quality (IQ) was assessed in terms of image noise, signal-to-noise ratio’s (SNR) and sharpness. Subjective IQ assessment by two blinded expert readers was performed by scoring several parameters and structures such as noise, bony structures and overall diagnostic acceptability. Statistical evaluation was performed with independent T-test, non-parametric Mann-Whitney U test and kappa analysis.

RESULTS
CONCLUSION
The use of MBIR in cranial 3D CT allows sub-0.1 mSv effective dose for the diagnosis of craniosynostosis without impairing diagnostic quality.

CLINICAL RELEVANCE/APPLICATION
Implementation of novel CT technologies allows for increased radiation safety in paediatrics.
PURPOSE
The aim of this study is to determine whether a complete abdominal ultrasound (US) is necessary in the evaluation of children with lower right quadrant (RLQ) pain suspicious for appendicitis in the Emergency Department (ED), and whether performing a limited RLQ US would miss a clinically significant diagnosis.

METHOD AND MATERIALS
This is a retrospective review of 1204 consecutive initial initial abdominal US studies done from March through December of 2008 for children presenting to a tertiary pediatric ED with abdominal pain concerning for appendicitis. Primarily performed limited ultrasound examinations, and examinations done for those with chronic disease such as cystic fibrosis, and sickle cell disease were excluded.

Our limited US examination excludes evaluation of the pancreas, spleen and left kidney. Data were extracted from the complete abdominal US to see if any abnormalities were noted of the pancreas, the spleen and the left kidney, and patients charts were reviewed to see if any positive findings in these organs were clinically significant.

RESULTS
Of the 704 US examinations included in this study, there were 65 potential missed diagnoses, ie abnormal US findings noted in the pancreas, spleen or left kidney. Only 6 of these findings were clinically significant and 5 were managed medically while 1 (a left ureteropelvic junction obstruction) underwent surgical intervention. The chance of missing a diagnosis is calculated as 65/704 = 9.2% (95% confidence interval: 7.2% - 11.7%) and the chance of missing a diagnosis that is clinically significant is 6/704 = 0.85% (95% confidence interval: 0.35% - 1.94%).

The average time to perform a complete abdominal US exam was 71 minutes and our limited exam required an average of 44 minutes (measured on those patients who had these performed who were not in our study group). The charge for a complete US vs limited US is $681 vs $484

CONCLUSION
In children with acute abdominal pain concerning for appendicitis, evaluation with a limited RLQ US provides a timely diagnosis, while missing only 1 case of surgically treatable abdominal pain. The limited US resulted in overall savings in time to perform examination and charges.

CLINICAL RELEVANCE/APPLICATION
By limiting the ultrasound examination, significant time and expense can be saved with the chance of missing a clinically significant diagnosis of only 0.85%.

PURPOSE
Despite its current use as a metric in the low-contrast resolution test for the American College of Radiology (ACR) CT Accreditation Program, contrast to noise ratio is not appropriate for iterative reconstruction (IR). The purpose of this study was to develop and validate a quantitative metric using a channelized Hotelling observer (CHO) that can be used to assess low-contrast resolution in the ACR phantom for IR methods.

METHOD AND MATERIALS
The proposed metric is based on a CHO model, which predicts the index of detectability from a number of 2-alternative forced choice (2AFC) trials, in this case generated from repeated CT scans of the ACR phantom. To test this metric, the low-contrast module of the ACR phantom was scanned on a 128-slice scanner (Definition Flash, Siemens) and a 64-slice scanner (Lightspeed VCT, GE). Routine abdomen protocols were used at three dose levels (CTDIvol=16, 12, and 8 mGy), each scanned 100 times. On each scanner, images were reconstructed with one filtered-backprojection kernel and 2 IR settings: B40 and I40 with strengths of 3 and 5 for Siemens; Standard and ASIR with a mix ratio of 50% and 100% for GE. Three board-certified medical physicists blindly evaluated images in a random order (totally 1800 images = 2 vendors x 3 doses x 3 reconstructions x 100 images), and recorded a quality score for detecting all four 6-mm rods using a 6 point scale. Percent correct of the 2AFC was calculated using CHO. The correlation between the index of detectability predicted by CHO and the scores by human observers was tested.

RESULTS
A strong correlation between CHO and human observer scores was observed. Pearson correlation coefficients were 0.932 (95% CI: [0.70, 0.99]) for Siemens and 0.926 (95% CI: [0.68, 0.98]) for GE. Both IR methods improved low-contrast performance, with one more significantly than the other (p = 0.005).

The proposed task-based low-contrast detectability metric may provide an objective measure of low-contrast performance in ACR CT evaluation.

CLINICAL RELEVANCE/APPLICATION
Use of IR methods challenges existing low-contrast performance tests, such as with the ACR phantom. The proposed metric provides an objective and reliable measure of low-contrast performance.
dose recorded by the chamber approaches $D_{eq}$, the value that would be reached for an infinite scan. By recording the dose rate as a function of position during the scan, the dose $D(L)$ at the central plane can be determined for any scan length $L$. From this record, the approach to equilibrium function $H(L)$, defined as the ratio $D(L)/D_{eq}$, is determined. These concepts can be extended to axial scans on stationary tables and are not limited by the width of the beam. Testing has been performed on a Philips Brilliance 64 scanner and a Toshiba Aquilion One.

Discussion

$H(L)$ is a robust function and displays only a weak dependence on tube potential and z-axis collimation. Our measurements show that the central plane dose is substantially more uniform than that for the CTDI body phantom. The phantom design is easily and transparently scalable, making it readily adaptable to the size specific dose estimates described by the report of AAPM Task Group 204 resulting in an index that remains simple but accounts for both girth and scan length. Correlations to air and small phantom measurements can be used for verification in the field.

SSK19-03 • A Comprehensive Study of Single- and Dual-source Coronary CT Angiography with Stents Using an Anthropomorphic Phantom with a Beating Heart Model

**George S Fung PhD (Presenter) * ; Karl Stierstorfer PhD * ; Satomi Kawamoto MD * ; Katsuyuki Taguchi PhD * ; Matthew K Fuld PhD * ; Thomas G Flohr PhD * ; Elliot K Fishman MD * ; Benjamin Tsui PhD * ; John J Demarco PhD ; Les R Folio PhD ; Michael F McNitt-Gray PhD ; Thomas G Flohr PhD; Karl Stierstorfer PhD ; Satomi Kawamoto MD ; Katsuyuki Taguchi PhD ; Matthew K Fuld PhD ; Thomas G Flohr PhD ; Elliot K Fishman MD ; Benjamin Tsui PhD.

**PURPOSE**

The object is to study the effect of coronary stents and heart motion on the quantification accuracy of lumen diameter and lumen attenuation of coronary stents using an anthropomorphic phantom with a beating heart model and a CT projection simulator in single- and dual-source CT (SSCT and DSCT) angiography.

**METHOD AND MATERIALS**

The digital 4D phantom with a beating heart model, coronary arteries and stents, was developed and used in simulating coronary CT angiography (CTA) image data with different heart rates (HRS), i.e., 50-110bpm. Clinical stainless steel coronary stent models of different diameters, i.e., 2.5-4mm, were deployed at 3 coronary locations, i.e., LAD, LCX and RCA. Single and dual-source CTA images of the phantom were generated using an instrumental-accurate CT projection simulator at mid-diastolic phase and reconstructed using standard clinical protocols. Artificial in-stent lumen narrowing (ALN) and lumen attenuation (ALA) were calculated from the reconstructed CTA images using both SSCT and DSCT systems at the different HRS.

**RESULTS**

In the static heart study, CTA images from all 3 stents suffered similar degradation, as ALN increased from 28% to 48% and ALA increased from 2% to 68% as the stent diameter decreased from 4mm to 2.5mm, due to partial volume (PV) and metal beam-hardening (BH) artifacts. In the beating heart study using SSCT, there were minor degradations for LAD stent at all HRSs and for RCA stent at 50-70bpm. For LCX stent at 90-110bpm and for RCA stent at all HRSs, lumen diameter and attenuation could not be robustly measured due to the high variation of in-stent attenuation and deformed structure of the stents in the CTA images. In the beating heart study using DSCT, CTA images of LAD and LCX stents at all HRSs and RCA stent at 50bpm had minor motion artifacts. The RCA stent in CTA images suffered from significant motion artifacts at 70bpm and above. When compared to SSCT, DSCT achieved comparable ALA for LAD stent at all HRSs and over 30% of improvement in ALA for LCX and RCA stents at low HRSs.

**CONCLUSION**

High temporal resolution provided by DSCT overcomes most of the motion artifacts for the stents at the LAD and LCX over large range of HRSs in CTA images. Additional research is needed to reduce artifacts due to the large motion of RCA, and PV and BH effects.

**CLINICAL RELEVANCE/APPLICATION**

DSCT overcomes most of the motion artifacts for the stents at the LAD and LCX over large range of HRSs in CTA.

SSK19-04 • Size-specific Organ Dose Calculation Using Age and Gender Specific Computational Human Phantoms in Patients Undergoing Computed Tomography Examinations

**Choonsik Lee PhD (Presenter) ; Jennifer W Siegelman MD, MPH ; Mark P Supanich PhD * ; Les R Folio DO, MPH**

**PURPOSE**

To develop a method to estimate organ doses for patients with different torso diameters that can be readily used in clinical settings without the need for Monte Carlo simulation. CT Dose Index (CTDI$_{Vol}$) and Dose Length Product (DLP) are available from the dose report for patients undergoing computed tomography (CT) examinations but are based on CTDI phantom measurements that do not represent patient organ dose. As direct measurement is not feasible, intensive Monte Carlo simulation coupled with computational human phantoms is used to calculate patient organ doses; more important measure.

**METHOD AND MATERIALS**

We employed a set of computational human phantoms in six age groups (newborn to adult) based on ICRP reference data to pre-calculate an organ dose library using the known x-ray spectra of a reference CT scanner (Siemens Sensation 16). CTDI$_{Vol}$-normalized doses to major organs included in (or close to) the scan coverage was calculated for head, chest, abdomen-pelvis (AP), and chest-abdomen-pelvis (CAP) scans using head and body filters and 120 kVp. Effective diameters at the middle level of the scan range were measured and exponential regression curves were derived between organ doses and the effective diameters. Illustrative organ doses were calculated for a given CT scanner and patients with different effective diameters by multiplying the organ dose library by the CTDI$_{Vol}$ of the given CT scanner.

**RESULTS**

Exponential regression coefficients were established for male and female patients scanned for head, chest, AP, and CAP examinations for a range of effective diameters. Illustrative organ doses were calculated for hypothetical male patients with the effective diameters of 10, 20, 30, and 40 cm scanned for a CAP exam (CTDI$_{Vol}$ of 11.1 mGy). Exponential fitting coefficients for CAP scan normalized by body phantom were used for the calculation.

**CONCLUSION**

A convenient method to calculate doses for patient organs included in or close to scan coverage was developed for major examinations. Once the effective diameter of a patient and the CTDI$_{Vol}$ measurement (or from dose report) are available, organ dose may be calculated using the proposed method with the exponential fitting coefficients.

**CLINICAL RELEVANCE/APPLICATION**

The proposed method will be useful for calculating patient organ dose using the effective diameter of the patient and CTDI$_{Vol}$ measurement without performing intensive Monte Carlo simulation.

SSK19-05 • Validation of Monte Carlo Simulation Dosimetry Method Using In-Vivo Measurements in Patients Undergoing CT Examinations

**Maryam Khatonabadi (Presenter) * ; Jonathon Mueller ; Kyle McMillan * ; Maria Zankl PhD ; Dianna D Cody PhD * ; Christopher H Cagnon PhD ; John J Demarco PhD ; Michael F McNitt-Gray PhD * ; DO, MPH ; Kyle McMillan ; Michael F McNitt-Gray ; Christopher H Cagnon ; John J Demarco ; Maryam Khatonabadi ; Jonathon Mueller ; Dianna D Cody ; Maria Zankl ; Michael F McNitt-Gray ; John J Demarco ; Christopher H Cagnon.

**PURPOSE**

The purpose of this study was to validate Monte Carlo (MC) simulation based dose estimates by generating voxelized models of patients for the purpose of simulations and comparing simulated values with in-vivo dose measurements from clinical CT scans.

**METHOD AND MATERIALS**

We employed a set of computational human phantoms in six age groups (newborn to adult) based on ICRP reference data to pre-calculate an organ dose library using the known x-ray spectra of a reference CT scanner (Siemens Sensation 16). CTDI$_{Vol}$-normalized doses to major organs included in (or close to) the scan coverage was calculated for head, chest, abdomen-pelvis (AP), and chest-abdomen-pelvis (CAP) scans using head and body filters and 120 kVp. Effective diameters at the middle level of the scan range were measured and exponential regression curves were derived between organ doses and the effective diameters. Illustrative organ doses were calculated for a given CT scanner and patients with different effective diameters by multiplying the organ dose library by the CTDI$_{Vol}$ of the given CT scanner.

**RESULTS**

Exponential regression coefficients were established for male and female patients scanned for head, chest, AP, and CAP examinations for a range of effective diameters. Illustrative organ doses were calculated for hypothetical male patients with the effective diameters of 10, 20, 30, and 40 cm scanned for a CAP exam (CTDI$_{Vol}$ of 11.1 mGy). Exponential fitting coefficients for CAP scan normalized by body phantom were used for the calculation.

**CONCLUSION**

A convenient method to calculate doses for patient organs included in or close to scan coverage was developed for major examinations. Once the effective diameter of a patient and the CTDI$_{Vol}$ measurement (or from dose report) are available, organ dose may be calculated using the proposed method with the exponential fitting coefficients.

**CLINICAL RELEVANCE/APPLICATION**

The proposed method will be useful for calculating patient organ dose using the effective diameter of the patient and CTDI$_{Vol}$ measurement without performing intensive Monte Carlo simulation.
**SSK19-06 • Lower Bound on Detectable Lung Nodule Growth Using Phantom CT Data**

**Marios A Gavrielides** PhD (Presenter) ; **Qin Li** ; **Rongping Zeng** PhD ; **Kyle J Myers** PhD ; **Berkman Sahiner** PhD ; **Nicholas Petrick** PhD

**PURPOSE**

to determine the minimum detectable growth in lung nodules of various sizes.

**METHOD AND MATERIALS**

Four different combinations (layouts) of synthetic nodules were placed in the vasculature insert of an anthropomorphic phantom and scanned with a 16-detector row CT scanner (Philips, MX8000). Each layout included four nodules of different shapes (spherical, elliptical, lobulated, and spiculated) but with the same size (5, 8, 9, or 10 mm) each placed in a fixed location. For each layout, ten repeat scans were acquired at 20, 100, and 200 mAs; 1.2 pitch; thin or thick slice collimations (16x0.75mm and 16x1.5mm, respectively); and reconstructed to 0.8, 1.5, and 3mm for the thin slice collimation, and 2, 3, and 5mm for the thick slice collimation. Nodule volume estimates were determined using a previously developed 3D matched filter estimator. For each nodule size, the pooled distribution of volume estimates was shifted by a percentage c to simulate a growing nodule. The standard deviation of the shifted distribution was also accounted for. Analysis of nodule growth was then conducted as a detection problem, where the shifted distribution was considered the signal present distribution and the baseline (non-shifted) distribution was considered signal absent. The area under the receiver operating characteristic curve (AUC) was used as a detectability metric, where c was varied until a target AUC was reached. The resulting value of c was the minimum detectable change for that AUC value. Bootstrap re-sampling was used to derive 95% confidence intervals on the value of c.

**RESULTS**

Both nodule size at baseline and choice of slice collimation protocol had an effect in the value of minimum detectable growth. For AUC=0.95, the minimum detectable nodule growth (volume increase) across all protocols and shapes was \( \{45\% \ [42-48], 21\% \ [20-21] \} \) and \( 16\% \ [16-17] \) for nodule sizes of 5, 8, and 9 mm respectively. Minimum detectable growth fell to \( \{17\% \ [16-17], 19\% \ [19-21] \} \) when the thin slice collimation protocol (16x0.75mm) was used.

**CONCLUSION**

Our phantom study indicates that the lower bound for detectable nodule growth in subcentimeter nodules is relatively small, on the order of 20% or less in volume for a thin slice CT acquisition protocol.

**CLINICAL RELEVANCE/APPLICATION**

These results could complement findings from theoretical and clinical studies to determine a potentially useful role for volume as a surrogate metric of nodule size change.

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**SSK19-07 • Iterative Reconstructions and Low Contrast Resolution Measurements: Are ACR Accreditation Threshold Values Still Valid?**

**James M Kohler** PhD (Presenter) ; **Lifeng Yu** PhD ; **Shuai Leng** PhD ; **Yi Zhang** ; **Zhoubo Li** ; **Cynthia H McCollough** PhD *

**PURPOSE**

The ACR recently switched from visual analysis of low contrast resolution (LCR) to quantitative measurement of contrast-to-noise ratio (CNR). This study compares the use of CNR threshold values as pass/fail criteria with use of visual impressions of LCR by human observers for the task of evaluating iteratively reconstructed (IR) phantom images.

**METHOD AND MATERIALS**

Two scanner models from 2 manufacturers (Lightspeed VCT, GE: Definition Flash, Siemens) were used to acquire data of the low contrast resolution section of the ACR CT accreditation phantom at CTDIvol levels of 8, 12, and 16 mGy. Images were reconstructed at 5mm image thickness using 3 different algorithms (FBP and 2 IR) at different strength settings. ImNotage acquisition and reconstruction were repeated 100 times for each, yielding a total of 1800 images. All images were blindly reviewed by 3 board-certified physicists using a 6-point scale to rate the detectability of the four 6-mm rods. CNR measurements were recorded, with a CNR = 1.0 indicating pass, which is the CNR threshold value used by the ACR accreditation program for adult abdominal protocols.

**RESULTS**

CNR measurements for nearly all of the IR images, at all dose levels, passed the ACR accreditation criteria. Visual analysis, using previous ACR criteria, showed a marked decrease in the pass rate with decreasing dose levels for all reconstruction methods. At an arbitrary pass rate of 20% (i.e., 20% of the 100 images passed), visual analysis showed 1 IR strength (vendor 1) and 2 IRs strengths (vendor 2) as passing at 12 mGy (all IRs pass at 16 mGy; all fail at 8 mGy). Using a CNR threshold of 1.0, all IR images pass at all dose levels.

**CONCLUSION**

CNR threshold values currently used by the ACR CT accreditation program are misleading with respect to the visual assessment of LCR for IR images.

**CLINICAL RELEVANCE/APPLICATION**

The established quality assured by ACR CT accreditation will not be maintained with IR images. Very poor quality images, as rated by observers, pass the ACR CNR criteria by a wide margin.

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**SSK19-08 • Patient-specific Whole-body Voxel Models for Accurate Organ and Effective Dose Estimation**
The mean difference between measurements and simulations based on the unamended CT volumes was 19%; using the whole-body model reduced the difference to 6%. In contrast to unamended CT volumes, whole-body models intrinsically also provided the dose values for organs outside the scanned volume. These organs contributed 17%, 34% and 36% to effective dose for the adult, 5y.o. and 1 y.o. phantom, respectively.

CONCLUSION

Patient-specific whole-body models allow to increase accuracy of dose estimation and to calculate dose for all relevant organs.

CLINICAL RELEVANCE/APPLICATION

The approach is useful for individual patient dose estimation, especially for clinical studies.

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**SSK19-09 • A Single Phantom for Objective Quality Control of Both CT and Dental CBCT**

Hugo De Las Heras PhD, MSc (Presenter) *; Felix Schofer PhD *; Wilhelm J Van Der Putten PhD *

CONCLUSION

The QUART phantom (with software) is an objective, reliable, time and cost-efficient alternative to perform the tests required for the quality control of both dental CBCT devices and CT scanners.

Background

The latest developments in quality control for dental cone beam CT (CBCT) devices have a much more objective and efficient approach than traditional QC phantoms for CT scanners. We present a phantom and software that recently became the German and Italian standard for dental CBCT (QUART DVT APC). The phantom is designed to evaluate all test parameters required in national and international protocols for CT quality control (IAEA publication 19, EU criteria publication 162 and ACR QC manual), as well as to test noise reduction algorithms and tube current modulation. In order to evaluate its application to whole body CT scanners, evaluations were performed using it and a standard Catphan® phantom.

Evaluation

Both phantoms were scanned in a CT scanner using the same settings. Consecutive scans were obtained at 130 kVp with exposures varying from 50 to 300 mAs. Both phantoms could evaluate uniformity, imaged slice width, position accuracy, noise and CT number accuracy. However, in addition, the QUART phantom and software presented here enabled the direct, automatic evaluation of contrast (between 120 and 150), limiting resolution (0.6 lp/mm at 10% of the modulation transfer function) and contrast-to-noise ratio (CNR, increasing from 128 to 290) in less than 20 seconds per image.

Discussion

The EQN is an objective, straightforward and time-efficient measure that releases equivalent results to traditional low contrast-detail tests and increases the reliability of quality control tests. As an example, the attached figure shows a comparison of contrast and CNR for both phantoms. The observed sensitivity (score range divided by uncertainty) of the CNR evaluation (0.013 ± 0.002 mAs) was twice the one obtained with the Catphan contrast-detail evaluation method (0.007 ± 0.002 mAs).

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**SSK20-04 • Stability of Iodine Density Measurements with Spectral Detector CT in an Anthropomorphic Phantom of Varying Size: Comparison of Conventional and Virtual Mono-energy Images**

Isaac Leichter PhD (Presenter); Tzvi Lipschuetz; Zimam Romman *; Michal H Gabbai MD; Jacob Sosna MD *

PURPOSE

Simultaneous dual-energy CT (DECT) data can be used to generate virtual mono-energy images at varying keV levels. These images include in-plane and object-size beam-hardening corrections. We aimed to evaluate the stability of iodine density measurements in virtual mono-energy images, using a phantom of two sizes.

METHOD AND MATERIALS

A customized water-equivalent anthropomorphic CT phantom (ORM, Moehrendorf, Germany) was scanned with and without a 2.5 cm extension ring to enable measurements at 2 phantom sizes (20x30 cm and 25x35 cm). The phantom included 8 tubes of 11.1 mm diameter, 2 tubes of 7.9 mm diameter, and 2 tubes of 6.4 mm diameter, all filled with 7 mg/ml iodine solution. The tubes were arranged 3x11 cm from the phantom center (Fig. 1). Conventional and 65 keV mono-energy images for both phantom sizes were obtained at 120 kVp and 300 mAs using a novel Spectral Detector CT (SDCT) prototype (Philips Healthcare, Cleveland, OH, USA). Variation between HU values of the iodine tubes was analyzed (paired T-test) for tube location, tube diameter, image type, and phantom size.

RESULTS

Mono-energy image HU values for the iodine tubes were independent of tube location, tube diameter, or phantom size. There was no significant difference (p=0.39) in the standard deviation (SD) of HU values at different tube locations in the small-size phantom (SD=0.76%) vs. the large-size phantom (SD=0.88%). Variation of the HU values between tubes with different diameters was even smaller, 0.46% in the small-size and 0.64% in large-size phantom. Compared to mono-energy images, in the conventional images the variation of HU values at different tube locations was significantly higher (p

CONCLUSION

The quality of virtual mono-energy images at 65 keV was superior to that of conventional images, with no beam-hardening effect. Mono-energy images demonstrated stable iodine density measurements, independent of phantom size, tube location, and tube diameter.

CLINICAL RELEVANCE/APPLICATION

Stable density measurements of contrast material, independent of patient size and ROI location, are important for integration of Spectral Detector CT into clinical practice.
SSK20-02 ● The Size-based Emphysema Quantification Using Length Scale Analysis in 3D Volumetric Chest CT

Minho Lee PhD (Presenter) ; Namkug Kim PhD ; Joon Seung Lee MD, PhD ; Jee Yongjun Chang MD

PURPOSE
To propose a quantification method to classify emphysema clusters by size using length scale analysis in volumetric chest CT.

METHOD AND MATERIALS
Volumetric CT scans of twenty patients with chronic obstructive pulmonary disease (COPD) were performed by a 16-multi detector row CT scanner (Siemens Sensation 16) with an 0.75mm collimation. Using thresholding by -950 HU, emphysema index (EI) of low attenuation area (LAA) mask was evaluated. Based on these LAA masks, a length scale analysis to estimate each emphysema cluster size was performed as follows. First, Hole filling and algorithm was performed on the emphysema mask and Gaussian low pass filter (LPF) with various size of kernel (5mm) was performed from large to small size, iteratively. Maximum density voxel in the each filtered volume was selected and dilated by the size of the kernel, which was regarded as the specific size emphysema mask. In this way, emphysema cluster with specific size range was classified and evaluated from the LAA mask. The accuracy of this classification was evaluated and compared by an expert thoracic radiologist with 10 scale visual evaluation to determine size classifying accuracy and to determine probabilities for incorrect estimation. In addition, an artificial phantom study for mimicking emphysema and a COPD patients study were performed to evaluate the accuracy of this algorithm.

RESULTS
The proposed method achieved an accuracy of 0.91 for the classification of emphysema clusters by size and a probability of 0.85 for the classification of incorrect estimation.

CONCLUSION
This method is especially useful in measuring size based emphysema analysis and could be possible to evaluate etiology and progression of COPD using 3D volumetric chest CT.

SSK20-03 ● Virtual Non-contrast CT Using Dual Energy Spectral CT: Reproducibility of Calcium Mass for Coronary Calcium Scoring

Myung Jin Chung MD * ; Wan-Youk Kim (Presenter) ; Dong Il Cha MD ; Sung Mok Kim MD ; Moon C Kim RT ; Kyung Sang Lee MD, PhD

PURPOSE
To create virtual non-contrast CT, two-material decomposition is allowed from Spectral CT based on sinogram space, instead of three-material decomposition method allowed in image space. However, various virtual non-contrast images can be made from various material decomposition (MD) methods in spectral CT. We evaluated the feasibilities of three different virtual non-contrast (VNC) images derived from single source dual energy spectral CT compared to true non-contrast (TNC) image.

METHOD AND MATERIALS
This HIPAA-compliant study was approved by institutional review board and informed consent was provided from all patients. Twenty-four patients prospectively underwent non-contrast CT followed by contrast enhanced chest CT using single source fast kVp switching dual energy scan. Iodine eliminated images so called as VNC were reconstructed using two kinds of 2-material decomposition algorithms (MDW, material density-iodine/water; MDC, material density-iodine/calcium) and material suppression algorithm (MSI, iodine suppression image). Using third party workstation, semiautomatic calcium measurements were performed.

RESULTS
Quantified calcium scores (AJ score) from all three VNCs correlated well with that of TNC (R^2 = 0.95, 0.88, and 0.88 for MDW, MDC, and MSI, respectively). However correlation coefficients were less than 0.9 (C = 0.83, 0.62, and 0.63 for MDW, MDC, and MSI, respectively). Measured calcium volumes on VNCs also correlated well with that of TNC (R^2 = 0.94, 0.87, and 0.90 for MDW, MDC, and MSI, respectively), with correlation coefficients of 0.78, 0.59, and 0.63 for MDW, MDC, and MSI, respectively. Among the three VNCs, MDW correlated best with TNC.

CONCLUSION
VNC image from contrast enhanced CT using dual energy material decomposition/suppression is feasible for coronary calcium scoring. However, among various methods to make virtual noncontrast image from spectral CT, material quantifications are different depending on the decomposition methods. Furthermore, the absolute value on VNC tends to be smaller than that on TNC and should be considered with calibration.

CLINICAL RELEVANCE/APPLICATION
Absolute values of calcium scoring on VNC tend to be smaller than that on TNC and should be considered with calibration.

SSK20-04 ● Reproducibility of Imaging Features Computed from Same-day Repeat CT Scan Images Reconstructed at Different Acquisition Parameters

Binsheng Zhao DSc (Presenter) ; Yongqiang Tan PhD ; Mingshi Wang ; Hyun-Ju Lee MD, PhD ; Chuanmiao Xie ; Jing Qi ; Ross C Ehmke BA ; Lawrence H Schwartz MD

PURPOSE
Radiogenomics promises the genetic assessment of cancer patients with non-invasive radiographic imaging studies. To date, little attention has been paid to the sensitivity of imaging features to repeat scans and acquisition parameters. This study explored the reproducibility of imaging features computed on repeat CT scans reconstructed at different parameters.

METHOD AND MATERIALS
This study included a retrospective dataset containing 32 lung cancer patients, each having two same-day repeat CT scans and reconstructed into 6 image series, i.e., a combination of 3 slice intervals (5, 2.5 and 1.25mm) and 2 reconstruction algorithms [Lung (L) and Standard (S)]. Three radiologists independently used an in-house algorithm to segment 32 tumors (= 1 cm; one per patient) in all image series. 261 imaging features describing tumor size, histogram, shape, edge and texture were computed from the final tumor volumes, based on the common volumes obtained by 2 out of the 3 radiologists. The concordance correlation coefficient (CCC) was used to measure the agreement between each feature computed from two repeat scans reconstructed at the 6 series, i.e., 1.25L (first scan) and 1.25L (second scan), 1.25Sand1.25S, 2.5Land2.5S, 2.5Sand2.5S, 5Land5S and 5Sand5S.

RESULTS
Out of the 261 features, CCC of 32 features were = 0.95 and of 169 features were = 0.75 for all 6 series. Size and histogram features were highly reproducible for all parameter settings; shape index and boundary gradient strength were the least reproducible. For 2.5Sand2.5S re-scans, all run-length, GTDM and spatial correlation features had CCC=0.95; surprisingly, many features showed inferior reproducibility with 1.25Land1.25L re-scans, possibly due to noise.

CONCLUSION
Image registration for prostate MR guided biopsy using automated biomechanical modeling

**Purpose**
To investigate the effect of extending a non-rigid surface-based registration method with biomechanical modeling for prostate MR guided biopsies on the target registration error (TRE) using internal reference landmarks. The method is fully automated and we compare accuracy to previous results obtained with manual optimization of parameters in every patient.

**Method and Materials**
The accuracy of a novel non-rigid registration method involving biomechanical modeling to account for deformations inside the prostate was determined. While MR–TRUS registration is the ultimate goal, we used MR guided MR biopsy imaging data from six consecutive patients for this evaluation. The data included T2-weighted images (0.8x0.8x3.0 mm) before and after insertion of a needle guide causing deformation of the prostate. The needle guide had an orientation and dimension comparable to a transrectal needle guide causing prostate deformation. The needle guide was segmented in both images assuming identical prostate orientations. Next, a tetrahedral volume mesh was generated from the image before needle insertion. Prostate deformations due to needle insertion were simulated using the surface displacements as boundary conditions. A 3D thin-plate spline deformation field was calculated by registering the mesh vertices. The TRE was defined as the Euclidean distance between registered and reference landmark position and was calculated for 45 reference landmarks manually annotated in both T2-weighted images. The results of this automated method were also compared to previous results obtained with manual optimization.

**Results**
The median TRE of the automated surface-based registration method with biomechanical regularization was 2.21 mm (range 0.55–7.32 mm), which was significantly lower than a median TRE of 3.02 mm (range 0.85–7.95 mm) obtained without biomechanical regularization (P = 0.10).

**Conclusion**
Non-rigid surface-based image registration extended with biomechanical modeling can be automated and improves the registration accuracy for prostate MR guided biopsies.

**Clinical Relevance/Application**
The automated surface-based registration method extended with biomechanical modeling is applicable to MR–TRUS registration and can help to improve effectiveness of MR guided TRUS biopsy procedures.

Validity of Myocardial Perfusion Asynchrony Measurements

**Purpose**
Left ventricular (LV) asynchrony can be quantified by both gated blood pool (BP) and myocardial perfusion (MP) tomography. A concern regarding MP phase measurements is their reliance on tracking myocardial walls in cases of severely reduced MP, for which counts are low. PET data are acquired in gated list mode and both BP and MP data are available for the same pts. To test validity of MP phase measurements for severely decreased MP we compared MP to BP phase measurements, which are not affected by decreased MP.

**Method and Materials**
Data were analyzed retrospectively for 67 pts (42 males; 23 females; 71±12 yrs) with suspected heart disease evaluated by 82Rb PET/CT. Data were collected in gated list mode and rebinned into BP tomograms of tracer imaged during the first pass transit through the heart chambers, and separately into MP tomograms of tracer imaged during equilibrium. For BP PET data LV contraction phases were computed for each of 17 LV segments. The 3 most basal-septal segments to ensure LV cavity sampling the bandwidth (BW) of contraction phases were computed, defined as % of the R–R interval accounting for 95% of LV regional contractions. MP tomograms were analyzed by commercial algorithms, which computed summed rest scores (SRS), indicating severity of MP defects, and MP phase BW derived from phases of maximum count brightness corresponding to regional end-systole at each voxel at locations identified by algorithms as corresponding to the myocardial wall.

**Results**
37 pts had negligible defects (SRS = 4) with BP phase BW = 16±8%, lower than the 30 pts with significant MP defects (SRS > 4) (33±22%, p = 0.0001). BP and MP phase BW were similar for all pts (24±% versus 26±16%, p = 0.49), pts with SRS = 4 (16±8% versus 19±9%, p = 0.15), and pts with SRS > 4 (33±23% versus 36±19%, p = 0.50). BP and MP phase BW correlated significantly and similarly with SRS (r = 0.59, p < 0.0001 and r = 0.61, p < 0.0001), consistent with greater amounts of asynchrony being related to more severe myocardial damage. Differences between BP and MP phase BW had no correlation to SRS (r = 0.04, p = 0.75). Thus, severe MP defects had no deleterious effect on MP phase quantitation.

CONCLUSION
Detection of LV asynchrony by phase measurements derived from gated 82Rb PET/CT tomograms are robust and reliable, regardless of severity of MP defects.

CLINICAL RELEVANCE/APPLICATION
It is justifiable to include scintigraphic asynchrony measurements in forming clinical impressions for pts exhibiting severe MP defects.

SSK20-08 ● Classification of Osteoarthritic and Healthy Chondrocyte Patterns in Human Patellar Cartilage on Phase Contrast Computed Tomography through Topological and Geometric Features

Mahesh Nagarajan (Presenter) ; Paola Coan ; Markus B Huber PhD ; Paul C Diemoz PhD ; Christian Glaser MD ; Axel Wismueller MD, PhD

PURPOSE
Phase-contrast X-ray computed tomography (PCI-CT) has been demonstrated at achieving soft-tissue contrast with micrometer scale resolution while imaging cartilage. This study proposes to quantitatively evaluate the performance of topological and geometrical approaches in characterizing chondrocyte patterns as observed in PCI-CT of human patellar cartilage as healthy or osteoarthritic.

METHOD AND MATERIALS
Five osteochondral cylinders (7 mm diameter, 3 osteoarthritic, 2 healthy) extracted from post-mortem human patellae were subject to PCI-CT at 26 keV (European Synchrotron Radiation Facility, Grenoble, France). From reconstructed CT images of the cartilage, 842 regions of interest (ROI) of size 51x51 pixels capturing chondrocyte patterns were then annotated in the radial zone of the cartilage matrix from high resolution images (voxel size: 8 x 8 x 8 μm-3). Two texture analysis techniques - (1) Scaling Index (SIM), that estimates local scaling properties and (2) Minkowski Functionals (MF), that evaluates topological properties, were used to extract features from the ROIs. Random sub-sampling cross-validation was utilized in optimizing a support vector regression model with a radial basis function kernel for the classification task. Performance was measured using area under the Receiver-Operator Characteristic (ROC) curve (AUC) for each feature.

RESULTS
With the experimental conditions used in this study, the best classification performance was observed with the SIM histogram (0.95 ± 0.06) which was significantly better than the performance achieved by all Minkowski Functionals ◆ Area (0.61 ± 0.07), Perimeter (0.85 ± 0.10) and Euler Characteristic (0.88 ± 0.09).

CONCLUSION
Our study investigates the use of advanced texture analysis techniques in images acquired with PCI-CT to quantitatively evaluate their ability in distinguishing between healthy and osteoarthritic cartilage. Our results show that geometrical features derived from SIM can capture differences in chondrocyte patterns annotated in the radial zone of knee cartilage matrix extracted from healthy and osteoarthritic specimens with high accuracy, and significantly outperform topological features derived from MF at the same task.

CLINICAL RELEVANCE/APPLICATION
Computer-aided feature analysis can distinguish between osteoarthritic and healthy chondrocyte patterns in knee cartilage as seen on Phase Contrast CT imaging studies with micrometer scale resolution.

SSK20-09 ● Analysis of Treatment Response of Bladder Cancers on CT Scans: Comparison of Computerized Volume Estimation with WHO and RECIST Criteria

Lubomir M Hadjiiski PhD (Presenter) ; Alon Z Weizer MD ; Ajjai S Alva MD ; Elaine M Caoili MD, MS ; Richard H Cohan MD * ; Heang-Ping Chan PhD ; Kenny H Cha BEng ; Stephen Dailey

PURPOSE
To evaluate the accuracy of our Auto-Initialized Cascaded Level Set (AI-CALS) 3D segmentation system, the WHO and the RECIST criteria in estimation of treatment response of bladder cancer using CT scans.

METHOD AND MATERIALS
The AI-CALS system is designed to extract 3D lesion boundary based on level sets. The system uses as input an approximate bounding box for the lesion of interest. With IRB approval, pre- and post-chemotherapy treatment CT scans of 20 patients with bladder cancers were collected retrospectively for this preliminary study. For all cases, cystectomy was performed after treatment and the disease outcome was available as reference standard of treatment response. 35% of patients had pT0 disease (complete response) at cystectomy. A radiologist marked 20 temporal pairs of primary site cancers and also manually outlined full 3D contours bounding box for the lesion of interest. With IRB approval, pre- and post-chemotherapy treatment CT scans of 20 patients with bladder cancers were collected retrospectively for this preliminary study. For all cases, cystectomy was performed after treatment and the disease outcome was available as reference standard of treatment response. 35% of patients had pT0 disease (complete response) at cystectomy. A radiologist marked 20 temporal pairs of primary site cancers and also manually outlined full 3D contours bounding box for the lesion of interest. Two texture analysis techniques - (1) Scaling Index (SIM), that estimates local scaling properties and (2) Minkowski Functionals (MF), that evaluates topological properties, were used to extract features from the ROIs. Random sub-sampling cross-validation was utilized in optimizing a support vector regression model with a radial basis function kernel for the classification task. Performance was measured using area under the Receiver-Operator Characteristic (ROC) curve (AUC) for each feature.

RESULTS
For the 20 cancers, the average pre- and post-treatment volumes from radiologist◆ segmentation were 36.0 and 17.6 cm3, respectively. The AUC for prediction of pT0 disease at cystectomy was 0.68±0.13 for the AI-CALS compared to 0.72±0.11 for the manual segmentation. The difference was not significant. Prediction of pT0 disease using the RECIST criteria by two radiologists was lower than the two 3D methods with AUCs of 0.59±0.14 and 0.66±0.12, respectively. Prediction of pT0 disease using the WHO criteria by the two radiologists had AUCs of 0.50±0.14 and 0.56±0.12, respectively, which were lower than all other methods.

CONCLUSION
The 3D pre- and post-treatment volume estimates obtained by manual radiologist segmentation and AI-CALS provided more accurate depiction of the irregular 3D tumor shapes and volume changes compared to the 1D (RECIST) and 2D (WHO) estimates.

CLINICAL RELEVANCE/APPLICATION
For tumors with irregular shape such as bladder cancers the 3D automated segmentation has the potential to accurately and efficiently determine tumor volume and response to treatment.
RESULTS
The pO2 measured in air correlated strongly and significantly with the mean of fp*DPp(r=0.88), as well as Dp in air(r=0.84), which indicates fp and fp*DP are sensitive to pO2 in air. When gas challenge was given, Strong correlation with fp was found for ?pO2cb (pO2 in carbogen-pO2 in air(r=0.80) and ?pO2c2(pO2 in oxygen-pO2 in air)(r=0.89). A similar strong and significant correlation was found between ADCv and ?pO2cb and ?pO2c2 (r=0.86 and r=0.92). It suggests that the baseline fp as well as ADCv determines the size of tumor response to gas challenge.

CONCLUSION
This study indicates that the perfusion parameters derived from IVIM MRI serve as a sensitive imaging biomarker of tumor oxygenation. IVIM Perfusion MRI may also be of value in the assessment of tumor microenvironment, monitoring tumor radiation therapy response.

CLINICAL RELEVANCE/APPLICATION
The IVIM Perfusion MRI provides a unique tool for assessment of tumor oxygenation and tumor microenvironment without the use of exogenous contrast.

SSK21-02 • Establishing Cell Structure-based Biomarkers of Disease Using Label-free Optical Quantification of Cell Mass, Volume, and Density in Early and Late Stage Colorectal Cancer Cell Lines

Sophia Bornstein MD, PhD ; Eric Anderson MD, PhD ; Melissa Wong PhD ; Owen McCarty PhD ; Kevin Phillips MD (Presenter)

ABSTRACT
Purpose/Objectives Metastasis, the leading cause of all cancer-related deaths, is facilitated by the heterogenous transport of circulating tumor cells (CTCs) from the primary tumor site to distant organs. We have developed label-free optical tools to quantify the basic physical features of CTCs including their total dry mass content and subcellular density distribution. To interpret these biophysical signatures of cancer at the single cell level, we investigated these quantitative features as a function of tumorigenic potential in the patient-matched SW480/SW620 colorectal cancer cell lines as a model of early and late stage disease.

Materials/Methods
Using non-interferometric quantitative microscopical (NIQPM), a technique that can be carried out on commercial microscopes, we quantified the dry mass content and sub-cellular density distribution of cultured cell lines plated on microscope slides. The density distribution was fit with a bi-modal Gaussian distribution whose size parameters quantified the contributions of small and large density structures to the overall composition of the cells. The Jarque-Bera test was used to evaluate normality of all parameters. One-way analysis of variance with Bonferroni post hoc analysis was used to assess statistical significance among parameters across multiple normally distributed cell parameters.

Results
SW620 cells demonstrated a morphology-dependent total dry mass content. The relative amount of small and large micron-scale density contributions to cellular density was found to be morphology-dependent among SW480 cells. SW620 cells possess significantly denser small-scale structures in comparison to SW480 cells. The density contributions from large-scale structures are conserved across all the SW cell types.

Conclusions
Micron scale characterization of the SW cell types with NIQPM demonstrated a systematic bimodal distribution of the subcellular density distribution whose small-scale peak was sensitive to tumorigenic potential of the SW620 cells. Total mass was also specific to hypoxic regions. The work qualitatively elucidates distinct cellular architectural phenotypes of early and late stage colorectal cancer in an in vitro setting. These results provide a rational for the use of label-free optically derived metrics to be tested clinically as biomarkers capable of monitoring responses among CTCs to radiological interventions.

SSK21-03 • Comparison of Quantitative Approaches to Identify Patients with Parkinsonism Using Dopamine Transporter Scans

Kenneth Nichols PhD (Presenter) * ; Maria B Tomas MD ; Christopher J Palestro MD

PURPOSE
Presynaptic dopamine transporter 123I-ioflupane (DaT) SPECT imaging facilitates the differentiation of Parkinsonism from essential tremor (ET). Some groups advocate quantitative analyses of caudate (C) or putamen (P) counts for improved differentiation of these two entities, while others recommend applying normal limits to background-corrected counts. This investigation was undertaken to determine which data analysis approach agrees most strongly with a final diagnosis of Parkinsonism.

METHOD AND MATERIALS
We performed a retrospective analysis of 123I-FP-CIT SPECT data for 50 pts (age 64±12 years; 28 F; 22 M) who were evaluated for movement disorders. Data were reconstructed by OSEM (12 iterations, 8 subsets) and corrected for attenuation by the Chang method. BASGAN software (Eur J Nucl Med Mol Imaging 2007;34:1240-53) generated ratios of automated caudate (AC) and automatic putamen (AP) counts versus background counts per pixel, and dichotomous abnormal values for caudate (DC) and putamen (DP) by applying recently updated age- and sex-adjusted normal limits (Eur J Nucl Med Mol Imaging 2013;40:565-73). In separate processing sessions, a medical physicist manually drew regions of interest to determine maximum caudate (MC) and maximum putamen (MP) counts, without knowledge of other clinical or quantitative results. The diagnosis of the patient’s official report was set as the reference standard. ROC analysis determined optimal discrimination thresholds and kappa statistics evaluated strength of agreement.

RESULTS
Twenty-seven pts had Parkinsonism and 23 had ET. Highest agreement with final diagnoses was found for MP (AUC 0.72), followed by DC, MC, AC, AP and DP (AUC 0.67, 0.64, 0.64, 0.63 and 0.41, respectively). MP also had highest accuracy (86%), with sensitivity of 78% and specificity of 96%. Pixel averaging and statistical noise of background counts were likely reasons that automated output from BASGAN software underperformed manual determinations of maximal counts.

CONCLUSION
We conclude that, in the analysis of presynaptic dopamine transporter SPECT scans, a straightforward detection of abnormally suppressed putamen counts is the single quantitative measure that agrees most strongly with a diagnosis of Parkinsonism.
In these patients, the time required to reach 95% of the final volume of distribution ranged from 0.79 to 11.08 days, which is calculated.

Following a single intravenous injection, the plasma concentration of a radioactively labeled glomerular filtration marker, was obtained. Plasma clearance and the time required to reach 95% of the final GFR marker volume of distribution were 51.

K-edge imaging to detect targeting Gold-Nano-Particles with Computed Tomography is feasible. The specific Gold-images can be used for a fast assessment of the distribution of the particles and therefore the density of the bindings sites for the molecule.

K-edge imaging with Spectral CT can be used to track Nano-particles with high Z cores like Gold that could be designed to specifically display e.g. tumors or cardiac scars.

The highest signal to noise and Gold to anatomical background ratios were achieved at 10 min after the injection of the Lisinopril-Gold-Nano-particles. The highest signal was measured in the heart muscles and the lung parenchyma. The anatomical background was completely eliminated in the k-edge images of the Gold. The signal to noise ratio in these images was >5:1. An overly of the anatomical images and the Gold images better demonstrated the distribution of the Gold particles. There were no gold signals detectable in mice that were pre-treated with Lisinopril prior to the conjugate injection.

In this current study we found that with prolongation of isoproterenol (ISO) stimulation in vitro and in vivo, the expression level of miRNA-22 was up-regulated by ISO stimulation. However, the firefly luciferase (Fluc) activity of CMV/Fluc, as a positive control, was not affected with ISO treatment. Furthermore, knockdown of miR-22 by antagomir-22 could reverse the repressed Gluc activities in vitro and in vivo.

The development of imaging strategies related to miRNAs will be critical to advance our understanding of the interactions of miRNAs with their target genes and signaling pathways, and eventually to evaluate the use of miRNAs as a novel class of diagnostics and therapeutic targets in cardiovascular disease.
SSK21-07 • Prognostic Value of Metabolic Tumor Volume Measured by Differing Methods on Staging 18F-fluorodeoxyglucose Positron Emission Tomography in Esophageal Cancer

Vinod Malik MBCh, MA (Presenter); Ciaran J Johnston MD; Julie A Lucey PhD; John V Reynolds MD

PURPOSE

Metabolic tumor volume (MTV) is a volumetric parameter obtained on 18F-fluorodeoxyglucose positron emission tomography/computed tomography (18F-FDG PET/CT) which has been shown to be an independent prognostic factor for survival in patients with esophageal cancer. This study ascertained if different methods of calculating MTV would have an effect on its utility as a prognostic factor.

METHOD AND MATERIALS

From December 2008 to May 2011, 150 patients with biopsy-proven cancer of the esophagus or esophagogastric junction underwent staging 18F-FDG PET/CT. Maximum standardized uptake value (SUVmax) and MTV of the primary tumor was recorded at different thresholds (absolute cut-offs of SUV 2.5 and 3.5, threshold values of 42% and 50% SUV max and a variable method depending on the SUV max of the primary tumor). Survival analysis was performed using Kaplan-Meier and independent prognostic factors determined using Cox regression multivariate analysis.

RESULTS

18F-FDG PET/CT SUVmax < 4.1 (p = 0.0014), 18F-FDG PET/CT MTV (absolute cut-off SUV 2.5 method) < 14.5 cm^3 (p = 0.001), 18F-FDG PET/CT MTV (absolute cut-off SUV 3.5 method) < 7.5 cm^3 (p = 0.0013), 18F-FDG PET/CT MTV (threshold value of 42% method) < 5.9 cm^3 (p = 0.0005), 18F-FDG PET/CT MTV (threshold value of 50% method) < 4.4 cm^3 (p = 0.0004), 18F-FDG PET/CT MTV (variable method) < 4.7 cm^3 (p = 0.0008) were all significantly associated with outcome on analysis.

CONCLUSION

Regardless of the method used to measure MTV, it consistently was able to predict survival even when simple quantitative analysis only is performed.

CLINICAL RELEVANCE/APPLICATION

MTV is a valuable prognostic factor in patients with esophageal cancer even when performed with simple quantitative analysis which is available on all clinical scanners.

SSK21-08 • Determining the Minimal Required Radioactivity of F-18 FDG for Reliable Semi-quantification in PET-CT Imaging: A Phantom Study

Ming-Kai Chen MD, PhD (Presenter); David H Menard; David W Cheng MD, PhD *

PURPOSE

The aim is to investigate minimal required radioactivity of F-18 FDG and corresponding imaging time for reliable semi-quantification in PET-CT imaging in an effort for dose reduction.

METHOD AND MATERIALS

We performed F-18 FDG PET-CT study using an ECT phantom containing various spheres (diameter: 3.4, 2.1, 1.5, 1.2, 1.0 cm) filled with a fixed concentration of 165 kBq/ml and background 23.3 kBq/ml (total 156.8 MBq) at multiple time points up to 20 hrs of radioisotope decay. The images were acquired for 10 min/bed at each time point using 3-D mode in a hybrid GE Discovery 690 scanner equipped with LYSO detectors and a 64-slice CT. The images were reconstructed in 1, 2, 3, 4, 5, and 10 min per bed using ordered-subset expectation maximum (OSEM) algorithm with 24 subsets and 2 iterations. The standardized uptake values (SUV) of the spheres with both maximal and average were measured by applying volume of interests (VOI) in serial PET images. The minimal required activity concentrations at various acquisition time were determined as well as the minimal product of activity concentration and acquisition time.

RESULTS

The minimal required activity concentration for precise SUVmax quantification in spheres (threshold value of 50% method) < 4.4 cm^3 (p = 0.0004), 18F-FDG PET/CT MTV (threshold value of 50% method) < 4.4 cm^3 (p = 0.0004), 18F-FDG PET/CT MTV (variable method) < 4.7 cm^3 (p = 0.0008) were all significantly associated with outcome on analysis.

CONCLUSION

Regardless of the method used to measure MTV, it consistently was able to predict survival even when simple quantitative analysis only is performed.

CLINICAL RELEVANCE/APPLICATION

MTV is a valuable prognostic factor in patients with esophageal cancer even when performed with simple quantitative analysis which is available on all clinical scanners.

SSK21-09 • Detecting Osteoporosis Using Photoacoustic Spectroscopy

Behnoosh Tavakoli (Presenter); Xiaoyu Guo; Shadpour Demehri MD; Abdullah Muhit PhD; John A Carrino MD, MPH *; Emad Doctor PhD, MSc *

CONCLUSION

Photoacoustic spectroscopy is technically for detecting the osteoporosis at no radiation cost. This method may be sensitive to the micro structural changes in the bone. In addition with multi spectral imaging, it is possible to analyze different components of the bone tissue such as calcium by decomposing the photoacoustic spectrum to the standard tissue absorbers optical spectrums.

Background

Osteoporosis, is the most common metabolic bone disorder. Monitoring the micro architectural deterioration of the bone tissue and the decrease of the bone mineral density are necessary for early detection the osteoporosis. Broadband attenuation of ultrasound signal is correlated with bone mineral density and its microstructure. In addition, the optical absorption spectrum of the bone tissue analyzes its mineral, water, lipid and oxy-deoxy hemoglobin content. Therefore photoacoustic spectroscopy as a hybrid functional method that combines both optical and ultrasound information is a promising technique for determination of osteoporosis in early stages.

Evaluation

In this study, the quantitative ultrasound calcaneal phantoms of normal and osteoporotic bone were imaged in the transmission mode and the corresponding photoacoustic spectra were obtained. Our photoacoustic imaging system includes a tunable Q-switch Nd:YAG laser followed by an OPO system generating pulses at the wavelength range of 690 nm-950 nm. The photoacoustic signal is detected with the FDA approved Sonix RP ultrasound system including a data acquisition device for recording the raw data. Multiple points of each phantom were evaluated using a linear US probe with 128 elements. Finally the maximum raw data was extracted from the elements and the value was normalized to the illuminating laser energy.

Discussion

The result revealed a general decrease in the spectrum of the osteoporotic phantom compared to the normal one. The trend matches the optical spectrum of the calcaneus bone tissue. In this test, there was about two times contrast between the normal and osteoporotic case. These phantoms were modeling the bone microstructure and more contrast is expected in the real bone tissue including other tissue absorbers.
Early Outcomes with the Use of Intensity Modulated Radiation Therapy with Simultaneous Integrated Boost as a Part of Neoadjuvant Therapy with Concurrent Chemotherapy for Advanced Stage Rectal Cancers

Shilpa Vyas MD (Presenter); Nitika Thawani MD; Dharanipathy Rangarajan MD; Niloyjyoti Deb MD; Subhakar Mutyala MD

ABSTRACT

Title: Intensity Modulated Radiation Therapy decreases acute toxicity of neoadjuvant pelvic radiation with concurrent 5-Fluorouracil based chemotherapy for rectal cancer compared to Three Dimensional Conformal Radiation Therapies. Objective: To compare the acute toxicity of neoadjuvant pelvic radiation with 5-FU based chemotherapy with IMRT. We compared twenty-two (22) patients treated on an institutional IMRT protocol versus twenty-eight (28) patients treated with 3DCRT. All patients received 45-50.4 Gy to the pelvis in 3DCRT group. All patients with IMRT received 45 Gy in 25 fractions to the pelvic nodes and primary rectal tumor along with a simultaneous integrated boost to a dose of 50 Gy in 25 fractions to areas of gross disease. IMRT planning was done with dose constraints for bladder, rectum, and small bowel and bone marrow. All patients in both groups received 5-FU based chemotherapy during radiation. Evaluation of toxicity was based on RTOG criteria. Two patients in the 3DCRT group and two in IMRT group received either growth factors or blood-products transfusion and needed hospitalization during treatment secondary to acute toxicities. Results: All patients completed their prescribed course of radiation. Complete response rates were 5/21(23%) in 3DCRT and 4/21(19%) in the IMRT-SIB group (p-value 0.74). 9/21(42%) and 15/22(71%) in the IMRT group underwent Low anterior resection according to the location of the tumor. There was no grade 4 toxicity in the IMRT-SIB group. Overall grade 2 toxicity in 3D Vs IMRT-SIB group was - GI -52% Vs 19%, GU -8% Vs 8%, skin 42 Vs 4%, hematologic 33 Vs 47%. Overall Grade 1 toxicity in 3DCRT Vs IMRT group was- GI -33% Vs 52%, GU 23% vs 28%, Skin 52% Vs 38%, hematologic 4% Vs 33%. Table: Total Incidence of toxicity

<table>
<thead>
<tr>
<th>Grade</th>
<th>3D</th>
<th>IMRT</th>
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<tbody>
<tr>
<td>1</td>
<td>1(4%)</td>
<td>7(33%)</td>
</tr>
<tr>
<td>2</td>
<td>21(66%)</td>
<td>10(47%)</td>
</tr>
<tr>
<td>3</td>
<td>3(14%)</td>
<td>3(14%)</td>
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<td>4</td>
<td>4(9.5%)</td>
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Conclusions: Neoadjuvant pelvic radiation with concurrent 5 FU for rectal cancer has less GI, skin and hematologic toxicity when delivered via IMRT-SIB versus 3DCRT with comparable complete response rates. Long-term follow up is needed to assess for chronic toxicity and disease outcomes.
Twelve consecutive patients with biopsy-proven rectal cancers who were treated with neo-adjuvant chemoradiation were identified who underwent PET/CT imaging in treatment planning position. CT simulation was performed with double contrast barium enema. GTV was delineated on simulation CT by 1) double contrast enema, 2) FDG activity on pretreatment PET/CT, and 3) CT portion of the PET/CT. CTVs were generated to account for microscopic disease. CTVs generated using double contrast enema and CT/ PET were generated by PET using correlation coefficients. We also compared the percent non-overlap between the CTV generated by PET and double contrast enema.

Results:
The mean and median GTV volumes based on PET were 21.9 and 20.1 cc respectively (range 4.27 - 57 cc). The mean and median GTV volumes based on double contrast enema were 47.5 and 49.1 cc respectively (range 5.7 - 85.2 cc). The mean and median GTV volumes based on CT/PET were 39.1 and 38.8 cc respectively (range 5 - 96 cc). The correlation coefficient between PET GTV and double contrast enema GTV was 0.74 and between PET GTV and CT/PET GTV was 0.85 suggesting strong correlation for both. The mean and median non-overlap volume between CTVs generated from PET and double contrast enema was 36% and 34% respectively (range 27% - 64.8%).

Conclusion:
In our pilot study we found that there was a good correlation between the GTVs generated both from PET and double contrast enema and also between PET and CT/PET. We also noticed that the CTV generated with double contrast enema accounted for intratumoral activity with a potential of missing tissue not used. Limitations include inability to assess nodal volume. Double contrast enema is low cost technique with several advantages.

SSK22-07 • The Use of a Neoadjuvant Hypofractionated Chemoradiation Approach for Unresectable Pancreatic Adenocarcinoma

Roberto Sabater (Presenter) ; Chance Matthiesen ; Salahuddin Ahmad PhD ; Terence Herman

ABSTRACT

Objective: Initial surgical resection is the most curative therapy approach for pancreatic cancer. Many patients are not resectable due to locally advanced tumor. For such patients, the optimal approach is unclear. Chemotherapy with and without standard fractionation radiation has been studied in multiple trials with conflicting results, and continues to be the subject of ongoing trials. We report on our institutional experience utilizing a neoadjuvant hypofractionated chemoradiation approach for inoperable pancreatic adenocarcinoma.

Methods: A retrospective review was performed identifying eleven patients diagnosed with adenocarcinoma of the pancreas and treated with RT from 2009-2012. Median age for the group was 65 years (range 50-80 years). Patients were deemed unresectable via MRI CT criteria (80% of patients) or newly diagnosed with adenocarcinoma of the pancreatic head (8, 72.7%), body (2, 18.2%), or multicentric (1, 9.1%). Disease TNM staging included T4N0M0 (5, 45.5%), T2N0M0 (2, 18.2%), T3N1M0 (2, 18.2%), T3N0M0 (1, 9.1%), and T4N0M0 (1, 9.1%). Pretreatment PET/CT was performed in seven (63.6%) patients, with a median tumor SUV of 9.55 (range 3.8-13.7). Median pretreatment CA 19-9 was 428.7 (range 31.3-2526.1) in nine patients. Ten patients received induction chemotherapy with FOLFIRINOX (10, 90.9%) or Gemcitabine/Capecitabine (1, 9%). All patients received concurrent Capetitbine (5, 45.5%), Gemcitabine (1, 9%), or 5-FU (5, 45.5%) with radiation. Radiation therapy consisted of median treatment dose of 49.5 Gy in 18 fractions via IMRT (range 49.5 - 60 Gy in 18-30 fractions). Goals of neoadjuvant therapy in all patients were to achieve an R0 resection following therapy completion.

Results: Four patients completed RT without complications or treatment interruption. Median follow up after RT was 6 months (range 0-21). Eight (72.7%) patients had post-RT PET/CT. Results showed four lesions with a complete resolution of hypermetabolic activity, and four lesions decreased to a median SUV of 4.4 (range 2.7-5.4). Median post-RT CA 19-9 nadir was 51 (range 0-2393.1). Five patients (45.5%) proceeded to surgical resection. All achieved a R0 resection. Pathologic staging was ypT3N1 (1, 20%), ypT0N0 (minimal residual disease) (1, 20%), and ypT3N0M1 (1, 20%). One (20%) patient died of surgical complications; the other four (80%) remain disease free. Six patients (54.5%) remained inoperable at completion radiotherapy. At the time of review, seven (63.6%) patients remain alive, three (27.3%) are deceased, and one (9.1%) was lost to follow up.

Conclusion: Hypofractionated chemoradiation is a well-tolerated treatment approach for unresectable pancreatic cancer. This approach can achieve resectability in some patients. Further investigation is warranted.

SSK22-08 • Adjuvant Chemoradiotherapy for Resected Hepatocellular Carcinoma

Ato O Wright MD (Presenter)

ABSTRACT

PurPOSE: Curative surgical approaches for hepatocellular carcinoma (HCC) include partial hepatectomy (PH) and liver transplantation. In other malignancy subsites, data demonstrate a benefit of adjuvant therapy for close or positive margins and/or positive lymph nodes. It may be reasonable to extrapolate these oncologic principles to the management of HCC. The purpose of this study is to evaluate the outcomes and toxicity in patients with HCC treated with PH followed by adjuvant radiation therapy (RT). To our knowledge, this is the first study to evaluate the role of RT in HCC.

METHOD: This study includes patients who underwent PH and adjuvant RT at our institution between 2001 and 2012 for HCC. Patients with distant metastatic disease were excluded.

RESULTS: Six patients were identified who met inclusion criteria. All patients were locally advanced, with stage III-IVa disease, based on AJCC 7th edition. Preoperative Childs-Pugh grade was class A for five patients and class B for one patient. Preoperative alpha fetoprotein (AFP) level was less than 200ng/mL for 5 patients and unknown for one patient. The median AFP level for the 5 patients was 3.5ng/mL. The resection margins ranged from 0 mm to 8 mm, with a median margin of 4 mm. Tumors from 4 patients demonstrated vascular invasion, one was negative for vascular invasion and unknown for one. Five of 6 patients had lymph node sampling, with 3 having involved nodes. The median radiographic dose was 45 Gy in 1.8 Gy fractions. Five patients received concurrent Capetitbine and one patient received concurrent infusional 5-fluorouracil. After a median follow up of 62 months (range 12-75 months), the overall survival rate is 83% (5 of 6 patients alive). The overall local and distant recurrence rates were 17% (1 of 6 patients) and 17% (1 of 6 patients), respectively. One patient had progression of disease within the liver and one patient developed distant metastatic disease. Two patients were diagnosed with grade 1 liver toxicity and 2 patients experienced grade 1 liver toxicity. One patient experienced grade 3 fatigue. There were no late grade 3/4 toxicities. One patient developed worsening liver dysfunction from Childs-Pugh A to B, 1 patient from B to A and the rest were unchanged.

DISCUSSION: The safety and efficacy of PH have greatly improved over the last two decades, largely due to advances in radiologic assessment, patient selection and perioperative care. In our retrospective study, we have demonstrated that adjuvant radiation therapy for patients undergoing PH for locally advanced HCC is safe and may potentially improve outcomes. Randomized studies are required to validate these findings.
Between 1992 and 2011, temporary and long-term CVA placement procedures increased from 638,703 to 808,071 (+27%) and 76,444 to 316,042 (+313%), respectively. For temporary CVCs, radiology (0.4% in 1992 to 32.6% in 2011) now exceeds anesthesiology (37.0% to 22.0%) and surgery (30.4% to 11.7%) as the dominant provider group. Surgery continues to dominate in placement and explantation of long-term CVADs (80.7% to 50.4% and 81.6% to 47.7%, respectively), but radiology’s share has grown enormously (0.7% to 37.6% and 0.2% to 28.6%). Although volumes remain small (CONCLUSION
Over the last two decades, CVA procedures on Medicare beneficiaries have increased considerably. Radiology is now the dominant overall provider.

CLINICAL RELEVANCE/APPLICATION
As venous access procedures have increased dramatically in Medicare beneficiaries over the last two decades, radiology’s relative contributions to these important services has expanded dramatically

SSK23-02 • Mechanical Failure with a Radiologically Placed Totally implantable Central Venous Arm Port System

Jasmin D Busch MD (Presenter); Catherine T Mahler; Christian R Habermann MD; Andreas Koops MD; Gerhard B Adam MD; Harald Ittrich MD

PURPOSE
To evaluate the frequency of mechanical failures, in particular catheter line rupture and fragment embolization, related to a radiographically controlled and brachially placed totally implantable central venous arm port system (TCVAP) used for mid- to long-term vascular access.

METHOD AND MATERIALS
A retrospective audit of our Centricity Radiology Information System (GE Healthcare, Braunschweig, Germany) was performed from 2006 until April 2013 to determine the number of Cook Vital-Port Mini Titanium (Cook Medical Inc., Limerick/Ireland) implanted between January 1, 2006, and June 30, 2011 and the frequency of device-related complications (mechanical failure, rupture and fragment embolization) until demise or explantation.

RESULTS
CONCLUSION
With the Cook Vital-Port Mini Titanium implanted at the upper arm we observed in 2.3% a partially or complete catheter line fracture associated with a high incidence of fragment embolization. The high rate of clinically unapparent catheter line fractures demands special attention of TCVAP users to recognize malfunctions. Despite from the risk of extravasation in patients under chemotherapy, in particular, fragment embolization puts the patients at risk for further severe complications.

CLINICAL RELEVANCE/APPLICATION
TCVAP are a proper tool for vascular access. However, due to the accumulation of material failure further investigation are warranted to determine the cause of material failure.

SSK23-03 • Characteristics of an Infectious Complication on Implantable Venous-access Port

Jisue Shim; Tae Seok Seo MD, PhD; In-Ho Cha MD, PhD; Myung Gyu Song MD (Presenter); Eun-Young Kang MD; Hwan Seok Yong MD; Chang Hee Lee MD

PURPOSE
The purpose of this study is to assess the demographic and bacteriologic characteristics and risk factors of implantable venous-access port (IVAP)-associated infection.

METHOD AND MATERIALS
Between August 2003 and November 2011, we placed 1,747 ports in interventional radiology suites. A total of 144 and 1,603 ports were placed in patients with hematologic malignancy and with solid tumor, respectively. We removed 45 ports to treat port-related infection, from 37 patients with systemic febrile symptom and 8 patients with signs of local infection. We evaluated the incidence of port-related infection, demographic factors, bacteriologic data, and patients’ progress by review of medical record. Univariate analyses (chi-square test and Fisher’s exact test) and multivariate logistic regression analyses were used to determine the risk factors for complications.

RESULTS
Overall, 45 (2.58%) out of 1,747 ports were removed for infectious symptom, with an incidence rate of 0.075 events/1,000 catheter-days. The incidence rate of port-related infection was higher in hematologic disease patient than in solid organ tumor patient (p=0.03). The infection rate was higher in inpatients intervention than outpatients (p=0.02). Hematologic malignancy was the only significant risk factor of IVAP-related infection (OR 0.304, 95% confidence interval 0.144-0.643, p=0.002). Microorganisms were isolated from 30 (66.7%) blood samples. Causative organisms were Staphylococcus species (n=13), Candida species (n=9), Non-tuberculosis Mycobacterium (n=2), Escherichia coli (n=1), Acinetobacter baumannii (n=2), Klebsiella pneumonia (n=2), Rhodotorula mucilaginosa (n=1) and Enterococcus faecium (n=1). Additionally, catheter tip culture studies were positive in nine cases and isolated microorganisms were same as blood culture studies. Wound culture in localized infection revealed no organisms in all cases.

CONCLUSION
The incidence of IVAP-related infection was significantly higher in hematologic malignancy patient and when intervention was done after admission. The common causative organisms were Staphylococcus and Candida species. The explantation of devices seems to be helpful for treatment of local and systemic infection suspiciously related with IVAPs.

CLINICAL RELEVANCE/APPLICATION
The knowledge of the characteristics of IVAP-related infection may be helpful to manage infected port.

SSK23-04 • Patients’ Perceptions of Peripherally Inserted Central Catheter for Cancer Treatment: A Comparative Single-institution Prospective Analytic

Francois-Xavier Arnaud MD (Presenter); Christophe Teritehau; Gabrielle Weber-Donat; Denis Metivier; Caroline Bouzad; Julien Potet MD *

PURPOSE
To prospectively assess the perceptions of cancer patients of having a PICC and to compare these perceptions with those of non-cancer patients.

METHOD AND MATERIALS
Patients’ perceptions were registered on three occasions (T1, right after PICC placement; T2: 1 week after placement and T3: three weeks after placement), with the use of two specific questionnaires. Questionnaire I contained 17 items covering five domains (anxiety, information, pain, procedure duration and discomfort), whereas questionnaire II was made up of 17 items covering 6 domains (anxiety, information, restrictions in daily activities, anxiety, discomfort and overall satisfaction). Results were analyzed considering the cancer group and then compared to the non-cancer group using Pearson chi-squared or Fisher’s exact tests and Student T-tests. Regression tests were performed to study the association between different factors and the procedure-related pain at T1 or the global satisfaction at T2 and T3.
RESULTS
150 PICCs were implanted in 125 consecutive patients (78 patients in the cancer group and 47 in the non-cancer group). Pain level was low (2.5, 95% CI 2.0-2.9) in cancer patients at T1 and decreased at the end of the procedure (0.5, 95% CI 0.2-0.7). 96.2% of cancer patients found that the pain was equal or lower than expected before the procedure. Disturbing factors were venous puncture (24.4% of patients), local anesthesia (23.1%) and lying position on the angiography table (20.5%) in cancer patients. Pain levels at exit-site at T2 and T3 were low but significantly higher in the cancer group than in the non-cancer group (T2: 0.9 vs 0.4, p=0.05 and T3: 0.8 vs 0.2, p=0.01). At T2, global satisfaction was 5.4 times worse in painful patients (p=0.02). Cancer patients stated that the PICC interfered when taking a shower (48.1% of patients at T2), but not for basic activities. They mostly feared that PICC might be a source of infection (46.3% vs 18.2% in non-cancer patients, p=0.008). No factor of disturbance, discomfort or fear was associated with a worse global satisfaction.

CONCLUSION
PICC placement and port during hospitalization were well accepted by cancer patients. Physicians should focus on exit-site pain treatment in cancer patients for a better satisfaction.

CLINICAL RELEVANCE/APPLICATION
PICC placement was well tolerated and PICC device were a well-accepted method of delivering chemotherapy and supportive agents in the daily life of cancer patients.


H. Y. J Leung (Presenter) ; Simon C Yu MD ; Ka Lok Lee MBCHB ; Mabel M Tong MBBCh ; Helen Hoi Lun Chau ; Eva Chun Wai Cheung ; Alyssa Sze Wai Wong ; Anil T Ahuja MD

PURPOSE
To assess the safety and efficacy of ultrasound guided high-intensity focused ultrasound (USgHIFU) treatment of symptomatic uterine fibroids using high sonication energy protocol.

METHOD AND MATERIALS
This was a prospective on going phase one study. Protocol was approved by institutional review board and informed consent were obtained. A total of 20 patients with 22 symptomatic fibroids were included in the study and were treated with US-guided HIFU ablation. The fibroids were ablated using dot mode under power output of 800 -1500W for 1500 - 2000 sonication pulses at each spot. The primary endpoints were peri-procedural complications. The secondary endpoints were clinical symptomatic improvement and radiological evidence of treatment response including degree of fibroid infarction and volume shrinkage at 3 months after treatment. The symptoms studied include pain, menorrhagia, and fibroid related urinary symptoms and these were assessed by patient global chart score, Urogenital Distress Inventory (UDI-6) and Incontinence Impact Questionnaire (IIQ-7). The degree of fibroid infarction was assessed by dynamic contrast 3T MRI and was reflected by non-perfused ratio (NPR) calculated as non-perfused volume as a percentage of the total fibroid volume.

RESULTS
Nineteen patients tolerated the treatment well and were treated on an outpatient basis. One patient who received treatment for a fibroid located peritoneum was hospitalized for 2 days. There were no major complications and none of the patients found the procedure to be more painful than expected.

CONCLUSION
USgHIFU may be safe and effective in treating symptomatic uterine fibroids in carefully selected patient group. Uterine fibroids which are located in the pelvis and close to the uterine wall can be treated effectively using USgHIFU.

CLINICAL RELEVANCE/APPLICATION
USgHIFU ablation using high sonication energy protocol may be safe and effective in treating symptomatic uterine fibroids in carefully selected patient group.

SSK23-06  Non-invasive In Vivo Estimation of Uterine Fibroid Thermal Conductivity in Magnetic Resonance Imaging Guided High Intensity Focused Ultrasound (MR-HIFU) Therapy

Jiming Zhang * ; John H Fischer MD ; Pei-Herng Hor PhD ; Raja Muthupillai PhD (Presenter) *

PURPOSE
To estimate in vivo thermal conductivity of uterine fibroid tissue from the spatio-temporal evolution of temperature during MR guided focused ultrasound surgery (MR-HIFU) in women.

METHOD AND MATERIALS
All MR-HIFU was performed at 1.5 T using a commercial MR-HIFU platform (Sonalleve™, Philips Healthcare) with a 256Ch spherical shell HIFU transducer (1.2-1.4 MHz), and an integrated receiver coil. The temperature evolution after 13 volumetric sonications in three women was recorded in real-time using a multi-shot echo planar imaging technique described previously. Subjects provided written informed consent as per IRB guidelines.

Estimation of thermal conductivity: Thermal conductivity is calculated based on Penne’s bio-heat transfer equation. The spatio-temporal temperature evolution following heating is modeled by a Gaussian distribution. From the recorded spatio-temporal temperature profiles, the thermal conductivity (k) was estimated to be 0.5 ± 0.06 W/(m.K).

RESULTS
A total of 13 cells with diameters of 4mm (n=3), 8mm (n=7), and 12mm (n=3) were used to treat uterine fibroids. The mean temperature elevated from 37ºC to 64.8 ± 1.4ºC, resulting in an average 240 EM dose volume of 1.8 ±1.3 cm³ across cells. From the recorded spatial-temporal temperature profiles, the thermal conductivity (k) was estimated to be 0.5 ± 0.06 W/(m.K).

CONCLUSION
These results from our study show that it is possible to estimate thermal conductivity of human uterine fibroid tissue in vivo from spatio-temporal evolution of temperature during volumetric MR-HIFU. In-vivo uterine fibroid thermal conductivities across different cell sizes were within 13% of the mean, indicating close agreement, and is roughly similar to reported thermal conductivities of skeletal muscle. 1. Kohler, et al. Med. Phys., 36(8), 3521-35, 2009 2. Zhang, et al. JMRI, 37(4), 950-7, 2012

CLINICAL RELEVANCE/APPLICATION
1. Effectivness of tissue ablation during MR-HIFU in vivo is influenced by tissue thermal properties such as thermal conductivity which can be estimated from spatio-temporal evolution of temperature.

SSK23-07  MRgFUS Treatment of Uterine Fibroids: Evaluation of Fibroid Volume, Perfused Volume (PV) and Clinical Scores Modifications at 6-month and 12-month Follow Up

Marta Vaiani MD (Presenter) ; Irene Invernizzi MD ; Paola Enrica Colombo ; Fabio Zucconi MPH ; Angelo Vanzulli MD ; Cristina Ticca MD

PURPOSE
To assess the correlation between fibroid volume, perfused volume (PV) and clinical scores modifications at 6-month (6-m) and 12-month (12-m) follow up evaluation, in 28 patients with 32 fibroids treated with Magnetic Resonance guided Focused Ultrasound Surgery (MRgFUS).

METHOD AND MATERIALS
32 symptomatic uterine fibroids in 28 women (age 35-54 y-o) underwent MRgFUS treatment between September 2010 and January
Incidence and Prognostic Factor for Stent Migration after Retrievable Expandable Metallic Stent Placement: Experience in 444 Patients with Esophageal Stricture

Soo Hwan Kim
Jung-Hoon Park

PURPOSE
To evaluate the incidence, prognostic factor, and interventional management of stent migration after placement of retrievable expandable metallic stents in patients with esophageal strictures.

METHOD AND MATERIALS
Quantitative and qualitative relations between fibroid volumes, PV and clinical scores modification at baseline, 6-m and 12-m were measured (analysis of variance, Spearman correlation).

RESULTS
Fibroid volume significantly decreased from 140±126cm³ to 102±107cm³ (6-m) and 100±103cm³ (12-m) (p) The average post-treatment PV ratio (p-tPV ratio, considered as post-treatment PV divided by initial volume) was 29±17% and PV significantly increased between baseline and 12-m from 44±56cm³ to 74±88cm³ (p)

CONCLUSION
MRgFUS treatment of uterine fibroids determines significant fibroid shrinkage and clinical improvement already after 6-m, and results are still important even after 12-m. The significant PV increase between post-treatment and 12-m is not correlated with p-tPV ratio and does not affect the clinical improvement of patients.

CLINICAL RELEVANCE/APPLICATION
MRgFUS is a non-invasive, safe and effective treatment for uterine fibroids; the PV significant increase between post-treatment and 12-m does not affect the important clinical improvement of patients.

SSK23-08  The Apparent Diffusion Coefficient (ADC) Value of the Uterine Adenomyosis for the Prediction of the Potential Response to Uterine Artery Embolization (UAE)

Yaewon Park  (Presenter)  ;  Dae Chul Jung  ;  Man Deuk Kim  MD

PURPOSE
To determine the utility of the apparent diffusion coefficient (ADC) value for the prediction of the potential response to uterine artery embolization (UAE) for symptomatic adenomyosis.

METHOD AND MATERIALS
Our study included twenty-three patients who underwent diffusion weighted (DW) MRI before UAE between June 2011 and November 2012. All patients underwent 3 months follow-up MRI after UAE. The embolic agent used was polyvinyl alcohol (PVA) particle. A quantitative measurement of the ADC was performed for each adenomyosis. Complete response was defined as more than 90% of non-perfusion area of adenomyosis following UAE at 3 months follow-up MRI. Incomplete response was defined as less than 90% of non-perfusion area at follow-up MRI. ADC value was compared between patients that achieved complete response and incomplete response after UAE via analysis. Statistical analysis was performed to evaluate the diagnostic performance of the predictor for differentiated the complete from the incomplete response.

RESULTS
Of the twenty-three patients, seventeen showed complete response and six showed incomplete response. The ADC ranged from 0.8413 ± 1.2440 x 10 -3mm²/s(mean 1.0745 ± 0.1122). The mean ADC of the complete response group was 1.0449 ± 0.1063 and 1.1585 ± 0.0881 in the incomplete response group (p value = 0.029). Using a threshold of lesser than 1.1475 x 10 -3mm², the sensitivity and specificity of the ADC for the prediction of success after UAE were 83.3% and 82.4%, respectively.

CONCLUSION
The ADC of uterine adenomyosis can be utilized as a predictor for successful response of UAE in adenomyosis.

CLINICAL RELEVANCE/APPLICATION
The ADC of uterine adenomyosis is a potential predictor for complete response of UAE in symptomatic adenomyosis.

SSK23-09  Embolization of Symptomatic Post-abortition Uterine Arteriovenous Malformations

Helene Vernhet-Kovacsik  MD, PhD  ;  Valerie Monnin-Bares  ;  Hamid Zarqane  (Presenter)  ;  Sebastien Bommart  MD

PURPOSE
To assess immediate and mid-term clinical outcome of hyperselective embolization of symptomatic post-abortition uterine arterio-venous malformations (AVM).

METHOD AND MATERIALS
Since January 2009, 13 consecutive women with acquired symptomatic (bleeding) intra-uterine post-abortion arteriovenous malformation were referred in our institution. Women with AV malformation persisting 10 weeks after abortion, as demonstrated by my MR angiography and/or US doppler were referred for embolization. MRI was performed before and after embolization (1 month). Technical success, immediate and mid-term (6-36 months) clinical outcome (recurrent bleeding, myometral necrosis or infection) and imaging follow-up (myometral thickness and enhancement after injection of gadolinium, presence of residual AVM) were recorded.

RESULTS
At 10 weeks after abortion, 11/13 women had persistent AV malformation. Hyper-selective embolization using Onyx (n=9), particles (n=2) was performed during 1 (n=6), 2 (n=2) up to 3 (n=3) sessions. Complete technical success was reached in 9/11 cases. The MAV could not be completely occluded in 2 case (arterial ovarian supply, uterine supply). Bleeding was stopped in all cases and recurrent spotting at 3 months was noted in 2 cases (cases with technical failure). No uterine necrosis nor infection was present at -mid-term follow-up. At MRI, a persistent active AVM was present in 2 cases, myometral thickness was decreased at the site of the embolized AVM in 2 cases and normal enhancement of the entire uterine wall was present in 10/11 cases.

CONCLUSION
Hyperselective embolization of post-abortion uterine AVM is safe and immediately efficient but clinical mid-term outcome closely depends on technical success of embolization.

CLINICAL RELEVANCE/APPLICATION
Hyperselective embolization of post-abortion uterine AVM is safe and efficient when complete.
METHOD AND MATERIALS
Retrievable expandable metallic stents were placed under fluoroscopic guidance in 444 patients with symptomatic esophageal stricture. We retrospectively reviewed collected patient records to evaluate the incidence and interventional management of stent migration. Multivariate analysis was performed to evaluate prognostic factors of stent migration. Stent migrations were classified into four patterns on the basis of the location of migrated stent.

RESULTS
Stent migration occurred in 50 (11.3%) of 444 patients 1–228 days (mean, 42 days) after stent placement. Multivariate analysis revealed that young patients (odds ratio [OR], 1.026; P = 0.036), grade 2: able to tolerate soft food without vomiting before the procedure (OR, 5.989; P < 0.001), and benign stricture (OR, 3.044; P = 0.017) were independent prognostic factors of stent migration. 39 (78%) of 50 patients with stent migration were required second interventional management. The remaining 11 patients showed improvement of the strictures until the end of the follow-up.

CONCLUSION
The overall incidence of stent migration was 11.3%. Stent migration occurs most commonly in young age, capability to tolerate soft food without vomiting before the procedure, and in patients with benign stricture. Stent migration can be successfully managed by additional intervention.

CLINICAL RELEVANCE/APPLICATION
Patients with capability to tolerate soft food without vomiting before the procedure were considered contra-indication for esophageal stent placement.

SSK24-02 • Metallic Stent Placement in Patients with Recurrent Malignant Obstruction in Surgically Altered Stomach

Soo Hwan Kim (Presenter) ; Ho-Young Song MD ; Jin Hyoung Kim MD ; Jung-Hoon Park RT ; Young Chul Cho BS ; Ki Back Lee

PURPOSE
To assess the technical feasibility and clinical effectiveness of expandable metallic stent placement in 196 patients for recurrent malignant obstruction in surgically altered stomach.

METHOD AND MATERIALS
The 196 patients were treated with five different types of gastric surgery for gastric cancer: total gastrectomy (type 1) in 72 patients, distal gastrectomy with gastroduodenectomy (type 2), in 39 patients, distal gastrectomy with a Roux-en-Y gastrojejunostomy (type 3) in 21 patients, distal gastrectomy with a gastrojejunostomy (ie, Billroth type II operation) (type 4) in 49 patients, palliative gastrojejunostomy for unresectable gastric cancer (type 5) in 14 patients. Technical and clinical success, complications, and dysphagia score were evaluated and complications compared between fully covered stent and partially covered stent. Overall survival and stent patency rates were calculated according to the Kaplan-Meier method.

RESULTS
Stent placement was technically successful in 192 of 196 patients (97.9%) with 184 of 192 patients (95.8%) showing symptomatic improvement. In four patients, the guide wire could not pass through the stricture. The mean dysphagia score improved from 3.24 ± 0.64 to 1.48 ± 0.82 (P < 0.001). The complication rate was 25%. Incidence of stent migration was significantly greater in fully covered stents than partially covered stents (P < 0.001). The median survival and stent patency were 127 and 41 days, respectively.

CONCLUSION
Placement of expandable metallic stents in patients with recurrent cancer after surgically altered stomach technically feasible and clinically effective.

CLINICAL RELEVANCE/APPLICATION
Accurate knowledge of the type of surgical procedure performed and determination of the pattern of tumor recurrence are important for successful stent placement.

SSK24-03 • The Use of Colorectal Stents to Avoid the Need for a Stoma When Treating Colorectal Cancer

Victoria H Wilkinson MBChB, FRCR ; James N Hampton MBBS ; Rina George MRCS ; Junaid Saeed MBBS, MRCS (Presenter)

PURPOSE
To ascertain the rate of stoma avoidance in patients having a colorectal stent inserted as a bridge to surgical resection of their colorectal cancer.

METHOD AND MATERIALS
The records of patients who had had a colorectal stent for large bowel obstruction between December 2007 and February 2012 in Sheffield Teaching Hospitals were retrospectively analysed.

RESULTS
121 colorectal stents were placed over a 4.5 year period. 19 patients had the procedure as a bridge to surgical resection of their colorectal cancer. 2 patients had a clinically unsuccessful stent and required subsequent Hartmann’s procedures. 11 patients had a primary anastomosis, of whom 2 had a stoma formed subsequently due to complications. Thus 9 of the 19 patients (47%) avoided a stoma at any point.

CONCLUSION
Only a minority of the colorectal stents placed in Sheffield are as a bridge to surgical resection of colorectal cancers with the majority being a palliative procedure. The use of stenting prevents some patients with surgically treatable disease needing a stoma. A significant number however still require stoma formation due to a failed stent or patient or surgical factors which prevent a primary anastomosis.

CLINICAL RELEVANCE/APPLICATION
Colorectal stenting as a bridge to surgical resection of a tumour can be used to avoid the morbidity associated with a stoma.

SSK24-04 • Primary Mushroom-cage Radiologically Inserted Gastrostomy (RIG) without need for Conscious Sedation: 10-year Single Centre, Single Operator Experience in 206 Patients

Stephen Gregory MBBS (Presenter) ; Ounali Jaffer MBBS, FRCR ; Dylan Lewis MBCh, FRCR ; Thoraya Ammar ; Paul S Sidhu MRCP, FRCR *

PURPOSE
To retrospectively review experience in primary insertion of the skin-level mushroom cage gastrostomy tube (Entristar TM, Covidien, MA, USA); under radiological guidance.

METHOD AND MATERIALS
Over a 10-year period (2002 to 2012), patients who underwent a primary RIG procedure by a single operator utilizing 4 gastropexy sutures, under local anaesthetic without conscious sedation were reviewed for procedural complications (minor or major), 30-day mortality and tube longevity. Indications for RIG were noted. Radiological reports, PACS images, biochemical and hematological parameters, clinical notes and discharge summaries were reviewed.
CONCLUSION
Our large number, single centre, single operator experience suggests that primary placement of this durable gastrostomy tube is safe with acceptable complication rates and no procedure related deaths in this cohort of 206 patients.

CLINICAL RELEVANCE/APPLICATION
Primary insertion of gastrostomy tubes of the mushroom-cage type is safe and should be considered in all patients requiring RIG as a means for long term nutrition. Tube longevity is unmatched.

SSK24-05 • Parietal Contrast Enhancement as a Sign of Giant Cell Arteritis and as an Inflammatory Marker

Jose Gutierrez MD; Pedro Arguis MD (Presenter); Marcelo Sanchez MD; Daniel Barnes; Sergio Prieto; Maria C Cid; Ana I Garcia MD

PURPOSE
1. To evaluate the parietal contrast enhancement of the aorta as a sign of Giant Cell Arteritis (GCA), in recently diagnosed patients
2. To determine the relevance of parietal contrast enhancement as an inflammatory marker

METHOD AND MATERIALS
1. CT-angiography (CTA) was performed in 16 newly diagnosed biopsy-proven GCA patients
2. All patients had an evaluable CTA with arterial and venous phases
3. We defined significant enhancement as an increase of 20 UH or more, between the arterial and venous phases
4. 16 patients without evidence of arteritis were used as the control group. They were chosen for having similar clinical characteristics, and an equivalent burden of aortic calcifications, for each patient with GCA
5. A CTA was performed one year later
6. Levels of erythrocyte sedimentation rate (ESR) before the first CTA and a year later were tested

RESULTS
1. All patients (100%) presented high levels of ESR at the moment of diagnosis and normal levels in follow up testing one year later
2. 15 of 16 patients (93.75%) presented enhancement. None of the normal controls showed enhancement
3. 11 of 15 patients (73.3%) presented absence of enhancement in the CTA acquired a year later. 3 of 15 (20%) were classified as non-evaluable (because the arterial wall had less than 2 millimeters), and only 1 (6.66%) of them were enhanced

CONCLUSION
1. Parietal enhancement of the aorta is an excellent sign in non-treated GCA, and could be considered a diagnostic criterion, especially in patients with doubtful parietal thickening
2. Parietal enhancement is useful as an inflammatory marker, as absence of enhancement in most of treated patients on CTA performed one year later (with normal ESR values) was observed, despite the fact that 11 of them still presented parietal thickening

CLINICAL RELEVANCE/APPLICATION
Parietal enhancement could detect inflammation before the systemic markers, distinguish inflammatory thickening from parietal fibrosis, and determine important therapeutic decisions

SSK24-06 • Technical Working Group Postmortem Angiography Methods (TWGPAM): Preliminary Results of a Multicenter Study for Validating Post-mortem Computed Tomography Angiography

Silke Grabherr (Presenter); Jochen M Grimm MD; Axel Heinemann; Giuseppe Guglielmi MD; Krzysztof Wozniak; Franziska Eplinius; Fabrice Dedouit; Florian Fischer MD; Guy N Rutty; Bruno Morgan MD; Holger Wittig; Patrice Mangin MD, PhD; Richard Dirnhofer

PURPOSE
Post-mortem CT-angiography is an exam that aims to increase the sensitivity of post-mortem radiology. However, until today all applied methods have remained research. There is a need to define a standardized method and technical equipment in order to transform postmortem CT-angiography into a routine examination. With this aim, an international working group called TWGPAM (Technical Working Group Postmortem Angiography Methods) has been created in spring 2012. It consists of nine participating centers in six European countries. The goal of this prospective international multi-center study is to validate the technique, define its conditions and evaluate its advantages and limitations.

METHOD AND MATERIALS
In 2013, a study comparing findings of the recently developed Multi-phase Postmortem CT-Angiography (MPMCTA) with conventional autopsy has been published by our research group. Based on results of this study, the multicenter study was initiated. Each center performed MPMCTA on their cases using the standardized study protocol. 500 cases of medico-legal and clinical autopsies will be included. Data collection is performed by a team of one radiologist and two forensic pathologists (one to extract data from autopsy reports and one to review the radiological data with the radiologist). All findings are entered into a common data base for analysis.

RESULTS
Nearly all findings were visualized with both techniques. However, some findings can better or exclusively be visualized with one of them. MPMCTA has a higher sensitivity for identifying skeletal and vascular lesions. However, conventional autopsy gives more information about organ morphology and remains the only way to diagnose a vital vascular occlusion with certitude. Preliminary results of the ongoing study confirm these results.

CONCLUSION
MPMCTA can reveal important findings, not visible at conventional autopsy. However, some diagnoses remain autopsy-diagnoses. The multi-center study confirms these results and will enable the new technique to be accepted in the medico-legal community.

CLINICAL RELEVANCE/APPLICATION
Post-mortem CT angiography is a new technique allowing the diagnosis and visualisation of vascular findings. This study enables the new method to become a routine investigation.

SSK24-07 • Utilization and Results of Adrenal Mass Biopsy in the PET/CT Era: 10-year Retrospective Analysis

Ari C Sacks MD (Presenter); Nisha Sainani MD; Cheryl A Sadow MD; Robert W Gordon MD; Edmund Cibas MD *; Stuart G Silverman MD *

PURPOSE
To evaluate indications for and results of percutaneous image-guided adrenal mass biopsy in the era of FDG-PET/CT.

METHOD AND MATERIALS

RESULTS
Ninety-four percutaneous adrenal mass biopsies were included in 92 patients (53 males, 39 females), average age 66.2 years (range 37-85). When comparing before (n=22) and after (n=72) January 2004, there was statistically significant difference in the number of pre-biopsy PET/CT scans 22.7% (n=5) vs. 65.3% (n=47) (p

CONCLUSION
Increasing use of PET/CT in the workup for malignancies has resulted in increase in number of adrenal mass biopsy being performed
Chemotherapy

SSK24-08 • Adequate Biopsy Sampling in the Molecular Treatment Era: Factors Predicting Successful Cancer Sampling for Genetic Tests

Mikhail Silk BS (Presenter); Jeremy C Durack MD; Natasha Rekhtman; Cyrus Hedvat MD; Joseph P Erinjeri MD, PhD; Stephen B Solomon MD *

PURPOSE
To determine the procedural factors that influence the success rate for biopsies taken for cancer genetic testing.

METHOD AND MATERIALS
We retrospectively reviewed all percutaneous image-guided needle biopsies taken for genetic testing by the interventional radiology department from January 2002 to March 2013 at a single institution. The number of biopsy reports deemed diagnostic by rapid touch preparation cytology and reported as insufficient for genetic testing were reviewed for reason for failure and biopsy type (FNA vs. Core).

RESULTS
The Interventional Radiology Department conducted 2417 biopsies [1536 (64%) core + FNA, 572 (24%) FNA only, 254 (11%) core only, and 55 (2%) unidentified in reports] for genetic testing during the observation period. In this cohort 248 (10%) deemed diagnostic by rapid touch preparation cytologic review at the time of biopsy did not contain sufficient tissue for genetic testing. Of the 248, 166 (67%) by slide review contained too few tumor cells to advance to testing and 82 (33%) were test failures due to inadequate DNA. Of the 166 determined by the pathologist as insufficient to advance for genetic testing, 89 (54%) had a core + FNA sample taken, 56 (34%) were FNA only, 18 (11%) were core only and 3 (2%) were unidentified in reports. Of the 82 failures that advanced to genetic testing 47 (57%) had a core + FNA sample taken, 16 (20%) were FNA only, 11 (13%) were core only, and 8 (10%) were unidentified in reports.

CONCLUSION
Genetic testing is an increasingly important aspect of cancer biopsies. Insufficient DNA quantity or poor DNA quality are relatively common reasons for genetic testing failure. We found that when genetic testing is planned, biopsies without a core component were more likely to be insufficient than those that did. Improved systems for rapid assessment of DNA quantity at the time of biopsies may improve the rate of adequate sampling for genetic testing.

CLINICAL RELEVANCE/APPLICATION
When genetic testing is planned adding a core biopsy has a higher chance of being adequate and reduces the need for repeat sampling due to inadequate tumor tissue.

Breast Imaging (MRI Lesion Characterization) Wednesday, 03:00 PM - 04:00 PM • Arie Crown Theater SSM01 • AMA PRA Category 1 Credit ™:1 • ARRT Category A+ Credit:1 Moderator Christiane K Kuhl, MD * Moderator Janice S Sung, MD

SSM01-01 • Ability of Background Parenchymal Enhancement on Breast MRI to Predict Tumor Response to Neoadjuvant Chemotherapy

Kirti Magudia PhD (Presenter); Janice S Sung MD; Jennifer Brooks PhD; Jennifer B Kaplan MD; Maxine S Jochelson MD; D. David Dershaw MD; Elizabeth A Morris MD

PURPOSE
To evaluate if changes in background parenchymal enhancement (BPE) on breast MRI predict tumor response to neoadjuvant chemotherapy.

METHOD AND MATERIALS
Retrospective, IRB-approved review identified 86 patients with biopsy proven breast cancer that underwent bilateral breast MRI both before and after neoadjuvant chemotherapy between September 2008 and August 2012. Patients with synchronous bilateral cancers or a history of contralateral cancer were excluded. Clinicopathologic data were obtained from the electronic medical record. A breast-imaging radiologist blinded to clinical data rated the BPE level using BI-RADS criteria of the unaffected breast on pre- and post-neoadjuvant chemotherapy breast MRIs. Odds ratios (OR) and 95% confidence intervals (CI) were estimated using multinomial logistic regression adjusting for age, menopausal status and family history of breast/ovarian cancer.
RESULTS
Age at cancer diagnosis ranged from 25-72 years (mean: 46). Tumor size ranged from 1.4-17.0 cm (mean: 6.3). 62 (72%) patients were pre/perimenopausal and 24 (28%) postmenopausal. 36 (42%) tumors were unifocal, and 50 (58%) multifocal/multicentric. There were 26 (42%) ER+, 28 (33%) PR+, and 32 (37%) triple negative (TN) tumors. Results suggest that a decrease in BPE between pre- and post-chemotherapy MRI is associated with a complete imaging response in ER+ (OR 9.1, 95% CI 1.1, 78.3, p=0.04) and PR+ (OR 18.8, CI 1.1,307.7, p=0.04) tumors, though the confidence intervals are wide. BPE reduction was not associated with tumor response with TN or HER 2+ tumors. Changes in BPE were also not associated with clinical stage, MR imaging features, or disease fociety.

CONCLUSION
Tumor response to neoadjuvant chemotherapy may be associated with a decrease in BPE in patients with ER+ tumors but not with other subtypes.

CLINICAL RELEVANCE/APPLICATION
Although larger studies are needed to confirm these results, analysis of BPE change in patients with ER+ tumors undergoing neoadjuvant chemotherapy may be useful to predict tumor response.

SSM01-02 • Does Morphologic and Volumetric MR Tumor Response in Locally Advanced Breast Cancers Correlate with Disease Free Survival?

Chiara Iaconi MD (Presenter); Punam Bajaj MD, MBBS; Elizabeth A Morris MD; D. David Dershaw MD

PURPOSE
To analyze a possible correlation between morphology prior to treatment, RECIST response, volumetric reduction, shrinkage pattern and disease free survival (DFS) in locally advanced breast cancers (LABC).

METHOD AND MATERIALS
This is a retrospective analysis of 52 women (mean age 44 years, range: 31-69 years) with LABC who had breast MR before and after neoadjuvant chemotherapy. Dynamic breast MR was acquired using 1.5 or 3 T scanners with dedicated breast coils. 3D-tumor volume measurements were done with automated segmentation of MR images using Sentinelle Aegis 2.0.1. Morphology of tumor at diagnosis (solitary, grouped in same quadrant, separated in different quadrants, total breast replaced by tumor), response to treatment according to RECIST, volumetric response (complete, partial volume reduction: 65-99%, stable: volume reduction < 64%) as well as shrinkage pattern (no residual enhancement, concentric shrinkage, concentric with surrounding lesions, multinodular lesions, diffuse enhancement of the breast) were evaluated and correlated to DFS defined in months after the end of chemotherapy. DFS was evaluated on mammography and PET-CT or total-body CT. Receptor status was also correlated to DFS.

Pathological response was defined according to pathology report. Mantel-Cox test was used for the statistical analysis.

RESULTS
Agreement in the evaluation of treatment response between diameter at MR and pathology was observed in 38/52 (73%), overestimated in 4/52 (8%) and underestimated in 10/52(19%). Tumor morphology at diagnosis did not significantly correlate to DFS (p=0.33). RECIST versus volumetric response in women with complete, partial or stable disease did not significantly affect the DFS (p=0.6, 0.24 and 0.31 respectively). DFS was independent of shrinkage pattern of tumors (p=0.69). No statistical difference in DFS was found between complete and residual pathologic response (p=0.76). The percentage of volume reduction was higher in triple negative cancers compared to others (p=0.003), but DFS was significantly lower (27 months) than the other group (66 months)( p=0.04).

CONCLUSION
DFS in LABC is not related to pre and post treatment breast MR morphology.

CLINICAL RELEVANCE/APPLICATION
DFS in locally advanced breast cancer is better predicted by tumor receptor status than tumor morphology at MR, both prior to and after treatment.

SSM01-03 • Breast Cancer 21-gene Assay Recurrence Score: Correlation between MR Imaging Phenotype and Genotype

Elizabeth J Sutton MD (Presenter); Kirti Magudia PhD; Anne S Reiner MPH; Monica Morrow MD; D. David Dershaw MD; Elizabeth A Morris MD

PURPOSE
Oncotype Dx breast cancer 21-gene assay recurrence score (RS) is used clinically in early stage estrogen receptor (ER) positive breast cancer to quantify (range 0-100) the likelihood (increased with score) of recurrence and magnitude of chemotherapy benefit. The purpose of this study was to assess ER positive, HER2 negative early breast cancer pre-operative magnetic resonance imaging (MRI) features and their ability to predict the Oncotype Dx RS.

METHOD AND MATERIALS
This retrospective study received institutional review board approval and need for informed consent waived. Pre-operative MRIs were reviewed of 50 women (mean age 51; range 32-76) with ER positive, HER2 negative early invasive ductal carcinoma (IDC) and an Oncotype Dx (Genomic Health) RS (mean score 33; range 0-78). MRI features included mass shape, margin, internal enhancement, T2 signal, diameter (mean 1.4 cm, range 0.5-2.8 cm), volume (mean 1.4 cc, range 0.1-8.0 cc) and dynamic time-intensity contrast enhancement kinetics. Clinical and pathologic data was collected. Exclusion criteria included prior history of cancer and BRCA genetic carriers.

RESULTS
All 50 women had stage 1 or 2A ER positive, HER 2 negative IDC. Increased Oncotype Dx recurrence score was significantly associated with increased tumor volume (Spearman correlation=0.35; p=0.01) and an increased percent of the tumor having phase 1a dynamic kinetics upon segmentation (Spearman correlation=0.32; p=0.03). Increased Oncotype Dx recurrence score was significantly associated with irregular tumor shape (p=0.03) and increased tumor (hyperintense and heterogeneous) T2 signal (p=0.002).

CONCLUSION
Several IDC MRI features are significantly associated with an increased Oncotype Dx RS, which has prognostic and predictive significance.

CLINICAL RELEVANCE/APPLICATION
MRI IDC phenotype is significantly associated with their genotype supporting the advent of radiogenomics and possible role in directing targeted therapy.

SSM01-04 • Imaging and Clinicopathologic Factors Associated with Recurrence in Triple-negative Breast Cancers

Min Sun Bae MD, PhD (Presenter); Woo Kyung Moon; Nariya Cho MD; Jung Min Chang MD; Su Hyun Lee MD; Won Hwa Kim MD, MS; Hye Ryong Koo MD; Hye Mi Gweon MD; Mirinae Seo MD; A Jung Chu MD

PURPOSE
Triple-negative breast cancer (TNBC) defined as a tumor that is negative for estrogen receptor (ER), progesterone receptor (PR), and HER2 is a biologically aggressive subgroup with poor prognosis. The aim of this study was to identify imaging and clinicopathologic factors associated with breast cancer recurrence in patients with TNBC.
METHOD AND MATERIALS
Of 3237 patients with invasive breast cancer diagnosed between January 2003 and December 2008, 515 patients who underwent breast-conserving surgery or mastectomy were diagnosed with TNBC. 55 patients who had neoadjuvant chemotherapy were excluded. Among 459 patients (median age, 47 years; range, 21-81 years), 69 (15%) had locoregional (n=32) or distant (n=37) recurrence after a median follow-up of 51 months. The imaging and clinicopathologic data were examined. The univariate and multivariate analyses were performed.

RESULTS
Age, family history of breast cancer, histologic type, histologic grade, surgical margin status, and adjuvant therapy showed no significant differences between recurrent group and non-recurrent group (P > .0969). In the multivariate analysis, preoperative breast MRI (P < .0001), mammographic breast density (P = .0034), and LN metastasis (P = .0005) were independent factors associated with recurrence in TNBC patients. The recurrence was more frequent in women without preoperative MRI (n=66) compared to women with preoperative MRI (n=393) (35% vs 12%; adjusted odds ratio [OR], 4.81; 95% confidence interval [CI], 2.51 to 9.20), in women with dense breasts (BIRADS density 3 or 4; n=319) compared to women with non-dense breasts (BIRADS density 1 or 2; n=140) (17% vs 10%; OR, 2.86; 95% CI, 1.14 to 5.78), and in patients with LN metastasis (n=138) compared to patients without LN metastasis (n=321) (24% vs 11%; OR 2.72; 95% CI, 1.55 to 4.81).

CONCLUSION
Risk factors associated with breast cancer recurrence were the lack of preoperative MRI, dense breast tissue on mammography, and LN metastasis. These factors can be predictive of the likelihood of recurrence in TNBC patients.

CLINICAL RELEVANCE/APPLICATION
The use of preoperative breast MRI should be considered for TNBC patients with dense breast tissue.

SSM01-05 • Invasive Breast Cancer MRI Phenotype and Receptor Status as Predictors of Clinical Outcome
Kirti M Kulkarni MD (Presenter); Kirsten Gaarder MD; Lingyun Xiong MD; Hiroyuki Abe MD; Maryellen L Giger PhD *; Gillian M Newsstead MD *; Charlene A Sennett MD; Akiko Shimauchi MD; David V Schacht MD

PURPOSE
Can aggressive MRI characteristics and receptor profile of invasive breast cancers be used to predict clinical outcome and metastases/recurrence rates?

METHOD AND MATERIALS
54 patients (mean age 56 yd) with biopsy-proven invasive breast cancer and staging MRI (1.5T Phillips) at University of Chicago from 2002-2003 were included in a HIPAA-compliant retrospective study. Patients with prior history of invasive or in-situ breast cancer or distant metastases at time of breast cancer diagnosis were excluded. Imaging and clinical notes were reviewed to identify local recurrence or distant metastases. Average follow up time was 7.8 years. All breast cancers were measured on MRI as maximum diameter in axial dimension. Aggressive MRI morphologic features such as non-mass enhancement (NME), rim or heterogeneous enhancement and multifocality were analyzed in consensus by two board-certified fellowship-trained radiologists. Receptor profiles of all cancers were obtained from pathology reports.

RESULTS
Histology yielded IDC 46/54 (85%) and ILC 8/54 (15%). 9/54 (17%) of the total patients developed distant metastases. Average time to metastases was 2.8 years, range 0.7 to 6.8 yrs. Histology of all metastatic cancers was IDC. 33% of cancers were grade 2 and 37% were grade 3. Grade 3 tumors metastasized in (6/20) 30% of cases and grade 2 in (1/18) 6%; tumor grade was not included in the pathology report in 2 cases. Cancers were categorized based on receptor profile as triple negative (9/54; 17%), Her2+ (12/54; 22%), and ER+Her2- (33/54; 61%). ER+Her2- cancers metastasized in 9% (3/33) and all were unifocal. Her+ cancers metastasized in 25% (3/12) (1 unifocal, 2 multifocal) and triple negative cancers in 33% (3/9) (1 unifocal, 2 multifocal). Analysis of the MRI morphologic features showed that 25% of rim-enhancing tumors, 22% with NME, 18% of multifocal and 16% of unifocal cancers metastasized.

CONCLUSION
Pilot data shows that grade 3, triple negative, NME and multifocal IDC have higher rates of metastases compared to unifocal, low grade, and ILC. Distant metastases presented as late as 6.8 yrs after diagnosis. We intend to analyze a total of 200 patients in our final study.

CLINICAL RELEVANCE/APPLICATION
To determine the group of patients that can benefit from close follow up and metastatic work up to prevent or detect local recurrence/distant metastases.

SSM01-06 • MR Imaging Phenotype of Breast Cancer: Kinetic Assessment for Molecular Subtypes
Eric M Blaschke MD (Presenter) ; Hiroyuki Abe MD

PURPOSE
To evaluate the dynamic contrast enhanced MR kinetic characteristics of newly diagnosed breast cancer in molecular subtypes.

METHOD AND MATERIALS
Breast MRI examinations of 200 patients with newly diagnosed breast cancer at the University of Chicago Medical Center from 2011 through 2012 were reviewed. Cases of newly diagnosed IDC were sorted by molecular subtype (17 triple negative, 7 Her2+, 73 Luminal A/B) and lesion segmentation and kinetic analyses were performed on a dedicated workstation. For kinetic assessment, 50% through 2012 were reviewed. Cases of newly diagnosed IDC were sorted by molecular subtype (17 triple negative, 7 Her2+, 73 Luminal A/B) and lesion segmentation and kinetic analyses were performed on a dedicated workstation. For kinetic assessment, 50% and 100% thresholds were employed for display of medium and rapid uptake, respectively. Kinetic profiles in terms of percent maximum diameter in axial dimension. Aggressive MRI morphologic features such as non-mass enhancement (NME), rim or heterogeneous enhancement and multifocality were analyzed in consensus by two board-certified fellowship-trained radiologists. Receptor profiles of all cancers were obtained from pathology reports. statistical analysis of the kinetic profiles was performed using the student t-test.

RESULTS
Percent volume of Her2 positive lesions with greater than 50% uptake at early phase was significantly greater compared with luminal A/B (98.7 +/- 1.14 vs. 91.5 +/- 3.05; P < .0004) and all others (98.7 +/- 1.14 vs. 91.9 +/- 2.62; P < .0002). There was a nonsignificant trend towards higher >100% uptake at early phase in Her2 positive lesions versus Luminal A/B (87.3 +/- 9.77 vs. 69.3 +/- 6.94; P .11) and all other subtypes (87.3 +/- 9.77 vs. 71.4 +/- 5.87; P .199). No significant difference in uptake ratios was noted for Her2 positive vs. triple negative tumors or triple negative tumors vs. all other subtypes. No significant difference was observed in BIRADS assessment of kinetic patterns.

CONCLUSION
Her2 positive breast cancers demonstrates a unique MRI kinetic phenotype with significantly increased rapid uptake ratios compared to other molecular subtypes.

CLINICAL RELEVANCE/APPLICATION
MR kinetic phenotypes of newly diagnosed breast cancer may provide a means of predicting molecular subtype and thus aid early treatment planning.
Breast Cancers Not Recognized on Second-look Ultrasound Examination

Phillip B Shaffer MD (Presenter) ;  Woo Kyung Moon ;  Won Hwa Kim MD, MS ;  Su Hyun Lee MD ;  Jung Min Chang MD ;  Nariya Cho MD ;  Hye Ryoung Koo MD ;  So Yeon Park

PURPOSE
Androgen receptor (AR) is expressed in approximately 15% to 25% of triple-negative breast cancer (TNBC) and emerging data suggests that AR may serve as a therapeutic target for a subset of TNBC. We retrospectively reviewed imaging findings for 102 patients with TNBC on mammogram, ultrasound (US), and MRI to determine if AR-positive and AR-negative tumors have distinguishing imaging features.

METHOD AND MATERIALS
A total of 102 consecutive patients (median age, 52 years; range, 28-81 years) with triple-negative (ER-/PR-/HER2-) invasive breast cancers and immunohistochemical data on AR status were included in this study. Two dedicated breast radiologists (5 and 22 years of experience, respectively) reviewed the mammogram, US, and MRI without knowledge of the clinicopathological findings based on the ACR BI-RADS lexicon. If different imaging findings were assigned by the two readers, a consensus was reached after the findings were discussed. A cutoff value of 10% was used to define AR positivity. The association of AR status with all imaging features was assessed with Fisher exact test.

RESULTS
Twenty-four (24%) patients had AR-positive TNBC and 78 (76%) patients had AR-negative TNBC. Lesion shape on mammogram (P = .008), US (P = .001), and MRI (P = .001), lesion margins on mammogram (P = .004) and US (P = .003), echo pattern on US (P = .002), and calcifications on mammogram (P < .0001), and lesion type on MRI (P = .003) were significantly associated with AR status. AR-positive TNBC was more likely to have irregular masses (88% vs 41%), indistinct margins (84% vs 56%), and non-complex hypoechoic masses (96% vs 65%) and be associated with calcifications (54% vs 12%) or nonmass-like enhancement (17% vs 0%).

CONCLUSION
Our results suggest that AR-positive and AR-negative TNBC have different imaging features.

CLINICAL RELEVANCE/APPLICATION
Understanding the imaging heterogeneity of TNBC may be helpful in identifying a subset of TNBC with AR expression, which has been shown to be associated with increased mortality among TNBC patients.

Are Suspicious Breast MRI Lesions with an Ultrasound Correlate Higher Histological Grade Tumors?

Punam Bajaj MD, MBBS (Presenter) ;  Junting Zheng ;  D. David Dershaw MD ;  Chaya Moskowitz ;  Elizabeth A Morris MD

PURPOSE
To determine if suspicious breast MRI lesions proven to represent invasive ductal carcinoma with an ultrasound correlate are of different histological grade compared with ultrasound occult lesions.

METHOD AND MATERIALS
Institutional review board approved retrospective study of 310 MRI examinations performed between 2008 and 2011 yielded 350 suspicious lesions for which biopsy was recommended. Subsequent high resolution targeted ultrasound was performed and histopathological grade of carcinomas was recorded as I (low), II (intermediate) or III (high). Statistical analysis was performed applying the Fisher's exact test, Kruskal-Wallis test and exact Wilcoxon rank sum test.

RESULTS
Targeted ultrasound demonstrated a correlate in 181/350 (52%) suspicious MRI lesions yielding 63/181 (35%) malignant lesions. The remaining 169 (48%) lesions which were sonographically occult, yielded 25/169 (15%) malignant lesions. Sonographic correlates were seen for 72% (63/88) of malignant lesions. Of these, 97% (53/55) were invasive carcinomas and 13% (8/63) were ductal carcinomas in situ.

Histological grade was available for 46 invasive ductal carcinomas with ultrasound correlate (3(6.5%),13(28.3%) and 30(65.2%) were histological grade I, II and III, respectively) and 8 without correlate (4(50%),3(37.5%) and 1(12.5%) were histological grade I, II and III, respectively). There was no statistically significant difference in the size of tumors with or without an ultrasound correlate (p=0.163). In the group with ultrasound correlate, no significant difference was observed in tumor size between the recorded histological grades (p=0.052). A grade III tumor was more likely to be present in the group with an ultrasound correlate (p = .009).

CONCLUSION
When a suspicious breast MRI lesion has a correlate, it is more likely to represent invasive carcinoma of higher histological grade.

CLINICAL RELEVANCE/APPLICATION
The presence of an ultrasound correlate for a suspicious breast MRI lesion may indicate a more aggressive cancer.


Phillip B Shaffer MD (Presenter)

PURPOSE
Investigate the US appearance of regions with positive MR scans later proven to be cancer.

METHOD AND MATERIALS
In our experience of 373 total MR directed biopsies, 33 patients were found who 1) had suspicious areas discovered on an MR and 2) had a second look US that was negative and 3) subsequently had a malignant diagnosis as a result of MR biopsy. This patient group is interesting because they were examined with prior knowledge of the precise locality of a suspicious lesion; nevertheless, the ultrasound was negative.

RESULTS
Of the 33 patients, 13 had a final diagnosis of DCIS, MR imaging size range 0.6 to 5.4 cm. 15 had a final diagnosis of invasive ductal carcinoma (IDC), MR imaging size range 0.7 to 12.0 cm. 4 had a final diagnosis of invasive lobular carcinoma (ILC), MR imaging size range 0.6 to 8.4 cm. There was one adenosquamous carcinoma of 1.0 cm. On US examination by dedicated breast sonographers and experienced radiologists the pattern seen was judged to not be sufficiently suspicious to be certain of correlation with the MR. These were regarded as “negative” US exams. The pattern present on the ultrasound was closely examined in 30 patients (43 sets of images were not available), and divided by appearance into two groups: Group QP: which were in retrospect Questionably Positive, and Group B: Benign. In Group QP, two distinct patterns were observed: low echogenicity area (6 patients) and shadow without mass (8 patients). In Group B, three distinct patterns were seen: Normal tissue (7 pts), Heterogeneous without mass (4 pts), and small mass with benign characteristics (5 pts). When segregated by histology, the following was observed: IDC: Group QP= 10 pts Group B- 4 pts. ILC: Group QP= 2 pts Group B- 2 pts. DCIS: Group Q-2 pts Group B-10 pts.

CONCLUSION
Even when positive MR images direct the radiologist precisely to the area of high suspicion for malignancy, thus eliminating search errors, those malignancies may remain subtle or totally undetectable by the usual US criteria, even for tumors up to 12 cm in size. The ultrasonographic tissue characteristics of these tumors are simply indistinguishable from that of normal breast.
SSM02-04  Breast MRI as a Problem-solving Tool in the Evaluation of Mammographically and Ultrasonographically Detected Architectural Distortions: Are There Any Predictive Parameters?

Rubina Noemi Cavallin (Presenter); Claudio Losio MD; Marta Maria Panzeri; Elena Venturini MD; Giulia Cristel MD; Alessandro Del Maschio MD

PURPOSE
Despite accounting for only 3% of mammographically detected findings, architectural distortion (AD) may be caused by a wide range of benign and malignant breast lesions, and it is the 3rd most common presentation of non palpable breast cancer. Because of its indefinite mammographic and ultrasonographic features, percutaneous or surgical biopsy is mandatory.

In our study we evaluated the potential role of dynamic Breast MRI including diffusion-weighted imaging (DWI) as a problem-solving tool in mammographically and ultrasonographically detected AD.

METHOD AND MATERIALS
Out of 232 patients undergoing MRI for problem solving, 34 were examined for a mammographic or ultrasonographic AD. MRI (1.5T) included T2-TSE sequences, dynamic study and DWI (b-values: 0, 900 s/mm2). For each lesion detected we evaluated morphology, dynamic enhancement patterns and final histopathological result. A cut-off ADC value differentiating benign from malignant breast lesions had been previously established in a large population of women. The difference between the mean Apparent Diffusion Coefficient (ADC) values and the mean T2 signal in malignant and benign findings was evaluated with Mann-Whitney U test.

Results
Univariate and multivariate analyses of ADC values, T2 signal and time-enhancement curves (T-Ec) were performed for prediction of malignancy.

RESULTS
MRI confirmed all 38 known findings. At histopathology 25 lesions were benign and 13 malignant. The most represented T-Ec in malignant AD were type 3 (n=2) and 2 (n=3), while benign lesions showed a washout kinetic. Univariate and multivariate analysis showed that T-Ec were significant predictors of malignancy (p).

CONCLUSION
Time-enhancement curves were the most predictive MRI feature to distinguish benign from malignant AD. The contribution of DWI to their differential diagnosis is limited due to ADC borderline values. MRI low negative predictive value, however, suggests to avoid MRI to strengthen the diagnosis after a benign core biopsy.

CLINICAL RELEVANCE/APPLICATION
MRI could not replace breast biopsy to confirm the nature of architectural distortions.

SSM02-05  Evaluation with Digital Mammography (DM), DM Combined with Digital Breast Tomosynthesis (DBT), Ultrasound (US) and Dynamic Breast MRI of Pathological Response after Neoadjuvant Chemotherapy (NC) Treatment of Breast Carcinoma

Giovanna Mariscotti; Manuela Durando (Presenter); Pier Paolo Campanino; Maddalena Rigo; Elisa Regini; Mattia Robella; Laura Bergamasco; Paolo Fonio; Giovanni Gandini MD

PURPOSE
To evaluate the accuracy of DM, DM combined with DBT, US and MRI in predicting residual tumour size and pathological response after NC for locally advanced breast cancer.

METHOD AND MATERIALS
44 patients (mean age 49.2 years; range 31-71) with locally advanced breast cancer who underwent NC were enrolled in the study. We retrospectively evaluated size and response of tumours to NC by DM, DM combined with DBT, US and MRI before, during and at the end of treatment. We assumed as gold standard the tumour size measured at pathology. Patients were divided into responders (with pathologic complete (pCR) or partial response (pPR)) and non-responders (NR). Measurements were considered concordant if they were ±10 mm. Tumour size assessments were statistically analyzed with paired t-test, regression line and Pearson’s linear correlation coefficient and Bland-Altman Plots; categorical variables were arranged in contingency tables and analyzed with chi square test or Fisher’s test; 95% Confidence Intervals were estimated for all percentages.

RESULTS
For pCR patients (16/44), size estimates by all modalities showed an exponential decrease during treatment time (r=0.9; p=0.005). The size agreement with pathology was 29 (95%CI 10-55)% for US, 36(14-62)% for DM, 33(12-62)% for DM+DBT, 54(27-79)% for MRI. For pPR patients (18/44), size estimates by imaging showed a linear decrease during treatment (r=0.9; p=0.04). The size agreement was 69(41-89)% for US, 54(27-79)% for DM, 70(38-92)% for DM+DBT, 82(62-98)% for MRI. For NRs (10/44), US, DM and DM+DBT overestimated tumour size, while MRI measurements agreed with pathology. For the responders, the agreement between pCR predictions at mid-treatment and pathological responses was 7.1(0.4-90.5)% for both US and DM, 11.1(15.7-65.9)% for DM+DBT, 38.5(15.7-65.9)% for MRI; pPR prediction at mid-treatment was 54.5(25.9-81)% for US, 54(27-79)% for DM and 54(27-79)% for MRI; pPR prediction was 54.5(25.9-81)% for US, 54(27-79)% for DM and 54(27-79)% for MRI; pPR prediction was 54.5(25.9-81)% for US, 54(27-79)% for DM and 54(27-79)% for MRI.

CONCLUSION
Predictions of response and residual tumour size made on MRI showed a better agreement with pathology than DM, DM+DBT, US. DBT in addition to DM improved conventional imaging in pPR and NR predictions.

CLINICAL RELEVANCE/APPLICATION
Breast MRI can be considered the most reliable imaging modality for pathological response evaluation after neoadjuvant chemotherapy, but the addition of DBT improves conventional imaging performances.

SSM02-06  Analysis of the Influence of Surrounding Fat Tissue in the Detection Rate of Ultrasound and Digital Breast Tomosynthesis after Normal Mammography

Pedro Sion MD; Jon Etxano MD (Presenter); Maria Paramo Alfaro MD; Romina Zalazar MD; Arlette Elizalde; Luis Pina MD, PhD; Fernando Martinez Regueira; Natalia Rodriguez-Spiteri

PURPOSE
To assess the features of the tissue surrounding the additional detected cancers by US and DBT after normal Mammography.

METHOD AND MATERIALS
We retrospectively analyzed 75 histologically confirmed tumors in 55 patients (13 ductal carcinomas in situ and 62 invasive carcinomas). All the patients underwent Digital Mammography, US and Tomosynthesis. The tumors were classified in four categories according to the amount of peritumoral fat ( I = >75%, II = 50-75%, III =25-75% and IV = Gold Standard) was established with histological study obtained after surgery.

The detection rate of additional tumors by US and DBT was compared regarding to the percentage of peritumoral fat using the McNemar test (SPSS, 15.0).

RESULTS
Out of the 75 tumors, DM detected 42 (56%) and 33 (44%) were detected by additional techniques. The number of additional
We validated the usefulness of beam hardening (BH) reduction with a rapid kV switching dual energy CT (DECT) protocol in quantitative myocardial CT perfusion (QMCP).

**PURPOSE**

Atherosclerotic plaque imaging by absorption-contrast computed tomography (ACT) is limited due to poor contrast in low absorbing materials like soft plaque. Phase-contrast CT (PCT) is an experimental technique relying on X-ray phase-shift rather than absorption, yielding a higher contrast in biological soft tissue. Phase-contrast Hounsfield units (HU-P) can be calculated in analogy to absorption-contrast HU (HU-A) using the refraction index. We hypothesized that plaque components including fibrous (Fib), lipid-rich (Lip) and calcified tissue (Cal) can be differentiated based on HU-P.

**METHOD AND MATERIALS**

Ten ex-vivo human coronary arteries were imaged at a laboratory-based set-up using a conventional X-ray tube (35kV) and a grating-interferometer to obtain the phase- and absorption-signal simultaneously. Tomographic images were reconstructed with an effective pixel size of 100 μm and correlated with histopathology sections. In both ACT- and PCT-data, regions corresponding to Fib, Lip or Cal based on histopathology as well as reference regions in surrounding normal tissue were manually traced. Mean HU-A, HU-P and signal-to-noise ratios (SNR) were calculated for all analyzed regions.

**RESULTS**

A total number of 276 cross-sections with 206 Fib, 113 Lip and 115 Cal containing regions were assessed. Fib, Lip and Cal were associated with significant different mean HU-P (57.5±9.3, 28.9±5.8 and 325.0±113.0; p<0.01) although there was no difference for Cal (p=0.72).

**CONCLUSION**

In an ex-vivo experimental set-up PCT can reliably differentiate important components of atherosclerotic coronary lesions based on quantitative HU-P, indicating its high potential for improved assessment of coronary artery disease.

**CLINICAL RELEVANCE/APPLICATION**

Phase-contrast computed tomography might improve characterization of coronary atherosclerotic plaque morphology compared to conventional absorption CT.

**SSM03-02 Non Contrast T2-mapping Detects Area at Risk in Acute Myocardial Ischemia Rats**

**Rui Xia** (Presenter) ; **Xi Lu**  ; **Jichun Liao** ; **Jie Zheng** PhD ; **Fabao Gao** MD, PhD

**PURPOSE**

To compare the area at risk in rats with myocardial infarction and reperfused myocardial ischemia with a T2-mapping method on 7.0T MR.

**METHOD AND MATERIALS**

Two groups(7 each group) of reperfused myocardial ischemia(MI30) and myocardial infarction(MI) rats were investigated. For MI30, the left anterior descending coronary artery was occluded for 30 minutes while MI was induced by permanent ligation of the left anterior descending coronary artery. MRI scans were taken at 24 hours after the occlusion.

The T2-mapping was optimized on 7.0T MR(BRUKER BIOSPEC 70/30). Multiple single-slice turbo spin-echo T2-weighted images were acquired on the short axis slices during mid-diastolic phase and end-inspiratory period using both ECG and respiratory gating systems(TR/TE=1500ms/10.20,30ms,MTX=192x192,FOV=50x50mm,slice thickness=1.5mm).Then late gadolinium enhancement(LGE) imaging was performed by FISP(TR=5.2ms,TE=1.8ms,FA=25°,MTX=256x256,FOV=50x50mm,slice thickness=1.5mm) after an injection of Gd-DTPA. After MRI scan, rat hearts were cut into transverse slices for TTC staining. The T2-maps were calculated using a custom-made software. Area at risk were defined as the difference between edema areas with high T2 values(> mean ± 2SD in remote normal tissue areas) and positive enhanced area in LGE images. The T2 values in edema regions were normalized by the T2 values in the remote normal tissue regions. All areas were expressed as a percentage of the whole myocardial tissue of left ventricle.

**RESULTS**

There was no significant difference between two groups (MI 1.62±0.27, MI30 1.59±0.16, p>0.05) in normalized mean T2 values of myocardial edema areas. The total size of infarction regions in MI30(23.2±4.7%) was significantly higher than MI30(16.3±4.2%, p<0.05). No significant difference was found for the edema area (MI 26.9±4.4%, MI30 21.1±7.2%, p>0.05). No significant difference was found for the infarcted area defined by LGE and TSC staining for MI30(17.5±2 vs. 15.2±4, n=3, p>0.05) and MI(22.5±3 vs. 21.2±2, n=3, p>0.05).

**CONCLUSION**

After 30 min myocardial ischemia in rats, reperfusion can reduce myocardial infarction, but not area at risk and edema.

**CLINICAL RELEVANCE/APPLICATION**

Area at risk may not always be the target of therapy for patients who undergo reperfusion after acute myocardial infarction.

**SSM03-03 Beam Hardening Correction in Quantitative Myocardial CT Perfusion with Rapid kV Switching Dual Energy CT: A Validation Study with Microspheres**

**Aaron So** PhD (Presenter) ; **Jiang Hsieh** PhD *; **Yasuhiro Imai** MS *; **Jean-Baptiste Thibault** *; **Kelley Branch** MD *; **Ting-Yim Lee** MSc, PhD *; **Suresh Narayanan** MS *; **Sandeep Dutta** PhD *

**PURPOSE**

We validated the usefulness of beam hardening (BH) reduction with a rapid kV switching dual energy CT (DECT) protocol in quantitative myocardial perfusion (MP) imaging against microspheres measurement of MP.
METHOD AND MATERIALS
Normal pigs were scanned using a Discovery 750HD scanner (GE Healthcare (GE)) with a DECT protocol: 140/80 kilovolts (kV) alternating at 0.2 ms intervals, 640 mA and a 35 s gantry period. In each study, 22 axial scans covering 40 mm of the heart were triggered under normal physiologic conditions every 1-2 heart beat at mid-diastole together with contrast injection contrast at 4 ml/s. Single energy CT (SECT) and DECT monochromatic 70 keV images were reconstructed with 140 kV and both 80 and 140 kV projections respectively. The SECT images were also corrected for BH using an image-based correction algorithm (iBHC). Each image set was analyzed using CT Perfusion (GE) to derive MP functional maps. Fluorescent microspheres were injected into the left atrial appendage of the heart after the CT perfusion studies to measure MP. Mean MP in the lateral, apical and septal segments over 4 to 6 consecutive 5-mm-thick slices measured by microspheres and from the three CT image sets were compared using linear regression and Bland-Altman analysis. A total of 57 segments in 19 slices in four pigs were analyzed in this study.

RESULTS
DECT exhibited the highest correlation with microspheres (R=0.77) compared to SECT with (R=0.56) and without (R=0.49) iBHC. DECT also had the smallest difference in mean MP from microspheres (2.2 ml/min/100g) compared to SECT without iBHC (29.2). Despite a comparable mean difference from microspheres (-2.0), SECT with iBHC showed a wider limits of agreement (-45.0 to 41.0 ml/min/100g) than DECT (-30.7 to 35.2).

CONCLUSION
DECT provided better BH correction and the most accurate and smallest variation of MP measurements compared to microspheres MP gold standard. In SECT MP imaging, iBHC reduced the spatially inconsistent overestimation of MP in myocardial segments but did not outperform DECT.

CLINICAL RELEVANCE/APPLICATION
DECT minimizes beam hardening in contrast-enhanced cardiac images which leads to a more accurate MP measurement with CT Perfusion to facilitate reliable assessment of ischemic heart disease.

SSM03-04 • A Computational Algorithm for the Automated Detection of the Napkin-ring Sign: A High-risk Plaque Feature in Coronary CT Angiography
Christopher L Schlett MD, MPH (Presenter) ; Nabeel Ali BS ; Maros Ferencik MD ; Hans-Ulrich Kauczor MD * ; Udo Hoffmann MD

PURPOSE
To develop a fully automated computational algorithm which allows highly efficient, accurate and reproducible detection of the Napkin-Ring Sign (NRS), which has been validated as a highly specific marker for vulnerable plaque in coronary CT angiography (CTA). NRS is characterized by a center of lower CT attenuation representing a lipid-rich/necrotic core in histology surrounded by a rim-like area of higher CT attenuation representing fibrous tissue (figure). So far, NRS detection is limited to a manual and time-intensive reading by CCTA experts.

METHOD AND MATERIALS
The algorithm was developed utilizing MATLAB (Mathworks, Natick, MA), which employs computational image-analysis techniques. A database of cross-sectional CCTA images of coronary arteries from ex-vivo human cadaver hearts co-registered with histology was used. Presence of NRS for each CCTA cross-section was evaluated by a manual reading of a CCTA expert. The vulnerable status of the plaques was confirmed based on the co-registered histology images. Images were randomly split into a training and validation sets, each containing 15 NRS-positive and 45 NRS-negative CCTA cross-sections. The algorithm was developed with iterative steps based on the training set and the performance of the algorithm was verified based on the validation sets.

RESULTS
The algorithm analyzes each cross-sectional image by establishing Line Density Profiles (LDP) at the lumen centre in fixed intervals of rotation. Based on the training set, the following decision rule was established. A LDP was positive if it had a bi-peak curve with its first peak (labelled as X) at a minimum of 0-100 Hounsfield Units (HU) and second peak (labelled as Y) >0 HU and Y>X intervals of rotation. Based on the training set, the performance of the algorithm was verified based on the validation sets.

CONCLUSION
We have developed a novel computational algorithm that automatically detects the presence of the NRS in cross-sectional coronary CTA images with a good accuracy.

CLINICAL RELEVANCE/APPLICATION
If our NRS algorithm is combined with vessel segmentation software, a routine detection of high-risk plaques should be feasible even in larger cohorts and a treatment possible before the event occurs.

SSM03-05 • Cardiac Magnetic Resonance Elastography of the Right Ventricle in Canines with Congenital Pulmonary Valve Stenosis
Juliana S Da Silveira MD (Presenter) ; Brian A Scansen ; Peter Wassenaar MS * ; Brian Raterman ; Ning Jin * ; Richard D White MD ; John D Bonagura ; Arunark Kolipaka PhD

PURPOSE
To demonstrate the feasibility of quantifying right ventricular (RV) stiffness using cardiac magnetic resonance elastography (CMRE) and correlate it against RV thickness and mass in dogs with severe congenital pulmonary valve stenosis causing RV hypertrophy (RVH).

METHOD AND MATERIALS
RESULTS
Figure 1 shows a short-axis magnitude image (A), snap shots of wave propagation (B-E) and the corresponding stiffness map (F) with a stiffness value of 6.8kPa from one dog. Figure 2A shows poor inverse correlation between normalized RV mass and RVFW stiffness during ED (R2=0.05) and ES (R2=0.40). Figure 2B shows a poor inverse correlation between RVFW stiffness and thickness during ED (R2=0.19), but a good inverse correlation during ES (R2=0.81).

CONCLUSION
It is known that wall thickness has been used as a surrogate for estimating myocardial stiffness. However, our results do not show an increase in stiffness with an increase in wall thickness or mass; suggesting that thickness or mass do not reflect changes in the intrinsic mechanical property of the RV myocardium.

CLINICAL RELEVANCE/APPLICATION
CMRE is a noninvasive method to estimate myocardial stiffness and can potentially facilitate better understanding of the impact of RVH.

SSM03-06 • Evaluating Myofibre Architecture of Rhesus Monkey with Myocardial Infarction Using DT-MRI
Yuqing Wang (Presenter) ; Lei Wang ; Rui Xia ; Fabao Gao MD, PhD

PURPOSE
METHOD AND MATERIALS
Infarction had been produced by permanent suture ligation of the left anterior descending coronary artery for 12 weeks. Both infarcted and healthy monkeys were sacrificed under deep surgical anesthesia with pentobarbital for excising heart. The excised heart was immediately perfusion-fixed by and stored in a 4% paraformaldehyde solution. All experiments were performed in accordance with regulations for the humane care of laboratory animals at Sichuan university.

The diffusion tensor imaging (DTI) of each excised heart was performed on 7.0T MR (Bruker BioSpec 70/30, Germany). Each DTI dataset consisted of a single non-weighted and 30 diffusion-weighted 3D spin echo scans (TR/TE=12000/32ms, MTX=100×100, FOV=50×50mm, slice thickness=0.8mm) encoded in 30 gradient directions. The scan time for each DTI dataset was the same, approximately 20 hrs. All DTI datasets were analyzed to calculate the diffusion parameters such as fractional anisotropy (FA) and apparent diffusion coefficient (ADC) using Diffusion Toolkit package and the myocardial fiber tractography was performed by using Trackvis software.

RESULTS
The figure 1A and B revealed respectively the myocardial fibers in healthy monkey and in infarcted monkey. In the infarcted heart, the decreased FA (0.2457) and increased ADC (0.00048) in infarcted area (red arrow) than in remote area (FA: 0.817; ADC: 0.0019) indicated damaged completeness of myocardial fibers in infarcted area. In contrast, the healthy heart revealed homogeneous FA and ADC in whole heart. Moreover, the myocardial fibers were intermittent (=2500 track/ml) in infarcted area but holonomic (=4977 track/ml) in remote area.

CONCLUSION
Higher similarity of fibers architecture with the ex-vivo human's heart made us to accurately deduce and interpret the human's myocardial infarction using infarcted monkey's hearts. To the best of our knowledge, this study is a first in monkeys for myocardial fiber imaging using 7.0T MR.

CLINICAL RELEVANCE/APPLICATION
The monkey model enable us to deduce and understand the human's myocardial infarction in more accurate manner.

PURPOSE
In 2009, the add-on codes for spectral Doppler and color flow Doppler echocardiography (echo) were bundled into the primary transthoracic echo (TTE) code. The relative value units for the new single code were substantially lower than the previous sum for the 3 codes that were usually done together. Our purpose was to see what effect this had on Medicare echo utilization rates and on the distribution of outpatient echos between cardiology offices and hospital outpatient departments (HOPDs). This is important because the costs to Medicare of echos done in HOPDs are substantially higher than of those done in offices.

METHOD AND MATERIALS
The nationwide Medicare Part B databases for 2005-2011 were used. All echo CPT codes were selected. Specialty codes were used to identify echos done by cardiologists (who do most echos). Place-of-service codes were used to identify echos done in offices and HOPDs. Procedure volumes and utilization rates per 1000 were determined, and trends were evaluated before and after bundling occurred in 2009.

RESULTS
Cardiologists' office echo utilization rate rose from 219.5 per 1000 in 2005 to 257.1 in 2008, then dropped to 100.0 in 2009 (-61%). Their HOPD echo rate rose from 72.2 in 2005 to 76.5 in 2008, then dropped to 35.0 in 2009 (-54%). From 2009 to 2011, cardiologists' office echo rate dropped again from 100.0 to 88.8 (-11%), while their HOPD echo rate increased from 35.0 to 46.1 (+32%). In 2008 (the last year before bundling), 23% of all outpatient echo was done in HOPDs; this increased to 34% by 2011.

CONCLUSION
Echo code bundling produced a sharp drop in outpatient claims from cardiologists. After bundling, office echo rates continued to drop but HOPD echo rates increased. This was likely due to migration of cardiology office practices into hospitals. The technical component national fee for office TTE is $148 vs $393 for HOPD echo. It appears that in this instance, code bundling (which also occurred with cardiac nuclear scans) led to closure of many cardiology offices and a resultant shift of echos from that lower cost setting to the much higher cost HOPD setting. From the perspective of Medicare and other payers, this is a drawback of code bundling.

CLINICAL RELEVANCE/APPLICATION
not applicable
SSM04-05 • Standard Weight-based Gadolinium Dosing over Corrects for Body Size in Obese Individuals when Evaluating the Myocardium: The Multi-Ethnic Study of Atherosclerosis (MESA)

Songtao Liu MD (Presenter) ; Chia-Ying Liu ; Jing Han ; Evrim B Turkbey MD ; Bharath Venkatesh ; Diane Bild ; Andrew E Aral MD ; Robyn McClelland ; William Hundley ; Antoinette S Gomes MD * ; Russell Tracy ; Richard Kronnal ; Joao A Lima MD * ; David A Bluemke MD, PhD

PURPOSE
Gadolinium-based contrast agents (GBCAs) are administered in direct proportion to body weight according to FDA approval. However, body fat is less vascular than either visceral organs or muscle and has a lower contribution to the extravascular fluid space. The purpose of this study was to evaluate the impact of body weight based GBCA dosing on myocardial T1 time in a large multi-center study.

METHOD AND MATERIALS
1231 study participants (mean age 67±9 years) free of clinical cardiovascular disease at enrollment (2000) in the Multi-Ethnic Study of Atherosclerosis (MESA) underwent gadolinium enhanced CMR. GBCA (Magnevist,0.15mmol/kg) was administrated and T1 mapping was performed at the mid-ventricular level before and after GBCA using a MOLLI sequence. Study participants with focal late gadolinium enhancement were excluded. The associations of myocardial T1 time with body weight and body mass index (BMI) were evaluated by a linear model adjusting for age, ethnicity, traditional risk factors and creatinine.

RESULTS
The mean BMI was 28.4±5.6 for women and 27.9±4.2 for men. The mean post-contrast myocardial T1 times were 440±39 ms (@12min), and 504±38 ms (@25min) for women. For men, the corresponding values were slightly higher, 469±31 ms (@12min), and 532±33 ms (@25min). Pre-gadolinium T1 times were not associated with either body weight or BMI. Post-gadolinium T1 times were significantly related to both body weight and BMI. Post-gadolinium T1 times were related to both body weight and BMI (women, weight, r=-0.43; BMI, r=-0.41; men, weight, r=-0.25; BMI, r=-0.23; all p < 0.001). For an individual with BMI of 35 kg/m², weight-based GBCA administration resulted in a 38 msec lower T1 time for women, and a 20 msec lower T1 time for men relative to an individual with a BMI of 20 kg/m². Similar results were obtained when considering waist circumference as a measure of obesity.

CONCLUSION
For myocardial T1 evaluation, standard body weight based administration of GBCA overdoes individuals with elevated BMI, this effect is slightly greater for women compared to men.

CLINICAL RELEVANCE/APPLICATION
Standard weight based dosing of a GBCA may result in overcorrection in obese subjects, lowering myocardial T1 time, potentially confounding interpretation of T1 results.

SSM04-06 • Ethnic Differences in Aortic Stiffening across the Adult Life Span: Results from MRI Aortic Pulse Wave Velocity Measurements in the Dallas Heart Study

Akshay Goel BS (Presenter) ; Ronald M Peshock MD ; Christopher Maroules MD ; Colby Ayers MS ; Roderick McColl PhD ; Kevin S King MD

PURPOSE
Aortic pulse wave velocity (APWV) is a non-invasive measure of aortic stiffness, independently associated with end organ damage and mortality. The purpose of this study was to assess ethnic differences in aortic stiffness across the adult life span using MRI measured APWV in a large population based study.

METHOD AND MATERIALS
The study consisted of 1197 participants from the Dallas Heart Study-1 (DHS-1), a multiethnic, population-based study of cardiovascular health. APWV was measured across the thoracic aortic arch using phase contrast (PC) cardiac gated MRI, expressed as velocity in m/s. APWV measurements were log transformed to normalize the distribution. Linear regression was used to model the age-related increase in APWV stratified by Black ethnicity and Non-Black ethnicity.

RESULTS
The determinants of aortic stiffness included age, hypertension, smoking, diabetes, and body mass index. For an individual with BMI of 35 kg/m², weight-based GBCA administration resulted in a 38 msec lower T1 time for women, and a 20 msec lower T1 time for men relative to an individual with a BMI of 20 kg/m². Similar results were obtained when considering waist circumference as a measure of obesity.

CONCLUSION
For myocardial T1 evaluation, standard body weight based administration of GBCA overdoes individuals with elevated BMI, this effect is slightly greater for women compared to men.

CLINICAL RELEVANCE/APPLICATION
Standard weight based dosing of a GBCA may result in overcorrection in obese subjects, lowering myocardial T1 time, potentially confounding interpretation of T1 results.
SSM05-02 • Comparison of Diffusion Weighted Imaging with Background Suppression (DWIBS) Sequence and Classic Spectral Diffusion Sequence (DWI) in Mediastinal Lymph Node Analysis at 3T

Caroline Mesmann MD (Presenter); Adva Abergel MD; Francois Tronc MD, PhD; Yves Berthezene MD, PhD; Philippe Douek MD, PhD; Loic Boussel MD

PURPOSE
To compare DWIBS sequence with DWI both with and without respiratory gating in mediastinal lymph node analysis at 3T.

METHOD AND MATERIALS
26 patients (27-79 years-old) scheduled for surgical lymph node analysis, prospectively undergone a whole thoracic exploration with DWIBS (TR/TE 6674/44; FatSat STIR with TR=260ms; Slice Thickness=5mm) and DWI sequences (TR/TE 1291/59; Spectral FatSat; Slice Thickness=5mm) with and without (free breathing) respiratory gating with 0, 400 and 800 b-values at 3T. For four sequences, a qualitative analysis, defined by fat-sat homogeneity and presence of motion artefacts, rated from 0 to 4, was independently performed by two radiologists. The signal to background (STB) of mediastinal lymph node was also calculated as the signal of the lymph node divided by the mean signal of the thoracic muscles. Kruskal Wallis and ANOVA tests were performed to compare respectively the qualitative and the quantitative data of DWI and DWIBS images with adapted post-hoc tests.

RESULTS
Quality of fat suppression was better for DWIBS in comparison with DWI both for the ungated (image quality score 3.9±0.33 vs 1.5±1.2). Furthermore, motion artefacts were significantly reduced in DWIBS both for ungated (image quality score 3.13±0.55 vs 1.86±0.76, p). Quantitative analysis showed a significantly higher STB in lymph nodes for DWIBS images in comparison with DWI both for the ungated (score 3.9±0.33 vs. 1.5±1.2, p)

CONCLUSION
DWIBS sequence improves the fat-sat homogeneity, reduce motion artefacts and increase the STB of mediastinal lymph node in comparison with DWI. Respiratory gating doesn’t improve significantly DWIBS image quality.

CLINICAL RELEVANCE/APPLICATION
DWIBS sequence improves image quality in mediastinal lymph node imaging in comparison with the standard DWI sequence.

SSM05-03 • Lung Adenocarcinomas Presenting with Concurrent Lymphangitic Metastasis at the Initial CT: Clinical Characteristics and Prognostic Implications- Work in Progress

Hyun-Ju Lim MD (Presenter); Kyung S Lee MD, PhD; Myung-Ju Ahn; Myung Jin Chung MD *; Joonghyun Ahn

PURPOSE
To evaluate the clinical characteristics and prognostic implications of patients with lung adenocarcinoma presenting with concurrent lymphangitic metastasis at CT

METHOD AND MATERIALS
We retrospectively reviewed the clinical data base of patients who were newly diagnosed to have non-small cell lung cancer (NSCLC) from 2007 through 2010. We searched for the cases in which radiologic report text harbored the term lymphangitic metastasis and clinically ensured that the findings are suggestive of lymphangitic metastasis by excluding those who were proven to have pulmonary edema on follow-up study. The extent of lymphangitic metastasis was classified into having involved the same lobe, the ipsilateral lung but different lobe and the different lung. Two chest radiologists reviewed CT scans and decisions were reached by consensus. We excluded the patients with non-adenocarcinoma pathology or with surgery or irradiation history. After restaging with CT and PET/CT results by the new 7th TNM classification, CT and clinico-demographic data were investigated for those in subject group (with lymphangitic metastasis) and in control group (without lymphangitic metastasis). New clinical stage group, sex, age and history of chemotherapy were matched to assess the impact of lymphangitic metastasis on patient overall survival.

RESULTS
The subject group (n = 54) consisted of four stage IIIIB (7.4%) and 50 stage IV (93.6%) lung adenocarcinoma patients (34 men, 20 women; mean age 59 ± 10 years). Of these patients, lymphangitic metastasis was depicted in the same lobe in 10, in the ipsilateral lung but different lobe in 32 and in the different lung in 12 patients. Forty two patients received chemotherapy and 12 patients did not. There was no significant difference in overall survival between lung adenocarcinoma patients with and without lymphangitic metastasis (p = .758). The extent of lymphangitic metastasis also showed no significant correlation with patient prognosis (p = .121).

CONCLUSION
Stage IIIIB or IV lung adenocarcinoma patients with lymphangitic metastasis at the initial CT does not show significantly different prognosis compared with those without the condition, and the extent of lymphangitic metastasis also does not affect on patient overall survival.

CLINICAL RELEVANCE/APPLICATION
In advanced stage (IIIB and IV) lung adenocarcinoma, the presence of lymphangitic metastasis or its extent does not have any impact on patient prognosis.

SSM05-04 • Prognostic Value of Metabolic Tumor Volume in Patients with Esophageal Carcinoma

Sonia L Betancourt Cuellar MD (Presenter); Wayne L Hofstetter; Arlene M Correa PhD; Osama R Mawlawi PhD; Diana M Palacio MD; Edith M Marom MD

PURPOSE
To determine if 18F-fluorodeoxiglucose (FDG) metabolic tumor volume (MTV) imaged by positron emission computed tomography (PET-CT) in newly diagnosed patients with esophageal carcinoma can determine overall survival.

METHOD AND MATERIALS
185 patients with esophageal carcinoma, treated with surgery alone (n=62) or multimodality therapy: neoadjuvant chemoradiotherapy followed by surgery (n=123) were included in this study. SUVmax, volumetric metabolic measurements such as MTV and other clinical variables, including clinical staging were assessed by Cox’s proportional hazards regression model to test prognostic significance.

RESULTS
Univariable Cox regression analysis of the entire group of 185 patients showed that clinical staging, and maximal tumor length as assessed by endoscopic ultrasound and all methods for assessing FDG uptake were associated with overall survival (p)

CONCLUSION
Some pretreatment FDG tumor uptake measurement techniques can be useful for tailoring therapy to either surgery or multimodality therapy in patients with esophageal carcinoma.

CLINICAL RELEVANCE/APPLICATION

SSM05-05 • Dual-energy CT in Differentiating Thymic Epithelial Tumors: An Initial Experience
By using the proposed software comparative contrast enhancement is possible even when using lesser concentrated contrast bolus shaping software.

**CONCLUSION**

Dual-energy CT using a monophasic injection protocol was chosen with 90ml (400mg Iodine per ml) concentration (400mg/ml), for the second 72 patients received contrast enhanced computed tomography of the abdomen twice during clinical follow up. The first time (group 1) a monophasic injection protocol was chosen with 90ml (400mg Iodine per ml) concentration (400mg/ml), for the second examination (group 2) the patients received 103ml contrast medium (350mg Iodine per ml). Both flow rates started with 2 ml per sec, the bolus shaping software however reduced the flow during injection to 1.7ml. Attenuation values (HU) of the liver, aortocaval lymph nodes, abdominal aorta and portal vein of both groups were compared to analyze contrast enhancement.

**RESULTS**

Average attenuation of the liver was 99HU (range: 82-105HU) (group 1) vs. 104 HU (range: 92-107HU) (group 2) (p = 0.64). Portal vein enhancement was 148HU (range: 125-155HU) vs. 169 HU (158-189HU) (p = 0.31), enhancement of the aorta was measured with 130HU (range: 105-138HU) vs. 140 HU (range 119-152HU) (p < 0.01). Lymph node enhancement was similar with an average of 37HU (range: 17-50HU) (group 1) resp. 33HU (range: 15-41HU) (p=0.75).

**CONCLUSION**

Lower iodine concentration does not lead to a lesser enhancement of the liver or great abdominal vessels when using the proposed bolus shaping software.

**CLINICAL RELEVANCE/APPLICATION**

VPCT might be considered as an additional complementary tool for precise quantification of "vascular normalization" effect, assessment of antitumor treatment effects.

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This is a sample of text from a document. The text is formatted in a standard academic style, typical of scientific or medical publications. It includes sections like **PURPOSE**, **METHODOLOGY AND MATERIALS**, **RESULTS**, **CONCLUSION**, and **CLINICAL RELEVANCE/APPLICATION**. Each of these sections contains detailed information about the study, including methods used, results obtained, and the conclusions drawn, as well as the implications for clinical practice or further research.

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The document appears to be discussing the development and application of a new software tool for improving contrast enhancement in computed tomography (CT) scans, specifically focusing on improving image quality and analyzing vascular normalization effects in various medical contexts.
SSM06-03 • Comparison of Four Contrast Injection Protocols with a Combination of Fixed Injection Duration and Patients’ Body-weight-Tailored Dose of Contrast Material for Multiphasic Hepatic CT: A Prospective Randomized Study

Masakatsu Tsurusaki MD, PhD (Presenter); Keitaro Sofu; Tomoko Hyodo MD; Yukinobu Yagyu MD; Mitsuru Matsuki MD; Takamichi Murakami MD, PhD *; Masahiro Okada MD

PURPOSE
We performed a prospective randomized study using 4 protocols for multiphasic hepatic CT applying a combination of fixed injection duration and patients’ body-weight-tailored dose of contrast material, and to compare the quantitative and qualitative analyses among 4 protocols.

METHOD AND MATERIALS
The subjects comprised 1144 cases with an estimated glomerular filtration rate of no less than 60 mL/min/1.73 m2, who underwent imaging between October 2011 and February 2013. To stabilize the contrast effects of abdominal contrast-enhanced CT and to make reproducible testing possible in our hospital, abdominal contrast CT was conducted with a fixed injection time (30 s), a weight-specific dosage (600 mgI/kg), an adjustable injection speed, saline flushing, and bolus tracking. CT values of the aorta (celiac and superior mesenteric), portal vein trunk, liver parenchyma, and hepatic vein were measured among the subjects in each body weight group: [39 kg, 40–49 kg, 50–55 kg, 56–62 kg, and > 63 kg (63-75kg, >76kg), and >63kg (63-79kg, >80kg)]. In addition, the contrast effects according to the contrast medium concentration (240, 300, 350, or 370 mgI syringes) were compared within each group. The upper limit for the contrast medium dosage was set at 350 mgI/135 mL.

RESULTS
No significant differences in the contrast effects were noted within each group because of differing contrast medium concentrations in the aorta, portal vein, liver parenchyma, and hepatic vein. In addition, no clear differences were observed in the contrast effects groups. In the very high weight groups (96 kg or heavier in particular), the total contrast medium dosage restrictions resulted in lower iodine volumes (less than 499 mgI/kg), and the contrast effects were somewhat inferior to the other body weight groups.

CONCLUSION
When conducting abdominal dynamic CT with weight-specific dosages, fixed injection times, bolus tracking, and saline flushing, and selection of different contrast medium volumes and concentrations for each group makes it possible to maintain necessary iodine volumes and reduce waste of contrast medium. In addition, it makes it possible to inhibit excessively fast injection speeds.

CLINICAL RELEVANCE/APPLICATION
Abdominal Contrast-enhanced Computed Tomography using Weight-specific Dosages and Fixed Injection Time is recommended.

SSM06-04 • A Study of Reducing Contrast Agent Dose in Abdominal CTA

Weibing Wang MMed (Presenter); Jinbai Huang MA; Jie Peng MMed; Jing Luo MMed

PURPOSE
To evaluate the image quality and the diagnostic value of using Low contrast dose, low contrast concentration and low flow rate for abdominal CTA on spectral CT imaging.

METHOD AND MATERIALS
120 patients prescribed to take abdominal CTA (Discovery CT750 HD, GE Healthcare) were enrolled and divided randomly and averagely into 2 groups. This study was approved by our institutional ethics committee. Use SmartPrep software to start every CTA scan at the threshold of 100HU. Use GSI viewer software to get optimal keV images with optimal contrast noise ratio (CNR). Two CTA protocols (group A: n=60, fast 80 kVp/140 kVp switching,60ml,300mgI/ml,3ml/s; group B: n=60, 120 kV,70ml,350mgI/ml,5ml/s) were compared. The image quality parameters [mean CT value and CNR for abdominal aorta] and the weighted dose index (CTDIw) were evaluated and the display ratio of right gastroepiploic artery were observed in VR images.

RESULTS
The image quality in both groups met the diagnostic need. The optimal keV for abdominal CTA in spectral CT imaging was 50 kVp. There was no statistical difference for CNR and the display ratio of right gastroepiploic artery between optimal keV images and conventional CT images (26.32±6.95 vs 27.36±7.05) (88.3% vs 81.7%) (p>0.05). Total contrast dose for CT scans was 60ml in group A, 14% less than the 70ml in group B. Total contrast concentration was 300mgI/ml in group A, 14% less than the 350mgI/ml in group B. The injection speed was 3ml/s in group A, 40% less than 5ml/s in group B. There was no statistical difference in CTDIw between 2 groups (16.87mGy vs 14.98±8.12mGy) (P>0.05).

CONCLUSION
The use of low contrast dose, low contrast concentration and low flow rate combined with spectral CT imaging provided contrast dose reduction, contrast concentration and injection speed reduction with similar or better image quality in comparison with the conventional CTA protocol.

CLINICAL RELEVANCE/APPLICATION
A new protocol using longer injection duration of 38sec and middle concentration of contrast material may yield satisfactory enhancement.

SSM06-05 • Reduction of Total Iodine Dose by Using Low Tube Voltage and High Tube Current Technique in Combination with Adaptive Statistical Iterative Reconstruction for Dynamic CT of the Pancreas

Yoshifumi Noda MD (Presenter); Satoshi Goshima MD, PhD; Hiroshi Kawada MD; Haruo Watanabe MD; Hiroshi Kondo MD
**SSM07-06 • High Concentration (400 mgI/mL) versus Low Concentration (320 mgI/mL) Iodinated Contrast Media in Multi Detector Computed Tomography of the Liver: Comparison between 100 kV and 120 kV Acquisition Protocol**

**Fabrizio Vecchietti** MD (Presenter); **Marco Rengo** MD; **Davide Bellini** MD; **Damiano Caruso** MD; **Domenico De Santis** MD; **Andrea Laghi** MD *

**PURPOSE**
To compare two contrast media with different iodine concentration (Iodixanol 320 mgI/mL and Iomeprol 400 mgI/mL) in terms of liver parenchymal enhancement in multidetector computed tomography at 100 kV and 120 kV.

**METHOD AND MATERIALS**
110 patients were prospectively randomized into three groups. In Group A patients received 637.5 mg of Iodine per kg of Lean Body Weight of Iodixanol 320 and images were acquired at 120 kV. In Group B patients received 637.5 mg of Iodine per kg of Lean Body Weight of Iodixanol 320 and images were acquired at 100 kV. In Group C patients received 750 mg of Iodine per kg of Lean Body Weight of Iomeprol 400 and images were acquired at 120 kV. Attenuation values were measured on pre contrast and portal venous phase. Contrast Enhancement Indexes (CEI) were calculated by subtracting basal densities from post contrast acquisitions. Means were compared with Paired T-test. Image quality was evaluated by a blinded independent reader.

**RESULTS**
Mean CEIs for groups A, B and C were respectively 49.37 HU (±7.2), 58.04 HU (±11.3), 54.55 HU (±8.9). Liver enhancement achieved injecting Iodixanol 320 was significantly higher at 100 kV if compared with imaging at 120 kV (P = 0.0369; CI 0.67-18.2). Liver enhancement achieved injecting Iodixanol 320 at 100 kV was not significantly different from that achieved injecting Iomeprol 400 at 120 kV (P = 0.4183; CI -5.581 -12.56). Liver enhancement achieved injecting Iodixanol 320 at 120 kV was not significantly different from that achieved injecting Iomeprol 400 at 120 kV (P = 0.0526; CI -12 -0.07). No significant differences were observed in terms of image quality among the three groups.

**CONCLUSION**
Similar liver enhancement values were observed injecting a lower amount of Iodixanol 320 compared to the ones achieved injecting Iomeprol 400. Values were even more similar when images obtained at 100 kV with Iodixanol 320 were compared to the ones obtained at 120 kV with Iomeprol 400 with no significant differences in terms of image quality.

**CLINICAL RELEVANCE/APPLICATION**
Our study demonstrated the possibility of the iodine-dose reduction in 80-kVp CT imaging of the pancreas. This information is useful for designing clinical protocols for pancreatic CT imaging.

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**Gastrointestinal (Esophagus) Wednesday, 03:00 PM - 04:00 PM • E353B Back to Top**

**SSM07-01 • Esophageal Carcinoma: With Diffusion-tensor MR Imaging and Tractography Ex Vivo**

**Ichiro Yamada** MD (Presenter); **Keigo Hikishima** PhD, MS; **Naoyuki Miyasaka** MD; **Yutaka Tokairin** MD; **Tatsuyuki Kawano** MD; **Eisaku Ito** MD; **Daisuke Kobayashi** MD; **Yoshinobu Eishi** MD; **Hideyuki Okano** MD, PhD; **Hitoshi Shibuya** MD

**PURPOSE**
To determine the usefulness of diffusion-tensor MR imaging and tractography for evaluating the depth of mural invasion by esophageal carcinomas.

**METHOD AND MATERIALS**
Twenty esophageal specimens containing 20 carcinomas were studied using a 7.0-T MR system with a four-channel phased-array surface coil. Diffusion-tensor MR imaging was performed by using a diffusion-weighted spin-echo pulse sequence based on a Stejskal-Tanner diffusion preparation. The imaging parameters were: repetition time, 3000 msec; echo time, 25 msec; field of view, 50-60 x 25-30 mm; matrix, 256 x 128; section thickness, 1 mm without intersection gaps; voxel size, 0.195-0.234 x 0.195-0.234 x 1 mm (0.036-0.055 mm3); number of excitations, two; b value, 0 sec/mm2 or 1000 sec/mm2; and motion-probing gradient, in seven noncollinear directions. Diffusion-tensor tractographic images were computed with TrackVis software. MR images were compared with the histopathologic findings as the gold standard.

**RESULTS**
Diffusion-tensor MR imaging and tractography are capable of clearly depicting the individual tissue layers of the normal esophageal wall, and they have excellent diagnostic accuracy for evaluating the mural invasion of esophageal carcinomas. Thus, they may make it possible to noninvasively diagnose the depth of mural invasion by esophageal carcinomas.
**SSM07-02 • Is PET-CT a Better Tool than EUS for Preoperative Staging of Esophageal Cancer? A Comparative Study**

Seyed Mahdi Abtahi MD (Presenter); Azadeh Elmi MD; Yingbing Wang MD; Yuen Chi Ho; Sandeep S Hedgire MD; Mukesh G Harisinghani MD

**PURPOSE**
Currently, there is no single ideal staging modality for preoperative staging of esophageal cancer. The aim of this study was to assess the role of PET-CT in the pretreatment staging of esophageal cancer. We also compared the diagnostic accuracy of PET-CT with endoscopic ultrasound (EUS) in distinguishing low-stage disease (T1 and T2) from advanced T-stage disease.

**METHOD AND MATERIALS**

**RESULTS**
The overall accuracy of PET-CT in predicting the correct stage was significantly higher than EUS (p=0.002). However, there was no significant difference in comparison made for T-staging between the two modalities (p-value= 0.247). Correct T-staging was performed by PET-CT in 72.2% and by EUS in 55.58% of the patients. Overstaging was more observed by EUS (p=0.008). The sensitivity of the modalities was similar for distinguishing advanced T-stage disease; however, the specificity was significantly higher for PET-CT (93.8% vs. 62.5%, p=0.006). The performance of PET-CT for evaluating nodal involvement was significantly higher than EUS (accuracy of 91.4% and 73.6%, respectively, p=0.002). The sensitivity and specificity for distant metastasis were 82.5% and 93.7% for PET-CT and 75% and 81% for EUS.

**CONCLUSION**
Combination of PET-CT has a superior overall staging ability over EUS in our study group especially for nodal and distant disease staging. The tests showed similar performance in tumoral staging while PET-CT demonstrated improved specificity in distinguishing advanced T-stage disease.

**CLINICAL RELEVANCE/APPLICATION**
Integration of PET-CT into the staging work-up of esophageal cancer may improve the accuracy compared with EUS alone. PET-CT may contribute to better treatment planning for advanced T-stage disease.

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**SSM07-03 • Chemotherapy Response in Gastroesophageal Tumours with Magnetic Resonance and 18F-FDG-PET/CT: Correlation of Apparent Diffusion Coefficient (ADC) and Partial Volume Corrected Standardized Uptake Value (PVC-SUV) with Tumour Regression Grade (TRG)**

Francesco Giganti MD (Presenter); Francesco A De Cobelli MD; Carla Canevari MD; Francesca Gallivanone; Carlo Staudacher MD; Alessandro Del Maschio MD

**PURPOSE**
Patients with locally advanced gastroesophageal tumours (GT) or adenopathies are treated with neoadjuvant chemotherapy (NC) to make radical resection possible. TRG is a histological objective indicator of treatment response which scores residual tumour in 5 grades (0-4). Aim of our study was to compare ADC and PVC-SUV changes during NC with TRG to evaluate if molecular imaging biomarkers from Diffusion Weighted Imaging (DWI) Magnetic Resonance (MR) and 18F-FDG-PET/CT may help to differentiate between Responders (R) and Non Responders (NR) to NC.

**METHOD AND MATERIALS**
31 patients affected by GT (7 esophageal, 3 gastro-esophageal junction, 21 stomach) were evaluated on a 1.5-T MR system including DWI performed using b value of 0 and 600 s/mm2, before and 3 weeks after the end of NC and ADC were calculated. Patients also underwent a basal and a follow up 18F-FDG-PET/CT scan, before and after NC, and PVC-SUV were obtained, as quantitative PET biomarkers.

**RESULTS**

**CONCLUSION**
DWI-MR, which can be performed in a relatively short examination time compared to 18-FDG-PET/CT, may become an important imaging technique in evaluating CT response in patients with GT. Our study suggests that DWI-MR is potentially capable of offering more accurate information for treatment response than 18F-FDG-PET/CT in these Patients and modifications of ADC may represent a reproducible tool to assess tumor response to NC.

**CLINICAL RELEVANCE/APPLICATION**
DWI-MR and ADC modifications are potentially capable of offering more accurate information for treatment response than 18F-FDG-PET/CT in gastroesophageal cancers.

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**SSM07-04 • Diagnosing Leak after Esophagectomy for Esophageal Cancer by CT-esophageal Protocol (CTEP) and Standard Esophagram (SE): Is the Old School Still the Best School?**

Diana M Palacio MD (Presenter); Wayne L Hofstetter; Arlene M Correa PhD; Sonia L Betancourt Cuellar MD; Edith M Marom MD

**PURPOSE**
This retrospective study, compares CTEP and SE, alone or in combination, to the clinical diagnosis of leak established by endoscopy, operation and/or clinical course.

**METHOD AND MATERIALS**
We reviewed the charts of patients who underwent esophagectomy for esophageal cancer between 1/2005 to 1/2009. A final diagnosis of leak was made based on a combination of clinical course, endoscopic and/or surgical evaluation: Type 1= Subclinical leak, imaging diagnosis only. Type 2= Clinical suspicion for leak +/- positive imaging, conservative management. Type 3= Clinical suspicion for a leak, +/- positive imaging, requiring an intervention. Type 4= conduit necrosis diagnosed at re-operation, +/- positive imaging. Reports of all diagnostic CT-EP and SE performed < 31 days post-op were reviewed and the diagnosis of leak classified as either small/contained vs. large /uncontained. A cross match between the clinical leak diagnosis and the imaging results was made.

**RESULTS**
382 patients underwent esophagectomy. 23 patients did not have any imaging and were excluded. Of the remainder 359, 18F-FDG-PET/CT alone, 18F-FDG-PET/CT and CTEP only, and 66 CTEP+SE. SE was done 4-31 d post-op (mean=13), and CTEP done 1-31 d post-op (mean=9). If CT+SE, both were performed.

**CONCLUSION**
SE alone has higher S, S, PPV, and NPV than CTEP alone for identification of leak. Although SE+CTEP slightly improves sensitivity, the specificity only improves compared to CTEP alone. CTEP had greater false+ and false- than SE. SE may continue to be the imaging method of choice to evaluate anastomotic leak.

**CLINICAL RELEVANCE/APPLICATION**
Despite the increased availability and usage of Chest CT-EP, when an esophageal leak is suspected after esophagectomy, an esophagram is recommended due to its greater accuracy as compared to CT.
Eosinophilic esophagitis (EE) is a chronic inflammatory condition of the esophagus that presents with symptoms of dysphagia and food bolus impaction. The patients are referred for barium swallow examination (BSE) either from the community or following inconclusive endoscopy. The aim of this study was to determine the sensitivity and specificity of BSE for diagnosing EO by using histology as the gold standard. Established radiological features from previous studies were used.

RESULTS
A total of 824 outpatient BSE were performed for a variety of oesophageal symptoms. Sixteen patients were diagnosed as EE of which 14 patients were confirmed to have EE on subsequent histology. Fifteen patients were diagnosed with EE on histology, which also included the 14 patients that were diagnosed by BSE. One patient was diagnosed on a random endoscopic biopsy but had not undergone BSE. The most common symptom was intermittent dysphagia (14 patients) followed by food bolus obstruction (10 patients). The most common radiological feature was presence of ring deformity (16 patients), followed by a fixed stricture (5 patients). The true positives were 87.5%; false positives, 12.5%; true negatives, 100%; false negatives, 0%. This sensitivity of diagnosing EE on BSE was 100% and specificity was 99.7%.

CONCLUSION
In an appropriate clinical setting, BSE can be used as a reliable investigation for the diagnosis and management of EE.

CLINICAL RELEVANCE/APPLICATION
EE is often erroneously treated for reflux esophagitis. BSE can help in appropriate diagnosis and management of difficult cases.

SSM07-06  Oral Effervescent Powder Administration for Multidetector CT Evaluation of the Esophagus - A Validation Study

Kristina J Ringe MD (Presenter); Simone Meyer; Frank K Wacker MD *; Hans-Juergen Raatschen MD

PURPOSE
To quantitatively and qualitatively assess the value of oral effervescent powder administration for CT evaluation of the esophagus in patients without underlying esophageal disease.

METHOD AND MATERIALS
This prospective study was IRB approved. 42 patients (27 males/15 females, mean age 57y) who where referred for thoraco-abdominal staging CT were included. Contrast-enhanced CT was performed on a 64-slice scanner after oral administration of 3g effervescent powder immediately before image acquisition. Distension of the esophagus was assessed at three levels (proximal/middle/distal) by volumetry of the inner (ID) and outer diameter (OD), using a thin client software. In addition, esophageal distension in the corresponding segments was evaluated qualitatively separately by two blinded readers on a three-point scale. Further, at an interval of two weeks, both readers in consensus decided on the number of diagnostic esophageal segments in each patient in terms of the possibility to decide upon a potentially underlying pathology. Findings were compared with results from an age and sex matched control group (42 patients; 30 males, 12 females; mean age 62 y). Quantitative and qualitative results of both groups were compared (T-Test, Mann-Whitney-U-Test). Inter-observer variability was calculated (weighted-Cohen-k).
Our study suggests that heterogenous hyperintensity in the hepatobiliary phase of gadoxetic acid-enhanced MR imaging is a new potential than other HCCs. Heterogeneously hyperintense HCCs in the hepatobiliary phase of gadoxetic acid-enhanced MR imaging have more malignant independent prognostic factor for disease-free survival (P = .0308).

In multivariate analysis, heterogeneous hyperintensity in the hepatobiliary phase of gadoxetic acid-enhanced MR imaging was an hypointense (P = .0155 and P = .0215) and hyperintense (P = .0330 and P = .0220) groups. In univariate analysis, Kaplan-Meier method with the log-rank test and Cox proportional hazard model.

Kruskal-Wallis test and Mann-Whitney U test where appropriate. The patient disease-free survival analysis was performed by the background liver. The clinicopathological findings were compared among these three groups by Fisher’s exact test, the FLLs were classified as homogeneously hypointense (n = 44), A total of 68 patients with 70 pathologically proved HCCs who underwent gadoxetic acid-enhanced MR imaging prior to surgery were enrolled. Based on the signal intensity in the hepatobiliary phase, lesions were classified as homogeneously hypointense (n=136), 2)acute hepatitis (n=9), 3)chronic hepatitis (n=240), 4)cirrhosis (n=254) and cause of diseases are classified as 1)viral infection (n=362), 2)alcohol (n=176), 3)others (n=125) by clinicopathologic settings. We compared mean values and standard deviation (SD) provided by SWE and calculated median values.

RESULTS
Mean values of LS as follows: normal, 6.19±1.83kPa; fatty liver disease, 7.88±5.96kPa; acute hepatitis, 12.66±6.31kPa; chronic hepatitis, 8.47±5.57kPa; cirrhosis, 19.54±13.70kPa. There is significant difference of mean values and SD between cirrhosis and each other liver disease (p<0.01). According to causes of liver diseases, mean values of LS were significantly different: chronic hepatitis by virus, 8.04±4.01kPa; by alcohol, 12.60±11.56kPa (p

CONCLUSION
LS values by SWE is significantly higher in cirrhosis than in other hepatic diseases and also affected by causes of chronic hepatic diseases. Degree of alcoholic liver disease cannot be possible by SWE.

CLINICAL RELEVANCE/APPLICATION
SWE could help to distinguish cirrhosis from diffuse liver diseases. In chronic hepatic diseases, the measured values by SWE have to be adjusted according to causes such as virus and alcohol.

Veyesel Akgun MD (Presenter); Murat Kocaoglu MD; Bilal Battal; Yalcin Bozkurt; Mustafa Tasar MD

PURPOSE
The aim of this study is to assess the value of visual assessment of DWIs and ADC maps in determining hemangiomas and simple cysts without additional sequences and contrast medium administration and its capability in exclusion of malignancy.

METHOD AND MATERIALS
283 focal liver lesions (FLL) (69 malign, 214 benign) in 130 patients (74 men, 56 women, mean age 50.7, age range 15 to 80 years) that were detected in ultrasonography or computed tomography underwent MR and diffusion weighted imaging with non breath-hold single-shot echo-planar spin echo sequences. Most of the benign FLLs were cysts (n=89, 38.7%) and hemangiomas (n=96, 41.7%). The lesions that were hyperintense on diffusion weighted images (DWI) with low b value and ADC maps and hypointense on DWIs with high b value were noted as hemangiomas and simple cysts, respectively. The signal intensities of the FLLs on DWIs with low and high b values and ADC maps were noted by two radiologists blinded to the pathological and radiological diagnoses in consensus. All FLLs were classified according to pathological diagnosis or radiologic follow-up. Then we formed a cross table to determine sensitivity, specificity, positive and negative predictive values for characterization of the simple cysts and hemangiomas and for exclusion of malignancy.

RESULTS
The sensitivity and specificity were 98.6% and 99.5%, respectively. The positive predictive value was 98.6% and negative predictive value was 98.6% for the visual assessment of the DWIs and ADC maps for the characterization of the hemangiomas and simple cysts and in exclusion of malignancy for these 185 FLLs.

CONCLUSION
Visual assessment of DWIs and ADC maps can be useful in characterization of the hemangiomas and simple cysts, and in exclusion of malignancy without additional sequences and contrast medium administration. As a consequence, this technique can decrease study time and cost.

CLINICAL RELEVANCE/APPLICATION
By using DWIs and ADC maps we can characterize most of the hemangiomas and simple cysts and exclude malignancy without additional sequences and contrast medium administration.

Nobuhiro Fujita MD, PhD (Presenter); Akihiro Nishie MD; Yoshiki Asayama MD; Yasuhiro Ushijima MD; Yukihisa Takayama MD *; Hiroshi Honda MD; Dai Shimamoto; Ken Shirabe; Yuichiro Kubo MD

PURPOSE
To clarify the relationship between biological behavior of hepatocellular carcinomas (HCCs) and signal intensity in the hepatobiliary phase of gadoxetic acid-enhanced MR imaging with a special focus on its heterogeneity.

METHOD AND MATERIALS
A total of 68 patients with 70 pathologically proved HCCs who underwent gadoxetic acid-enhanced MR imaging prior to surgery were enrolled. Based on the signal intensity in the hepatobiliary phase, lesions were classified as homogeneously hypointense (n = 44), heterogeneously hyperintense (n = 20) and homogeneously hyperintense (n = 6) groups, by comparing with the signal intensity of the background liver. The clinicopathological findings were compared among these three groups by Fisher’s exact test, Kruskal-Wallis test and Mann-Whitney U test where appropriate. The patient disease-free survival analysis was performed by the Kaplan-Meier method with the log-rank test and Cox proportional hazard model.

RESULTS
The tumor size and serum level of PIVKA-II were significantly higher in heterogeneously hyperintense group than homogeneously hypointense (P = .0155 and P = .0215) and hyperintense (P = .0330 and P = .0220) groups. In univariate analysis, heterogeneously hyperintense group showed lower disease-free survival rates than homogeneously hypointense group (P = .0125). In multivariate analysis, heterogeneously hyperintensity in the hepatobiliary phase of gadoxetic acid-enhanced MR imaging was an independent prognostic factor for disease-free survival (P = .0308).

CONCLUSION
Heterogeneously hyperintense HCCs in the hepatobiliary phase of gadoxetic acid-enhanced MR imaging have more malignant potential than other HCCs.

CLINICAL RELEVANCE/APPLICATION
Our study suggests that heterogenous hyperintensity in the hepatobiliary phase of gadoxetic acid-enhanced MR imaging is a new imaging biomarker to indicate malignant potential of HCCs.
**SSM08-05 • Intrahepatic Mass Forming Cholangiocarcinomas (IMCC): Utility of Feature Analysis for Differentiation from Other Intrahepatic Mass Lesions**

Laura Heacock MS, MD (Presenter); Andrew B Rosenkrantz MD; Sooah Kim MD; Nicole M Hindman MD

**PURPOSE**
To evaluate the imaging features of intrahepatic mass-forming cholangiocarcinomas (IMCC) at contrast-enhanced dynamic CT and MRI, which allow for differentiation from other common intrahepatic tumors.

**METHOD AND MATERIALS**
Study was IRB approved with waiver of informed consent. 41 patients with 41 pathologically confirmed IMCCs underwent contrast-enhanced dynamic CT or MRI. Size-matched lesions of pathological proven hepatocellular carcinoma (HCC, n=36), isolated hepatic metastases (n=43), liver abscesses (n=39) and imaging proven (stability over >2 years) hemangiomas (n=42) were evaluated. Two blinded readers (R1, R2) retrospectively assessed all lesions for morphologic and enhancement features and assigned a diagnosis from the tumor types included. Features analyzed were: heterogeneous rod-like internal enhancement, a peripheral complete rim of enhancement, progressive delayed central enhancement, presence of capsular retraction, portal vein thrombosis, or biliary dilatation proximal to the mass. Imaging feature frequencies were compared between lesion types.

**RESULTS**
Readers correctly identified 51.2% of IMCCs, 86.9% of hemangiomas, 87.5% HCCs, 77.4% metastases and 83.4% of abscesses. The most frequently seen imaging features in IMCC were biliary dilatation proximal to the mass (R1: 53.7%; R2: 61%) and portal vein thrombus (R1: 46.3%; R2 46.3%); these features were present significantly more frequently in IMCCs than other lesions (p < 0.01). Differentiation of IMCC from other liver masses is best determined by the presence of portal venous thrombosis and proximal biliary dilatation. Heterogeneous rod-like internal enhancement helps distinguish IMCC from HCC and may be particularly useful in cirrhotic patients, for whom other focal hepatic lesions are less likely.

**CLINICAL RELEVANCE/APPLICATION**
The presence of portal vein thrombosis, proximal biliary dilatation and heterogeneous internal rod-like enhancement are important imaging features for distinguishing IMCC from other hepatic lesions.

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**SSM08-06 • Liver Remnant Regeneration in Donors after Living Donor Liver Transplantation: Long-term Follow-up Using CT and MR Imaging**

Andreas Koops MD (Presenter); Philipp Simon MD; Harald Ittrich MD; Lutz Fischer; Thorsten Klink MD; Gerhard B Adam MD

**PURPOSE**
To assess liver remnant volume regeneration and maintenance, and complications in long-time follow-up of donors after living donor liver transplantation using CT and MRI.

**METHOD AND MATERIALS**
47 patients with a mean age of 33.5 years who donated liver tissue for transplantation and were available for follow-up imaging were included in this retrospective study. Contrast-enhanced CT and MR images were acquired according to standardized protocols of the upper abdomen. Two observers evaluated pre- and postoperative images, analyzed liver volume regeneration, and documented postoperative complications.

**RESULTS**
47 preoperative and 89 follow-up studies covered a mean period of 22.4 months (range, 1-84). Right liver lobe (segments V-VIII) was donated in 18 cases, left liver donation of segment II and III was performed in 24 cases, and of segments II-IV in 5 cases. Liver remnants regenerated rapidly within the first 6 months. After 36 months, the remnant volume was not significantly reduced compared to the preoperative liver volume (p=0.2155), and was maintained at a minimum of 80% in most patients. Minor postoperative complications were found early in 4 patients. No severe or late complications or mortality occurred.

**CONCLUSION**
Remaining liver volume regenerated rapidly in all donors, and was restored and maintained in most patients despite minor complications. No severe or late complications occurred during long-term follow-up.

**CLINICAL RELEVANCE/APPLICATION**
CT and MRI are valuable tools in the follow-up of donors after live liver transplantation.

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**Genitourinary (Evaluation of Hematuria) Wednesday, 03:00 PM - 04:00 PM • E351**

**SSM09 • AMA PRA Category 1 Credit™ • ARRT Category A+ Credit: 1 Moderator Amy M Neville, MD**

**SSM09-01 • 640-slice CT Perfusion Imaging in Tumor of Urinary Bladder: An Initial Study**

Sun Bo MENG, BMBS (Presenter); Hao Xiaoru; Lai Tingmei; Sun Chang Hua; Wang Chuntao; Lin Li; Xv Guang Chao; Liu Yuyan

**PURPOSE**
To explore the clinical value of 640-slice CT perfusion imaging (CTP) in diagnosis and differential diagnosis for tumor of urinary bladder.

**METHOD AND MATERIALS**
One hundred and five patients with urinary bladder tumor were qualified for this reseach. All patients underwent routine CT scanning and dynamic volume scanning with TOSHIBA Aquilion ONE 640-slice CT scanner. The patients were divided into Group A (benign bladder diseases) and B (bladder carcinoma) according to the malignancy. Time-density curve (TDC) of the patients was depicted. Perfusion parameters of CT, BV, and Clearance were obtained automatically. All parameters were statistically analyzed between groups. All patients achieved 640-slice CT enhancement perfusion imaging, thirty one of them were enrolled in the benign group, in which ten were divided into subgroups of urothelial papilloma and twenty one were divided into subgroups of adenocystitis. Seventy four patients enrolled in the malignant group and they were all urothelial carcinoma, and twenty eight were divided into subgroups of low grade of papillary urothelial carcinoma and forty six were divided into subgroups of high grade of papillary urothelial carcinoma.

**RESULTS**
TDC speeds up fast and sustains then descends slowly in malignant groups, whereas benign groups show low and flat in TDC. Moreover AF, BV, Clearance of malignant groups are respectively 163.92±35.733ml/100g/min, 42.19±10.464 ml/100ml, 10.185±1.144 ml/min/100ml; AF and BV of benign groups are respectively 58.890±9.238 ml/100g/min and 3.62±0.472 ml/100ml. But the clearance of benign group can not be measured. The difference in AF and BV is statistically significant between two groups( P< 0.001).

**CONCLUSION**
640-slice CTP might have the potential capability for exactly demonstrating the blood flow features of bladder, and it shows great reference value for differential diagnosis between benign bladder disease and bladder carcinoma.
Valuable tool for T staging of urinary bladder cancer. The purpose was to evaluate values of DWI in orthogonal planes for T staging of urinary bladder cancer.

**METHOD AND MATERIALS**

Thirty-two patients underwent CTU including ultra-low dose tri-phasic EPs acquired on 5, 10, and 15 minutes after administration of contrast media using adaptive iterative dose reduction 3D. For qualitative analysis, opacification scores for four segments of upper urinary tracts (renal collecting systems, upper, middle, lower ureters) and urinary bladders were recorded and were compared among the three phases. For quantitative analysis, the ratio of the CT values of anterior and posterior portion of the urinary bladder was compared among the three phases. For statistical analysis, we used Friedman test for opacification scores, and Cochran's Q test if opacification scores were analyzed.

**RESULTS**

Opacification scores for the upper urinary tracts were not statistically different in all segments among the three phases, while those for the urinary bladders were significantly higher in EP with longer delay time (5 vs 10 minutes, P <0.05). Complete opacification of the upper urinary tracts, however complete opacification of bladder is difficult even with tri-phasic acquisition.

**CONCLUSION**

The optimal delay time may be 15 minutes for the urinary bladder in the excretory phase (EP), but upper urinary tracts are not adequately delineated even in multi-phasic EP.

**Clinical Relevance/Application**

Be much valuable in the follow-up for patients with bladder carcinoma after tumor resection.

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**SSM09-03 • Low Dose CT Urography: Does Longer Delay Time or Tri-Phasic Acquisition for Excretory Phase Achieve Complete Opacification of Urinary System?**

Hiroshi Juri (Presenter) ; Takahiro Tsuyobayama MD ; Seishi Kumano MD ; Yuki Inada ; Kazuhiro Yamamoto MD ; Yoshifumi Narumi MD ; Mitsuhiro Koyama MD ; Hiroyuki Akagi MD ; Masako Yuki MD ; Haruhiro Azuma

**Purpose**

To evaluate if longer delay time or multi-phasic acquisition for the excretory phase (EP) in CT urography (CTU) can achieve complete opacification of urinary systems.

**METHOD AND MATERIALS**

Thirty-two patients underwent CTU including ultra-low dose tri-phasic EPs acquired on 5, 10, and 15 minutes after administration of contrast media using adaptive iterative dose reduction 3D. For qualitative analysis, opacification scores for four segments of upper urinary tracts (renal collecting systems, upper, middle, lower ureters) and urinary bladders were recorded and were compared among the three phases. Patients were recorded if all upper urinary segments were delineated completely on single-, bi-, and tri-phasic EPs. For quantitative analysis, the ratio of the CT values of anterior and posterior portion of the urinary bladder was compared among the three phases. For statistical analysis, we used Friedman test for opacification scores, and Cochran's Q test if opacification scores were analyzed.

**RESULTS**

Opacification scores for the upper urinary tracts were not statistically different in all segments among the three phases, while those for the urinary bladders were significantly higher in EP with longer delay time (5 vs 10 minutes, P <0.05). Complete opacification of the upper urinary tracts, however complete opacification of bladder is difficult even with tri-phasic acquisition.

**CONCLUSION**

The optimal delay time may be 15 minutes for the urinary bladder in the excretory phase (EP), but upper urinary tracts are not enough delineated even in multi-phasic EP.

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**SSM09-04 • Evaluation of the Usefulness of DWI in Orthogonal Planes for T Staging of Urinary Bladder Cancer at 3T MRI**

Kazuma Terauchi (Presenter) ; Takayuki Masui MD ; Motoyuki Katayama MD ; Kimihiko Sato MD ; Kei Tsukamoto ; Kenichi Mizuki MD

**Purpose**

Diffusion-weighted imaging (DWI) at 3T using 32 channel body array multicoil can visualize anatomical structures well and are useful tool for T staging of urinary bladder cancer. The purpose was to evaluate values of DWI in orthogonal planes for T staging of urinary bladder cancer at 3T MRI.

**METHOD AND MATERIALS**

This study was approved by the IRB in our hospital. 50 consecutive patients were included in the study, who underwent MRI for evaluation of the urinary bladder cancer at 3T MRI (Discovery MR750 GEHC, 32 channel body array coil) between October 2010 and January 2012. There were 41 men and nine women (mean age 71.3 years) and written informed consent was obtained from each patient. Of the total 66 lesions, 65 lesions were resected with TUR and the one patient with one lesion underwent cystectomy after TUR. Pathologic tumor staging for T1 or lower, T2, T3, and T4 was 54, 5, 2, and 2. DWI in a transverse plane (b value = 1500, TE = 5000/58.3 msec, slice thickness 3 mm) and additional either coronal or sagittal plane were obtained. T stage criteria of DWI for urinary bladder cancer was as follows: T1 or lower; flat tumor or tumor with submucosal stalk, T2; tumor without submucosal stalk or tumor bulging with smooth surface, T3; tumor with irregular margin, T4; tumor extending to adjacent organ. It was referred to as T1, if stalk was visualized in any one plane when evaluated with DWI in two planes. Two radiologists evaluated the depth of invasion in the case of transverse DWI and DWI in two planes. Sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV) regarding the presence or absence of muscle invasion were also calculated.

**RESULTS**

63 lesions (95.5%) could be detected by both transverse DWI, and DWI in two planes. The number of preoperative tumor stage for T1, T2, T3, and T4 were 18, 16, 2, and 2 for transverse DWI: 49, 11, 1, and 2 for DWI in two planes, respectively. The sensitivity, specificity, PPV, and NPV for tumor of stage between T1 or lower and T2 or higher were 90.9%, 84.6%, 55.6%, and 97.8% for transverse DWI; 90.9%, 92.3%, 71.4%, and 98.0% for DWI in two planes respectively.

**CONCLUSION**

DWI in two planes can accurately evaluate the presence or absence of muscle invasion and improves tumor staging for urinary bladder cancer.

**Clinical Relevance/Application**

Preoperative T staging is important for management of urinary bladder cancer.
PURPOSE
To optimize CT Urography (CTU) of the lower urinary tract by combining a distended urine-filled bladder in the urothelial phase with a distended, homogeneously contrast-opacified bladder in the excretory phase.

METHOD AND MATERIALS
The study included 115 patients referred for CTU. All patients drank 1 liter of water 2 hours prior to the examination and were instructed not to void. Patients were randomised into five equal groups: A) standard single-bolus 3-phase CTU with unenhanced, unopacified (UroP) and 5 min delay excretory (EP) phases; B) standard 3-phase CTU with 5 mg IV furosemide; C) Voiding after the UroP and 15 min delay EP without IV furosemide; D) Voiding after the UroP and 30 min delay EP without IV furosemide; E) Voiding after the UroP and 30 min delayed EP with IV furosemide. Two observers evaluated bladder volume and the percentage of contrast opacification.

RESULTS
Median EP bladder contrast opacification was 20% in group A, 50% in group B, and 100% in groups C-E. The mean EP bladder volume and mean percentage of bladder volume in EP compared to the UroP in group A was 350 ml +20%; group B 438 ml and +48%; group C 162 ml and -29%; group D 281 ml and -17%; group E 469 ml and +106%. A trend curve of groups C-D, estimating the time to achieve EP bladder volume similar to UroP pre-voiding is 43 minutes. Use of furosemide will allow complete bladder refilling in less than 30 minutes.

CONCLUSION
Voiding following the UroP and performing a long-delay EP will create optimal conditions for diagnosis of bladder cancer. Use of furosemide will keep scan delay times for EP practical.

CLINICAL RELEVANCE/APPLICATION
Using furosemide and voiding after the UroP and performing a 30-min delayed EP scan a practical combination of optimal UroP and EP for bladder cancer detection in CTU protocols can be achieved.

SSM09-06 • Isotropic Volume Diffusion-weighted Imaging of Bladder Cancer: Feasibility and Preliminary Evaluation of Staging Accuracy

Mitsuru Takeuchi MD, PhD (Presenter); Kiyotaka Mori; Hirohito Kan; Nobuyuki Arai MS; Tatsuya Kawai MD; Yuta Shibamoto MD, PhD; Takatsune Kawaguchi MD; Yuki Kamishima; Masaki Hara MD, PhD

PURPOSE
To investigate the feasibility of obtaining isotropic volume diffusion-weighted imaging (VDWI) of bladder cancer and its staging accuracy.

METHOD AND MATERIALS
Between May 2012 and April 2013, 25 patients (15 men and 10 women; mean age, 72 years) with bladder cancer underwent 3-T MRI: Axial and sagittal conventional DWI (CDWI) (b value, 1,000 s/mm\(^2\); repetition time/echo time, 5,900/61 msec; matrix, 128 x 128; thickness/gap, 4 /0.4 mm; field of view, 320 x 260 mm) and axial VDWI (b value, 1,000 s/mm\(^2\); repetition time/echo time, 14,000/72 msec; matrix, 140 x 140; thickness/gap, 2.2 /0 mm; field of view, 280 x 240 mm) were obtained. Sagittal and oblique planes were reconstructed from axial VDWI. The contrast-to-noise-ratio (CNR) of the lesion and bladder muscle on CDWI and VDWI were measured. The subjective image quality of the axial and sagittal CDWI, axial VDWI and reconstructed sagittal and oblique plane DWI were visually scored with a 5-point scale for bladder muscle layer and bladder cancer. For the evaluation of the CNRs and subjective image qualities, Wilcoxon matched-pairs test was used to compare CDWI and VDWI. The 25 bladder cancers were staged using CDWI and VDWI based on the following findings: bladder cancer, tumor stalk and muscle layer show high, low and intermediate signal intensity, respectively. The staging accuracy of the CDWI and VDWI was evaluated with pathological stage and compared with McNemar test.

RESULTS
The CNR of the bladder cancers on CDWI and VDWI were 81.6 and 79.9, respectively, with no significant difference. The mean subjective image quality scores of bladder muscle layer and bladder cancer were respectively 4.6 and 4.9 on both axial CDWI and sagittal CDWI, 4.3 and 5.0 on axial VDWI, and 4.2 and 5.0 on reconstructed sagittal and oblique plane DWI. There were no significant differences between subjective image quality of CDWI and VDWI. Overall staging accuracy, sensitivity and specificity of bladder tumor invasion on VDWI were 84%, 86% and 94%, respectively, and were the same as those of CDWI.

CONCLUSION
Obtaining VDWI is feasible with good image quality and staging accuracy similar to those of CDWI. It is an advantage of VDWI that optimal arbitrary planes for each tumor staging can be obtained from one volume data.

CLINICAL RELEVANCE/APPLICATION
VDWI could be applied for patients with bladder cancer, in particular in which axial or sagittal planes are not perpendicular to the tumor base.

ISP: Health Service, Policy and Research (Medicolegal and Ethics) Wednesday, 03:00 PM - 04:00 PM • S102D

SSM10 • AMA PRA Category 1 Credit ™
Moderator James V Rawson, MD
Annette J Johnson, MD, MS

SSM10-01 • Health Service, Policy and Research Keynote Speaker: Medicolegal and Ethics
James V Rawson MD (Presenter)

SSM10-02 • The Medical Malpractice Environment for Radiology at a Large Integrated Health System: A 5-Year Survey

H. B Harvey MD, JD (Presenter); Sam T Boland; Deborah LaValley RN; Garry Choy MD, MS

PURPOSE
Medical malpractice liability is a pervasive concern among radiologists and shapes the way radiology is practiced. Working with a professional liability insurer, we studied the radiology malpractice liability environment at a large integrated health system over a five-year period.

METHOD AND MATERIALS
All medical malpractice claims asserted against the health system from 1/1/2008 to 12/31/2012 were collected and analyzed. Claims were categorized based on the medical specialties involved, total liability costs incurred, and the disposition of closed cases. Claims involving radiology were further evaluated to determine severity of the injury asserted, health care setting involved, primary allegation asserted, and, for missed diagnosis cases, the primary diagnosis missed. When possible, comparison was made to the Comparative Benchmarking System (CBS), a large national HIPAA-compliant, medical malpractice claims database.

RESULTS
Over the five-year period, 1,126 malpractice claims were asserted against the health system resulting in $623M of total incurred liability. Claims involving radiology made up 8% of the cases, representing the 5th most commonly involved medical specialty, compared to 7th nationwide. Of the radiology claims, 57% were dropped or dismissed, 39% settled, 2% resulted in a defense verdict, and 2% resulted in a plaintiff verdict. The nature of the claims involving radiology was also assessed. Of those claims, 52%
involved a high level of injury severity (defined as injury resulting in death or permanent significant deficit). The majority of the claims involving radiology involved the ambulatory setting (80%), followed by the inpatient setting (13%) and emergency department (7%). The most commonly asserted allegation against radiology involved diagnosis-related negligence (65%), followed by treatment-related (39%) and medication-related (3%) negligence. Cancer was the most commonly missed diagnosis representing 65% of missed diagnosis cases. There was little difference in the nature of the radiology claims compared to nationwide data.

CONCLUSION
Radiology is a significant contributor to malpractice liability with claims commonly originating in the ambulatory setting, involving allegations of diagnostic failure, and resulting in high severity injuries.

CLINICAL RELEVANCE/APPLICATION
Medical malpractice claims data can offer valuable insight into the current liability environment and can direct strategies for reducing liability exposure.

SSM10-03 • SECURE Study: Observational Post-marketing Study on the Safety of Gadoterate Meglumine - Interim Analysis
Harsh Mahajan MD, MBBS (Presenter)
PURPOSE
To prospectively assess the safety profile of gadoterate meglumine and the overall incidence of nephrogenic systemic fibrosis (NSF).

METHOD AND MATERIALS
An ongoing worldwide multicentre post-marketing study (PMS) is conducted to collect safety data in 40,000 patients (adults and children) with or without renal insufficiency, scheduled to undergo a routine contrast-enhanced magnetic resonance (MR) examination using gadoterate meglumine (Dotarem®). Risk factors at inclusion, indications for MR imaging, conditions of the contrast material administration, occurrence of adverse events are recorded. For any patient identified as renally impaired at the time of inclusion (i.e., estimated creatinine clearance or estimated glomerular filtration rate

RESULTS
As of October 23, 2012, the cut-off date for the interim safety analysis, this ongoing PMS included data on 29689 patients (mean age: 50 years; range: 0–98 years; female, 53.4%). MR examinations were mainly performed to image the central nervous system (55.1%). The main risk factors were renal insufficiency (12.7%) and hypertension (11.8%). Moderate to severe impaired renal function was reported in 552 patients (1.9%). Among them, 391 (70.8%) were reported without suspicion of NSF during the 3-month follow-up. For the remaining patients (29.2%), the follow-up evaluation was not yet reported at the time of data analysis.

CONCLUSION
This interim safety analysis already confirms the very good safety profile of gadoterate meglumine.

CLINICAL RELEVANCE/APPLICATION
(dealing with safety of contrast enhanced MRI in patients with or without renal insufficiency regarding NSF) this interim safety analysis confirms the very good safety profile of gadoterate meglumine.

SSM10-04 • Patient-centered Care: Lessons Learned from Brief Radiologist-patient Interviews Prior to Musculoskeletal Magnetic Resonance Imaging
Derik L Davis MD (Presenter); Michael E Mulligan MD; Arie Moszkowicz MD; Charles S Resnik MD
PURPOSE
To determine if brief radiologist-patient interviews before musculoskeletal magnetic resonance imaging (MRI) improve the quality of clinical information available during image interpretation.

METHOD AND MATERIALS
The institutional review board approved this retrospective study and waived informed consent. A total of 186 screening questionnaires completed by outpatients prior to musculoskeletal MRI at a single institution between August and November 2011 were separated into two cohorts: (1) outpatient imaging center (IC) forms with no radiologist-patient interaction; (2) hospital (H) forms with radiologist-patient interviews before MRI. Two musculoskeletal (MSK) radiologists and one MSK fellow independently reviewed each form while blind to the patient demographics, imaging site, clinician referral information, and MR images. The reviewers rated the forms for quality on a 5-point scale: 5(outstanding) to 1(poor). A third MSK radiologist performed a separate analysis to determine if each question received an answer, and also to quantify the response to the open-ended symptoms question. The unpaired t test, Fisher exact test and z2 test were used to compare the two cohorts.

RESULTS
The mean score of the H-cohort among reviewers was higher than the IC-cohort: 3.79 (±0.98) versus 3.04 (±1.00), P

CONCLUSION
Direct radiologist-patient interaction prior to musculoskeletal MRI improves the quality of clinical information available during image interpretation.

CLINICAL RELEVANCE/APPLICATION
The interpretation of imaging studies with inadequate clinical information is not uncommon. Direct radiologist-patient communication before imaging may remedy this problem.

SSM10-05 • The ABR’s Practice Analysis Survey: Comparison of 2010 and 2013
June C Yang PhD,RN (Presenter); Anthony Gerdeman PhD; Kay H Vydareny MD; Gary J Becker MD; Jennifer Bosma PhD
PURPOSE
To present the findings of the 2013 ABR Practice Analysis survey, performed to determine the critically important and frequently performed activities in clinical practice, and to note changes in practice patterns since the prior survey in 2010.

METHOD AND MATERIALS
The survey instrument was distributed electronically to 17,721 members of American College of Radiology with a unique identification code for each individual in 2010 and to 16,369 individuals in 2013. A five-point scale was established for both frequency and importance variables. Rating scales were identical both in 2010 and to 16,369 individuals in 2013.

RESULTS
In 2010, 2909 (19.32%) diagnostic radiologists answered the survey, while in 2013, there were 1964 (13.00%) respondents as of April 2, 2013, 2233 (76.8%) of the respondents indicated that they spent at least 50% of their time in clinical practice in 2010 whereas 1368 (69.65%) diagnostic radiologists who participated reported practicing 50% or more in clinical practice thus far in 2013. The test of statistical significance will be tested in the clinical practice settings and in other demographic data between the two surveys, 2010 and 2013. Changes in top three activities/indications in importance and frequency between the two surveys will be compared.

CONCLUSION
The 2013 practice analysis survey may show changes in practice patterns between 2010 and 2013. These changes will be incorporated into the exam development processes of the ABR.
DICOM Image Lifecycle Management - Reducing Cost by Applying Rules Based Deletion

Carol L Joseph RN (Presenter)

CONCLUSION

The use of rules based deletion can effectively facilitate the removal of aged images from a DICOM archive. Running rules based deletion enables an archive to be maintained at nearly zero growth. These two actions will significantly reduce the cost of future storage expansion. Sites located in States with complex rules may not be able to enable deletion until vendor solutions mature and focused on potential shortages of radiologists, residency positions and medical physicists, while others focused on effective solutions to problems they face everyday.

RESULTS

Survey results indicated that most of the countries (90%), need to establish more radiology residency training positions. For improving knowledge in radiology, 100% thought online teaching modules would be most effective, and 30% believed onsite teaching workshops would help. 60% of radiologists (95% CI being 47.6 to 72.4%) believed that the subspecialty in which they feel most deficient is neuroradiology with musculoskeletal imaging and pediatric imaging being the second and third most highly ranked choices. Only 60% (95% CI being 47.6 to 72.4%) had access to a medical physicist and most believed that they need education in radiation safety and dose reduction. Other practical questions focused on image transfer, organizational development and informatics.

CONCLUSION

This survey helps radiologists around the world communicate the imaging needs in their respective countries and how they can be addressed. This survey can help radiologists who want to reach out in their humanitarian efforts to improve imaging around the world.

Global outreach programs can use this survey to determine more effective ways of improving radiology in developing countries.

Purpose

To assess the clinical needs of radiologists in 10 developing countries to identify unmet imaging needs and to evaluate the potential impact of a pilot ISN site.

Method and Materials

A standardized questionnaire containing 11 questions was sent to radiologists in 18 developing countries across the world. Radiologists from 10 countries responded (response rate=55%). These include Sri Lanka, Thailand, Costa Rica, Belarus, Serbia, Macedonia, Singapore, the Czech Republic, Lithuania and Slovenia. Some questions addressed the overall status of radiology in their countries and focused on potential shortages of radiologists, residency positions and medical physicists, while others focused on effective solutions to problems they face everyday.

RESULTS

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Global outreach programs can use this survey to determine more effective ways of improving radiology in developing countries.
SSM11-03 • Integration of Globus Online with RSNA Clinical Trial Processor (CTP) for High-throughput Image Data Transfer

Stephen J Granite MS, MBA; Dinanath Sulakhe MS (Presenter); Ravi Madduri; Ian T Foster PhD; Rai Winslow PhD

CONCLUSION
RSNA’s CTP suite already improves data transfer rates for imaging data. Adding Globus to CTP improves the transfer rate even more, allowing more time for physicians to analyze data and improve patient care.

Background
The clinical imaging trials involving images coded according to Digital Imaging and Communications in Medicine (DICOM) standard produce large volumes of data and require sophisticated tools to ensure de-identification, transfer, management and distribution. While RSNA’s Clinical Trial Processor (CTP) software suite addresses many of the challenges in handling the imaging data, we present here the development and integration of Globus Online (Globus)-based ExportService within CTP, for a secure, high-throughput data transfer between CTP nodes.

Evaluation
CTP is a tool developed by RSNA that processes and handles data objects in clinical trials in the form of pipelines. The imaging data goes through various stages (i.e., Import Service, Processors, Storage Services and Export Services). In multi-center clinical image collection projects, CTP’s Export Services transfers the DICOM images from the facility producing the images, and CTP’s Import Services receives the data at another center. Currently, CTP supports various export services, implemented using HTTP, DICOM-SCP and FTP protocols. We implemented a GlobusExportService (Fig. 1) within CTP that initiates data transfers of DICOM images between two Globus online endpoints. Globus leverages GridFTP for high performance transfer of single files and directories. It can manage security credentials; select transfer protocol parameters for high performance; monitor and retry transfers when there are faults, and allow users to monitor status.

Discussion
CTP’s HTTP based export service only allows one file transfer at a time (e.g., 500 MB MRI transfer takes 3 hours). The GlobusExportService extends the existing CTP functionalities, collecting all the files from CTP and initiating a bulk transfer using Globus REST API (e.g., same 500 MB transfer takes 2 hours). Thus we preliminarily estimate that the GlobusExportService provides a 33% performance improvement over the existing transfer capabilities of CTP. More tuning may increase performance.

SSM11-04 • Leveraging 3D Immersive and Collaborative Environments (3D-ICE) to Enhance Interactive Collaboration in the Radiology Workflow

Rohini Pangrikar BEng, MS (Presenter); Sarita S Akolkar

CONCLUSION
3D-ICE facilitates interactive collaboration in Radiology workflow. It can seamlessly integrate at hospital sites while ensuring secure access and confidentiality of data.

Background
In the Radiology workflow, referring physicians need to interact directly with radiologists to review medical images or critical results. PACS systems facilitate sharing of patient data but do not support interactive collaboration. When interacting remotely, collaborators juggle with image viewing applications, communication equipment and patient reports. This collaboration is error prone and affects quality of patient care. Productive collaboration entails a single environment enabling real-time interactions and easy access to patient data while adhering to healthcare standards.

Evaluation
3D-ICE is increasingly used as a virtual, one stop, cost-effective remote collaboration solution. In 3D-ICE users are represented as human-like 3D Avatars capable of interpersonal interactions inside customizable Virtual Workspace (VW). VWs simulate real workplaces aiding interactions with minimal training. 3D-ICE:

- Enables real-time, one-stop collaboration using integrated tools
- Ensures secure access to patient data
- Restricts access to VW preserving data confidentiality
- Supports viewing of 3D-reconstructions
- Is also supported on mobile devices

These features can enhance physicians and radiologists’ collaboration while retaining integrity of patient data.

Discussion
3D-ICE can utilize existing infrastructure and integrate into radiology workflow while adhering to healthcare standards:

- Users login to 3DICE clients over secure connections (to a secure 3D-ICE server) to enter VW
- Connect to an IHE compliant facility via shared web-browser in VW ensuring access to patient data across enterprises (XDS-I.b) and auditing (ATNA)
- Integrate file sharing systems with VW or drag-drop files in VW for consolidated view of patient data
- Use images, reports or share monitor screen using integrated shared applications
- Use 3D cues to point ROI in images for precise reference
- Restrict access to VW or export of data outside VW in compliance with local policies
- Auto-delete VW contents after predefined time ensuring data safety

SSM11-05 • Always on Virtualization: A Dramatic Improvement for PACS/RIS Applications and Desktops

Craig Dunwoody (Presenter) *

CONCLUSION
Virtual desktop infrastructure (VDI) solutions have been available for many years, but recent technological improvements have now made VDI truly compelling to radiology organizations.

Background
Radiology professionals are facing significant challenges integrating an increasingly complex environment of different devices, operating systems, and applications. Radiology professionals use multiple devices throughout their day, resulting in an inconsistent desktop experience. Users must contend with multiple logins, varying hardware configurations, and limited tablet access options. The potential for managing and securing the desktop environment is soaring. Maintaining uptime is critical, but is difficult to achieve, especially in large organizations, when hardware or software refreshes are taking place.

Evaluation
In this paper, I will evaluate these challenges and present a strategy that addresses them. A number of virtualization strategies can
SSM11-06 • Strategies for Foreign Study Ingestion by a PACS Interfaced to a XDS Affinity Domain

Alain Gauvin MSc (Presenter) * ; Suzanne Laframboise RT ; Greg Ruthman BSC *

PURPOSE
Ingestion by a local PACS of foreign images is a challenge when importing studies. This work is based on the implantation of a XDS-I.b proxy to allow a PACS to receive pre-fetch priors from other hospitals in a same XDS affinity domain. The coercion of DICOM tags of foreign studies in the context of their ingestion by the PACS needed to be carefully defined. Given that the model was to be used for 6 different PACS technologies, a single automatic ingestion methodology was devised to satisfy all PACS requirements.

METHOD AND MATERIALS
The implementation of the XDS-I.b proxy took place in a center producing about 250 000 studies/year. The XDS registry used in the affinity domain initially allowed the proxy to access studies from 3 different sites. The proxy was able to determine the required pre-fetch set from the HL7 activity of the RIS. Given the modality type and body part of the upcoming study, the required priors were determined by the proxy from a set of pre-defined rules, pulled from their locations, and sent to PACS after the coercion of multiple DICOM tags. The list of coerced tags includes MRN, accession number, institution name, study description and the alphanumeric code of the study. The coercion of the 2 last values of that list was more complex, and was accomplished using logic based on the modality, anatomical code, and keyword detection in the study description of the ingested study. These combined criteria allowed to achieve a granular normalized exam table, comprising more than 170 codes. A simulation tool was set up to allow refining the choice of keyword rules. The normalized codes were configured in the ingesting PACS alongside with the local procedure codes.

RESULTS
The initial daily rate of study intake was on average between 7 and 8, which was expected given that the content of only 3 sites were initially looked up in the XDS registry. That figure was expected to rise to 18 within the following few weeks, and further again over the course of a few months.

CONCLUSION
The implementation of XDS-I in an affinity domain supporting various PACS technologies for the purpose of automatic pre-fetching of prior exams requires careful management of issues related to foreign study ingestion.

CLINICAL RELEVANCE/APPLICATION
It is possible to use the XDS-I.b IHE profile to enhance medical imaging interpretation by increasing the number of priors accessed during reading, as long foreign studies are properly coerced.
A new class of high r1 relaxivity, sub-5 nm, super small iron oxide nanoparticles with oligosaccharide coating as T1-weighted MRI contrast agents was provided while using reverse T2 contrast was used in MRI angiography.

METHOD AND MATERIALS
The sSIO nanoparticles were obtained from the encapsulation of iron oxide core in a thin oligosaccharide shell through in situ polymerization. SIO solutions with different concentrations were examined by a 3T MRI scanner using T1- and T2-weighted fast spin echo sequences, inversion recovery turbo spin echo sequence and multi-echo T2-weighted spin echo sequence. R1 and R2 relaxivities were calculated by fitting signal changes in multi-IR T1 and multi-TE T2 images using simple exponential equations. SIO with different sizes and Gd-BOPTA were intravenously administrated into mice. Fat suppressed T1-weighted spin echo images were obtained to investigate the contrast changes in liver, kidney and iliac artery at the different time points.

RESULTS
The prepared sSIO has an r1 value of 4.2 mM-1s-1 and a high r1/r2 ratio (0.28), which is competitive with commercial Gd-based contrast agent. Significant T1 contrast enhancement in the kidney and iliac artery were evidenced in vivo MRI after intravenously administration of sSIO in mice, similar to that observed in Gd-BOPTA enhanced MRI. The positive contrast enhancement is attributed to the small size and the reduced susceptibility of the nanoparticles, as well as the excellent colloidal stability in physiological environment. Such T1 contrast enhancement is not obvious when using a larger size SIO-10 or 20. Interestingly, uptake of SIO-3 in liver led to strong T2 effect or signal drop in liver further improves the image quality for visualizing liver tissue and hepatic vasculature in T1 weighted MRI. Furthermore, SIO-3 has a much longer blood retention time than small molecule Gd for prolonged imaging time for organs of interest, providing a potential long half time T1 weighted imaging agents for imaging of vasculature of disease tissues.

CONCLUSION
sSIO-3 has a much longer blood retention time than small molecule Gd for prolonged imaging time for organs of interest, providing a potential long half time T1 weighted MR imaging agents for MRI Angiography.

CLINICAL RELEVANCE/APPLICATION
The suprasmall SIOs exhibit excellent T1 contrast in vivo MRI studies, especially for kidney and iliac artery, providing a potential long half time blood pool MR imaging agents.

SSM12-03 • In Vivo Mesenchymal Stem Cell Labeling Using FDA Approved Iron Oxide: Ferumoxytol
Aman Khurana MD (Presenter) ; Fanny Chapelin MS ; Graham Beck ; Jessica Donig BA ; Solomon Messing ; Heike E Daldrup-Link MD

PURPOSE
To develop an immediately clinically applicable approach for labeling of bone marrow derived mesenchymal stem cells (MSC), which would not require ex vivo manipulations of harvested MSC.

METHOD AND MATERIALS
Sprague DAWley rats were injected with IV ferumoxytol (0.5mmol/kg). 48 hours later, MSC were extracted from long bones (femur & tibia) as per established protocols. The labeling efficiency of these in vivo labeled cells was compared with traditional ex vivo labeling procedures using fluorescence, confocal and electron microscopies. These in vivo labeled stem cells were cultured for 7 days before imaging them on 7T GE MR scanner (T-2 ME/SE; TE-15, 30, 45, 60 TR-4000; NEX: 1) along with unlabeled controls to calculate T1 and T2 relaxation times and generate T2 maps. Day-7 labeled in vivo cells were subsequently transplanted in osteochondral defects of 12 knees of 6 nude Sprague DAWley rats and followed up for 4 weeks using MR imaging. Quantitative T2 relaxation times were compared for significant differences between labeled cells and controls using t-tests. MR imaging data were correlated with histopathology of cell samples and implants.

RESULTS
Fluorescent & confocal microscopy confirmed presence of iron oxides in in vivo labeled cells, with 3.2 times higher intracellular quantities than standard ex vivo labeled cells. Electron microscopy localized iron oxide nanoparticles in secondary lysosomes. In vivo labeling demonstrated significant T2 shortening effects both in vitro & in vivo when compared to unlabeled controls (T2 times in vitro: 8.2 vs 33.6 ms, in vivo: 15.4 vs 24.4 ms; p

CONCLUSION
To the best of our knowledge, this is the first report of in vivo stem cell labeling with an immediately clinically applicable iron oxide supplement. This method eliminates risks of ex vivo contamination and alterations of stem cell due to manipulations between harvest and transplantation and thus could be rapidly translated to the clinic via label use of the FDA-approved Ferumoxytol.

CLINICAL RELEVANCE/APPLICATION
In vivo labeling could be widely used for tracking of MSC in various target tissues as it involves no additional cell manipulation between harvest & transplantation & provides strong MR signal in vivo.

SSM12-04 • Optical Imaging with a Novel Cathepsin-B Activated Probe for Enhanced Detection of Colorectal Cancer
Shadi A Esfahani MD, MPH (Presenter) ; Pedram Heidari MD ; Umar Mahmood MD, PhD

PURPOSE
Despite significant advances in diagnosis and treatment, colorectal cancer (CRC) is still the fourth most common cause of cancer death with a global incidence rate of greater than 1 million people per year. Although the colonoscopy is a routine method for CRC diagnosis, it could provide an adjunct to standard WL colonoscopy. Cathepsin B activatable probe has the potential in early detection of colorectal cancer. By fluorescently highlighting neoplastic xenografts and spontaneous tumors. This protease probe has the potential to improve CRC tumor detection by fluorescently imaging of the colon was performed using NIRF imaging system. IHC evaluation of CTSB expression in both human and mouse tumors, and in both xenografts and spontaneous tumors. This protease probe has the potential to improve CRC tumor detection by fluorescently highlighting neoplastic regions, it could provide an adjunct to standard WL colonoscopy.

RESULTS
Multispectral epifluorescence imaging revealed increased fluorescent signal in both human and mouse tumors, and in both xenografts and spontaneous tumors. This protease probe has the potential to improve CRC tumor detection by fluorescently highlighting neoplastic regions, it could provide an adjunct to standard WL colonoscopy.

CONCLUSION
This method eliminates risks of ex vivo contamination and alterations of stem cell due to manipulations between harvest and transplantation and thus could be rapidly translated to the clinic via label use of the FDA-approved Ferumoxytol.

CLINICAL RELEVANCE/APPLICATION
In vivo labeling could be widely used for tracking of MSC in various target tissues as it involves no additional cell manipulation between harvest & transplantation & provides strong MR signal in vivo.

SSM12-05 • PET Imaging of Periostin, a Novel Extracellular Matrix Protein Target in the Tumor Microenvironment
Shadi A Esfahani MD, MPH (Presenter) ; Pedram Heidari MD ; Nazife S Turker ; Peiman Habibollahi MD ; Timothy C
SSM12-06  •  Monocyte Specific Single Photon Emission Computed Tomography (SPECT) Imaging Reveals Local Inflammation Activity In-vivo

Michel Eisenlaetter MD (Presenter) ;  Rebekka Hueting ;  Margaret Cooper ;  Walter L Heindel MD ;  Thomas Vogl PhD ;  Christoph B Bremer MD ;  Tobias R Schaeffter PhD

PURPOSE

The release of the protein S100A8/A9 by activated monocytes has been shown to reflect local disease activity in numerous inflammatory disorders. Monocytes are among the initial drivers of inflammation and S100A8/A9 has in this context been shown to act as a proinflammatory cytokine, crucial for maintenance of inflammation. Having shown the feasibility to specifically visualise S100A8/A9 using optical imaging (OI), we now demonstrate the first specific SPECT imaging of monocytes activity in order to overcome the limitations of OI with regards to complex disease models or translational purposes. For this first approach, we used a well established model of local innate immune response.

METHOD AND MATERIALS

Local inflammation was induced at the right ears of female Balb/c mice by application of 2% croton oil (n=10). A S100A9-antibody (aS100A9) was conjugated to DTPA and labelled with In111. The labelling efficacy and purity of the compound was assessed using HPLC. Mice received the labelled tracer iv in doses, corresponding to about 10 MBq activity 24 h after induction of inflammation. An equivalently labelled IgG of irrelevant specificity in mice was used to control for unspecific tracer distribution. SPECT was performed immediately after tracer injection and repeatedly up to 48 h later. Tracer biodistribution was assessed after in-vivo imaging. For correlation of imaging findings, S100A9 serum levels were determined at the imaging time points and immunohistochemistry for S100A9 was performed.

RESULTS

SPECT imaging immediately after tracer injection did not reveal a specific tracer uptake in the region of inflammation but already allowed for estimation of perfusion properties. 24 h later however, the diseased area showed a significant uptake of aS100A9 with excellent contrast to the healthy control side and other tissues, as confirmed by ex-vivo biodistribution measurements (%ID/g right ear: 51.9; left ear: 3.1; liver: 2.5; spleen: 8.5). Control experiments and histology supported the in-vivo imaging results.

CONCLUSION

In a first approach using a well established and controllable model, S100A9-mediated imaging of monocytes activity appeared to be a promising tool for specific visualisation of inflammation.

CLINICAL RELEVANCE/APPLICATION

Inflammation is widely accepted as the driving pathomechanism behind multiple diseases. Understanding and specific monitoring of the underlying cellular processes is therefore of utmost importance.

ISP: Musculoskeletal (Ankle/Foot) Wednesday, 02:00 PM - 04:00 PM  •  E450A  Back to Top  SSM13  •  AMA PRA Category 1 Credit™:1  •  ARRT Category A+  Credit:1  Moderator Corrie M Yablon , MD

SSM13-01  •  Musculoskeletal Key Speaker: New Developments in Foot and Ankle Imaging

Corrie M Yablon MD (Presenter)

SSM13-02  •  Do Conventional MRI, Ultrasound, Ultrashort-TE MRI, and Compressive Elastography Overestimate Achilles Tendinosis? A Cadaver Study with Histologic Correlation

Audrey J Slaughter MD (Presenter) ;  Michael L Loftus MD, MBA ;  Theodore T Miller MD ;  Matthew F Koff PhD * ;  Giorgio Perino MD ;  Parina Shah

PURPOSE

Ultrashort TE (UTE) MRI and compressive elastography (CE) have the potential to identify subtle tendon pathology before conventional MRI and ultrasound (US). Our purpose was to determine if UTE and CE would overestimate collagen disorganization and lead to false positive imaging.

METHOD AND MATERIALS

A pilot study utilizing five fresh-frozen human cadaveric legs was performed (mean age 71.4 years, range 65-76 years). Each specimen underwent conventional 3T MRI, UTE 3T MRI, conventional US, and CE at five standardized levels along the Achilles tendons. Conventional MR images were graded according to Lohman et al: grade 0 (normal signal), grade 1 (punctate hyperintensities), and grade 2 (larger hyperintensities), and T2* values from 2D UTE imaging were calculated from a multi-echo acquisition. Conventional US images were graded according to Archambault et al: grade 0 (normal tendon with parallel margins and homogenous echotexture), grade 1 (enlarged tendon), and grade 3 (hypoechoic area with or without tendon enlargement). CE images were evaluated per an experimentally proven color grading system (hardest tissues are blue to green and softest tissues are red), and by measuring peak strain ratios. The Achilles tendons were harvested and underwent both gross and histologic examination.

RESULTS

All five Achilles tendon specimens demonstrated normal imaging and quantitative characteristics at all five levels on conventional MRI, UTE MRI, conventional US, and CE without abnormal results from either UTE or CE. Sonoelastography strain ratios
CONCLUSION
Conventional MRI, UTE MRI, conventional US and CE did not overestimate disease in this sample of specimens without pathology.

CLINICAL RELEVANCE/APPLICATION
This pilot study established a baseline of normative data to support the next study phase in which we will evaluate UTE and CE in Achilles tendons with chemically-induced collagen disruption.

SSM13-03 • 3D Printing in the Pre-operative Assessment of Subtalar Coalitions Compared to 2-D and 3-D CT Datasets
Zbigniew Starosolski PhD (Presenter) ; J. H Kan MD ; Scott B Rosenfeld MD ; Ananth Annapragada PhD *

PURPOSE
3D printing is an emerging technology that can be used to generate physical models of 3D images. It has promise for treatment planning as well as patient education. The purpose of this paper is to explore its use in the preoperative phase for subtalar coalitions. In patients with subtalar coalitions, a 50% area threshold is used to decide between surgical arthrodesis and coalition resection. We tested if 3D prints based on a CT dataset correctly displays the CT dataset and the degree of subtalar coalition joint involvement.

METHOD AND MATERIALS
Anonymized CT images of the hindfoot from 12 patients ages 8-17 (who had been previously diagnosed with subtalar coalition based on those images) were used to segment the calcaneus and talus for 3D printing. The area of coalition was estimated in 4 ways: (1) a radiologist reading of the CT data (2) a curved MPR segmentation of the coalition (3) an orthopedic surgeon visually examining the 3D print and (4) breaking apart the 3D print and physically measuring the area. Areas were categorized as 50% by each method. Cohen's Kappa statistic was used to estimate correlation between the methods.

RESULTS
CONCLUSION
3D printing based on a CT dataset correctly quantifies the degree of subtalar joint involvement compared with 2-D and 3-D CT datasets review.

CLINICAL RELEVANCE/APPLICATION
3D printing may play a supplementary role in diagnosis, treatment planning, and patient education in children with subtalar coalitions.

SSM13-04 • Lateral Ligament Injury of the Ankle: Value of Additional Oblique MR Image Plane with Arthroscopic Correlation
Ji Eun Lee MD (Presenter) ; Jang Gyu Cha MD ; Hyun Joo Kim MD ; Young Koo Lee ; Jai Soung Park ; Eun Hye Lee MD ; Heon Lee

PURPOSE
To determine whether the additional oblique coronal and axial MR imaging planes play a valuable role in assessing the anterior tibiofibular(ATFL) and anterior talofibular(ATFL) ligament injuries.

METHOD AND MATERIALS
Data was collected retrospectively for 25 patients (M: F = 13: 12) with lateral ankle injury who underwent 3T MR imaging for diagnosis of ATFL and ATFL injuries. MR was performed in both standard three orthogonal planes and in additional coronal and axial oblique planes with 1mm thickness. Features of ligament injuries were each subdivided into two groups (ATFL: normal/abnormal, ATFL: partial tear/complete tear). Ligaments were first reviewed with routine MR imaging planes only, and then with additional oblique MR imaging planes. Arthroscopic result was considered as the standard of reference. Two musculoskeletal radiologists independently reviewed the MR images. Descriptive statistics were performed and receiver-operating characteristic(ROC) curve analysis was used to compare the improvement of diagnostic performance in using additional oblique MR imaging planes.

RESULTS
When imaging diagnosis of ATFL injury was based on routine MR images only, the diagnosis was made with a sensitivity of 40% and a specificity of 60-67%. With additional oblique MR imaging planes, the sensitivity and specificity increased up to 90% and 60-80%, respectively. Area under the curve(AUC) values showed significant difference (p < 0.05). The interobserver agreement(?) regarding injury of the ATFL and ATFL were good to excellent in both the routine and additional oblique imaging planes (? 0.66σ0.88) except in evaluation of ATFL in routine MR images. (? 0.43)

CONCLUSION
Using additional oblique MR imaging planes in patients with lateral ligament injury of the ankle can significantly improve the sensitivity and specificity in diagnosing ATFL injury.

CLINICAL RELEVANCE/APPLICATION
Using additional oblique MR imaging planes provides better diagnostic performance, leading to optimal management for ankle injuries.

SSM13-05 • Magnetic Resonance Microscopy of the Tendons, Pulleys, and Plantar Plates of the Toes at 11.7T
Paul A DiCamillo MD, PhD (Presenter) ; Sheronda Statum ; Christine B Chung MD ; Graeme M Bydder MBChB *

PURPOSE
MR studies of the anatomy of the tendons, pulleys and plantar plates of the toes have been performed with clinical systems at field strengths up to 3T. In this study we used a high performance small bore 11.7T system to study the anatomy of the toes in detail.

METHOD AND MATERIALS
Following institutional policy human cadaveric great and lesser toes were collected and imaged with a 11.7T Bruker BioSpec 117/16USR system (Bruker BioSpin, Billerica, MA) fitted with a 750 mT/m gradient system, using resonators (60 and 72mm internal diameter) with and without receive-only four element semi-circular surface array coils. Both spin echo (80x80x400um resolution, TE 7-14ms, TR 5000ms, 2 echoes, fat sat, NEX 5-16, 4-6 hour scans) and gradient echo (90-150um isotropic resolution, TE 6ms, TR 25ms, fat sat, NEX 9-25, 4-6 hour scans) images were acquired.

RESULTS
Unprecedented spatial resolution and contrast was achieved, with well over 20 times greater spatial resolution than previous reported in anatomic studies using clinical systems. Our acquisitions parameters reversed the typical contrast pattern of previous non-fat saturated studies. Tendons, pulleys, and plates had a high signal relative to the saturated fat. Flexor tendons, extensor apparatus, annular and cruciate pulleys as well as the fiber structure within the plates were well seen.

CONCLUSION
Use of a high performance 11.7T system allow detailed anatomic imaging of the tendons, pulleys and plates of the toes at a level that has not previously been described. These results are likely to help in the recognition of injury and disease of the tendons, pulleys and plates of the toes as stronger field strengths become clinically available.
SSM14-06 • Early Detection of Tendinopathy and Chondropathy in Patients with Diabetes Mellitus Type I by Means of Quantitative Sodium Imaging at 7 Tesla MRI

Wolfgang Marik MD (Presenter); Veronika Schopf; Stefan Zbyn; Manuela Karner; Bernhard Ludvik MD; Siegfried Trattning MD

PURPOSE
The purpose of this study was to investigate possible biochemical alterations of tendons and cartilage caused by diabetes mellitus (DM) Type 1 using quantitative in vivo sodium imaging at 7 Tesla.

METHOD AND MATERIALS
Eight patients (4f/4m, mean age 43a, SD 16,9a) with established diagnosis of DM Type 1 and no history of knee trauma were examined on a 7 Tesla whole body MR with a dedicated knee coil and compared with nine healthy volunteers. Controls were age and weight matched (3f/6m, mean age 40a, SD 17,2a). In all patients and volunteers axial, sagittal and coronal proton-density sequences were obtained for morphological diagnosis and localization of anatomical sites for Region of interest (ROI) analysis. For sodium imaging an optimized GRE sequence with variable TE was used and sodium-signal intensity was measured. Region of interest (ROI) analysis was performed manually for the femoral condyle cartilage layers and the patella tendon. Mean sodium intensity values were compared between both groups using the analysis of variance.

RESULTS

CONCLUSION
The preliminary data suggest that, although cartilage and tendons in patients with DM Type 1 appear morphologically intact, changes in the glycosaminoglycan content have already occurred. Thus, sodium imaging seems to be a promising non-invasive approach for early detection of tendinopathy and chondropathy in patients suffering from Diabetes mellitus Type 1.

CLINICAL RELEVANCE/APPLICATION
Quantitative sodium imaging due to its higher sensitivity compared to morphological imaging may improve early detection of tendinopathy and chondropathy in patients with Diabetes mellitus Typ 1.

SSM14 • AMA PRA Category 1 Credit ™•1 • ARRT Category A+ Credit:1 Moderator William G Bradley, MD, PhD

SSM14-01 • Whole Brain Volume as a Risk Factor for Post Lumbar Puncture Headache Requiring Blood Patch

Phillip J Hsu (Presenter); Tammie S Benzinger MD, PhD *; Shengmei Ma MS; Chengjie Xiong PhD, MS; John Morris *; Marcus E Raichle MD; Anne Fagan PhD; Russell Hornbeck MSc; Virginia Buckles PhD

PURPOSE
Post lumbar puncture headache (PLPH) is a common complication of lumbar puncture (LP) and is characterized by orthostatic headache that worsens when a patient moves from a supine to upright position. Blood patch, the injection of autologous blood near the puncture site, is the standard treatment of lasting PLPH. Though the exact cause of PLPH is uncertain, hypothesized causes include downward pull on pain-sensitive structures in the brain due to cerebrospinal fluid (CSF) leakage through the post-puncture opening. This study investigates whether whole brain volume affects risk of positional PLPH requiring blood patch (BPHA).

METHOD AND MATERIALS
Community-dwelling volunteers enrolled in prospective studies of memory and aging (n = 661) aged 43 to 91 years received LPs, 373 of which also received MRI scans for brain volume. Whole brain volume was calculating using FreeSurfer and normalized to intracranial volume (ICV). Logistic regression was used to determine effects of risk factors age, gender, and whole brain volume on risk of severe headache.

RESULTS
Of the 661 unique participants (285 male), 28 (5 male) experienced BPHA. As shown in previous studies, young age (p

CONCLUSION
Our finding that greater whole brain volume is correlated with BPHA risk is in accordance with the theory that PLPH is caused by the downward pull on pain-sensitive structures in the brain. Those people with larger brain volume are potentially more likely to have the brain to come into contact with the skull following lumbar puncture.

CLINICAL RELEVANCE/APPLICATION
Larger brain volumes are associated with risk of post-LP headache requiring blood patch; consideration should be given to recommending extra precautions for LP patients with large brain volumes.

SSM14-02 • Minimizing Iatrogenic Meningitis and Spinal Headache: Current Practice Patterns of Neuroradiologists in the Academic Setting

Yi C Zhang MD (Presenter); Alexander Chandler MD; Nolan J Kagetsu MD *

PURPOSE
Iatrogenic bacterial meningitis and dural leak resulting in spinal headache are serious sequelae of lumbar punctures and myelograms. Although the CDC and American Academy of Neurology have issued standardized techniques for dural puncture including use of facemasks and atraumatic spinal needles, there is a wide range of practice patterns. We undertook a survey of neuroradiologists with academic affiliations to evaluate the degree of technical compliance towards mitigating iatrogenic meningitis and dural leak.

METHOD AND MATERIALS
In February 2013 we surveyed neuroradiology fellows and attendings in the email directory of the Association of Program Directors in Radiology. We queried use of facemasks, use of atraumatic needles, and dural puncture practices. We sent a repeat questionnaire five weeks later. All data were collected anonymously.

RESULTS
A total of 96 survey responses were received. Only 48% always wear a facemask during lumbar punctures, and only 51% during myelograms. A majority of respondents (91%) use the Quincke cutting needle by default, compared to the 26% who have ever used atraumatic needles. Only 16% of respondents prescribe immediate post-procedure mobilization, which has been shown to reduce spinal headache. There are no statistically significant differences between attending neuroradiologists and fellows for these results.

CONCLUSION
Many neuroradiologists only partially conform to standard guidelines designed to prevent iatrogenic meningitis and spinal headache. Approximately half of the respondents do not wear facemasks during dural puncture, placing patients at risk for iatrogenic meningitis. Only 26% of neuroradiologists use atraumatic needles which have been shown to reduce dural leak. Only 16% of neuroradiologists prescribe immediate post-procedure mobilization which has been shown to decrease the incidence of spinal headache.
To evaluate the diagnostic accuracy of high spatial resolution three-dimensional magnetic resonance cerebrospinal fluid (CSF) flow with a high-sampling-efficiency technique (sampling perfusion with application optimized contrasts using different flip angle evolutions [SPACE]) versus TSE T2 (2 mm section thickness without flow compensation) over detection of aqueductal patency (AP) in patients with hydrocephalus, using three-dimensional (3D) constructive interference in the steady state (CISS) and cine phase contrast (Cine PC) sequences as reference standard at 3Tesa.

METHOD AND MATERIALS
68 patients with hydrocephalus who were suspected aqueductal stenosis and had 3.0T CSF flow MR imaging were included. In addition to routine sequences which consisted of sagittal TSE T2, 3D-CISS, and axial-sagittal cine PC, sagittal 3D-T2 SPACE was obtained to evaluate the cerebral aqueduct by two radiologists, independently. AP and visibility of flow void were scored on the TSE T2 and 3D-T2 SPACE on a relative 4-point scale and compared with cine PC as a reference standard of patency and 3D-CCS as a reference standard of image quality in terms of wall conspicuity, contrast, continuity, sharpness, and background homogeneity. The McNemar test was used to compare for statistical analysis. Inter-observer agreement was calculated using kappa statistics.

RESULTS
AP by 3D-T2 SPACE and TSE T2 were in agreement with cine PC findings in 100% (65/65) and 85% (58/68), respectively, and the sensitivity of 3D-T2 SPACE was equal to cine PC. Visibility of flow void in aqueduct and periaqueductus was significantly better with 3D-T2SPACE than TSE T2 (P < 0.05). Inter-observer agreement was almost perfect for TSE T2 and 3D-T2SPACE (kappa > 0.81).

CONCLUSION
3D-T2SPACE should be the method of choice as a stand-alone sequence for the evaluation of AP in hydrocephalus. Due to the high accuracy for physiologic information and the short-acquisition time with high resolution should be preferred to conventional TSE T2.

CLINICAL RELEVANCE/APPLICATION
Due to the high accuracy for physiologic information and the short-acquisition time with high resolution, 3D-T2SPACE should be preferred to conventional TSE T2 for aqueductal patency in hydrocephalus.
SSM15-04 • Effect of Spatial Resolution of T2WI on Diagnostic Efficacy of MR Imaging in Detection of Papilledema

Houman Sotoudeh MD (Presenter); Michyla L Bowerson MD; Ryan Bi Viets MD; Charles F Hildebolt DDS, PhD; Gregory Van Stavern; Aseem Sharma MBBS *

PURPOSE
To compare the diagnostic efficacy of high-resolution 3D-T2WI versus a conventional 2D-T2WI in detection of papilledema.

METHOD AND MATERIALS
In this retrospective study, axial T2WI from MR imaging of 25 patients with ophthalmologically proven papilledema and 66 controls were presented to two neuroradiologists, who interpreted these for presence of papilledema in each eye. All studies included conventional axial 2D T2WI (slice thickness 3-5 mm) and high-resolution axial 3D T2WI (slice thickness 0.7-1 mm), which were presented to the readers in a blinded and random fashion. Sensitivity, specificity, positive likelihood ratio, and negative likelihood ratio were calculated for each reader and for each technique. Assessment was done for all the eyes combined as well as for each side individually. The positive likelihood ratios for 2D and 3D techniques were compared using homogeneity of Odds-Ratio test. Interobserver variability was studied by calculating kappa, and using McNemar test.

RESULTS
For all eyes, the sensitivity, specificity, positive likelihood ratio, and the negative likelihood ratio for first reader were 56.3%, 85.8%, 3.97, and 0.51 for 2D T2WI, with the corresponding values of 83.3%, 93.3%, 12.4, and 0.18 respectively for 3D T2WI. The second reader achieved a sensitivity, specificity, positive likelihood ratio, and negative likelihood ratio of 54.2%, 94.0%, 9.07, and 0.49 respectively with 2D T2WI, and 87.5%, 91.0%, 9.77, and 0.14 respectively with 3D T2WI. The differences in positive likelihood ratio were statistically significant for first reader (p=0.0009), but not for the second (p=0.0793). A similar pattern was observed when results were analyzed for each eye individually. Substantial interobserver agreement (kappa 0.617) with 2D T2WI improved to an almost perfect interobserver agreement with 3D T2WI (kappa 0.824). McNemar test for paired proportions showed a significant difference of 6.59% in the positive and negative interpretations of two readers using 2D T2WI (p=0.0227), while the corresponding difference of 2.75% difference for 3D T2WI was not significant (p=0.2668).

CONCLUSION
Higher spatial resolution offered by 3D T2WI translates into improved diagnostic efficacy and a higher interobserver agreement for detection of papilledema, when compared to 2D T2WI.

CLINICAL RELEVANCE/APPLICATION
High resolution 3D T2WI can improve the diagnostic efficacy of MR imaging for detection of papilledema.

Neuroradiology (Neuro-Oncology) Wednesday, 03:00 PM - 04:00 PM • N227  Back to Top on SSM15 • AMA PRA Category 1 Credit •:1 • ARRT Category A+ • Credit:1 Moderator Rivka R Colen, MD

SSM15-01 • Myeloperoxidase Inhibition Worsens Survival after Radiation Therapy in a Murine Model of Glioblastoma

Muhammad Ali MBBS (Presenter); Giulia Fulci PhD; Benjamin Pulli MD; Gregory R Wojtkiewicz MSc; Anning Li PhD; Jenny J Linnoila MD, PhD; John Chen MD, PhD *

PURPOSE
Radiation therapy is widely used in treatment of glioblastoma (GBM) with resultant tissue inflammation. We hypothesized that radiation will upregulate the key inflammatory enzyme myeloperoxidase (MPO) that could be tracked in vivo with the specific and sensitive molecular MRI probe MPO-Gd (bis-5HT-DTPA-Gd), and that inhibition of MPO activity could change outcome.

METHOD AND MATERIALS
Radiated brain tumors had significantly increased MPO activity (figure, A; 9.7 ± 2.4 vs. 1.1 ± 0.3 RFU/sec/mg; P=0.03), and MPO-secreting inflammatory monocytes were also elevated (B; P=0.13). ABAB administration decreased MPO-Gd enhancement (C+E; P<0.03), consistent with successful partial MPO inhibition in vivo. Surprisingly, tumor size was ~1.5 times larger with ABAB treatment compared to saline (+D; P=0.11), and we also observed decreased survival with MPO inhibition compared to saline control (F, median survival with ABAH: 37 days vs. saline: 50 days; P=0.04).

CONCLUSION
Our results show that MPO has an important role in host defense against GBM and inhibition of its activity after radiation therapy increased tumor growth and decreased survival. MPO-Gd MRI is a sensitive noninvasive method to measure MPO activity in gliomas and can follow treatment response, evaluating both tumor volume and degree of inflammation.

CLINICAL RELEVANCE/APPLICATION
Our study suggests a role for pro-inflammatory anti-tumor therapies in conjunction with radiation. Upon translation, MPO-Gd can be used to monitor inflammation and post-radiation treatment response.

SSM15-02 • Differentiation of Pseudoprogression and Real Progression in Glioblastoma Using ADC Parametric Response Maps

Alexander Radbruch (Presenter) *; Caroline Reimer; Markus Graf; Katerina Deike; Ralf Floca PhD; Martin Bendszus; Sabine Heiland PhD; Benedikt Wiestler

PURPOSE
Pseudoprogression describes the radiologic phenomenon that patients with high-grade glioma undergoing their first or second radiation MRI show increased contrast enhancement that eventually subsides without any change in treatment. Currently it is not...
METHOD AND MATERIALS

29 patients with proven progression and 7 patients with pseudoprogression were identified in a retrospective case study. For all patients ADC baseline and follow-up maps were available. The ADC baseline map and the ADC follow up map were coregistered on the contrast enhanced T1-weighted follow up images. Subsequently the enhancement in the follow up contrast enhanced (Dotarem (Gadoterate meglumine)) T1-weighted image was manually delineated and a reference ROI was drawn in the contralateral white matter. Both ROIs were transferred to the ADC images. Relative ADC(baseline)/reference ROI(baseline) values and ADC(follow up)/reference ROI(follow up) values were calculated for each voxel within the ROI. The corresponding voxels of rADC (follow up) and rADC (baseline) were subtracted and the percentage of all voxels within the ROI that exceeded the threshold of 0.25 was quantified.

RESULTS

rADC voxels showed an increase of 21.9+-26.3 % above 0.25 in patients with real progression and in 55.7 + 28.3% in patients with pseudoprogression. ROC analysis revealed a very good diagnostic performance (AUC = 0.82).

CONCLUSION

The introduced parametric response map for rADC maps provides a potential tool for the differentiation between pseudoprogression and true progression. Generally an ADC increase is supposed to be correlated with a decrease of cellularity and hence with therapy response. Therefore our findings of an increased number of voxels with increased ADC values in patients with pseudoprogression are in line with these basic pathophysiologic considerations.

CLINICAL RELEVANCE/APPLICATION

The reliable differentiation of real progression and pseudoprogression is crucial not only for the therapeutic decision but also for the correct radiological assessment within clinical studies.

SSM15-03 • Prognostic Value of ADC in Glioblastoma Multiforme and Its Correlation with Histopathologic Biomarkers

Roina Zalazar MD ; Miguel D Hernandez Arguello MD ; Pablo D Dominguez MD ; Maria Paramo Alfaro MD ; Pedro Sion MD (Presenter) ; Jon Etzano MD ; Ricardo Diez-Valle MD, PhD ; Miguel Idote ; Jose Luis Zubiate ; Maria De Los Reyes Garcia De Eulate

PURPOSE

To analyse whether apparent diffusion coefficient (ADC) values derived from diffusion-weighted imaging (DWI) MRI correlate with overall survival (OS), progression-free survival (PFS) and with molecular status on glioblastoma multiforme (GBM)

METHOD AND MATERIALS

Retrospective study in 60 patients with untreated GBM that underwent DWI study before surgery (mean time 6 days). Patients included were followed-up for at least 12 months or until death. Circular 5 mm2 ROI were drawn on ADC map. First on the solid enhancing tumor with the highest restriction value, without evidence of bleeding on SWI. Then on peritumoral area with hyperintensity on T2 FLAIR. Finally on the normal-appearing contralateral white matter (NCWM). Minimum, maximum, and mean ADC (ADCmin, ADCmax, ADCmean) were evaluated as well as ADCindex defined as a ratio between tumoral ADCmin and NCWM ADC. Copy number of EGFR amplification (EGFR) and MGMT methylation (MGMT) in solid component of the tumor were performed. Normal-appearing contralateral white matter ADC was used as a reference. MGMT methylation, epidermal growth factor receptor (EGFR) amplification and EGFRvIII status, tumoral volume, residual volume, OS and PFS were evaluated. ROC curves, Student t-test, Kaplan-Meier curves and Cox regression model were performed.

RESULTS

30 males and 30 females (median age 60.5, range 28-78) were evaluated. 48 patients had complete resection (80%). Presurgical tumoral volume (mean = 41.02 cm3, range 2.2-111.8) and post-surgical volume (mean = 0.55, range 0.2-13) had no association with PFS and OS. MGMT promoter status (n= 54) was not methylated in 26. EGFR amplification (n=51) was positive on 19. EGFRvIII (n=25) was present on 6. MGMT promoter methylation, EGFR amplification and EGFR overexpression status had no correlation with ADC. MGMT status correlated with PFS p CONCLUSION

ADCmin values of solid component of the tumor as well as ADCindex have a significant correlation with PFS and OS independent of the molecular status of MGMT and EGFRvIII and EGFR amplification in GBM. ADCindex could be a stronger predictor of overall survival

CLINICAL RELEVANCE/APPLICATION

ADCindex value is a new parameter that could predict the prognosis in GBM

SSM15-04 • Variability of rCBV Measurements of Glioblastoma between Three FDA-approved Software Packages

Zachary S Kelm BS (Presenter) ; Leland S Hu MD ; Panagiotis Korfiatis PhD ; Ravi Lingineni MPH ; Rickey Carter PhD ; John Daniels RT ; Bradley J Erickson MD, PhD *

PURPOSE

We measured the variability between three FDA-approved perfusion software packages with respect to their relative cerebral blood volume (rCBV) output for dynamic-susceptibility contrast MRI of glioblastomas. The hypothesis is that they should produce the same rCBV values when obtaining measurements of the same image locations.

METHOD AND MATERIALS

We retrospectively identified 45 glioblastoma cases where within 6 months post-radiation therapy, an MRI was interpreted to contain a worrisome increase in hyperintensity on the T1w post-gad and/or T2w images. Using IB Neuro, GE Functool, and nordicICE, we generated rCBV images for each case, repeating the processing with three different operators for Functool and nordicICE. The operators were naive to the patient’s tumor. For IB Neuro since it did not require manual input. For each of the 7 operator-software combinations, we calculated a representative rCBV value for each brain, using measurements of the exact same regions. The tumor regions were semi-automatically defined using only enhancement information in the post-gad volume that we had mapped to the same space as the rCBV volumes. We normalized the tumor rCBV values by the mean of a normal-appearing white matter region in the contralateral hemisphere. In addition to the mean normalized rCBV value for the tumor, we calculated the 95% rCBV value to robustly represent a tumor ‘hot-spot’ analysis.

RESULTS

For the mean and 95% normalized rCBV values for the tumors, the intra-class correlation coefficients (ICCs) (with 95% confidence interval in parentheses) for the 7 operator-software combinations were 0.835 (0.766, 0.893) and 0.727 (0.630, 0.817) respectively. For inter-operator analysis, the ICCs for GE Functool were 0.880 (0.813, 0.928) for the mean rCBV, and 0.910 (0.858, 0.946) for the 95% rCBV. For nordicICE, they were 0.971 (0.953, 0.983) and 0.959 (0.933, 0.976) respectively. The higher ICCs for nordicICE were expected since it requires less manual input in the rCBV processing than GE Functool.

CONCLUSION

Due to the variability in rCBV determination, we recommend that the software package be considered and potentially adjusted for when using results and thresholds published in the literature.

CLINICAL RELEVANCE/APPLICATION

Glioblastomas are often imaged using perfusion-weighted acquisitions, but the determination of rCBV is not standardized. This results in different rCBV measurements depending on the software used.
SSM15-05 • Fast Whole-brain Magnetic Resonance Spectroscopy (MRS) for Patients with Brain Tumors

Yi Zhang (Presenter) ; Jinyuan Zhou PhD ; Paul A Bottomley PhD

PURPOSE
The clinical application of multi-voxel MRS is often limited by long scan times. It is shown here that a recently proposed method, spectroscopy with linear algebraic model (SLAM), combined with parallel imaging or ‘SENSE’, offers dramatically faster MRS acquisitions than conventional chemical shift imaging (CSI).

METHOD AND MATERIALS
The SLAM method reconstructs spectra from multiple compartments using a small subset of CSI phase-encodes from central image k-space. Compartmental models are derived from co-registered MRI, and compartment-average spectra are reconstructed using linear algebra. 8 patients with brain tumors were scanned with a 32-channel head coil in a 3T Philips MR system. A ~6 min three-slice conventional proton MRS SENSE CSI sequence and a five-slice pro-active SENSE SLAM sequence providing whole-brain coverage (thickness 83.6 mm) in ~1.5 min were acquired. Five compartments were segmented on a multi-slice ‘FLAIR’ image: tumor; cingulate and posterior lobe of cerebellum (PLC); rest of the brain; scalp; and background. For quantitative validation, retroactive SENSE SLAM spectra were reconstructed retroactively from the central 20% of k-space extracted from the SENSE CSI acquisition, for an effective scan-time of 1.1 min. Choline (Cho), creatine (CR) and n-acetyl aspartate (NAA) levels were quantified in SENSE SLAM spectra, and compared to those from compartment average SENSE CSI spectra in tumor and contralateral brain compartments.

RESULTS
The validation analysis revealed differences between SENSE SLAM and SENSE CSI (percentage mean ± standard deviation) of: Cho, -4.2 ±4.5%; CR, -3.1 ±5.7%; NAA, 1 ±10%, which are considered negligible. Applied pro-actively, SENSE SLAM could achieve whole-brain coverage in just 1.5 min, which was not feasible for SENSE CSI due to the limited time available for spectroscopy in the current study protocol.

CONCLUSION
SLAM combined with SENSE can produce quantitatively the same results as the standard CSI method much faster (5-fold demonstrated). This speed advantage enables inclusion of brain MRS in studies that may otherwise be precluded by scan-time limitations. SENSE SLAM could potentially supplant CSI for clinical studies in which lesion-averaged MRS measures can suffice.

CLINICAL RELEVANCE/APPLICATION
With SLAM, whole-brain proton MRS studies of brain tumor patients can be conducted within 1-2 min, greatly increasing its potential clinical utility.

SSM16-01 • Altered Spontaneous Brain Activity in Type2 Diabetes: A Resting-state Functional MRI Study

Ying Cui (Presenter) ; Yun Jiao PhD ; Yu-Chen Chen ; Gao-Jun Teng MD

PURPOSE
Type 2 diabetes mellitus (T2DM) has been associated with increased risk of cognitive impairment. Population with impaired cognition showed decreased spontaneous brain activity. In this study, we aimed to investigate this pattern in T2DM patients using resting-state functional magnetic resonance imaging (rs-fMRI).

METHOD AND MATERIALS
RESULTS
Compared with healthy controls, patients with T2DM showed diffuse decreased ALFF mainly in prefrontal regions, visual cortex and postcentral gyrus. Instructively, decreased ReHo showed quite a similar pattern. Meanwhile, increased ALFF were found in anterior cingulate and posterior lobe of cerebellum (PLC) while increased ReHo were found in precuneus (PCu) and PLC. Additionally, cognitive performance of patients were inversely correlated with the spontaneous brain activity, especially in the left cuneus.

CONCLUSION
Widespread abnormalities in intrinsic brain activity reflected by ALFF and ReHo were found in T2DM patients, which may provide insights into the neurological pathophysiology underlying diabetes-associated cognitive decline.

CLINICAL RELEVANCE/APPLICATION
SSM16-02 • Aging-related Altered Functional Connectivity in Putamen at Resting State

Tianyu Tang MS (Presenter) ; Yun Jiao PhD ; Xunheng Wang ; Hui Wang ; Ming Yang MD ; Zuhong Lu PhD

PURPOSE
Motor functions decline with the progress of aging and act differently in male and female brains. By investigating voxel-based functional connectivities (FCs) between putamen subdivisions and the whole brain, we aimed to study the effects of gender-related aging progress in putamen subdivisions.

METHOD AND MATERIALS
In this study, 176 healthy subjects including 120 young adults (male 62, female 58) and 56 older (male 28, female 28) adults were performed EPI functional MRI scanning. Firstly, after preprocessing of raw EPI data using FSL, an ICA based identification of subdivisions of putamen was applied and bilateral putamen were automatically parcelled. Secondly, time courses (TCs) of each subdivision of every subject were extracted. Thirdly, voxel-based FCs between TCs and whole brain were generated. Finally, FCs were compared between groups using two-sample t tests with a threshold at p < 64.

RESULTS
Based on temporal correlation parcel approach, putamen was automatically divided into six subdivisions: Left and Right Ventral Rostral Putamen (LVRP and RVRP); Left and Right Dorsal Rostral Putamen (LDRP and RDRP); and Left and Right Dorsal Caudal Putamen (LDCP and RDCP). With two-sample t tests, we found significant age-related increase of FCs between LVRP and Supplementary Motor Area (SMA) in male groups. In addition, an age-related decrease of FCs in male groups between LDCP and right insular was also detected. In females, we found significant age-related decrease of FCs between middle cingulum and RVRP.

CONCLUSION
Different patterns of age-related FCs changes in male and female groups were detected. The decrease of FCs between SMA and LVRP in elder male group may reflect the gender specific age-related motor function decline and provided evidence to explain the higher susceptibility of Parkinson’s disease in males. The age-related changes of FCs between putamen and whole brain could provide neuronal evidence for the aging brain.

CLINICAL RELEVANCE/APPLICATION
Our study provided evidences for gender specific brain degeneration in putamen and related brain functions.

SSM16-03 • Disrupted Functional Connectivity in the Human Brain Network during Short-term Hyperthermia Exposure

Shaowen Qian (Presenter) ; Kai Liu ; Gang Sun ; Min Li

PURPOSE
Passive hyperthermia is a potential risk factor to human in many extreme work environments, such as a product manufacturing plant, coal mine, military operation, firefighting and outdoor sports. Previous studies have shed light on the significant effects of passive hyperthermia on human cognitive performance and behavior. However, the potential principles of human cognition and behavior deteriorations were still not clearly known. Therefore, the aim was to examine the influences of passive hyperthermia on brain functional connectivity patterns and their relationships with behavioral performance.

METHOD AND MATERIALS
RESULTS
We identified decreased correlations of a set of regions with the PCC/PCu, including the medial orbitofrontal cortex (mOFC) and bilateral medial temporal cortex, and increased correlations with the partial orbitofrontal cortex particularly in the bilateral orbital superior frontal gyrus (Figure (a)). The decreased correlations mainly involved with the mOFC, temporal lobe and occipital lobe, while increased correlations were mainly located within the limbic system (Figure (b)). More importantly, the number of significant altered connectivities was positively correlated with an increase in executive control reaction time (Figure (c)).

CONCLUSION
The changes in the functional connectivity network might be a possible explanation for the cognitive and behavior alteration.

CLINICAL RELEVANCE/APPLICATION
The clear recognition for the potential mechanisms of the effects of passive hyperthermia may provide new evidence for protections of heat exposure in many extremely hot work environments.

SSM16-04 • Functional Connectivity of Resting State Networks in Spinocerebellar Ataxia Type 6 Correlates with Fractional Anisotropy of Cerebellar White Matter

Licia P Pereira MD (Presenter) ; Haris I Sair MD ; Raag D Airan MD, PhD ; Sarah H Ying

PURPOSE
To determine brain regions that have abnormal white matter and resting-state functional MRI (rs-fMRI) internetwork connectivity (IC) in patients with spinocerebellar ataxia type 6 (SCA6) and whether these measures correlated.

METHOD AND MATERIALS
RESULTS
We identified decreased correlations of a set of regions with the PCC/PCu, including the medial orbitofrontal cortex (mOFC) and bilateral medial temporal cortex, and increased correlations with the partial orbitofrontal cortex particularly in the bilateral orbital superior frontal gyrus (Figure (a)). The decreased correlations mainly involved with the mOFC, temporal lobe and occipital lobe, while increased correlations were mainly located within the limbic system (Figure (b)). More importantly, the number of significant altered connectivities was positively correlated with an increase in executive control reaction time (Figure (c)).

CONCLUSION
The changes in the functional connectivity network might be a possible explanation for the cognitive and behavior alteration.

CLINICAL RELEVANCE/APPLICATION
The clear recognition for the potential mechanisms of the effects of passive hyperthermia may provide new evidence for protections of heat exposure in many extremely hot work environments.

SSM16-05 • Resting State Neural Network in Monolateral and Central Tinnitus

Chang-Woo Ryu MD (Presenter) ; Hye Soo Koo MD ; Seong Jong Yun ; Moon Suh Park ; Geon-Ho Jahng PhD

PURPOSE
The neuronal activity in tinnitus was investigated with a task-based fMRI paradigm by using auditory or somatic modulation.
However, few studies have investigated the resting-state neuronal activity in tinnitus. The objective of this study is to identify the difference of resting-state networks among patients with monolateral and central tinnitus, and matching healthy control by using resting-state fMRI.

METHOD AND MATERIALS
Total 53 patients (18 left-sided, 16 right-sided, and 19 central tinnitus) and age-matched 20 healthy controls underwent resting-state fMRI scan. We computed the connectivity in default mode and auditory networks using the group independent component analysis, and the networks were compared among groups.

RESULTS
In the default mode network, the connectivity in the bilateral inferior frontal, prefrontal, and motor sensory areas were increased in tinnitus groups. Connectivity in the central tinnitus had increased at the bilateral angular gyri compared with the monolateral tinnitus and the healthy control. In the auditory network, the reduced functional connectivity of auditory network and increased functioning were found, including the prefrontal, and middle temporal regions.

CONCLUSION
These results suggested that the chronic tinnitus may be related to aberrant functioning of the default mode network. Alteration of the default mode and auditory networks between monolateral and central tinnitus imply that the two tinnitus types may have different mechanism.

CLINICAL RELEVANCE/APPLICATION
Our research suggested that resting-state fMRI would be useful to lateralize tinnitus and analyze the mechanism of tinnitus without a task-based paradigm.

SSM16-06 • Mapping Functional Reorganization of the Motor Network Connectivity after Training with a Novel MR-compatible Hand Induced Robotic Device

Asimina Lazaridou; Phaethon Philbrook (Presenter); Loukas Astrakas; Dionyssios Mintzopoulos PhD; Aneesh B Singhal MD; A. Aria Tzika PhD; Azadeh Khanicheh MS, PhD *; Michael Moskowitz MD; Bruce R Rosen MD, PhD *

PURPOSE
After stroke, the connectivity in the primary motor cortex (M1), supplementary motor area (SMA) and the cerebellum (Ce) are affected. This has been observed as a decrease in intrinsic neural coupling between M1 and Ce. Using fMRI and dynamic causal modeling (DCM) with a novel MR-compatible hand-induced robotic device (MR_CHIROD), this functional reorganization of the motor systems in the brain was further examined in chronic stroke patients.

METHOD AND MATERIALS
Healthy volunteers (n=12) and chronic stroke patients (n=5; = 6 months poststroke) were studied. fMRI was performed on a 3T Siemens using a block paradigm at baseline, during, and after 8 weeks of training, which consisted of squeezing a gel ball with the paretic hand at approximately 75% of maximum strength for 1 hour/day, 3 days/week. Patients squeezed and released the Mr_CHIROD during the action period at increments of 45%, 60%, and 75% of their maximum grip force. DCM of fMRI data was used to model the task-dependent influences that one area exerts over another to infer connectivity strengths. Connectivity region stimulation and posterior probability was calculated using the DCM SPMS utility.

RESULTS
Results indicated that in healthy volunteers performing a simple motor resulted in a minimum effective connectivity for the Ce to M1 pathway. However, in patients, M1 to SMA increased 98%, SMA to M1 increased 616% (p CONCLUSION
We suggest that training can induce functional connectivity in both healthy individuals and chronic stroke patients.

CLINICAL RELEVANCE/APPLICATION
fMRI is a clinically relevant personalized medicine approach, which will allow caregivers to select the most appropriate rehabilitation, and to fine-tune it based on brain maps obtained during therapy.

Nuclear Medicine (Comparative Technologies and Modalities) Wednesday, 03:00 PM - 04:00 PM • S505AB Back to Top

SSM17 • AMA PRA Category 1 Credit ™:1 • ARRT Category A+ Credit:1 Moderator Richard K. J. Brown, MD *

SSM17-01 • Comparison of F18-FDG PET-CT vs. 3T Diffusion Weighted (DWIBS) Whole-body Magnetic Resonance Imaging in Colon Cancer Staging

Ettore Squillaci MD (Presenter); Guglielmo Manenti MD; Francesca Bolacchi; Marco Nezzo MD; Orazio Schillaci MD; Giovanni Simonetti MD

PURPOSE
To assess the accuracy of 3T whole-body MRI (WB-MRI) in comparison with whole-body [18F]-2-Fluoro-2-deoxy-D-glucose (FDG) PET/CT for staging newly diagnosed colon cancer.

METHOD AND MATERIALS
40 consecutive patients with previously diagnosed colon cancer underwent 3T WBMRI (Philips Achieva, Best, The Netherlands) and Whole-Body [18F]-2-Fluoro-2-deoxy-D-glucose (FDG) PET/CT (GE Discovery ST 64) for staging of lymph node (N) and distant metastases (M) after resection of the primary tumor. WB-MRI was performed with multi-stacks approach, in the coronal plane using morphological (T1W, T2W-STIR), Diffusion-Weighted Imaging With Background Suppression (DWIBS) and contrast-enhanced T1w 3D sequences. Evaluation was done according to the American Joint Committee on Cancer Staging classification. MR images were evaluated by two radiologists while the PET/CT images by one radiologist and one nuclear physician. Histology and a mean clinical-radiological follow-up of 6-9 months served as the standards of reference.

RESULTS
The mean follow-up time was 22 months. Regional lymph node involvement was correctly determined in 30/40 cases as N-positive for WB-MRI (75%), p CONCLUSION
WB-MRI is a fast and feasible method for staging colon cancer patients but up-to-date does not reach the accuracy of 18F-FDG-PET/CT.

CLINICAL RELEVANCE/APPLICATION
The present study demonstrated expected advantages of PET/CT over WB-MRI in staging colon cancer patients.

SSM17-02 • Comparison of Diffusion Weighted MR Imaging with 18-FDG PET-CT for Lymph Node Assessment in Known Cases of Malignancy

Salli Bhargava DMRD (Presenter); Chalapathi R M. V. MD; Pupshpalatha Sudhakar MD

PURPOSE
To perform a node-by-node correlation of the maximum standard uptake value (SUV_{max}) and the minimal apparent diffusion coefficient (ADC_{min}) for each lymph node that shows radiotracer uptake on 18-FDG PET-CT. Develop a visual grading of diffusion restriction and assess its correlation with radiotracer uptake. Calculate the sensitivity and specificity of diffusion weighted
imaging (DWI) for the assessment of lymph nodes while using 18-FDG PET-CT as the gold standard.

METHOD AND MATERIALS
The study included 40 patients with histologically confirmed diagnosis of malignancy who were found to have significant lymph node involvement on 18-FDG PET-CT examination. These patients were subsequently imaged on a 1.5 T MRI scanner using a Torso-PA coil where DWI was performed using b values of 0, 100 and 1000 without respiratory gating. Blinded reading of the PET-CT and DW images was performed and SUV$_{max}$, ADC$_{min}$ abs and visual grade of diffusion restriction were recorded for each lymph node. Pearson’s correlation was performed over the entire data set and after segregating it into various subgroups.

RESULTS
Evaluation of 241 lymph nodes revealed a statistically significant inverse correlation (r=-0.190, p < 0.05) between SUV$_{max}$ and ADC$_{min}$ abs when compared to PET-CT. However, it is inaccurate in the evaluation of mediastinal lymph nodes suggesting the need for respiratory gating.

CONCLUSION
Increasing visual grade of lymph nodes on DWI consistently correlates with increase in radiotracer (18-FDG) uptake and low ADC values. DWI has a sensitivity and specificity of 89.9 and 93% when compared to PET-CT. However, it is inaccurate in the evaluation of mediastinal lymph nodes suggesting the need for respiratory gating.

CLINICAL RELEVANCE/APPLICATION
DWI is a cheaper, radiation-free imaging alternative that allows for qualitative and quantitative evaluation of lymph nodes, with findings closely paralleling those of 18-FDG PET-CT.

SSM17-03 • Misregistration of Intra-abdominal and Intrapelvic Organs: Comparison between PET-CT and PET-MR

Pinakpani Roy MD (Presenter); Joseph K Lee MD; Arif Sheikh MD; Meagan Shepherd; Stacy Hengsterman; Yueh Z Lee MD, PhD*; Wei Lin PhD

PURPOSE
To quantify and compare organ misregistration between PET-CT data and PET-MR data obtained on a hybrid whole body PET-MR system.

METHOD AND MATERIALS
Biograph mMR consists of a 3.0T whole-body magnet with body coils optimized for minimal 511 keV photon attenuation. The PET detectors are made of lutetium oxyorthosilicate crystals in combination with MR-compatible avalanche photodiodes. PET-CT data were acquired using a Siemens Biograph mCT system. Approximately 1 hour after 18-FDG injection, the CT data was acquired, followed sequentially by PET acquisition. IRB approval and informed consent were obtained.

RESULTS
With respect to misregistration, there was no significant difference between simultaneously obtained PET-MR data (mean 0.50 cm) and PET-CT (0.48 cm), but sequential acquired data (1.25 cm) showed significantly higher misregistration than PET-CT data (p<0.03). With respect to sequences, mean misregistration with T1 VIBE (mean 1.24 cm) was significantly higher (p<0.03) than with T2 HASTE (0.27 cm). Although mean misregistration with T2 STIR (0.27 cm) was lower than PET-CT and misregistration with breath hold T2 HASTE (0.62 cm) was higher than PET-CT, the results were not statistically significant.

CONCLUSION
Comparing BMI matched subjects, sequentially obtained PET-MR data has significantly higher misregistration than PET-CT data. Simultaneously obtained PET-MR data is non-inferior to PET-CT in that regard. Misregistration with T1 VIBE is significantly higher than with PET-CT.

CLINICAL RELEVANCE/APPLICATION
Simultaneously acquired PET-MR using T2 STIR sequence is comparable to PET-CT in terms of misregistration, which has diagnostic implications.

SSM17-04 • Preliminary Investigation of Composite Biomarkers in Simultaneous PET/MR: Relationship between SUV and ADC in Oncology Patients

Rajan Rakheja; Hersh Chandarana MD*; Linda Demello; Kimberly Jackson; Christopher Glielmi PhD*; Kent P Friedman MD (Presenter)

PURPOSE
To assess the correlation between SUV and ADC of neoplastic lesions using a simultaneous PET/MR and to investigate the value of a composite biomarker, SUVmax/ADCmin.

METHOD AND MATERIALS
Twenty-four patients with known primary malignancies underwent FDG-PET/CT followed by PET/MR (Biograph mMR). Diffusion weighted imaging was acquired using a single shot spin echo EPI sequence with b-values of 0, 350 and 750 s/mm2. ROIs were chosen, with the patients’ BMI range matching those of the PET-MR volunteers. Registration of MR-PET data in selected organs (liver, spleen, kidneys, colon, small bowel, bladder, uterus) was compared to that of PET-CT data with respect to organ type, MR sequence and mode of acquisition. Statistical analysis was performed using student T-test and Analysis of Variance (ANOVA).

RESULTS
No significant difference was found between simultaneously acquired PET-MR data and PET-CT data with respect to organ type, MR sequence and mode of acquisition. With respect to sequences, mean misregistration with T1 VIBE (mean 1.24 cm) was significantly higher than with PET-CT (0.48 cm). Although mean misregistration with T2 STIR (0.27 cm) was lower than PET-CT and misregistration with breath hold T2 HASTE (0.62 cm) was higher than PET-CT, the results were not statistically significant.

CONCLUSION
Comparing BMI matched subjects, sequentially obtained PET-MR data has significantly higher misregistration than PET-CT data. Simultaneously obtained PET-MR data is non-inferior to PET-CT in that regard.

CLINICAL RELEVANCE/APPLICATION
Simultaneously acquired PET-MR using T2 STIR sequence is comparable to PET-CT in terms of misregistration, which has diagnostic implications.

SSM17-05 • The Correlation between SUVmax of 18F-FDG PET/CT and Apparent Diffusion Coefficients (ADC) in Pancreas Cancer and Biliary Cancer

Shigeiki Nagamachi MD, PhD (Presenter); Ryuichi Nishii MD, PhD; Youchi Mizutani; Shogo Kiyohara; Eiji Furukoji MD, PhD; Tatefumi Sakae MD; Shozo Tamura MD, PhD; Hideyuki Wakamatsu MD; Seigo Fujita MD; Shigemi Futami MD, PhD

PURPOSE
To quantify and compare organ misregistration between PET-CT data and PET-MR data obtained on a hybrid whole body PET-MR system.

METHOD AND MATERIALS
Biograph mMR consists of a 3.0T whole-body magnet with body coils optimized for minimal 511 keV photon attenuation. The PET detectors are made of lutetium oxyorthosilicate crystals in combination with MR-compatible avalanche photodiodes. PET-CT data were acquired using a Siemens Biograph mCT system. Approximately 1 hour after 18-FDG injection, the CT data was acquired, followed sequentially by PET acquisition. IRB approval and informed consent were obtained.

RESULTS
With respect to misregistration, there was no significant difference between simultaneously obtained PET-MR data (mean 0.50 cm) and PET-CT (0.48 cm), but sequential acquired data (1.25 cm) showed significantly higher misregistration than PET-CT data (p<0.03). With respect to sequences, mean misregistration with T1 VIBE (mean 1.24 cm) was significantly higher (p<0.03) than with PET-CT (0.48 cm). Although mean misregistration with T2 STIR (0.27 cm) was lower than PET-CT and misregistration with breath hold T2 HASTE (0.62 cm) was higher than PET-CT, the results were not statistically significant.

CONCLUSION
Comparing BMI matched subjects, sequentially obtained PET-MR data has significantly higher misregistration than PET-CT data. Simultaneously obtained PET-MR data is non-inferior to PET-CT in that regard.

CLINICAL RELEVANCE/APPLICATION
Simultaneously acquired PET-MR using T2 STIR sequence is comparable to PET-CT in terms of misregistration, which has diagnostic implications.
RESULTS
In pancreas cancer, both ADC mean and ADC min was negatively correlated with SUVmax of early image ($r = -0.350$ and $r=-0.346$) and of delayed image ($r = -0.329$ and $r=-0.334$). In biliary cancer, both ADC mean and ADC min also negatively correlated with SUVmax of early image ($r = -0.602$ and $r=-0.414$) and of delayed image ($r = -0.599$ and $r=0.381$).

CONCLUSION
The present study demonstrated negative correlations between ADC and SUVmax in both pancreas cancer and biliary cancer. However, the correlation coefficients of biliary cancer were higher than those in pancreatic cancer. The correlation between cell density and glucose metabolism seems to be different considerably according to disease respectively.

CLINICAL RELEVANCE/APPLICATION
Because it is difficult to estimate SUVmax from a value of the ADC in pancreas tumor, both indices had better be evaluated together for understanding biological characteristics.

SSM17-06  ●  Growth and Utilization Trends in Outpatient PET by Place-of-Service and Specialty

David C Levin MD (Presenter) *; Vijay M Rao MD; Laurence Parker PhD; Charles M Intenzo MD; Andrea J Frangos MPH

PURPOSE
PET is the most rapidly growing segment of nuclear medicine. Our purpose was to study recent PET growth trends in private offices and hospitals, also to determine who owned the PET facilities in offices and who interpreted the PET scans in hospitals.

METHOD AND MATERIALS
The nationwide Medicare Physician/Supplier Procedure Summary Master Files for 2001-2011 were studied. All CPT codes for PET were selected and procedure volumes were determined for each year. Medicare location codes identified the settings where the scans were performed, and specialty codes identified the specialties of the facility owners (in offices) and interpreting physicians (in hospitals). Ownership in offices was established by tabulating global and technical component claims, while interpreting physician specialty in hospitals was determined by tabulating global and professional component claims.

RESULTS
In offices, Medicare PET volume grew from 31,422 in 2001 to 342,297 in 2011. In 2011, radiologists owned the office unit in 141,289 (43.3% share). Independent diagnostic testing facilities (IDTFs) had the next largest ownership share, 19.2%. IDTFs are listed as a specialty by Medicare, although the actual specialty of the physician provider cannot be determined. Cardiologists had a 13.4% share, and all other internal medicine specialties as a group had an 18.8% share. In hospitals, PET volume grew from 65,099 in 2001 to 340,870 in 2011. 95.6% of volume in the latter year was in outpatients. In 2011 in hospitals, radiologists interpreted 325,664 (90.2% share), while cardiologists interpreted 10,178 (3.0% share). Examination of the growth curves showed that in hospitals, PET volume underwent continued rapid growth during the entire period. Private office PET volume grew even more rapidly from 2002 to 2008, but then slowed from 2008-2011.

CONCLUSION
Outpatient PET is evenly split between private offices and hospitals. Rapid growth occurred from 2001-2011 in both locations, but the trend line began to flatten in offices in more recent years. Radiologists strongly predominated in hospital-based PET (96% share) in 2011. In offices, they also had a strong role, with the largest plurality (41%) of any medical specialty.

CLINICAL RELEVANCE/APPLICATION
Not applicable

SSM18-01  ●  Structural Abnormalities of the Lung in Children Born Extremely Preterm during the Surfactant Era

Karla M Logie BSc (Presenter) ; Conor Murray ; Graham L Hall PhD ; J. J Pillow MD ; Andrew C Wilson MD

PURPOSE
The long-term structural consequences of preterm birth upon the lungs remain unclear due to improved clinical management, survival rates and survival from younger gestations. Secondary to preterm birth, many infants develop bronchopulmonary dysplasia (BPD) the lung disease attributed to impaired morbidity and lung function. The purpose of this study was to assess lung structure in a contemporary cohort of children born at ≤32 weeks gestation. We hypothesised that structural abnormalities would be present in preterm children regardless of BPD status, increased frequency and severity in the BPD cohort.

METHOD AND MATERIALS
Images of 1mm thickness were obtained from a 64-slice CT machine (Philips Brilliance 64; Philips Medical Systems, Eindhoven, Netherlands). Inspiratory images were obtained at 10mm intervals from the lung apex to the diaphragm. Three expiratory images were collected at the level of the carina and the mid-points between the carina and the lung apex, and the carina and the diaphragm, respectively. Consensus scoring using a previously published, preterm specific protocol was performed by a paediatric thoracic radiologist and paediatric respiratory physician.

RESULTS
Structural lung abnormalities were present in 94 of the 100 preterm children. The most common abnormalities were the presence of linear/triangular sub pleural opacities ($n=86$), peribronchial thickening ($n=43$) and pulmonary hypoattenuation on expiration ($n=43$). Only hypoattenuation on inspiration and sub-segmental collapse/consolidation were more common in the BPD vs. Non-BPD cohort (45% vs. 19% and 18% vs. 0%, $p = 0.01$; respectively). The total chest CT score per child (sum of structural abnormalities a marker of extent of structural damage) ranged from 0 to 26 and was significantly higher in the BPD group (median total score of 8 vs. 4; $p=0.01$). Total score was associated with oxygen ($p = 0.02$) and mechanical ventilation durations ($p = 0.02$).

CONCLUSION
This study has shown that pulmonary structural abnormalities are present in 94% of children born preterm, regardless of neonatal diagnosis of BPD. The extent of structural damage, indicated by total chest CT score, was associated with extent of neonatal
SSM18-04 • Markov Model Optimization of the Imaging Screening Strategy for Cystic Pleuropulmonary Blastoma in Children with DICER1 Mutations

Divya Sabapathy (Presenter) ; R. Paul Guillerman MD ; Jack Priest MD ; Robert Orth MD, PhD * ; Eugene Kim MD ; William Foulkes MD ; Ananth Annapragada PhD *

PURPOSE
Pleuropulmonary Blastoma (PPB), the most common primary pediatric pulmonary neoplasm, is strongly associated with DICER1 gene mutations. Unresected type I (cystic) PPB may progress into more aggressive type II/III during early childhood. X-ray based screening for the disease bears the risk of radiation induced malignancies. We therefore compared the utility of chest radiography (CXR) and computed tomography (CT) screening strategies for cystic PPB in children with DICER1 mutations.

METHOD AND MATERIALS
A Markov model was used to project the outcomes of 100,000 hypothetical patients undergoing screening for PPB. Estimates of PPB risk given a DICER1 mutation, risk of progression from type I to type II/III PPB, and PPB subtype mortality were estimated from the International PPB Registry data. Scenarios included patients aged 0-3 years with annual, biannual and quarterly CXR or CT exams. Additional scenarios with only 1 or 2 CT exams during the entire 3 year period were also tested. Radiation doses were based on dosimetry estimates. Lifetime radiation-attributable risks of cancer incidence and mortality were derived from the BEIR VII report. Mortality and life expectancy loss were calculated using a life table method to evaluate lifetime detriment.

RESULTS
Patients screened with CT incur higher lifetime detriment due to radiation-induced cancer than those screened with CXR. However, CT identified virtually all cystic PPB at the first screen while CXR required multiple screening cycles. The model predicts that even for multiple (>2) CT examinations, the average loss of life expectancy is on the order of days. This is orders of magnitude lower than for undetected PPB, which results in an average loss in life expectancy of >10 years. Sensitivity analysis showed that model uncertainty was dominated by the exam radiation dose.

CONCLUSION
The model suggests that the benefits of chest CT for cystic PPB detection greatly exceed the potential risks attributable to radiation exposure.

CLINICAL RELEVANCE/APPLICATION
Markov modeling can be used to compare projected radiation-induced cancer and disease-related risks and guide optimization of imaging-based disease surveillance strategies.

SSM18-03 • Radiological Evaluation of Neonatal Ventilator - Associated Pneumonia

Roberto Llorens Salvador (Presenter) ; Maria Cernada Badia MD ; Amparo Moreno Flores MD ; Marta Aguar MD

PURPOSE
1. To illustrate the radiological patterns depicted in chest radiographies in those intubated neonates diagnosed of ventilator-associated pneumonia (VAP).
2. To discuss the impact of chest imaging in neonatal VAP diagnosis.

METHOD AND MATERIALS
Following the CDC/National Nosocomial Infection Surveillance criteria, persistent radiological infiltrates or consolidation in two sequential radiographs after initiation of mechanical ventilation, in the proper clinical and microbiological scenario, are necessary to diagnose VAP. After a prospective observational cohort study conducted in our tertiary-care regional referral center for a 2-yr period, two experienced pediatric radiologists, blinded to the clinical suspicion in the moment of imaging interpretation, reviewed the radiological patterns detected in the X-rays of 202 neonates included in the study. Both radiologists, separately, evaluated retrospectively the chest radiographs and registered in a electronic data sheet (Excel 2010,Microsoft) the radiological findings according to their individual interpretation following the criteria mentioned before. Detailed causative microbiological agents were investigated using invasive bronchoalveolar lavage (BAL).

RESULTS
Out of 398 newborn infants a total of 202 neonates were on mechanical ventilation (MV) more than 48h, of whom 16 were diagnosed of VAP (prevalence 8.1 %). The mean age at diagnosis was 29±15 days and a mean of 21±16 days on MV had elapsed at onset of VAP. Clinical suspicion of VAP required a radiological confirmation and the most frequent radiological features associated with VAP were persistent atelectasis or consolidation on chest radiograph (88.9% of episodes). Radiological infiltrate was described in 55.6 % of cases. Both radiologists considered equally the radiographies as to be suggestive of VAP in the 100% of cases finally diagnosed as VAP. The most frequently isolated microorganism (19%) was P aeruginosa, being the Gram negative organisms responsible for 61.9 % of VAP.

CONCLUSION
There are typical radiological patterns that radiologists should be able to recognize in chest radiographs of intubated neonates in the NICU. Under clinical suspicion, radiological information is a key feature to let neonatologists perform invasive techniques as BAL to confirm VAP diagnosis.

CLINICAL RELEVANCE/APPLICATION
Recognition of determined radiological patterns is important to lead invasive diagnosis of VAP in intubated neonates in the NICU.

SSM18-04 • Imaging for Assessing Progression in Cystic Fibrosis Lung Disease: What Is the Best Approach?

Robert H Cleveland MD (Presenter) * ; Catherine Stamoulis PhD ; Gregory Sawicki MD ; Emma L Kelliher MBBCh, MRCPI ; Evan J Zucker MD ; Christopher Wood BA ; David Zurakowski PhD ; Edward Y Lee MD, MPH

PURPOSE
To determine the best imaging tool in assessing longitudinal progression of Cystic Fibrosis (CF) lung disease.

METHOD AND MATERIALS
Four radiologists independently scored 211 serial chest x-rays (CXR) from 30 CF patients twice using the Brasfield and twice using the Wisconsin systems. Scores were compared to the patient’s simultaneously acquired PFTs (FEV-1 and FVC). Intra- and inter-rater correlation coefficients were estimated for each system to assess respective consistency and reproducibility. Brasfield and Wisconsin scores were averaged and then converted to z-scores and compared to each other and to z-scores of the FEV-1 and FVC to determine correlation to each other and to clinical gold standards. In addition to mean scores for each reader, the coefficient of covariance were calculated to determine variability within each system’s raw scores. As recently reported from the Wisconsin group, CT has not shown superiority over serial CXR for longitudinal assessment of CF lung disease. Therefore, CT results in increased radiation dose, cost and supplemental imaging, CT was not evaluated.
RESULTS
For the 4 readers, intra-rater correlation was in the range r=0.91-0.99 for Brasfield and r=0.83â 0.99 for Wisconsin (all p
CONCLUSION
When comparing reader reliability, the Brasfield and Wisconsin systems perform almost identically. Compared to each other and to
PFTs, both systems perform almost identically. More variability in scoring occurred with the Wisconsin system.

CLINICAL RELEVANCE/APPLICATION
Imaging has become recognized as a reliable outcome assessment tool in CF research. This study reveals that Brasfield and
Wisconsin assessment are equally reliable as such tools.

SSM18-05 • Low-dose CT Protocol with Post-processing Techniques in Children for Clinically Suspected Tracheobronchial
Foreign Bodies
Nong Qian (Presenter) ; Changjie Pan
PURPOSE
The purpose of our study was to assess the sensitivity and specificity of low-dose computed tomography (CT) in children for
suspected tracheobronchial foreign bodies (FBs) by using rigid bronchoscopy (RB) as the reference standard.

METHOD AND MATERIALS
A prospective study of 79 children who were admitted with suspected tracheobronchial FBs underwent non-contrast lung CT were
included in the study. All studies were performed on a Dual-source CT (DSCT) with high pitch scan model (low-dose protocol). All
patients performed Post-processing (PP) techniques including multiplanar reconstruction (MPR), minimum intensity projection (Min
IP), and virtual bronchoscopy (VB) were performed. Two radiologists independently evaluated the characterization of the
tracheobronchial FBs (location, shape and pulmonary complications). All patients underwent rigid bronchoscopy (RB) evaluation
within 24 hours after foreign bodies were confirmed or highly suspected in CT. Statistical analysis was performed with 2x2
contingency tables; 95% confidence intervals (CIs) were calculated with the Blyth-Still-Casella procedure.

RESULTS
Mean patient age was 1.9 years (range, 2 months to 6 years; 58% male patients). Tracheobronchial FBs were detected at RB in 72 of
79 patients. In 70 of 72 patients, DSCT with PP depicted a tracheobronchial FBs. Two patients with normal findings at DSCT with PP
had tracheobronchial FBs at RB. Sensitivity and specificity of CT with PP were 97.2% (95% Cs: 93.4%, 100%) and 85.7% (95% Cs:
4.3%, 100%), respectively. Positive and negative predictive values were 98.6% (95% Cs: 95.8%, 100%) and 75.0% (95% Cs:
35.0%; 97.0%), respectively. Overall accuracy was 96.2% (95% Cs: 92.0%, 100%). Mean effective dose was 0.57 mSv (range,
0.17â0.77 mSv).

CONCLUSION
DSCT with a low-dose protocol with post-processing techniques had high sensitivity and positive predictive values for depiction of
FBs in children. It can accurately exhibit the indirect signs and pulmonary complications.

CLINICAL RELEVANCE/APPLICATION
Low-dose DSCT with PP can noninvasively depict pediatric tracheobronchial FBs. Sensitivity, and PPV are high, particularly in
patients of the FBs are nonradiopaque, mean effective dose of all examina

SSM18-06 • Comparison of Low Dose Chest CT with CR Chest Images in the Management of Pediatric Pulmonary
Tuberculosis Infection
Elizabete Kadakovska (Presenter) ; Gabriel Bartal MD ; Ausma Ozolina MD ; Evija Livcane MD, PhD ; Iveta Ozere MD, PhD ;
Elina Valtere MD
PURPOSE
Currently diagnosis of Pulmonary Tuberculosis (Tb) is based on medical history, physical examination, specific tests for Tb infection
and chest computerized radiography (CR). Vast number of infected children remains undiagnosed, thus creating a reservoir for
future adult disease. Diagnosis of Lung Tb in children is complex can be easily missed and chest CR does not exclude all cases of
active Tb. Our purpose was to compare low dose Chest CT and chest CR in children following a course of medical treatment.

METHOD AND MATERIALS
Between January 2008 and December 2012, 61/295 children in the State Tuberculosis hospital of Latvia with clinical and laboratory
signs of Tb underwent low dose Chest CT (80 kV, 90 mAs, CTDIvol (mGy) 0.68, DLP (mGy-cm) 23.12) and CR following a course of
specific Anti Tuberculosis treatment. The inclusion criteria for the study were laboratory and clinical improvement. Two certified
chest radiologists (EK and AO) retrospectively, independently and blindly compared chest CR and CT findings.

RESULTS
Of 61/295 (21 %) had significantly improved bacteriology and clinical picture following the initial treatment. Comparison of
radiological findings between CR and CT was performed in the following parameters Chest CR vs. CT findings were as following: air
space consolidation 24 (39%) / 29 (47%), nodular lesions 16(26%) / 22(36%), lymphadenopathy 9(15%) / 25 (47%), pleural
effusion 9(15%) / 9(15%), cavitations with parenchymal lesions 7(11%) / 11(18%), Ghon complex 4(6%) / 13(21%), calcified
lymph nodes 2(3%) / 17(28%) respectively. Cavitations with parenchymal lesions were observed in 11/61(18%) on CT only. It was
possible to avoid unnecessary treatment based on CT findings.

CONCLUSION
Low dose CT can improve management of pulmonary Tb thus avoiding unnecessary and possibly harmful antibiotic treatment in
pediatric population.

CLINICAL RELEVANCE/APPLICATION
Low dose chest CT is valuable tool in diagnosis and management of Tb in children.

Physics (Quantitative Imaging III) Wednesday, 03:00 PM - 04:00 PM • N228
SSM19 • AMA PRA Category
1 Credit 
1 Credit 
SSM19 • Automated Pulmonary Nodule Elastometry as a Potential Diagnostic Tool
Mohammadreza Negahdar (Presenter) ; Billy W Loo MD, PhD * ; Maximilian Diehn MD, PhD * ; Dominik Fleischmann MD * ;
Lu Tian ; Peter G Maxim PhD
SSM19-02 • Multisite Quantitative Evaluation of the Accuracy and Precision of a Novel Test Bolus-based CT Angiography
Contrast-enhancement Prediction Algorithm
Johannes G Korporaal PhD (Presenter) * ; Andreas H Mahnken MD * ; Jiri Ferda MD, PhD ; Jorg Hausleiter ; Bernhard
Schmidt PhD * ; Thomas G Flohr PhD *
PURPOSE
To quantify the accuracy and precision of a novel test bolus-based CT angiography (CTA) contrast-enhancement prediction (CEP)
algorithm by comparing the amplitude, timing and curve shape of the predicted and true enhancement in the descending aorta
(DAo).

METHOD AND MATERIALS
After routine clinical scanning according to local scan and injection protocols, from three hospitals a total of 72 (3x24) anonymized
cardiac CTA exams were collected for retrospective analysis. Patients (30f/42m) had a median age and body weight or respectively 74y (range 31-81) and 79kg (range 61-125).

Since existing data were retrospectively analyzed, injection protocols, image acquisitions and reconstructions differed substantially between hospitals.

Test bolus (TB) scans were performed at the level of the pulmonary artery, after which the TB signal in the DAo was processed by the CEP-algorithm. This novel algorithm takes the injection protocols and kV settings of the TB and CTA scan into account, and uses population-averaged information to predict the CTA enhancement. The true enhancement was extracted from the CTA scan with a 6mm ROI along the DAo-centerline.

For each patient, the relative errors in the accuracy and precision were calculated. Deviations in the amplitude were quantified with Bland-Altman analysis and shape differences with the mean absolute error (MAE) of the normalized curves. The predicted curve was shifted along the true enhancement to find the timing error, which is the time shift for which the MAE is minimal.

RESULTS

Although differences in injection and acquisition protocols existed, no significant differences in the precision and accuracy were found between the hospitals. For the entire patient group, the predicted enhancement has an average deviation of 1.0±15.4% in the amplitude, 0.1±1.8s in the timing, and 5.5±2.4% in the curve shape.

CONCLUSION

No clinically relevant offsets in the timing and amplitude of the predicted enhancement exist, and the curve shape corresponds well with the true enhancement. With its excellent accuracy and good precision, this algorithm has high potential for CTA scan timing and injection protocol optimization.

CLINICAL RELEVANCE/APPLICATION

Most efficient usage of contrast agent, and thus maximum CNR in CTA images, can potentially be achieved by using this algorithm for scan timing and injection protocol optimization.

SSM19-03 ● Detecting Enhancing Lesions in Multiple Sclerosis Patients Using Visual Texture Analysis on Brain T2-weighted MR Images: A Feasibility Study

Nicolas Michoux (Presenter); Alain Guillet; Denis J Rommel MD; Thierry P Duprez MD

CONCLUSION

On-going research aims at assessing the performance of a texture-based decision system from T2 images acquired before Gd injection which, if effective, may offer an alternative to detect Gd-enhancing lesions in MS patients when Gd injection is contra-indicated or impossible. References


Background

MRI is the most sensitive technique for detecting multiple sclerosis (MS) lesions. While DCE-MRI is routinely used for evaluating the inflammatory activity, diffusion MRI is controversial (1). Texture analysis has been used with success to investigate pathological brain tissues (2). This study assesses the feasibility of texture analysis on T2-weighted MRI to detect changes within white matter in MS patients.

Evaluation

Patients

This retrospective study was approved by our institutional ethical committee. From post-Gd T1-weighted imaging, 44 enhancing lesions (EL), 37 non-enhancing lesions (non-EL) and contra-lateral regions in normal appearing white matter (NAWM) were identified in 21 patients diagnosed with MS.

MRI

Examinations were performed using a 3.0T whole body imaging system and a SENSE head 32 receiving coil. FSE T2, FSE FLAIR, EPI diffusion and 3D post-Gd GRE T1 sequences were acquired.

Computing

A 21-components vector (20 Textons + ADC) was derived for each region from grey level co-occurrence and run length matrices (3, 4).

Results

Differences between EL/non-EL and NAWM were statistically significant (p < 0.05) except for one Texton. Differences between EL and non-EL were significant except for one Texton and ADC. ROC analysis showed a performance of Textons and ADC ranging from moderate (AUC ADC = 0.58) to good (AUC Texton = 0.84). A good predictive model of EL (Se = 88%, Sp = 81%) was achieved based on a partial least squares classifier and a set of 6 Textons.

Discussion

Textons values result from the structural characteristics of the tissues and thus are affected by pathologic changes. Applying texture analysis to T2-weighted MRI is feasible and may help differentiating EL from non-EL in MS.

SSM19-04 ● Comparison Study of Spectral Imaging Associated with Iso-Osmolar Contrast Media on Vascular Evaluation in Rabbits

Pan Liang (Presenter); Jianbo Gao MD

PURPOSE

To compare the vascular enhancement between spectral imaging associated with iso-osmolar contrast media and traditional 120kVp scans with high-osmolar contrast media on vessel.

METHOD AND MATERIALS

6 adult New Zealand rabbits of similar age and size were enrolled in this study. Each rabbit underwent two epigastric CT protocols and interval time among every protocol is 24 hours. Protocol A: traditional CT gastric angiography (CTGA) with Iopromide 350 (2ml/kg, 1.5ml/s). Protocol B: spectral CT enhanced sequence with Iodixanol 270 (2ml/kg, 0.5ml/s). Images of spectral CT series will be reconstructed at 55 keV. Signal intensity, image noise, signal-to-noise ratio (SNR) and contrast-to-noise ratio (CNR) measured within the parallel groups in aortaventralis and left gastric artery, and inferior noise (p=0.029) only in left gastric arteries. The SNR and CNR of the 55 keV images had no significant differences from that of the traditional CTGA images (23.33±5.54 vs. 24.45±1.65, P=0.646; 18.19±4.28 vs. 17.74±1.03, P=0.806). Also, spectral CT images provide better overal image quality scores (p=0.05), the proportion of diagnostic images was higher (p

CONCLUSION

Spectral imaging associated with iso-osmolar contrast media of Iodixanol 270 can provide excellent gastric vascular images at 55 keV at equivalent radiation of traditional CTGA scans. In the meanwhile, contrast media dose can be greatly reduced.

CLINICAL RELEVANCE/APPLICATION

The association of iso-osmolar contrast media with spectral imaging can greatly reduce the amount of iodine while maintaining high quality of vascular images.
SSM19-05 • Assessment of a New Image-based Method of Monoenergetic Imaging

Katharine Grant PhD (Presenter) *; Bernhard Krauss PhD *; Martin U Sedlmair MS *; Thomas G Flohr PhD *

Christian Eusemann PhD *; Bernhard Schmidt PhD *

PURPOSE

Following the trend of low dose imaging, concerns regarding the detectability of low contrast lesions have been growing. The goal of this research is to evaluate if a new image-based algorithm (mono+) for monoenergetic imaging can improve the contrast-to-noise ratio and conspicuity of these low contrast objects.

METHOD AND MATERIALS

Three different anthropomorphic dual energy phantoms of different size representing a small medium and large phantoms containing 3 different iodine concentrations (known values of 20, 50 and 100HU @120kV) were scanned at 3 different dose levels (full, half and quarter dose). Images were reconstructed at both 40keV and 70keV using both a standard image-based monoenergetic algorithm and mono+ at three dose levels, resulting in 12 different images sets per phantom size. Hounsfield units and standard detection (noise) measurements were recorded from ROIs placed within the three inserts and one background for each image set.

To calculate monoenergetic images, similar to raw data approaches a two material decomposition into base materials is performed. Based on tabulated data, from the two material images, monoenergetic (keV) images can be calculated. Since by theory, any decomposition leads to an increase in noise, keV images of very low or high energy (e.g. 40 keV or 190 keV) show a substantial noise increase. Our newly developed method to calculate keV images suppresses this increase by applying a regional analysis-dependent frequency-based recombination of the high signal at lower energies and the superior noise properties at medium energies.

RESULTS

The mono+ algorithm resulted in a greatly improved image quality for both the 40 keV (Fig 1) and 70 keV. Both keV level displayed lower image artifacts and a significant reduction in image noise. CNR improved for all inserts using mono+ compared to the standard algorithm. For example for the small phantom CNR could be improved for the 40 keV by about 50%.

CONCLUSION

Mono+ improves CNR and low contrast lesion conspicuity in particular for low dose imaging, independent of phantom size.

CLINICAL RELEVANCE/APPLICATION

Mono+ provides significantly increased CNR, resulting in increased lesion conspicuity. These improvements should allow for added diagnostic confidence, higher throughput and reduced reader fatigue.

SSM19-06 • Automated and Optimized Imaging Simulation Platform for Virtual Clinical Trials of Breast Cancer Screening

Predrag R Bakic PhD (Presenter) *; Andrew D Maidment PhD *; Joseph H Chui MSC *; Ali N Avanaki PhD *; Cedric Marchessoux *; David D Pokrajac PhD; Kathryn S Espig MSc *; Tom Kimpe PhD *; Albert Xthona *; Miguel A Lago *; Varsha Shankla *

PURPOSE

We have developed an automated pipeline for the simulation and analysis of x-ray breast images. The simulation has been used to conduct Virtual Clinical Trials (VCTs) of digital mammography and digital breast tomosynthesis imaging.

METHOD AND MATERIALS

An automated pipeline has been developed (in C++ and OpenCL) that includes simulation of the normal breast anatomy and lesions (e.g. microcalcification clusters), breast deformation, image acquisition, image processing, display modeling, and image analysis using model observers. The breast anatomy is simulated using an octree-based recursive partitioning method, which allows for fast simulation of a large number of phantoms with very small voxel size. Clusters of microcalcifications (derived from stereomammographic clinical images) are added after identifying potential locations of cluster insertion based upon the convolution of simulated dense tissue regions with the minimal bounding box surrounding the cluster. The phantom deformation resulting from mammographic compression is simulated using a finite element model. Images of the deformed breast are then synthesized using a fast ray tracing method. Image processing is applied to create DICOM images and display modeling takes into account medical monitors effects including temporal effects and an accurate browsing speed simulation. Detection of microcalcifications is estimated using 2D, 2D+time, and 3D channelized Hotelling observers equipped with the spatio-temporal contrast sensitivity function of the human visual system in response to the simulated display of images.

RESULTS

The developed pipeline supports the simulation of 2D and 3D breast imaging. The GPU implementation has resulting in significant acceleration, with the simulation duration at each pipeline stage now being on the order of seconds. For example, compressed versions of 450ml breasts with voxel size of 200 microns are generated at a rate of more than 30 per minute. Extensive pipeline testing has demonstrated that detection results follow the same trends as human observers in terms of contrast and browsing speed.

CONCLUSION

We have developed an automated and accelerated pipeline for performing VCTs of breast imaging.

CLINICAL RELEVANCE/APPLICATION

VCTs have role as a preclinical optimization and validation tool prior to clinical trials of new imaging equipment.
Effect of Scan and Reconstruction Parameters on Grand Glass Opacity Visibility in Low-dose Lung Computed Tomography

Katsuhiko Ichikawa PhD (Presenter); Takeshi Kobayashi; Motoyasu Sagawa MD

PURPOSE
This phantom-based multicenter study aimed to investigate the effect of scan and reconstruction parameters on grand glass opacity (GGO) visibility in low-dose lung computed tomography (LDLCT).

METHOD AND MATERIALS
Eighteen screening centers participated. Phantoms for physical measurements and an anthropomorphic chest phantom that included simulated GGOs with CT numbers of -630 Hounsfield units (HU) (LGGOs) and -800 HU (HGGOs) were employed. The phantoms were designed to simulate a realistic lung phantom and the spatial frequency property of the simulated nodule image. The spatial resolution of IR images was highly dependent on contrast level. At high contrast, IR_1 and IR_2 had an almost identical MTF as FBP. The degradation of the MTF by IR relative to FBP became more severe as the contrast level decreased. The differences in spatial frequencies at the 50%, 10%, 2% MTF values between IR_1 and FBP were (21 HU: -0.02, 0.02, 0.02 cm^-1; 14 HU: -0.04, -0.04, -0.02 cm^-1; 7 HU: -0.02, -0.06, -0.08 cm^-1). IR_2 degraded the MTF even more than IR_1 due to a stronger regularization setting.

CONCLUSION
A novel methodology was used to measure the spatial resolution of IR at very low contrast levels. Quantifying contrast-dependent resolution is important for clinical use of IR. This is the first experimental study to demonstrate the degradation of resolution for IR at very low contrast levels.

SSM20-03 • Measuring the Contrast-dependent Spatial Resolution of CT Iterative Reconstruction Methods at Very Low Contrast Values

Lifeng Yu PhD (Presenter); Thomas J Vrieze RT; Shuai Leng PhD; Joel G Fletcher MD *; Cynthia H McCollough PhD *

PURPOSE
To measure the spatial resolution of iterative reconstruction (IR) methods at very low contrast values.

METHOD AND MATERIALS
The spatial resolution of IR is contrast- and noise-dependent because of the non-linear regularization term in IR. Studies exist that measure the spatial resolution at medium-contrast levels using the polyethylene (-90 HU) and acrylic (120 HU) test objects in the ACR CT phantom. However, because of the severe noise contamination of low-contrast edges, it is extremely challenging to perform precise spatial-resolution measurements at very low-contrast levels.

RESULTS
The spatial resolution of IR images was highly dependent on contrast level. At high contrast, IR_1 and IR_2 had an almost identical MTF as FBP. The degradation of the MTF by IR relative to FBP became more severe as the contrast level decreased. The differences in spatial frequencies at the 50%, 10%, 2% MTF values between IR_1 and FBP were (21 HU: -0.02, 0.02, 0.02 cm^-1; 14 HU: -0.04, -0.04, -0.02 cm^-1; 7 HU: -0.02, -0.06, -0.08 cm^-1). IR_2 degraded the MTF even more than IR_1 due to a stronger regularization setting.

CONCLUSION
A novel methodology was used to measure the spatial resolution of IR at very low contrast levels. Quantifying contrast-dependent resolution is important for clinical use of IR. This is the first experimental study to demonstrate the degradation of resolution for IR at very low contrast levels.

SSM20-04 • Measuring the Contrast-dependent Spatial Resolution of CT Iterative Reconstruction Methods at Very Low Contrast Values

Hewei Gao PhD (Presenter) *; Paul Fitzgerald *; Yannan Jin *; Jiao Wang *; Peter Edic *; Bruno De Man PhD *

PURPOSE
Geometric iRradiation Efficiency (GiRE) of a CT system, a function of the percentage of applied X-ray radiation useful for reconstructing a volume of interest (VOI) and the uniformity of the radiation within the VOI, is an important factor when considering noise uniformity and dose optimization. In this study, we propose a fast evaluation approach for relative comparison of different CT system architectures.

METHOD AND MATERIALS
First, a pseudo-sinogram whose values equal unity is back-projected according to the scan geometry. Voxel values within the irradiation volume represent the number of times the voxel is irradiated by X-ray flux, normalized by the number of views. If the voxel is irradiated at each view for once and only once, then its normalized value is unity. Then, the percentage of the useful radiation administered to the VOI relative to the entire irradiation volume is computed, denoted as a useful-irradiation rate. Next, an irradiation uniformity index is calculated by computing the mean absolute difference between the values within an ideal, uniformly-irradiated VOI and those of the actually irradiation distribution within the VOI, and then subtracting this value from unity. Finally, we obtain the GiRE as the product of the two above. In order to better reveal the irradiation uniformity relative to the X-ray tube power capability, we further introduce a few new metrics: sufficient-irradiation and always-irradiation rates (percentages of irradiation to VOI voxels that have at least 180-degree of data or equal the maximum) versus their corresponding mean integrated X-ray tube power.

RESULTS
We evaluate the GiRE of 4 CT system architectures for cardiovascular imaging including single source CT (half scan), dual (transaxial) source CT (full scan), and dual twin-Z source CT (half scan). Using the proposed evaluation criteria, their GiREs are 0.88 for the first three architectures, and 0.64 for the last one. Triple source CT is identified as the best based on irradiation uniformity versus X-ray tube power.

CONCLUSION
An approach for evaluation of GiRE is proposed and applied to the architecture analysis of the cardiac CT-specific scanner of the future.

CLINICAL RELEVANCE/APPLICATION
Our method is beneficial in identifying CT system with the best noise uniformity and dose utilization. It provides an easy way to better understand and illustrate the relative irradiation efficiency.

SSM20-05 • Measuring the Contrast-dependent Spatial Resolution of CT Iterative Reconstruction Methods at Very Low Contrast Values

Jiao Wang PhD; Peter Edic PhD; Bruno De Man PhD

PURPOSE
To measure the spatial resolution of iterative reconstruction methods at very low contrast values.

METHOD AND MATERIALS
First, a pseudo-sinogram whose values equal unity is back-projected according to the scan geometry. Voxel values within the irradiation volume represent the number of times the voxel is irradiated by X-ray flux, normalized by the number of views. If the voxel is irradiated at each view for once and only once, then its normalized value is unity. Then, the percentage of the useful radiation administered to the VOI relative to the entire irradiation volume is computed, denoted as a useful-irradiation rate. Next, an irradiation uniformity index is calculated by computing the mean absolute difference between the values within an ideal, uniformly-irradiated VOI and those of the actually irradiation distribution within the VOI, and then subtracting this value from unity. Finally, we obtain the GiRE as the product of the two above. In order to better reveal the irradiation uniformity relative to the X-ray tube power capability, we further introduce a few new metrics: sufficient-irradiation and always-irradiation rates (percentages of irradiation to VOI voxels that have at least 180-degree of data or equal the maximum) versus their corresponding mean integrated X-ray tube power.

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CONCLUSION
An approach for evaluation of GiRE is proposed and applied to the architecture analysis of the cardiac CT-specific scanner of the future.

CLINICAL RELEVANCE/APPLICATION
Our method is beneficial in identifying CT system with the best noise uniformity and dose utilization. It provides an easy way to better understand and illustrate the relative irradiation efficiency.

SSM20-06 • Measuring the Contrast-dependent Spatial Resolution of CT Iterative Reconstruction Methods at Very Low Contrast Values

Lifeng Yu PhD (Presenter) ; Thomas J Vrieze RT ; Shuai Leng PhD ; Joel G Fletcher MD * ; Cynthia H McCollough PhD *

PURPOSE
To measure the spatial resolution of iterative reconstruction (IR) methods at very low contrast values.

METHOD AND MATERIALS
The spatial resolution of IR is contrast- and noise-dependent because of the non-linear regularization term in IR. Studies exist that measure the spatial resolution at medium-contrast levels using the polyethylene (-90 HU) and acrylic (120 HU) test objects in the ACR CT phantom. However, because of the severe noise contamination of low-contrast edges, it is extremely challenging to perform precise spatial-resolution measurements at very low-contrast levels.

RESULTS
The spatial resolution of IR images was highly dependent on contrast level. At high contrast, IR_1 and IR_2 had an almost identical MTF as FBP. The degradation of the MTF by IR relative to FBP became more severe as the contrast level decreased. The differences in spatial frequencies at the 50%, 10%, 2% MTF values between IR_1 and FBP were (21 HU: -0.02, 0.02, 0.02 cm^-1; 14 HU: -0.04, -0.04, -0.02 cm^-1; 7 HU: -0.02, -0.06, -0.08 cm^-1). IR_2 degraded the MTF even more than IR_1 due to a stronger regularization setting.

CONCLUSION
A novel methodology was used to measure the spatial resolution of IR at very low contrast levels. Quantifying contrast-dependent resolution is important for clinical use of IR. This is the first experimental study to demonstrate the degradation of resolution for IR at very low contrast levels.
SSM21-05 • Patient Size Dependent Low Contrast Detectability in Abdominal CT

Yifang Zhou PhD (Presenter) ; Alexander W Scott PhD

PURPOSE
We chose to use the statistically defined minimum detectable contrast (MDC) as a gauge for image quality. We attempted to study MDC's relationship to patient size, dose and lesion size in typical abdomen CT scans.

METHOD AND MATERIALS
Seven abdomen phantoms (CIRS TE series) simulating patients from an infant to a large adult were used. Helical scans were conducted using a Siemens Sensation 64 (mCT) with 120 kVp and mAs ranging 35-595 (kernel B30s, pitch 1.4 and width 5 mm). For each phantom, the uniform sections of the contiguous slices were subtracted and the resulted regions were divided by grids of cells sized from 1.37 mm-6.84 mm. Standard deviations (sd) were computed from the means of all cells and scaled down by square root of 2. The MDC, quantifying the signal to background difference equal to 3.29sd, was fitted to dose D (phantom specific CTD1vol) and cell sizes (d). MDC versus patient size relationship was established by extracting the fitting parameter's dependency

RESULTS
MDC versus D and d was fitted to a power law (R square larger than 0.94), with power indices close to -0.5 and -1, respectively. The proportional constant versus patient size follows an exponential relationship with the an index of 0.18 /cm, close to the linear attenuation coefficient of the phantom.

CONCLUSION
The relationships of MDC versus patient size, dose and lesion size, were established. They can be used for task specific dose optimization.

CLINICAL RELEVANCE/APPLICATION
CT dose optimization for different patient sizes

SSM21-06 • CT Evaluation of Coronary Artery Stents: Impact of an Integrated Circuit Detector with Iterative Reconstruction

Lucas L Geyer MD (Presenter) ; George R Glenn BS ; Christian Canstein * ; Justin R Silverman ; Mark Van Horn PhD ; U. Joseph Schoepf MD ; Aleksander Krazinski ; Stefan Wirth MD * ; Fabian Bamberg MD, MPH * ; Maximilian F Reiser MD ; Philip Costello MD

PURPOSE
To assess the influence of higher out-of-plane resolution and iterative reconstruction algorithms on the visualization of coronary artery stents using an integrated circuit CT detector.

METHOD AND MATERIALS
Vessel phantoms bearing coronary artery stents with different diameters (2.0, 2.5, 3.0 mm) were investigated on a second-generation dual-source CT system equipped with an integrated circuit detector allowing for 0.5 mm beam collimation. Data acquisition was performed at two different heart rates (0 bpm, 60 bpm) using an anthropomorphic moving heart phantom. Images were reconstructed with filtered back projection (FBP) at a section thickness of 0.75 mm (FPB75), and with sinogram-continued iterative reconstruction at both 0.75 mm (IR75) and 0.5 mm (IR50) section thickness. Multi-row HU intensity profiles were modeled by using a sum-of-Gaussian-fits to analyze in-plane image characteristics: xy-upslope (indicator of sharpness), standard deviation (SD, indicator of blurring), signal- (SNR) and contrast-to-noise ratio (CNR), and noise (general image quality parameters).

RESULTS
Independent of stent diameter and heart rate, IR75 resulted in significantly increased xy-sharpness, SNR, and CNR as well as decreased blurring and noise compared with FBP75 (e.g., 2.0 mm-stent, 0 bpm: xy-upslope, 308.7 vs. 278.5; SNR, 46.6 vs. 33.5; CNR, 26.0 vs. 16.8; SD, 1.4 vs. 1.5; noise, 15.4 vs. 21.2, all p

CONCLUSION
The implementation of an integrated circuit CT detector with thinner beam collimation provides substantially sharper out-of-plane resolution of coronary artery stents in an ex-vivo analysis. In addition, the use of iterative image reconstruction contributes mostly to an improved in-plane stent visualization independent from stent diameter and heart rate.

CLINICAL RELEVANCE/APPLICATION
Implementation of an integrated circuit CT detector combined with iterative image reconstruction improves 3D visualization of coronary stents of clinically-relevant diameters.
grid (1.27) when using the same acquisition parameters. For DBT, at the central plane of the inserts, ACR phantom scores were similar with (13.3 ± 0.5) and without (13.2 ± 0.5) grid. Adding 2.5 cm PMMA, ACR phantom scores were higher with (10.3 ± 0.5) than without (8.3 ± 0.5) grid. In addition, the 3D-grid significantly improved signal uniformity throughout the phantom.

CONCLUSION
The 3D-grid demonstrated a potential of improving detectability of features for breasts above the average thickness, while preserving the dose in DBT.

CLINICAL RELEVANCE/APPLICATION
For breasts above the average thickness, most difficult to image in mammography, the 3D-grid offers scatter rejection benefits comparable to MG grids, yet capable of operating both in MG and in DBT.

SSM21-02  X-ray Differential Phase Contrast Tomosynthesis Imaging based on a Clinical Digital Breast Tomosynthesis System

Ke Li MS (Presenter) ; John W Garrett MS * ; Yongshuai Ge ; Guang-Hong Chen PhD *

PURPOSE
To systematically investigate the feasibility and clinical relevance of grating-based x-ray differential phase contrast (DPC) tomosynthesis imaging constructed based on the hardware setup of a clinical digital breast tomosynthesis (DBT) system.

METHOD AND MATERIALS
The feasibility of DPC tomosynthesis imaging was first demonstrated using a benchtop system (40 kVp, 80 micron pixel size), from which tomosynthetic images of three different contrasts (refraction angle, phase shift, and absorption) of physical phantoms were acquired. The feasibility of DPC tomosynthesis imaging using the hardware setup of a clinical digital breast tomosynthesis system with a rotary x-ray source and static detector (Hologic Selenia Dimensions) was studied using a framework that quantitatively relates the detection performance of DPC tomosynthesis with the associated absorption DBT. X-ray spectrum, noise power spectrum, and MTF of the absorption DBT involved in the framework were physically measured and the imaging task was created based on the materials’ phase and absorption properties provided by NIST.

RESULTS
Reconstructions of physical phantoms show improved signal difference to noise ratio (SDNR) compared with absorption images acquired under the same exposure (SDNR_{PMMA} = 5.9 and 0.6 for DPC and absorption, respectively). Equivalent spatial resolution for the two contrast mechanisms was observed. Design parameters of the DPC tomosynthesis system are compatible with the current clinical DBT system. The accuracy of the framework that predicts detectability in DPC-DBT was validated experimentally, and it suggests that the DPC mechanism will result in improved detectability of both small objects (e.g. calcification) and irregular-shaped objects (e.g. spiculated lesions).

CONCLUSION
It is feasible to build a DPC tomosynthesis system using the hardware setup of an existing clinical DBT system. The system shows promise in improving lesion and calcification detectability, and therefore merits further investigation.

CLINICAL RELEVANCE/APPLICATION
This study demonstrates potential improvement in lesion/calcification detection performance by combining the DPC mechanism with the tomosynthesis imaging method.

SSM21-03  Dynamic Four-dimensional Contrast-enhanced Tomosynthesis

Brian C Lee (Presenter) ; Susan Ng * ; Johnny Kuo PhD * ; Peter A Ringer BS * ; Andrew D Maidment PhD *

PURPOSE
To explore the feasibility of performing four-dimensional dynamic contrast-enhanced tomosynthesis (4D DCE-DT).

METHOD AND MATERIALS
A custom bench-top tomosynthesis system was designed and built to perform 4D DCE-DT. The system consists of a stationary x-ray source and selenium x-ray detector, and a computer-controlled filter wheel with a variety of filter materials and thicknesses; phantoms are mounted on a rotary stage set atop of an x-y linear translation stage. A computer system coordinates all components, including a contrast injector. Images are acquired using a slow-scanning method in which each projection image is acquired after a fixed delay. Between each acquisition the phantom orientation is changed; it is also possible to change the x-ray energy and filter type, as well as perform injections. Both temporal and dual-energy subtraction are supported. Real-time reconstructions are performed by backprojection filtering using a customized commercial software package. A dynamic flow phantom was constructed and imaged to test the feasibility of 4D DCE-DT. One projection was acquired per energy per angle per timepoint and reconstructions were performed on subsets of these images; e.g., if projections 1 through N are used in the reconstruction for one timepoint, projections 2 through N+1 are used for the next timepoint.

RESULTS
Real-time reconstruction is possible to allow viewing of arbitrary tomographic planes and timepoints. Measured data from reconstructed waveforms of iodine concentration over time observed in the dynamic flow phantom matched the expected iodine concentration over time after convolution with a square wave with width equal to the number of projections per reconstruction. Experiments involving binary pulses of iodine (simulating the movement of a bolus of iodine through a vessel) confirmed the linearity and shift-invariance of the system. It can be observed that as the number of projections per timepoint/reconstruction decreases an increase in temporal resolution is achieved at the cost of a decrease in tomographic ability.

CONCLUSION
4D dynamic contrast-enhanced tomosynthesis can be performed in a dose-efficient fashion.

CLINICAL RELEVANCE/APPLICATION
4D dynamic contrast-enhanced tomosynthesis should allow for measurement of both spatial and temporal characteristics of blood flow and lesion perfusion.

SSM21-04  Characterization of the Dependence of the Modulation Transfer Function in Tomosynthesis on Acquisition Geometry and Reconstruction Parameters

Brian C Lee (Presenter) ; Raymond Acciavatti ; Andrew D Maidment PhD *

PURPOSE
To characterize the spatial dependence of the in-plane modulation transfer function (MTF) in tomosynthesis and investigate the influence of the acquisition geometry.

METHOD AND MATERIALS
The in-plane MTF was calculated from measured edge spread functions using a custom test tool consisting of a 0.250 mm thick lead sheet affixed to a 5.88 mm acrylic sheet. Images were obtained using a non-clinical benchtop tomosynthesis system; reconstructions were performed using customized commercial software (Briona, RTT Inc., Villanova PA). The dependence of the MTF was measured with respect to the following factors: 1) the offset of the reconstruction plane from the plane containing the edge; 2) the obliquity of the reconstruction plane with respect to the detector; 3) the number of projections per reconstruction; and 4) the acquisition’s angular range. Findings were validated by developing an analytical model of the MTF (accounting for blurring due to
focal spot size, magnification, detector element size, out-of-focus plane, and reconstruction filter) and by replicating the experiment on a clinical tomosynthesis system.

RESULTS
The MTF is degraded when the edge is located between two reconstruction planes. The degree of degradation of the MTF increases as the distance between the edge and the reconstruction plane increases and as the angular range of acquisition increases. Degradation increases very slightly as the obliquity of the reconstruction plane with respect to the detector increases over the range 0º to 32º. The number of projections per reconstruction does not affect the degradation. The simulated MTFs generated by the analytical model were concordant with findings on the MTF degradation factors, and the validation experiment on the clinical tomosynthesis system provided independent confirmation that the MTF degrades with increasing distance between the edge and the reconstruction plane.

CONCLUSION
The MTF of tomosynthesis systems is anisotropic and varies with sub-slice spacing. Reconstruction of oblique planes results in minimal degradation of the MTF and thus may be clinically acceptable.

CLINICAL RELEVANCE/APPLICATION
Sub-slice misalignment of objects with the reconstructed DBT slices may adversely affect the conspicuity of small clinical features such as calcifications.

SSM21-05 • Comparative Performance Evaluation of Contrast-detail in Full Field Digital Mammography Systems Using Hotelling Observer Signal to Noise Ratio versus Automated CDMAM Image Analysis

Ioannis Delakis PhD, MSc (Presenter) ; Robert Wise ; Eugenia Kulama MSC ; Donald Mc Robbie

CONCLUSION
We compared the Hotelling observer SNR against the CDMAM technique, to evaluate the performance of FFDM detectors. Results showed that the Hotelling observer SNR methodology is more consistent and can be more representative of the system's performance characteristics.

Background
Image quality evaluation plays an important role in ensuring and enhancing the diagnostic value of mammography studies. According to EUREF [www.euref.org], image quality in mammography is assessed using images acquired with the Contrast Detail mammography (CDMAM) phantom (Arthin medical systems, Netherlands). However, CDMAM analysis can suffer from intra-observer variations, limited statistics and structural differences between CDMAM phantoms. The purpose of this work was to evaluate detector performance for a range of full field digital mammography systems using Hotelling observer SNR analysis and ascertain whether it can be an alternative to CDMAM evaluation.

Evaluation
FFDM units used in West of London Breast Screening were evaluated. Detector performance was first analysed using CDMAM phantom methodology. As part of Hotelling observer SNR analysis, the generalised normalised noise power spectrum (GNNPS) was measured by collecting flat field images of a 5cm PMMA phantom. The generalised modulation transfer function (GMTF) was measured by placing a 0.2mm Tungsten edge in the middle of the PMMA phantom. This setup allowed for scatter and focal spot unsharpness to be incorporated in the measurements. The Hotelling observer SNR was calculated for input signal originating from gold discs of varying thicknesses and diameters.

Discussion
The Hotelling SNR values were used to estimate the threshold gold thicknesses for each diameter as per CDMAM analysis. The Hotelling SNR technique was more consistent than CDMAM results. There were small differences between the two techniques, especially in small diameter details, which can be attributed to structural characteristics of the CDMAM, as confirmed by previous comparative work from our group. Overall, the Hotelling SNR technique showed variations in the performance of FFDM detectors, demonstrating the use of this metric as a differentiator.

SSM21-06 • Improving Image Quality for Digital Breast Tomosynthesis: Automatic Detection and Inpainting Method for Metal Artifact Reduction

Yao Lu PhD (Presenter) ; Heang-Ping Chan PhD ; Jun Wei PhD ; Lubomir M Hadjiiski PhD ; Ravi K Samala PhD

PURPOSE
Image quality is an important factor that will affect breast cancer detection in digital breast tomosynthesis (DBT). The high-attenuation metal clips embedded in the breast marking a previous biopsy site cause errors in the estimation of attenuation along the ray paths intersecting the clips during reconstruction, which result in interplane and inplane metal artifacts (MAs). Because of the small number of projection views (PVs) acquired in a limited angular range, the voxel value errors in the artifact region cannot be compensated for. This causes stronger MAs for DBT than those for CT reconstruction. We developed a new MA reduction (MAR) method to improve image quality.

METHODOLOGY AND MATERIALS
Our MAR methodology uses iterative detection and segmentation to automatically generate a clip location map for each PV. Correlation among different PVs is used to reduce false positive detections. Iterative diffusion-based inpainting is designed to replace the labeled clip pixels with estimated tissue intensity from the neighboring regions in each PV. The inpainted PVs are then used for DBT reconstruction. A voting technique is used to determine the location and shape of the clips and label them in the reconstructed volume. The MAR method does not depend on specific reconstruction techniques. With IRB approval and informed consent, DBT of human subjects was acquired with a GE prototype system (60º arc, 21 PVs, 3º increments). 20 DBT views from 10 breasts of various densities with clips were reconstructed with and without MAR. Five breasts had multiple large clips from lumpectomy, two of which and five other breasts had microclips from core biopsy. The improvement in MAs was visually assessed.

RESULTS
The clip detection rate in the PVs was 100% with no false positives. The interplane and inplane MAs were reduced to a level that was not visually apparent in the reconstructed slices regardless of the size and number of clips in the breast. The visibility of microcalcifications and breast tissues along the ray paths of the clips was improved.

CONCLUSION
The inpainting-based MAR method reduced the MAs while preserving the structured background and microcalcifications. The visibility of breast lesions obscured by the MAs was improved.

CLINICAL RELEVANCE/APPLICATION
DBT has strong potential to improve breast cancer detection. Reducing the MAs in DBT can improve detection and assessment of subtle breast lesions, especially recurrence near the biopsy site.
Comprehensive Chest Wall Irradiation: A Dosimetric Description of Tomotherapy and Linac-based IMRT

Christopher D Abraham MD (Presenter)

ABSTRACT
Purpose/Objectives(s):
Intensity modulated radiation (IMRT) for whole breast irradiation has been found to improve homogeneity while decreasing dose to critical structures including the heart and lung. However, there exists a paucity of data examining the role of IMRT in comprehensive chest wall and regional nodal irradiation. Therefore, the objective of this study is to generate dosimetric descriptions of two common inverse-planned IMRT delivery methods: Tomotherapy and linac-based IMRT (LB-IMRT).

Materials/Methods:
Women with locally advanced left sided breast cancer who underwent radiation to a PTV encompassing any residual breast tissue, chest wall, all levels of the axilla, interpectoral lymph nodes, intraclavicular lymph nodes, and the supraclavicular lymph nodes between April 2004 and March 2011 were retrospectively identified. A sample of 45 women were analyzed including 25 treated using Tomotherapy and 20 treated using LB-IMRT. The PTV and organs at risk were contoured at the time of initial treatment planning by the treating radiation oncologist. The dose to the PTV ranged from 50Gy to 50.4Gy. Mean dosimetric parameters were analyzed for the PTV, ipsilateral and contralateral lung.

Results:
The mean PTV V45Gy was 99% and 97% for Tomotherapy and LB-IMRT, respectively. The mean ipsilateral lung V5Gy was 79% for Tomotherapy and 75% for LB-IMRT. The ipsilateral lung meanV20Gy was 22% and 27% while mean ipsilateral lung dose was 15Gy and 17Gy for Tomotherapy and LB-IMRT, respectively. Contralateral lung mean V5Gy was 52% for Tomotherapy and 45% for LB-IMRT while V20Gy was 5.3% and 4.7%.

Conclusions:
Comprehensive chest wall irradiation using inverse-planned IMRT techniques remains to be adequately described in the literature. We retrospectively analyzed cases to better characterize the dosimetry of this treatment method. Further studies are required to validate these findings and to determine anatomic characteristics to optimize the benefits of both delivery methods for women undergoing comprehensive treatment.

Does Morbid Obesity Disadvantage Breast-conserved Treated Patients with Pre-invasive or Early Stage Breast Cancers?

Federico L Ampil MD (Presenter) ; Gloria Caltito PhD ; Benjamin Li MD ; Gary Burton MD ; Roger H Kim MD ; Quyen Chu MD

PURPOSE
The literature supports the association between obesity and poor prognosis of breast cancer (BCa) in both pre- and post-menopausal women. It is unclear whether these patients may benefit from standard of care interventions. This study compares the outcomes between morbidly obese (MO) and non-morbidly obese (NMO) breast-conserved treated (BCT) patients with pre-invasive or early stage breast cancers.

METHOD AND MATERIALS
We reviewed a retrospective cohort study of 100 patients who had undergone BCT (with negative surgical margins including postoperative whole breast 50 Gy irradiation) for minimally invasive BCAs during the period from 1992 to 2005. Each patient's body mass index (BMI) was calculated and the subjects were classified into the NMO group (BMI score < 30) and MO group (BMI score > 30). The primary endpoint was disease-free survival (DFS). DFS was calculated from the date of operation to the date of breast cancer recurrence.

RESULTS
At a median follow-up of 96 months (range 17-215 months), the local recurrence rates were similarly 4% in the MO and NMO patients (p=0.99); the corresponding regional failure rates were 8% and 3% (p=0.29). Although the 10-year overall survival prospect favored the NMO patients compared to the MO women (96% and 79% respectively, p=0.02), there was no significant difference in the 10-year disease-free survival rates between the compared groups (91% and 89% respectively, p=0.66). There were no differences between the MO and NMO patients in age, tumor estrogen/progesterone/HER-2 neu receptors and grade and the presence of co-morbid illness.

Intra-operative Radiotherapy in Early Breast Cancer-First Experience in the Middle East

Yasir Bahadur (Presenter)

ABSTRACT
Purpose: We report our early experience using the Intrabeam low-kV X-ray generator for intra-operative radiotherapy (IORT) in early breast cancer.

Methods: This phase 2 prospective study was performed between December 2010 and November 2012. All female patients eligible for breast-conserving surgery, with biopsy proven invasive ductal carcinoma, clinical mass 3 cm, lymphovascular invasion, multifocal lesion with area of >3 cm, extensive DCIS (>25%, or >3 cm), or lymph node metastasis. Patients received 46 Gy in 23 fractions over 4.5 weeks, using 2 whole-breast tangential fields and photons in the range of 6-15 MV. Early and late toxicity features were recorded using RTOG toxicity criteria.

Results: 45 female patients were included, with a median age 54 years (range, 27-79 years); the majority was more than 45 years (37 cases, 73.3%). Most of patients (36 cases, 80%) had tumor Conclusion: IORT for early stage breast cancer patients using the Intrabeam delivery system was easily implemented in our center, with an acceptable toxicity profile.
CONCLUSION
In this single institution experience, morbid obesity did not adversely affect long-term patient outcomes after BCT for minimally invasive breast cancers. It is suggested that the treatment options for select women with BCA should not be lessened on account of an excessively large body habitus.

CLINICAL RELEVANCE/APPLICATION
Morbid obesity should not ordinarily disqualify breast cancer patients from receiving breast conserving therapy.

SSM22-06 • Clinical Outcomes with a Radiation Therapy System: Results of a Prospective Trial
Tamer Refaat Abdeelrahman MD, PhD (Presenter); William Small MD; Jonathan B Strauss MD; Kevin Bethke MD; Judith A Wolfman MD *; Krystyna D Kiel MD; Ellen B Mendelson MD *

PURPOSE
To report the treatment induced adverse events (AEs), and treatment outcomes of accelerated partial breast irradiation (APBI) delivered with the MammoSite Radiation Therapy System (RTS) in breast cancer patients undergoing breast conservaive treatment.

METHOD AND MATERIALS
This is a prospective clinical trial that was approved by the IRB. The study included female breast cancer patients undergoing breast conservative treatment in the form of surgery and APBI delivered with the MammoSite RTS. The study included postmenopausal women with Invasive carcinoma =2cm, grade 1-2 ductal carcinoma in situ =2cm, or Grade 3 ductal carcinoma in situ =1cm. Exclusion criteria included extensive lobular carcinoma in-situ, Paget disease of the breast, multifocal or multilobular tumor, extensive intraaductal component, bilateral breast cancer, pregnancy or breast feeding, and patients with collagen vascular disease (except rheumatoid arthritis), bleeding disorder, postoperative infection, or prior breast irradiation. Patients and tumor characteristics, treatment-induced acute AEs based on CTC for AEs version 2.0, chronic AEs according to RTOG scale, treatment outcomes; local control (LC), disease free survival (DFS) and overall survival (OS) and cosmetic outcomes are reported.

RESULTS
The study included 36 eligible patients treated consecutively in Northwestern Memorial Hospital between November 2003 and August 2009. The age range was 45-83 years. A total of 29 patients had invasive disease (median size 1.1cm), while 7 patients had in situ disease only (median size 0.8cm). The skin distance in most of the patients (91.7%) was =1cm; only 3 patients (8.3%) had skin distance < 1 cm. The median balloon diameter was 5 cm (range 4-6 cm). At a median follow-up of 42 months (range 4-65 months), LC, DFS and OS were 100%. None of the patients experienced any grade III or IV acute or chronic AEs. However, cosmesis was not a focus of the study, 94% of patients stated good/excellent cosmesis during their last follow up visit.

CONCLUSION
APBI delivered with the MammoSite (RTS) is a feasible, tolerable and effective treatment modality in breast cancer patients undergoing breast conservative treatment.

Vascular/Interventional (Radiation Safety and Ergonomics) Wednesday, 03:00 PM - 04:00 PM • E352
SSM23 • AMA PRA Category 1 Credit™:1 • ARRT Category A+ Credit:1 Moderator Sarah B White, MD
Moderator James R Duncan, MD, PhD
SSM23-04 • A New Angiographic Imaging Technology Enables Substantial Dose Reduction without Compromise to Image Quality
Marco J Van Strijen MD (Presenter); Thijs Grunhagen MSc, DPhil *; Jan Albert Vos; Marc Van Leersum MD; Daniel A Van Den Heuvel MD

PURPOSE
Increasing use of radiation for medical imaging is a growing concern. Recently a new angiographic imaging platform has become available that can result in a considerable reduction in radiation dose without compromising image quality. The potential of this novel technique for reducing patient radiation exposure was studied in relation to the clinical image quality in digital subtraction angiography (DSA). The objective of this study was to establish the degree of patient dose reduction, while preserving equivalent image quality.

METHOD AND MATERIALS
In 50 Prospective patients scheduled for iliac intervention two angiographic runs were performed at the start of the procedure. One run was acquired using the conventional imaging platform (Allura Xper, Philips Healthcare); the other run was acquired using the new imaging platform (AlluraClarity, Philips Healthcare) at lower X-ray dose. The conventional-dose and low-dose acquisitions were performed in random order. Air Kerma and Dose Area Product values were recorded in all acquisitions and at the end of the procedure. In the second part of the study, qualitative image quality assessment of both runs was performed by five experienced interventional radiologists. The readers were blinded to the imaging parameters and imaging platform.

RESULTS
50 patients were prospectively included. Evaluation of the radiation dose in all procedures showed a mean reduction of radiation dose in iliac DSA of 83%. In all patients the new imaging technology was used in the remainder of the procedure, as image quality was considered sufficient for performing the intervention. Likewise, the qualitative image quality assessment revealed equivalence in image quality between the two paired runs.

CONCLUSION
With the new imaging technology, a reduction in radiation dose of 83% is possible without a compromise in image quality.

CLINICAL RELEVANCE/APPLICATION
Revolutionary and substantial dose reduction in interventional radiology without compromise of image quality.

SSM22-02 • Removal of the Grid during Routine Biliary Interventional Procedures Performed in a Flat Panel Interventional Suite: Preliminary Data on Image Quality and Patient Radiation Exposure
Kelvin Cortis MD, MRCS, FRCR (Presenter); Roberto Miraglia MD; Luigi Maruzzelli MD; Roberta Gerasia; Corrado Tafaro; Angelo Luca MD

PURPOSE
To determine whether grid removal during routine biliary interventional procedures performed in a flat panel intervention suite results in adequate image quality and in a significant reduction of the patient radiation exposure.

METHOD AND MATERIALS
Routine biliary interventional procedures were defined as those in which absence of fine image detail during fluoroscopy carries no procedural impact including change of internal-external biliary drains (BCC) or balloon dilatation of biliary anastomosis (bilioplasty). 10 consecutive patients were enrolled, 8 had a BCC and 2 bilioplasty. The study population consisted of 8 adults with an average Body Surface Area (BSA) of 1.64, and 2 children with an average BSA of 0.49. All patients had a previous procedure in which the grid was used. Constant object-to-detector and source-to-image distance were maintained in each patient during the grid/no-grid run was acquired using the conventional imaging platform (Allura Xper, Philips Healthcare); the other run was acquired using the new imaging platform (AlluraClarity, Philips Healthcare) at lower X-ray dose. The conventional-dose and low-dose acquisitions were performed in random order. Air Kerma and Dose Area Product values were recorded in all acquisitions and at the end of the procedure. In the second part of the study, qualitative image quality assessment of both runs was performed by five experienced interventional radiologists. The readers were blinded to the imaging parameters and imaging platform.

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50 patients were prospectively included. Evaluation of the radiation dose in all procedures showed a mean reduction of radiation dose in iliac DSA of 83%. In all patients the new imaging technology was used in the remainder of the procedure, as image quality was considered sufficient for performing the intervention. Likewise, the qualitative image quality assessment revealed equivalence in image quality between the two paired runs.

CONCLUSION
With the new imaging technology, a reduction in radiation dose of 83% is possible without a compromise in image quality.

CLINICAL RELEVANCE/APPLICATION
Revolutionary and substantial dose reduction in interventional radiology without compromise of image quality.
RESULTS
In all procedures image quality was considered adequate by two different interventional radiologists and all procedures were successfully completed without significant changes in fluoroscopy time between the two groups (p=0.37). In every procedure without the grid nDAP was inferior as compared to the nDAP in procedures performed using the grid. The mean reduction in dose was 32.3%±21.1% (p=0.01).

CONCLUSION
Our preliminary data shows that removal of the grid in routine biliary procedures is feasible and results in a significant reduction of patient radiation exposure. Larger studies with more procedures are warranted to confirm this data.

CLINICAL RELEVANCE/APPLICATION
Most routine biliary procedures can be performed without a grid with reduction in radiation exposure. This seems of particular relevance since most of these patients require frequent re-intervention.

SSM23-03  •  Comparison of Radiation Exposure and Image Quality of 14 and 16 Bit Angiographic C-Arm CT and MDCT

B ernhard C Meyer (Presenter) * ; Thomas Werncke MD, Dipl Phys ; Oliver A Meissner MD * ; Frank K Wacker MD * ; Christian Von Falk MD *

PURPOSE
To compare image quality and radiation exposure of a 64-row CT (MDCT) and angiographic C-Arm CT (CACT) using 14 bit and 16 bit flat detector angiographic systems for abdominal imaging.

METHOD AND MATERIALS
An anthropomorphic phantom (AP) representing a 70kg male was used for this study. To assess contrast resolution, one high contrast phantom insert with five line pair objects (LPO: 6, 8, 10, 11 and 12lp/cm) and four low contrast phantom inserts mimicking 32 spherical objects (SPO; 8 diameters, range 2 to 10 mm) and 24 tubular objects (TUO; 6 diameters, range 1.2 to 7mm) with four different densities (10, 20, 40 and 60HU) were inserted into the AP. MDCT imaging was conducted on a 64-row MDCT (Somatom Definition®), Siemens Healthcare) using the standard abdominal acquisition protocol (120kV, qualref = 210mA; SL 0.6mm). CACT imaging was acquired on 14 and 16 bit flat detector angiographic systems (CACT1: Artis ze™, CACT2: Artis ze™, Siemens Healthcare) using standard abdominal CACT protocols (both systems) and a reduced dose preset (CACT2). For each imaging protocol, effective dose(ED) was measured. The detectability of low and high contrast objects was assessed in 3mm transversal slabs. Objects were classified as visible when they were independently rated as clearly delineable by 3 readers.

RESULTS
The highest low contrast detectability was obtained by MDCT (SPO:14/32, TUO:10/24, ED 4.6mSv) followed by standard abdominal CACT using CACT2 (SPO:14/32, TUO:9/24, ED 6.1mSv) and CACT1 (SPO:12, TUO:8, ED 6.1mSv). The use of a reduced dose protocol (~38%ED) on CACT2 showed only a minor reduction of low contrast resolution (SPO: 11/32, TUO 9/24, ED 3.8mSv). Best high contrast resolution (LPO:2/5) was observed for CACT2 (LPO:2/5, both protocols) followed by MDCT and CACT1 (LPO:1/5).

CONCLUSION
16 bit CACT imaging provides improved low and high contrast resolution compared to 14 bit CACT. In comparison to MDCT, CACT is still slightly inferior for low contrast but superior with regard to high contrast resolution. Using significantly reduced dose protocols, a similar image quality compared to 14 bit CACT was observed.

CLINICAL RELEVANCE/APPLICATION
The outstanding low and high contrast resolution of 16 bit CACT provides excellent guidance during interventional procedures in unenhanced and contrast-enhanced images.

SSM23-04  •  Retrospective Analysis of the Effectiveness of Real Time Dosimetry Combined with Increased Emphasis on Radiation Safety in Reducing Healthcare Worker Exposure to Radiation

Oleg Mironov MD (Presenter) ; Thomas Lostracco MD ; David L Waldman MD, PhD ; Frederic Mis PhD

PURPOSE
The University of Rochester Medical Center (URMC) recently evaluated healthcare worker radiation exposure in high radiation areas. In 2011 there were multiple incidents of physician exposure in excess of 4 rem and approaching the 5 rem legal limit. Simultaneously, the University hired a new radiation safety officer who began a major radiation dose-lowering strategy which included education and real time exposure awareness. The purpose of this study was to measure the effect.

METHOD AND MATERIALS
Retrospective analysis was undertaken looking at historical radiation exposure to workers from 2010 to 2012. The radiation safety records of 253 physicians and staff were included in the study (49 faculty, 39 residents and 165 support staff). An aggressive radiation safety education program was initiated. A real time dosimetry (DoseAware, Philips Medical, Andover MA in conjunction with Unfor Instruments AB, Goteborg Sweden) for healthcare workers in high exposure radiation areas (Cath labs, Interventional Radiology labs, hybrid OR and Interventional CT scanner) was installed in March 2012.

RESULTS
Physician and staff collective exposure in 2010 and 2011 was 127 person-rem and 124 person-rem respectively. In 2011 there was quarterly average of 18 Level 1 and 6 level 2 ALARA radiation safety letters indicating excessive dose. In 2012 the exposure dropped by more than 50% to a collective exposure of 60 person-rem. ALARA letters declined by 50% in 2012 as compared to the 2 previous calendar years. Total staff dose continues to decline. In the most recent quarter there were zero employee ALARA notification letters.

CONCLUSION
The dose lowering initiative successfully achieved a 50% reduction in radiation exposure for health care providers working in high radiation areas. It remains uncertain if this accomplishment was the result of an aggressive education program or due to real time feedback from instantaneous dose monitoring. Regardless of the cause, the decrease in radiation exposure is significant and a pleasant surprise.

CLINICAL RELEVANCE/APPLICATION
Significant reductions in staff exposure to radiation can be achieved with the combination of increased emphasis on radiation safety and real time dosimetry thus creating a safer working environment.

SSM23-05  •  Effectiveness of Using a Novel Lead Curtain Applied to the Image Detector to Protect Operator and Staff in the Angiography Suite

Zubin Irani MD (Presenter) ; Bailin Alexander BA ; Da Zhang PhD ; Bob Liu PhD ; Rahmi Oklu MD, PhD

PURPOSE
Recent research suggest that long-term low-dose radiation exposure in the interventional (angiographic) suite may lead to greater stochastic effects than previously believed. Sufficient shielding from scatter radiation during fluoroscopy still remains a formidable
challenge. We designed and tested the utility of a disposable, sterile lead curtain applied to the image detector to reduce scatter radiation to the operator and staff during IR procedures.

**METHOD AND MATERIALS**
To simulate standard patient positioning on the angiography table, an anthropological phantom was used. Using a computer aided design software, a grid was overlaid on the procedure room. Using a high sensitivity radiation survey meter, measurements of scatter radiation from the phantom were made throughout the grid. Sequential measurements were made before and after the application of the curtain using a full field of view, a coned field of view and with maximal kVp. Results are presented as standard error of the mean. Statistical significance was measured using a student’s t-test.

**RESULTS**
Scatter radiation was attenuated throughout the grid (room). The highest level of scatter radiation was detected immediately adjacent to the phantom at 2 feet distance. In this location, which would approximate the position of the operator, attenuation by the curtain was also maximal averaging at 60% less dose to the operator. The use of the curtain did not result in increase scatter radiation detection to the phantom (patient).

**CONCLUSION**
The use of this lead curtain significantly reduces scatter radiation in the procedure room. Specifically, the curtain leads to reduction in radiation exposure to the operator at levels averaging 60%.

**CLINICAL RELEVANCE/APPLICATION**
Radiation exposure is known to have detrimental sequela. This curtain reduces radiation exposure to the operator and staff in the angiography room and may have significant impact on radiation safety.

**SSM23-06  Efficacy of Radiation Safety Glasses in Interventional Radiology**

**Bart Van Rooijen** (Presenter) ;  **Michiel W De Haan** MD, PhD ;  **Marco Das** MD * ;  **Carsten Arnoldussen** MD ;  **Rick De Graaf** MD, PhD ;  **Wim Van Zwan** MD ;  **Walter H Backes** PhD ;  **Cecile R Jeukens** PhD

**PURPOSE**
Recent evidence suggests that radiation-induced cataract to the eye occurs at a lower dose than previously thought. We have assessed how the design of radiation protection glasses and positioning of the operator influence the reduction of the eye lens dose.

**METHOD AND MATERIALS**
The scatter free attenuation and the dose reduction with the glasses were determined for several different spectacle designs on an antropomorphical head phantom. The phantom head was positioned at different locations relative to the radiation source to assess the effects of geometry and head rotation on the dose reduction.

The eye dose reduction achieved in clinical practice was measured using TLD dosimetry during 9 procedures with protective glasses and 13 procedures without.

**RESULTS**
The scatter-free attenuation of the glasses was approximately a factor of 100. For frontal irradiation of the phantom head, the dose reduction factor was in the range of 7.9 to 10.0. With the head phantom at a location typical for radiological interventions, the dose reduction factor was in the range of 3.4 to 8.3 (left eye) and 1.5 to 2.3 for the right eye. When the phantom head was rotated 45 degrees away from the tube in the axial plane, there was no significant dose reduction for the right eye and the dose reduction for the left eye was 1.1 to 2.5.

In clinical practice wearing leaded glasses resulted in a dose reduction of 2.1 (left eye) and 0.8 (right eye).

**CONCLUSION**
The dose reduction of radiation protection glasses reduces when incoming radiation faces the head laterally of inferiorly. Physicians performing x-ray guided interventions should be aware of these effects to optimize their posture and choose the appropriate model of glasses.

**CLINICAL RELEVANCE/APPLICATION**
- Protective eyewear should shield radiation entering from the side and below.
- The radiologist’s posture and the room layout should be adjusted to prevent radiation entering from the side or below.

**Vascular/Interventional (Vascular Ultrasound)** Wednesday, 03:00 PM - 04:00 PM  E450B  E450B  E450B  E450B  E450B  E450B  E450B

- AMA PRA Category 1 Credit ™  ARRT Category A+ Credit:1  Moderator Christoph A Binkert , MD *
- Moderator Robert A Morgan , MD *
- SSM24-01  Contrast-enhanced Ultrasound Evaluation of Peripheral Microcirculation in Critical Limb Ischemia Patients Undergoing Endovascular Revascularization

**Costantino Del Giudice** MD (Presenter) ;  **Fabrizio Chegai** MD ;  **Roberto Gandini** MD, PhD ;  **Antonio Orlacchio** MD ;  **Giovanni Simonetti** MD

**PURPOSE**
To evaluate peripheral microcirculation assessed with contrast-enhanced ultrasound (CEUS) in patients with critical limb ischemia undergoing endovascular recanalization in comparison to percutaneous oximetry.

**METHOD AND MATERIALS**
The study population comprised 14 diabetic patients (9 male, age 76±7.5 years old) with critical limb ischemia. Transcutaneous oxygen (TCPO2) and carbon dioxide (TcPCO2) tension was evaluated in the perilesional area. A ultrasound Doppler of the artery underling the lesion was used to judge the presence of peripheral arteriopathy.

**RESULTS**
Time- to-peak (TTP) and mean tissue transit time (TTT) were significantly prolonged and derived intensity peak (dIP) was significantly lower in the ischemic foot than the healthy contralateral (TTP 48.76±9.38 s vs. 32.12±6.8 s, p=0.011, A/Tt 6.81±4.52 s vs. 3.25±3.27 s, p=0.02 and dIP 4.8±2.3 db vs. 8.6±3.1 ). A significantly good correlation between transcutaneous parameters and CEUS parameters was observed.

**CONCLUSION**
Peripheral microcirculation may be evaluated with CEUS. TTP, TTT and dIP may be an alternative to percutaneous oximetry parameters to evaluate peripheral microcirculation in critical limb ischemia.

**CLINICAL RELEVANCE/APPLICATION**
Percutaneous oximetry may fail to evaluate peripheral microcirculation. CEUS;may be an useful alternative;in order to assess the degree of critical limb ischemia before endovascular revascularization.

**SSM24-02  Measurement of Peripheral Muscle Microperfusion (PMP) and Macroperfusion in an Animal Peripheral Artery Disease (PAD) Model Using Contrast-enhanced Ultrasound (CEUS) and Doppler Flow (DF) Measurement**
**SSM24-03 • Non-invasive Prediction of Hepatic Transplant Portal Vein Stenosis - Experience at a Single High Volume Transplant Center**

**Marie A Vasher** MD (Presenter); **Danny R Lababidi** MD; **Kamal Massis** MD; **Bruce R Zwiebel** MD; **Dana M Poletto** MD; **Haydy Rojas** RN; **Yougui Wu** PhD

**PURPOSE**
We sought to compare Doppler ultrasound findings to transhepatic catheter portal venogram findings of hepatic transplant main portal vein stenoses, and to determine which Doppler ultrasound criteria are often the best non-invasive measures for diagnosing portal vein stenosis.

**METHOD AND MATERIALS**
32 post-hepatic transplant transhepatic catheter portal venograms following initial Doppler ultrasound were performed at our institution on 30 patients from November 1, 2004 to May 31, 2012 due to clinical, biochemical, Doppler ultrasound, CT and/or MRI abnormalities. Doppler ultrasounds and catheter portal venograms were retrospectively reviewed. Doppler ultrasound criteria of main portal vein peak velocity, velocity step-up ratio, and change in velocity across the anastomosis were correlated with catheter portal venogram. Narrowing of the main portal vein of at least 50% on portal venogram was considered stenotic. 54 randomly chosen patients without suspicion of hepatic transplant portal anastomotic stenoses were assigned to our control group. Patients who underwent catheter portal venogram without findings of portal vein stenosis were also assigned to our control group.

**RESULTS**

**CONCLUSION**
In a porcine PAD model, CEUS may prove to be a useful tool in diagnosis of PAD and for evaluation of new therapies.

**SSM24-04 • Stenosis Index Is a Specific Secondary Screening Test for Patients with Suspected Transplant Hepatic Arterial Stenosis**

**Sherwin S Chan** MD, PhD (Presenter) *; **Thomas X Le** MD; **Michael F Mcneeley** MD; **Manjiri K Dighe** MD; **Theodore J Dubinsky** MD

**PURPOSE**
Stenosis Index (SI) is a novel angle-independent quantitative measure that is computed using Fourier analysis of the spectral Doppler waveform. We evaluate the utility of stenosis index (SI) as a secondary measure after resistive index (RI) to increase the accuracy of diagnosing transplant hepatic artery stenosis using Doppler ultrasound (US).

**METHOD AND MATERIALS**
An institutional anonymized retrospective case-control study was performed. Patients who underwent US for suspected post-transplant hepatic artery stenosis within 30 days at a large academic center in 2006-2010 were included. Patients who had no imaging of the transplanted artery on their angiography and patients who did not have complete ultrasound evaluation of their hepatic arteries were excluded. These Spectral Doppler images were imported into MATLAB and SI was calculated for each artery in each patient by obtaining a ratio of the power in high frequency bands to fundamental frequency. Main portal vein peak velocity, velocity step-up ratio, and change in velocity across the anastomosis were correlated with catheter portal venogram. Narrowing of the main portal vein of at least 50% on portal venogram was considered stenotic. 54 randomly chosen patients without suspicion of hepatic transplant portal anastomotic stenoses were assigned to our control group. Patients who underwent catheter portal venogram without findings of portal vein stenosis were also assigned to our control group.

**RESULTS**

**CONCLUSION**
Applying the Doppler ultrasound criteria yielded in our study will result in selecting the most appropriate hepatic transplant patients with main portal vein stenosis for catheter portal venogram.

**SSM24-05 • Should Ultrasound Be Used as Prophylactic Screening for Venous Thromboembolism in High Risk Patients with Malignancy?**

**Katherine A Kaproth-Joslin** MD, PhD (Presenter); **Charles Francis** MD; **Susan K Hobbs** MD, PhD; **Alok Khorana**; **Deborah J Rubens** MD
METHOD AND MATERIALS
Asymptomatic cancer patients initiating a new chemotherapy regimen and found to be high-risk for VTE based on a predictive risk model (score = 3) were enrolled on an ongoing prospective cohort study with informed consent. Patients were evaluated with a baseline and an every 4 (+1) week serial US study for up to 16 weeks. Additionally, CT scans obtained for restaging purposes were also evaluated for VTE.

RESULTS
Of the 35 high-risk patients enrolled, 8 (23%) were found to have VTE, 5 patients w/ DVT alone (14%), 1 w/ PE alone (3%) and 2 (6%) w/ both. 32 patients underwent a baseline US and 3 asymptomatic DVTs were identified (9%), w/ 1 patient also having an asymptomatic PE detected on staging CT. Subsequent US were performed in 23 patients at week 4 (0DVT), 21 patients at week 8 (0DVT) and 18 patients at week 12 (1 DVT, 6%). An additional 2 patients developed symptomatic DVT between screens. Restaging CT scans identified an asymptomatic PE in a patient at week 6 and an asymptomatic PE in a patient at week 9. Of the patients w/ isolated DVT, 2 had isolated unilateral calf clot, 2 had unilateral calf and thigh clot, and 1 had unilateral upper extremity clot.

CONCLUSION
In this prospective observational study, 23% of cancer outpatients deemed high-risk for VTE developed clot at a rate much higher than found in both normal and acutely ill hospitalized populations (0.5 and 6% respectively). This study confirms the validity of the previously described risk score developed by Khorana et al and makes this model highly predictive of identifying patients at risk for VTE. In addition, these findings suggest that screening US for asymptomatic clot should be considered in high-risk patients based on this risk score. This study highlights the importance of VTE screening in the calf, w/ 50% of patients w/ VTE having calf clot and 25% having isolated unilateral calf clot, indicating that this region should be included in the assessment of DVT.

CLINICAL RELEVANCE/APPLICATION
Screening ultrasonography for asymptomatic thrombosis should be considered in high-risk patients based on this risk score with the goal of reducing the morbidity and mortality associated with VTE.

SSM24-06 • A Comparison between Contrast-enhanced Ultrasound (CEUS) and Multi-slice Computer-tomography (MS-CT) in Detecting and Classifying Endoleaks in the Follow-up after EVAR

Dirk-Andre Clevert MD (Presenter) * ; Verena Guertler ; Wieland H Sommer MD ; Georgios Meimarakis ; Maximilian F Reiser MD

PURPOSE
To compare Contrast-Enhanced-Ultrasound (CEUS) and Multislice-Computed-Tomography (MS-CT) angiography in detecting and classifying endoleaks in the follow-up of patients following Endovascular-Aortic-Aneurysm-Repair (EVAR).

METHOD AND MATERIALS
In this retrospective study a cohort of 171 patients with both CEUS and MS-CT follow-up examinations after EVAR were included. In total 489 CEUS and 421 MS-CT examinations were assessed during the follow-up. B-scan, color Doppler and CEUS were performed in all patients. MS-CT was performed with a 16- up to 128-slice-scanner.

RESULTS
Regarding our inclusion and exclusion criteria we obtained 200 contemporary examination pairs out of the 132 patients of our cohort. MS-CT was used as the preferred examination in determining the presence of an endoleak. The true positive rate for the detection of endoleaks with CEUS was 42% (84/200), the false positive rate was 4% (8/200), the true negative rate was 52% (105/200), and the false negative rate was 2% (3/200). The sensitivity of CEUS was therefore 97%, and the specificity was 93%. McNemar's test value was 0.227 and kappa coefficient was 0.889.

CONCLUSION
CEUS appears to be as good as MS-CT in the detection of endoleaks in the follow-up after EVAR, with the added advantages of no radiation dose and no nephrotoxity of the contrast agents. A switch of the preferred examination from MS-CT to CEUS should be considered.

Breast Imaging (Ultrasound Screening) Thursday, 10:30 AM - 12:00 PM • Arie Crown Theater

SSQ01 • AMA PRA Category 1 Credit ™; ARRT Category A+ Credit:1.5 Moderator Ellen B Mendelson , MD *

Moderator Paula B Gordon , MD *

SSQ01-01 • Initial Experience of Technologist Performed Whole Breast Screening Ultrasound

Glensy Da Costa MBBS (Presenter) ; Janice S Sung MD ; Christopher E Comstock MD ; D. David Dershaw MD ; Elizabeth A Morris MD

PURPOSE
To evaluate the added cancer detection and false positive rate of a technologist-performed handheld screening breast ultrasound program

METHOD AND MATERIALS
IRB approved retrospective review was performed on 890 consecutive women who underwent screening hand held high resolution breast ultrasound performed by a breast ultrasound technologist between October 2011-February 2013. Radiologist performed targeted ultrasound only in cases if a solid or indeterminate lesion was identified by the sonographer. Clearly benign findings, such as simple and complicated cysts, were neither recorded nor re-evaluated by the radiologist. 63 probably benign or suspicious lesions were identified.

RESULTS
Of the 890 women, 299 (34%) were pre-menopausal and 591 (66%) peri/post-menopausal. 288 (32%) had a personal history of
breast cancer, 67(8%) a prior biopsy proven high-risk lesion, and 592(67%) a family history of breast cancer. 769(87.5%) patients had a mammogram within 6 months of the ultrasound. Breast density was predominantly fatty in 31(3%), scattered fibroglandular densities in 171 (20%), heterogeneously dense in 521 (60%), and extremely dense in 152(17%). 837 (94%) studies were assessed as BI-RADS 1 or 2, 20 (2%) as BI-RADS 3, and 43 (5%) as either BI-RADS 4 or 5. Biopsy was performed for 39/43 suspicious lesions, yielding malignancy in 3/39 (PPV 8%). The cancers were all solid masses between 1.0-1.3 cm in size in heterogeneously dense breasts. Of the 3 women with cancers, 2 had a personal history of breast cancer and the other had no additional risk factor. 2 had a negative mammogram within 5 weeks of the ultrasound and the third within 7 months. The overall cancer detection rate was 3.4 cancers per 1000 women.

CONCLUSION
Technologist performed handheld screening breast ultrasound demonstrates a cancer detection rate (3.4/1000) and PPV (8%) of biopsy similar to that reported for physician performed ultrasound screening.

CLINICAL RELEVANCE/APPLICATION
Screening breast ultrasound performed by technologists is a feasible alternative to physician performed ultrasound screening, reducing radiologists time and cost.

SSQ01-02 ● Comparison of an Automated Breast Volume Scanner and a Hand-held Ultrasound in the Detection of Breast Cancer: An Analysis of 5576 Patient Evaluations

Woo Jung Choi MD (Presenter) ; Seonah Jang ; Joo Hee Cha ; Hak Hee Kim MD ; Hee Jung Shin MD ; Hyunji Kim MD ; Eun Young Chae ; Sun Hye Jeong MD

PURPOSE
To retrospectively compare the accuracy and effectiveness of automated breast volume scanning (ABVS) and hand-held ultrasound (HHUS) in the detection of breast cancer in a large population group with a long-term follow-up, and to investigate whether different ultrasound systems may influence the estimation of cancer detection.

METHOD AND MATERIALS
A total of 1870 ABVS and 3706 HHUS participants, who underwent these procedures at our institute between September 2010 and August 2011, were included in this study. Cancers occurring during the study and subsequent follow-up were evaluated. The reference standard was a combination of histology and follow-up imaging (=12 months). The diagnostic accuracy, sensitivity, specificity, and positive (PPV) and negative (NPV) predictive values were calculated with exact 95% confidence intervals.

RESULTS
CONCLUSION
ABVS shows a comparable diagnostic performance to HHUS. We thus find that ABVS as an effective supplemental tool for mammography in breast cancer detection in a large population.

CLINICAL RELEVANCE/APPLICATION
In this study, ABVS shows comparable diagnostic performance when compared with HHUS in the detection of breast cancer in a large population group with a long-term follow-up.

SSQ01-03 ● Impact of Radiologists’ Professional and Practice Characteristics on Breast Cancer Detection in Women with Dense Breasts; A Reader Study Combining Mammography and Automated Breast Ultrasound

Karen Drukker PhD (Presenter) * ; Maryellen L Giger PhD *

PURPOSE
Evaluate variability in the clinical assessment of breast images, and its dependence on radiologists’ professional and practice characteristics, in a retrospective reader study combining X-ray mammography (XRM) and 3D automated breast ultrasound (ABUS) for breast cancer detection in women with dense breasts.

METHOD AND MATERIALS
The study involved 17 breast radiologists of which 7 came from academic radiology practices, 6 from private practice, and 4 from community clinics. A sequential study design was employed with readers first interpreting XRM alone, followed by an interpretation of the combined XRM+ABUS, with each interpretation including a forced BI-RADS scale and a likelihood that the woman had breast cancer. The analysis included 164 asymptomatic patients, including 31 breast cancer patients, with dense breasts and a negative screening XRM. Of interest were inter-reader variability in scoring for XRM alone, XRM+ABUS, and the dependence on reader experience, fellowship training, and type of practice. Performance analysis included Receiver Operating Characteristic (ROC), percentile, Kappa statistics, corelative, and Bland-Altman analyses. The statistical significance of the impact of consecutive reads was assessed for the kappa statistics using bootstrapping.

RESULTS
The median change in area under the ROC curve after ABUS interpretation was 0.12 (range 0.04-0.19). Reader agreement was fair with the median inter-reader kappa being 0.26 (0.05-0.48) for XRM alone, and 0.34 (0.11-0.55) for XRM+ABUS (95% confidence interval for the difference in kappa [0.06:0.11]). The only factor that appeared to have a substantial effect on reader performance was the type of clinical radiology practice, with the increase in area under the ROC curve the largest for the 3 radiologists from academic practices, with changes of 0.18, 0.19, and 0.19 respectively.

CONCLUSION
A modest, but statistically significant, increase in inter-reader agreement was observed after interpretation of ABUS, while radiologists from academic practice seemed to benefit the most from ABUS interpretation.

CLINICAL RELEVANCE/APPLICATION
Understanding reader variability and factors such as training and clinical practice will yield informed decisions on the use of multimodality imaging in breast cancer screening.

SSQ01-04 ● Whole Breast Ultrasound: Comparison of the Visibility of Suspicious Lesions with Automated Breast Volumetric Scanning versus Hand-held Breast Ultrasound

Cherie M Kuzmiak DO (Presenter) * ; Eun Young Ko MD, PhD ; Laura Tuttle ; Doreen Steed ARRT * ; Donglin Zeng PhD

PURPOSE
To assess how well radiologists visualize relevant features of lesions seen with automated breast volumetric scanning in comparison to hand-held breast ultrasound in population of women going to biopsy.

METHOD AND MATERIALS
Twenty-five patients were consecutively recruited from women who were scheduled to undergo a breast biopsy for at least one BI-RADS 4 or 5 lesion identified in a diagnostic setting in this IRB approved study. The enrolled subjects subsequently underwent imaging of the breast(s) of concern using a dedicated FDA-approved ultrasound system that allowed both a hand-held breast ultrasound (HHBUS) and automated breast volumetric scanning (ABVS) to be performed with the same imaging parameters. Five experienced breast imaging radiologists reviewed the randomized cases in a reader study. Each reader was asked to compare side-by-side the breast ABVS exam to the HHBUS exam, including the lesion recommended for biopsy. Each reader was asked to specify the lesion type, size and imaging features, BI-RADS score, probability of malignancy for each lesion for each modality and then they were asked to compare the lesion characteristics of shape and margins between the two modalities using a seven-point

CONCLUSION

Whole Breast Ultrasound: Comparison of the Visibility of Suspicious Lesions with Automated Breast Volumetric Scanning versus Hand-held Breast Ultrasound

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RESULTS
There were thirty biopsied lesions in this study. All were masses. Seven (23.3%) masses were malignant and 23 (76.4%) were benign. Across all lesions regardless of size or final pathology, there was no significant difference between the two modalities in the readers' BI-RADS classification, probability of malignancy, sensitivity or specificity (P > 0.15). For malignant lesions, the reader visualization confidence scores between the two ultrasound modalities were not significantly different (P > 0.1). However, analysis for non-malignant cases showed a statistically significant increase in reader visualization confidence in lesion shape and margins with ABVS (P < 0.001).

CONCLUSION
Radiologists showed equal confidence in visualization of suspicious masses with automated breast volumetric scanning in comparison to hand-held breast ultrasound mammography and increased confidence in visualization of non-malignant lesions with automated breast volumetric scanning.

CLINICAL RELEVANCE/APPLICATION
Dedicated automated whole breast ultrasound is a novel imaging technology that has the potential application for decreasing hand-held breast imaging use in a busy diagnostic clinic.

SSQ01-05 • Comparison of Transverse versus Coronal View of Automated Breast Ultrasound in Lesion Detection

Sun Young Lee MD (Presenter) ; Joo Hee Cha ; Eun Young Chae ; Hak Hee Kim MD ; Hee Jung Shin MD ; Hyunj Kim MD

PURPOSE
To compare the performance of coronal view of automated breast ultrasound (ABUS) with that of transverse view in the lesion detection

METHOD AND MATERIALS
Three breast radiologists independently interpreted the ABUS images from 113 women, 14 with negative findings and 99 with known breast lesions (99 benign and 53 malignant findings). The readers were asked to detect the presence or absence of the abnormalities using transverse and coronal view in the different reading session. If a lesion was detected, we evaluated the location, characteristics of lesions. Intraclass correlation coefficients and kappa statistics were used for statistical analysis. Time to review and interpret an examination was also evaluated.

RESULTS
The detection rate of malignant lesions was 95.6% and 87.4% for transverse and coronal view (p=0.0089). The detection rate of benign lesions was 72.4% and 56.6% for transverse and coronal view (p=0.0001). Larger lesions are more consistently detected by coronal view: detection rates were 7.4% at 5 mm or smaller; 48.4% at 6-10 mm; 80.1% at 11-15 mm; 89.1% for lesions larger than 15 mm pp

CONCLUSION
The detection rate of coronal view was significantly lower than that of transverse view for both benign and malignant lesions.

CLINICAL RELEVANCE/APPLICATION
Coronal view can be used as an additional method to transverse view. However, the role of coronal view by ABUS is not yet established, which needs to undergo further studies.

SSQ01-06 • Performance of Whole Breast Ultrasound in Women with Dense Breasts Following 3D Tomosynthesis Mammography

Regina J Hooley MD (Presenter) ; Jaime L Geisel MD ; Madhavi Raghu MD * ; Melissa A Durand MD ; Cary P Gross MD ; Susan H Busch ; Liane E Philpotts MD *

PURPOSE
Both whole breast ultrasound (WBUS) and 3D tomosynthesis (DBT) mammograms are being more widely utilized in the United States and both modalities can detect cancers not visualized on conventional digital mammography. The purpose of this study is to determine the performance of WBUS in women with a recent prior normal DBT mammogram.

METHOD AND MATERIALS
A retrospective chart review was performed on 1039 consecutive women who underwent handheld WBUS between 10/1/2011 and 9/20/2012 and who had a prior normal DBT mammogram performed within 12 months before the WBUS examination. All WBUS exams were performed by a breast ultrasound technologist and were immediately reviewed and interpreted by a radiologist.

RESULTS
The average patient age was 52.3 years (S.D. +/- 9.5 years, range 27-94). The average time between the mammogram and WBUS was 9/20/2012 and who had a prior normal DBT mammogram performed within 12 months before the WBUS examination. All WBUS exams were performed by a breast ultrasound technologist and were immediately reviewed and interpreted by a radiologist.

CONCLUSION
Supplemental WBUS performed in addition to DBT can detect mammographically occult breast cancers, although the rate is lower than previous studies of WBUS performed in addition to conventional mammography

CLINICAL RELEVANCE/APPLICATION
Multiple studies have demonstrated that supplemental WBUS has a cancer detection rate of 3-5/1000, although the performance of WBUS as a supplement to DBT mammography has yet to be determined.

SSQ01-07 • Supplemental Ultrasound (US) Screening in Patients with a History of Lobular Neoplasia (LN)

Kanchan Phalak MD (Presenter) ; Basak E Dogan MD ; Denai Milton MS ; Therese Bevers MD ; Wei T Yang MD

PURPOSE
To investigate the role of US screening as an adjunct to annual mammography (M) in breast cancer detection in women with a history of LN

METHOD AND MATERIALS
A retrospective review was performed of the clinico-pathology database at a single institution between 11/2004 and 11/2011 and yielded 195 women with biopsy proven lobular carcinoma in situ (LCIS) and/or atypical lobular hyperplasia (ALH) who underwent screening M, screening US, and/or screening MR. Patients with a concurrent diagnosis of breast cancer or those lost to follow-up were excluded. M, US, and when available, MR findings were reviewed. The sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), and cancer detection rate of each screening test was determined.

RESULTS
A total of 138 patients who had mammography, US, or MR available for review and were included in the study. Mean patient age was 53
years (range 30-83). All 138 patients underwent a mean of 3.0 years of screening with M, 115 (83%) a mean of 2.7 years of screening with US, and 30 (20%) patients a mean of 1.9 rounds of screening with MRI. Eleven (8.0%) patients were diagnosed with cancer. Of 115 patients who received both M and US, 10 (8.7%) were diagnosed with cancer. Mammographic cancer detection rate 2.6%. US cancer detection rate was 2.6%, and all these cancers were mammographically occult. A subgroup of 30 patients with LN and lifetime risk >20% received supplemental MRI screening; 5 (16.7%) of whom were diagnosed with cancer. US did not detect any of these 5 cancers, M detected 1 (3%) and MRI detected 2 (6.7%) while remaining 2 were detected clinically. The sensitivity (95% CI) of screening US was 30% (7%-65%), specificity (95% CI), PPV (95% CI), and NPV (95% CI) were 100% (97%-100%), 100% (29%-100%), and 94% (88%-97%), respectively. The sensitivity (95% CI) of screening M was 27% (6%-67%), specificity (95% CI), PPV (95% CI), and NPV (95% CI) were 100% (97%-100%), 100% (29%-100%), and 94% (89%-97%), respectively. The sensitivity of screening MRI was 50% (95% CI: 12%-88%), while NPV was 89% [95% CI: 71%-98%].

CONCLUSION
Annual screening US as a supplement to screening mammography resulted in an incremental cancer detection rate of 2.6% in patients with a history of LN.

CLINICAL RELEVANCE/APPLICATION
Supplemental US screening in patients with LN who do not fulfill the American Cancer Society criteria for high risk MRI screening may help detect mammographically occult malignancy.

SSQ01-08 • Reassessment and Follow-up Results of BI-RADS Category 3 Lesions Detected on Screening Breast US

Jung Lim Yoo MD (Presenter); Joo Hee Cha; Eun Young Chae; Hak Hee Kim MD; Hee Jung Shin MD; Hyunji Kim MD

PURPOSE
To determine the frequency and the malignancy rate of BI-RADS category 3 lesions detected on screening breast ultrasound and reassess whether they satisfied the ACRIN 6666 protocol.

METHOD AND MATERIALS
During two years, 28,796 asymptomatic women underwent screening mammography. Among them, 8359 women underwent additional breast ultrasound as part of a screening examination. Radiologists analyzed US lesion features and provided a final BI-RADS assessment. We retrospectively reviewed the initial US images with BI-RADS category 3 lesions and their mammography as well. We also investigated the outcome of these lesions. The reference standard was a combination of pathology and clinical follow-up for at least 24 months.

RESULTS
The frequency of category 3 lesions detected on breast US was 16.8% (1403/8359). Of 941 patients with follow up for at least 24 months or biopsy, six eventually proved to be malignant (0.6%). The malignancy rate was 1.5% (4/805) for patients with abnormal mammogram and 0.5% (2/136) for those with negative mammogram. When the ACRIN (American College of Radiology Imaging Network) 6666 protocol were strictly applied, 147 (15.6%) were retrospectively recategorized as BI-RADS 4 (n=7) or BI-RADS 2 (n=140).

CONCLUSION
The malignancy rate of BI-RADS category 3 lesions is very low, especially with negative mammogram.

CLINICAL RELEVANCE/APPLICATION
With BI-RADS category 3, careful assessment is needed to avoid unnecessary biopsy or short-interval follow-up.

SSQ01-09 • Review of Interval Cancers in a Mammographic Screening Programme: What Can We Learn? Are We Being Too Hard on Ourselves?

Katerina Lekanidi MRCP, MBBCh (Presenter); Phillip Dilks; Tamara Suaris MBBS; Hema N Purushothaman

PURPOSE
To determine the features of interval breast cancers considered to be detectable on previous screening.

METHOD AND MATERIALS
This study was approved by the clinical governance committee. As a requirement of the national breast screening programme, the previous screening mammograms for all interval breast cancers are reviewed and classified as: no signs, minimal signs or suspicious appearances. Patients with interval breast cancer over a period of 21 years were included in this study if minimal or suspicious signs were seen on most recent screening mammogram. 3 radiologists, individually and blinded to the site of interval cancer, reviewed the mammograms and documented the presence, site, characteristics and BIRADS classification of any abnormality. Findings were compared with the appearances of the subsequent symptomatic mammogram.

RESULTS
111/590 interval cancers documented in the study period fulfilled the study inclusion criteria. The mean age at the time of screening mammogram was 59.04 (range 51-75). The mean interval to the diagnosis of breast cancer was 17.30 months (range 1-36). 61.3% of cases were considered as "minimal signs" and 38.7% as suspicious. In 17.1% of the cases none of the readers identified a relevant abnormality on the screening mammogram. In 21.6% of the cases 1/3 readers identified the abnormality, 27.6% of cases 2/3 readers and 33.3% all 3 readers identified the abnormality. In 50% of one-reader recalls, the mammographic abnormality was an asymmetric density, followed by ill-defined mass (20.8%) and architectural distortion (20.8%). In three-reader recalls, microcalcification was the most common finding (35.1%), followed by asymmetric density (27%) and an ill-defined mass (24.3%). Overall, the most common abnormality was asymmetric density (36%), followed by ill-defined mass (15.3%) and microcalcification with or without a mass (15.3%).

CONCLUSION
The most common retrospectively and unanimously identified sign of breast cancer is microcalcification and the most common subtle sign is asymmetric density. Interval cancer mammographic review not blinded to the position of subsequent cancer overestimates the percentage of "minimal signs " cases.

CLINICAL RELEVANCE/APPLICATION
Review of interval breast cancers is a valuable learning tool in breast screening programmes and is more valid if done initially blinded to the position of the subsequent breast cancer.
SSQ02-01 • Computer Derived Texture Features on DCE-MRI Can Separate ER+ Breast Cancers with Low and High Oncotype DX Scores

Tao Wan PhD (Presenter) ; Boris N Bloch MD ; Donna M Plecha MD * ; Cheryl Thompson BS ; Hannah Gilmore ; Norbert Avril MD ; C. Carl Jaffe MD ; Lyndsay Harris MD ; Anant Madabhushi MS *

PURPOSE
Onctotype DX (ODX) is a gene-expression based assay for predicting response to hormonal therapy in estrogen receptor positive (ER+) breast cancers (BCa) patients. The goal of this study was to identify whether computer derived texture features on DCE-MRI can distinguish low and high ODX scores (i.e. ER+ BCa patients who would and would not benefit from adjuvant chemotherapy), thereby providing a non-invasive pertherapeutic gene-expression assessment tool predicting tumor treatment response.

METHOD AND MATERIALS
A total of 57 ER+ BCa patient studies were collected, in which 21 breast MRIs were acquired from a Phillips 1.5T magnet with a 7-channel breast coil, and 36 MRIs were acquired using a Siemens 1.5T magnet with an 8-channel breast coil, including DCE images obtained prior to, during, and after administration of 0.1 mmol/kg of Gd-DTPA. Each study was accompanied by: i) lesion annotations from an expert radiologist; and ii) ODX scores. A set of 6 morphological features, 3 pharmacokinetic features, 12 enhancement kinetic features (EKF), 12 intensity kinetic features, 312 textural kinetic features, 6 dynamic local binary patterns (DLBP), and 5 dynamic histogram of oriented gradients (DHog) features were extracted and used to characterize the appearance of the breast lesions. The computed features were evaluated by a linear discriminate analysis (LDA) classifier in terms of their ability to distinguish ER+ BCa with low or high ODX scores via a 2-fold randomized cross validation scheme.

RESULTS
The DHog, DLBP, and EKF texture features yielded AUC values of 0.85, 0.82, and 0.80 in conjunction with the 2-class LDA classifier for separating low and high ODX ER+ breast lesions.

CONCLUSION
This work to our best knowledge, the first attempt to quantitatively correlate texture measurements on DCE-MRI to patient outcome prediction via the ODX assay. Our results suggested that the DHog, DLBP, and EKF were robust and stable DCE-MRI markers in distinguishing between low and high ODX scores.

CLINICAL RELEVANCE/APPLICATION
An MRI-based assay to identify ER+ BCa patients that could non-invasively predict which patients would benefit from adjuvant chemotherapy, and could serve as a complement to Oncotype DX assay.

SSQ02-02 • Computerized Characterization of Mass and Non-mass-Like Lesions on Breast MRI

Hui Li PhD (Presenter) ; Maryellen L Giger PhD * ; Li Lan ; Sunny Y Duan ; Stephan Hu ; Gillian M Newstead MD * ; Hiroyuki Abe MD ; Michelle Lindgren MD

PURPOSE
To investigate the potential usefulness of quantitative imaging analysis on characterizing both mass and non-mass-like enhancement breast lesions in the task of distinguishing between malignant and benign lesions

METHOD AND MATERIALS
Study was performed on 123 biopsy-proven lesions from 103 MRI studies acquired between January 2009 and April 2010, including 35 benign mass, 50 malignant mass, 11 benign non-mass-like and 27 malignant non-mass-like lesions. Our quantitative imaging analysis method incorporated computerized 3D lesion segmentation and feature extraction, including kinetic, enhancement-variance kinetic, morphological, and textural features. The computed features were extracted and used to characterize the appearance of the breast lesions. The computed features were evaluated by a linear discriminate analysis (LDA) classifier in terms of their ability to distinguish ER+ BCa with low or high ODX scores via a 2-fold randomized cross validation scheme.

RESULTS
For mass lesions, the kinetic features of time to peak and curve shape index statistically differed between malignant and benign lesions. However, kinetic features did not contribute significantly in the diagnostic task with non-mass-like breast lesions. By merging computer-selected features with BANN classifiers, AUC values of 0.88 (SE=0.03), 0.95 (SE=0.02), and 0.82 (SE=0.08) were obtained in the task of distinguishing between malignant and benign lesions across the entire dataset, between malignant and benign mass lesions, and between malignant and benign non-mass-like lesions, respectively.

CONCLUSION
Kinetic characteristics are useful in differentiating malignant from benign mass lesions; however, their performance is reduced when the lesions are non-mass-like. Thus, quantitative analysis for diagnostic decision-making should be performed separately on mass and non-mass-like lesions.

CLINICAL RELEVANCE/APPLICATION
In order to improve clinical diagnostic accuracy, quantitative analysis for diagnostic decision-making should be performed separately on mass and non-mass-like lesions in the classification task.

SSQ02-03 • Use of Quantitative 3D Breast Image Analysis to Inform DCIS Staging

Stephanie M Burda (Presenter) ; Maryellen L Giger PhD * ; Li Lan ; Kathy Rodogliannis ; Hui Li PhD ; Gillian M Newstead MD * ; Ken Yamaguichi ; Koichi Ishiyama MD ; Hiroyuki Abe MD ; Michelle Lindgren MD ; Adam Starkey

PURPOSE
Uncertainty on which ductal carcinoma in situ (DCIS) cases will progress to invasive breast cancer currently results in overtreatment. Our purpose was to discern quantitative characteristics of pure DCIS, DCIS with an invasive component, and invasive cancers without DCIS to inform prognosis of patients with lesions presenting initially as DCIS.

METHOD AND MATERIALS
Retrospective, IRB-approved review of our radiology database 2005-2012 identified 303 pathology-proven cancers with correlating MR imaging. Histology yielded 54 pure DCIS lesions, 56 with both DCIS and invasive pathology, and 193 invasive cancers without DCIS. Quantitative 3D image analysis yielded morphological, kinetic, and texture lesion descriptors following semi-automated lesion segmentation. ROC analysis was performed on these image-based phenotypes comparing pure DCIS lesions, DCIS lesions with an invasive component and invasive cancers without an in situ component.

RESULTS
The combination of features that best distinguished pure DCIS from invasive cancer included kinetic feature time to peak, texture features of contrast and correlation, and morphological features of circularity, margin, and surface area. The combination of features that was best able to distinguish pure DCIS from invasive cancers with a DCIS component included contrast, margin, and ratio of surface area to volume. The margin characteristics (determined by spiculation and sharpness) and contrast (the difference between the average gray level of the cancer and the surrounding area) were found to be insightful in both comparisons. Time to peak was also significant in the comparison of Pure DCIS and invasive cancers, yielding an AUC value of 0.77. Round-robin evaluation of an LDA yielded AUCs of 0.85 and 0.74 distinguishing pure DCIS from invasive cancers and invasive cancers with a DCIS component, respectively.

CONCLUSION
Image-derived quantitative phenotypes, which indicate a likelihood of invasive disease of pure DCIS, could patient guide management of DCIS lesions, thus potentially reducing overtreatment.
SSQ02-04 • Undetected Breast Cancers on Commercial Breast MRI CAD (Computer-aided Detection) System

Chae Hyun Kim (Presenter); Seon Hyeong Choi; Ji Yeon Park; Yoonjung Choi MD; Shin Ho Kook MD

PURPOSE
To evaluate the immuno-histological factors of breast cancer not detected on breast MRI CAD system.

METHOD AND MATERIALS
The study included 327 preoperative breast MRI studies that were not detected on breast MRI CAD. The mean age was 57.7 years (range: 21-84) and the median age was 56.5 years. We retrospectively reviewed the CAD results, corresponding immuno-histopathological features, lesion size and age to determine factors affecting MRI CAD detectability. We categorized tumors into two groups: detected and undetected groups.

RESULTS
Of the 327 cases, the CAD system failed to detect breast cancer lesions correctly and 68(20.8%) were undetected on breast MRI CAD. The mean size and age were 18 mm (range: 1-70) and 50.0 y/o (SD: 9.9) in the undetected group and 22.8 mm (range: 3-120) and 51.4 y/o (SD: 10.7) in the detected group. The tumor type was a significant factor (p < 0.05).

CONCLUSION
Though the commercial breast MRI CAD system showed good performance, about 20% of breast cancers were not detected on MRI CAD. DCIS, low nuclear grade, low Ki-67 percentage, and HER-2 negative influence the breast MRI CAD detectability in breast cancer patients.

SSQ02-05 • Immunohistological Factors Affecting the Breast Cancer Size Measurement by MRI Computer-aided Detection (CAD) System

Ji Yeon Park (Presenter); Seon Hyeong Choi; Yoonjung Choi MD; Chae Hyun Kim; Shin Ho Kook MD

PURPOSE
To investigate immunohistological factors affecting the breast tumor size measurement discrepancy between the MRI CAD and the pathologic specimen.

METHOD AND MATERIALS
We retrospectively reviewed the 244 cases of breast MRI CAD images and pathologic findings of the 244 patients who underwent operation for breast cancer between July 2011 and December 2012. We compared the CAD generated tumor size with tumor size measured on pathologic specimen. We classified the tumors into three groups: underestimated, adequately measured and overestimated group. We investigated the statistical difference in histopathology including histologic type, presence of DCIS, extracellular component, nuclear grade, ER, PR and HER-2, among the 3 groups.

RESULTS
Median tumor size on CAD and specimen were 20 mm (2-163 mm) and 17 mm (0.8-82 mm), respectively. Adequately measured group was 68.6% (n=168). Invasive ductal carcinoma (IDC) showed significantly more adequate measurement, compared with DCIS (p=0.025). Among IDC, the presence of extensive intraductal component was significantly higher in overestimated group (p < 0.05).

CONCLUSION
Size assessment using breast MRI CAD was accurately measured in 68.6%. On MR CAD, breast cancer size was frequently overestimated in cases of DCIS, the presence of extensive intraductal component, and HER-2(+)..

SSQ02-06 • Quantitative MRI-based Phenotypes of Triple Negative Breast Cancers

Hui Li PhD (Presenter); Maryellen L Giger PhD *; Li Lan; Hiroyuki Abe MD; Michelle Lindgren MD; Eric M Blaschke MD; Gillian M Newsread MD *

PURPOSE
To investigate the potential usefulness of quantitative image analysis on characterizing the molecular subtypes of breast cancer in order to better understand the difference between triple negative and other molecular subtypes of breast cancer.

METHOD AND MATERIALS
Study was performed on 168 biopsy-proven breast cancer MRI studies acquired between November 2008 and August 2011, in which 40 cases were triple negative (ER-, PR-, and HER2-) breast cancers and 128 cases were of other molecular subtypes including Luminal A, Luminal B, and HER2. Quantitative MRI analysis included: 1) 3D lesion segmentation based on a fuzzy c-means clustering algorithm; 2) computerized feature extraction; 3) leave-one-out linear stepwise feature selection; and 4) discriminant score estimation using Linear Discriminant Analysis (LDA). The classification performance between triple negative and other molecular subtypes of breast cancer was evaluated using ROC analysis with area under the ROC curve (AUC) as the figure of merit.

RESULTS
The triple negative classification, in a round-robin evaluation, yielded AUC values of 0.90 (SE=0.05) and 0.67 (SE=0.05) on 3T and 1.5T MR scanners, respectively, in the task of distinguishing between triple negative and other molecular subtypes, statistically significantly higher than an AUC value of 0.5 (p-value < 0.05).

CONCLUSION
The results from this study indicate that quantitative MRI analysis shows promise in the discrimination of triple negative breast cancer from other molecular subtypes of breast cancer.

SSQ02-07 • Features of Undiagnosed Breast Cancers at Screening Breast MRI: Potential Utility and Limitation of Computer-aided Evaluation

Mirinae Seo MD (Presenter); Nariya Cho MD; Min Sun Bae MD, PhD; Eun Bi Ryu MD; Jung Min Chang MD; Hye Ryoung Koo MD; Su Hyun Lee MD; Won Hwa Kim MD, MS; Woo Kyung Moon; Hye Mi Gweon MD; A Jung Chu MD

PURPOSE
To evaluate the features of undiagnosed cancers at prior screening breast MRIs in patients who subsequently developed breast cancers and the potential utility and limitation of computer-aided evaluation (CAE).
METHOD AND MATERIALS
Between March 2004 and March 2013, 65 pairs of dynamic contrast enhanced breast MRIs including prior negative screening MRIs and subsequent MRIs with developed cancers (mean interval 36.5 months, range 5.4 - 96.7 months) were identified. The mean histological sizes of developed cancers was 2.0cm (range 0.5 - 9.5 cm) for invasive cancers (n=44) and 1.9cm (range 0.5 - 4.1 cm) for DCIS (n=21). Visible findings, their maximum lesion size and actionability, as well as causes for overlooked cancers on prior MRI were determined and classified by two experienced radiologists in consensus. A commercially available CAE program was retrospectively applied to the prior MRIs with visible findings for generation of kinetic features including washout, plateau, and persistent enhancement proportions. Presence of a washout component on CAE was also described.

RESULTS
Of the 65 areas where cancer later developed, 51% (33 of 65) of prior MRIs had visible findings and their mean lesion size was 1.0cm (range 0.4 - 5.2 cm). Of these visible findings, 24% (8 of 33) were classified as actionable and 76% (25 of 33) as underthreshold. Causes for actionable findings were mimicking of physiologic enhancement (n=3), mismanagement after benign results of biopsy (n=3), and satisfaction of search (n=2). Those of underthreshold findings were small lesion size (n=6), moderate to marked background parenchymal enhancement (n=11), mimicking of post-op scar (n=7), and peripheral location (n=1). Twenty three of the visible findings were available for CAE and the washout component was found in 14. However, 4 of 14 lesions with a washout component were not marked due to marked background enhancement with multiple enhancing lesions with a washout component. CAE did not show the washout component in 9 of 23 lesions.

CONCLUSION
On prior screening breast MRIs in which cancer later developed, 51% (33 of 65) had visible findings (24% actionable, 76% underthreshold). The addition of CAE has the potential to identify 43% (10 of 23) of overlooked findings. Yet, there are still some limitations on CAE.

CLINICAL RELEVANCE/APPLICATION
When an enhancing lesion shows a washout component on MR-CAE of screening breast MRI, closer attention is warranted.

SSQ02-08 • Evaluation of a Commercial CAD System for Detecting Lesions at Breast Digital Tomosynthesis
Lia Morra PhD *; Silvano Agliozzo PhD *; Luca A Carbonaro MD *; Manuela Durando (Presenter); Barbara Pesce MD; Giovanna Mariscotti; Alberto Bert PhD *

PURPOSE
To evaluate the performance of a commercial computer aided detection (CAD) system (CAD BREAST DTS, im3D S.p.A.) for detecting lesions at digital breast tomosynthesis (DBT) on an independent testing set.

METHODOLOGY AND MATERIALS
The CAD system was retrospectively tested on a set of 143 patients. Cranio-caudal (CC) and mediolateral oblique (MLO) DBT projections were acquired with a Hologic Selenia Dimensions system and reconstructed with the Briona library (Real Time Tomography LLC). All patients signed an informed consent form. A total of 80 histologically confirmed malignant lesions (57 masses, 18 microcalcification clusters and 6/6 masses with associated microcalcifications) were detected and annotated by experienced radiologists who drew a 3D bounding box around each lesion view. CAD BREAST DTS yields both masses and microcalcification clusters candidates. For masses, a CAD true positive was registered when the CAD marking overlapped by at least 20% the radiologists marking; for microcalcification clusters, when at least two of the microcalcifications identified by CAD fell within the radiologists marking. A CAD false positive was registered in all other cases, to avoid chance matchings. Masses with associated microcalcifications were considered correctly identified if CAD marked at least a mass or a microcalcification cluster.

RESULTS
At the selected operating point, per-lesion sensitivity was 89% (95% C.I. 80-94%). The system detected 48/56 masses, 17/18 microcalcification clusters and 6/6 masses with microcalcifications. Mean number of false positives per view was 2.8 ± 1.9 (mean ± standard deviation), of which 2 were marked as masses and 0.8 as microcalcification clusters.

CONCLUSION
The DBT CAD sensitivity is comparable to that observed for 2D digital mammography CAD systems, with a fairly low number of false positives per view. Further work, especially on difficult cases such as screening interval cancers, and comparing reading with and without CAD, is needed to understand its role in clinical practice.

CLINICAL RELEVANCE/APPLICATION
A commercial CAD system for masses and microcalcification clusters detection is evaluated on an independent testing set.

SSQ02-09 • Quantitative MRI Morphological Features of Breast Cancer: Correlation with Immunohistochemical Biomarkers and Subtypes
Min Sun Bae MD, PhD (Presenter); Mirinae Seo MD; Woo Kyung Moon; Nariya Cho MD; Jung Min Chang MD; Hye Ryoung Koo MD; Won Hwa Kim MD, MS; Su Hyun Lee MD; Hye Mi Gweon MD

PURPOSE
To investigate the correlation of the tumor roundness measured quantitatively at contrast-enhanced magnetic resonance imaging (MRI) and immunohistochemical biomarkers and subtypes in breast cancer.

METHODOLOGY AND MATERIALS
After IRB approval, we retrospectively reviewed 280 consecutive women (median age, 50 years; range, 28-79 years) with 282 invasive breast cancers (< 5 cm size). All patients underwent preoperative breast MRI. Images were assessed independently by the two radiologists who were unaware of pathological findings. Tumor roundness was measured quantitatively by a software developed in-house and was calculated according to the following equation: roundness = 4π x A / P^2 (A is the cross-sectional area of the tumor and P is the measured perimeter length of the tumor). The means of values measured by the two observers were recorded and interobserver variability was calculated. Associations between the tumor roundness (1-100 %) and biomarker (estrogen receptor [ER], progesterone receptor [PR], HER2, and Ki67) features were evaluated using Pearson's correlation coefficient and a multiple linear regression analysis. Tumor roundness was compared between breast cancer subtypes (luminal A, luminal B, HER2-enriched, and triple-negative).

RESULTS
Interoobserver agreement for MRI measurements was moderate with intraclass correlation coefficients of 0.75 (95% confidence interval: 0.67-0.80). A moderate inverse correlation was observed between the ER score and tumor roundness (r = -0.408, P < .0001). PR score, Ki67 index, and tumor grade correlated with the tumor roundness (P < .0001). In multiple linear regression, ER score (P < .0001) and Ki67 index (P = .003) were independent factors determining tumor roundness. Triple-negative tumors showed the highest mean roundness score compared with other subtypes.

CONCLUSION
Tumor roundness measured quantitatively at MRI correlated with ER score and Ki67 index in breast cancer. Triple-negative tumors showed the highest mean roundness score compared with other subtypes.

CLINICAL RELEVANCE/APPLICATION
Our data may have implications for possibly stratifying breast cancer patients with different clinical outcomes by using MRI morphological features.
SSQ03-01  Dynamic CT Myocardial Perfusion Imaging: Performance of 3D Semi-automated Evaluation Software

Ulrich Ebersberger MD (Presenter); Roy Marcus BS; Lucas L Geyer MD *; Gladys G Lo MD; Christian Canstein *; U. Joseph Schoepe MD *; Yining Wang MD; Fabian Bamberg MD, MPH *; Andrew D McQuiston BS

PURPOSE
To determine the performance and accuracy of dedicated 3D semi-automated evaluation software for the assessment of myocardial blood flow (MBF) and blood volume (MBV) at dynamic CT myocardial perfusion imaging.

METHOD AND MATERIALS
In an IRB-approved study, 37 dynamic, time-resolved myocardial perfusion CT datasets acquired using a 2nd-generation dual-source CT system (Definition Flash, Siemens) were assessed both manually and by use of the semi-automated prototype for MBF and MBV, based on the AHA segmental model. The prototype software employs an automatic 3D heart chamber segmentation system and a surface-based four-chamber heart model. For automated segmentation, a series of anatomical landmarks in the heart are detected followed by delineation of chambers. Marginal space learning is applied for automatic localization of anatomical structures. Subsequently, the 3D shape of the cardiac chambers is determined using a probabilistic boosting tree-based contour fitting. The resulting segmentation consequently allows for both manual placement of ROIs and calculation of a polar map employing the modified 17-segment AHA myocardial model. Time required for each assessment was recorded. Results were compared to SPECT as the standard of reference.

RESULTS
592 segments were evaluated. 19 (3.21%) were excluded due to insufficient coverage. Based on the results at SPECT, 42 segments in 17 patients were classified as showing pathologic myocardial perfusion (prevalence: 45.9% patient-based). Overall, both approaches yielded higher negative predictive value than positive predictive value, with NPV: 0.99 vs. 0.98 and PPV: 0.65 vs. 0.65 for the manual as compared with the 3D evaluation tool. A comparison of MBF and MBV measurements using the prototype versus manual assessment showed high correlation (Spearman rank correlation coefficient = 0.85/0.83, p<0.001).

CONCLUSION
The performance of 3D semi-automated evaluation software for dynamic CT myocardial perfusion imaging correlates highly with manual assessment of MBF/MBV values in good agreement with SPECT. Use of such software substantially decreases post-processing and interpretation times.

CLINICAL RELEVANCE/APPLICATION
These results promise for fostering the integration of dynamic CT myocardial perfusion imaging in actual clinical workflows.

SSQ03-02  Non-concordant Results by Myocardial CT Perfusion Imaging and SPECT Perfusion Imaging Compared with Invasive Coronary Angiography: A Post-hoc Analysis from the CORE320 Trial

Vishal C Mehra MD, PhD (Presenter); Marcelo F Di Carli MD *; Andrew E Arai MD; Kakuya Kitagawa MD, PhD; Armin Arbab-Zadeh MD; Julie Miller MD *; Andrea L Vavere; Klaus Kofod MD; Carlos E Rochitte MD, PhD; Marc Dewey MD *; Swee Yaw Tan MBBCh, MRCP; Hiroyuki Niinuma; Christopher Cox *; Melvin E Clouse MD; Joao A Lima MD *; Richard T George MD *

PURPOSE
The conventional form of non-invasive testing by stress single photon emission computed tomography (SPECT) perfusion imaging is known to be less reliable in the presence of clinical situations associated with balanced ischemia. The international multicenter CORE320 trial was designed to test a non-invasive risk stratification approach using combined computed tomography angiography (CTA) and adenosine stress CT perfusion (CTP) imaging compared to the reference standards of combined stress SPECT perfusion imaging and invasive coronary angiography (ICA). This design allows for the head-to-head comparison of the two forms of stress perfusion imaging (CTP and SPECT) vs. the reference standard of ICA in a post-hoc manner. The purpose of this analysis was to examine the rate of non-concordance of CTP and SPECT perfusion imaging among participants of the CORE320 trial and compare to percent stenosis by ICA.

METHOD AND MATERIALS
The international, multicenter CORE320 study enrolled 381 symptomatic patients referred for ICA. Prior to ICA, patients underwent rest CTA and adenosine stress CTP as well as SPECT perfusion imaging. CTA, CTP, ICA, and SPECT were all analyzed using parallel methods in blinded independent laboratories. As part of this post-hoc analysis, when SPECT and CTP showed discordant results, we compared these results to the reference standard ICA. ICA was defined as abnormal at the = 50% diameter stenosis threshold.

RESULTS
A positive CTP with a negative SPECT study occurred in 113 of the 381 enrolled subjects. Compared to ICA, 62% (70 of 113) of these had single vessel disease or greater and 33% (36 of 113) had multi-vessel (≥ 2 vessels) or left main disease. Conversely, a negative CTP with a positive SPECT study occurred in 33 subjects only 27% (9/33) of these had single vessel disease or greater and 18% (7/33) had multi-vessel disease (P=0.004).

CONCLUSION
These data suggest that in patients with discordant findings in CTP and SPECT, CTP imaging is more sensitive than SPECT imaging for the detection of anatomic coronary stenosis. The majority of positive CTP studies without concordant SPECT defects do, in fact, demonstrate single, multi-vessel or left main coronary artery disease.

CLINICAL RELEVANCE/APPLICATION
CT perfusion imaging is more accurate than SPECT perfusion in predicting significant coronary stenosis, by ICA.

SSQ03-03  Cardiac Troponin I Predicts the Development of Unrecognized Myocardial Infarctions Detected with Magnetic Resonance Imaging

Charlotte Ebeling Barbier MD (Presenter); Raquel E Themudo MD; Tomas Bjerner MD, PhD *; Lars O Johansson PhD *; Bertil Lindahl *; Lars Lind MD, PhD; Hakan K Ahlstrom MD, PhD

PURPOSE
To investigate whether plasma levels of cardiac troponin I measured with a high-sensitivity assay (hs-cTnI) could predict the development of unrecognized myocardial infarctions (UMIs) detected with late enhancement magnetic resonance imaging (LE-MRI).

METHOD AND MATERIALS
LE-MRI was performed on 248 randomly selected community-living 70-year-old subjects and hs-cTnI was determined with a highly sensitive premarket assay. Five years later the subjects were invited to a second LE-MRI, and 143 of them (68 women, 75 men) who had a follow-up LE-MRI were included in the analysis. A positive LE-MRI was defined as showing pathologic myocardial perfusion (prevalence: 45.9% patient-based). Overall, both approaches yielded higher negative predictive value than positive predictive value, with NPV: 0.99 vs. 0.98 and PPV: 0.65 vs. 0.65 for the manual as compared with the 3D evaluation tool. A comparison of MBF and MBV measurements using the prototype versus manual assessment showed high correlation (Spearman rank correlation coefficient = 0.85/0.83, p<0.001).

CONCLUSION
The performance of 3D semi-automated evaluation software for dynamic CT myocardial perfusion imaging correlates highly with manual assessment of MBF/MBV values in good agreement with SPECT. Use of such software substantially decreases post-processing and interpretation times.

CLINICAL RELEVANCE/APPLICATION
These results promise for fostering the integration of dynamic CT myocardial perfusion imaging in actual clinical workflows.
Artery Disease: A Cardiac CT Study

Half Scan and MR Delayed Enhancement

RESULTS

New UMs were detected in 37 subjects during follow-up. Plasma levels of hs-cTnI at 70 years of age, which were mainly within what is considered to be the normal range, were related to new UMs at 75 years of age with an adjusted Odds Ratio (OR) of 1.78 for 1 SD increase in hs-cTnI (95% CI 1.13-2.81; p=0.014). In the third and fourth quartiles of hs-cTnI the adjusted ORs were 5.63 (95% CI 1.08-29.38; p=0.043) and 10.11 (95% CI 1.89-54.22; p=0.007) respectively compared to the first quartile. Plasma levels of hs-cTnI at 70 years of age were associated with the volumes of the UMs detected at 75 years of age (p=0.022).

CONCLUSION

hs-cTnI in 70-year-old community-living women and men predicted the development of MRI-detected UMs within five years.

CLINICAL RELEVANCE/APPLICATION

It is debated whether MRI-detected UMs constitute real MIs. These results may be helpful in understanding the constitution and potential prognostic impact and of these UMs.

SSQ03-04  ●  T1 and T2 Mapping for the Detection of Myocardial Edema in Acute Myocardial Infarction by Cardiac Magnetic Resonance

Jerome Caudron MD (Presenter); Valentin Lefebvre; Benjamin Dubourg; Jeanneantes Fares MD; Jean-Nicolas Dacher MD *

PURPOSE

To evaluate quantitative T1 and T2 mapping sequences in assessing myocardial edema in patients with acute myocardial infarction (AMI)

METHOD AND MATERIALS

Single center study involving 24 patients referred for AMI (STEMI) and 24 healthy volunteers who served as controls to determine normal T1 and T2 values of the myocardium. Cardiac MRI was performed between day 2 and day 7 after acute event (Avanto 1.5T, Siemens, Germany). Standard protocol included CINE, T2w STIR, first pass and delayed enhancement (PSIR) sequences. In addition, steady state free precession T2 mapping sequences (3 echoes) and modified Look Locker inversion recovery T1 mapping sequences (11 inversion times) were performed on short axis views at basal, mid and apical levels of the left ventricle. Analysis was performed using the 16 left ventricular segments model, excluding the apex. Quantitative T1 and T2 values (in ms) were obtained from regions of interest encompassing each segment. Segments were therefore divided in 3 areas: infarct, peri-infarct and remote. Diagnostic accuracy of T1 and T2 mapping sequences was therefore calculated for detecting infarct area as defined by late gadolinium enhancement.

RESULTS

T1 and T2 maps were interpretable in all patients and controls. Mean T1 and T2 values in infarct areas (respectively 1135±69 ms and 69.8±8.7ms) were significantly longer than T1 and T2 values in peri-infarct (respectively 1018±36ms and 56.7±4.7ms) and remote areas (respectively 988±26ms and 53.5±4.9ms) (p-T2 maps AUC=0.922, Se=82.1, Spe=92.9, optimal threshold=61.4 ms -T1 map AUC=0.893, Se=80.3, Spe=89.6, optimal threshold=1053 ms).

Difference was almost significant between T2 and T1 maps (p=0.05).

CONCLUSION

T1 and T2 mapping are effective methods for quantifying myocardial edema in patients referred for AMI. Interestingly, T1 and T2 values of the remote areas in patients are longer than those measured in controls.

CLINICAL RELEVANCE/APPLICATION

Quantification of T1 and T2 values could be relevant in the evaluation of area at risk in AMI but also for the evaluation of new treatments, prognostic stratification and patients follow-up.

SSQ03-05  ●  Myocardial CT Delayed Enhancement Using Targeted Spatial Frequency Filtration: Comparison with Conventional Half Scan and MR Delayed Enhancement

Yusuke Kurobe MD (Presenter); Kakuya Kitagawa MD, PhD; Tatsuro Ito MD; Yoshie Kurita MD; Yasuyuki Shiraishi; Makiko Fujita; Motonori Nagata MD, PhD; Masaki Ishida MD, PhD; Hajime Sakuma MD *

PURPOSE

CT assessment of myocardial delayed enhancement (DE) is feasible but is not widely used due to relatively poor contrast-to-noise ratio (CNR) and artifacts associated with half scan reconstruction. Targeted spatial frequency filtration (TSFF) developed for dynamic myocardial perfusion imaging is a hybrid algorithm of half and full scan reconstruction that can achieve both high temporal resolution and improved stability of CT Hounsfield unit of the myocardium. The purpose of this study was to evaluate the feasibility and image quality of CTDE using TSFF in comparison with conventional half scan (CHS) reconstruction.

METHOD AND MATERIALS

Forty patients with suspected CAD underwent CTDE 7 minutes after administration of 120ml of contrast medium using dual-source CT. Images were reconstructed with TSFF and CHS. Two blinded readers independently determined the presence and size of DE. Signal-to-noise ratio (SNR) and CNR of DE lesions were also determined. Image artifact was assessed by a three-point scale (3=minimal, 2=moderate, 1=substantial). The presence of DE was compared between CT and CMR in 12 patients.

RESULTS

TSFF demonstrated significantly reduced artifact on CTDE images compared with CHS (2.4±0.7 vs 3.0±0.0, P<0.05). SNR and CNR were significantly higher in TSFF compared with CHS (p<0.05).

CONCLUSION

TSFF algorithm is highly effective in reducing artifacts on myocardial CTDE images and considerably improves inter-observer reproducibility of infarct sizing. Myocardial CTDE using TSFF allows for accurate infarct detection and reproducible infarct sizing in patients with known or suspected myocardial infarction.

CLINICAL RELEVANCE/APPLICATION

Myocardial CT delayed enhancement using TSFF algorithm markedly improves infarct detection and sizing, and is recommended for comprehensive assessment of CAD and myocardial infarction.

SSQ03-06  ●  Age-related Increase and Regional Difference of Extracellular Fraction of Myocardium in Subjects without Coronary Artery Disease: A Cardiac CT Study

Yoshie Kurita MD (Presenter); Kakuya Kitagawa MD, PhD; Tatsuro Ito MD; Naoki Nagasawa RT, PhD; Hiroshi Nakajima MD; Shiro Nakamori MD; Masaki Ishida MD, PhD; Hajime Sakuma MD *

PURPOSE

Assessment of extracellular fraction by CT is a new approach toward the evaluation of diffuse myocardial fibrosis. The purpose of this study was to describe the normal pattern of age-related and regional variation of extracellular fraction in subjects without coronary artery disease (CAD).

METHOD AND MATERIALS

Among 82 patients with known or suspected CAD who underwent comprehensive cardiac CT study consisting of non-contrast CT, stress CT perfusion, coronary CTA and myocardial CT delayed enhancement, we retrospectively identified 27 subjects without any of coronary artery stenosis, LV hypertrophy, stress perfusion deficits and delayed enhancement. After exclusion of subjects with calcium score of >100 (n=5), poor image quality (n=1), and without hematocrit measurement (n=5), 16 subjects (ages 43-80, median 65 years, 5
RESULTS
Mean extracellular fraction for each subject by CT was 25.7%±2.2 (range 23.2-29.7%), showing excellent agreement with the previously reported extracellular fraction values determined by MRI using T1 mapping method (mean extracellular fraction of 24.8-26.6%), and was strongly related to age (r=0.806, p<0.001).

CONCLUSION
Extracellular fraction values determined by CT in this study are in excellent agreement with previous reports using MRI. Strong linear correlation between extracellular fraction and age may indicate the ability of CT to demonstrate increasing diffuse fibrosis associated with normal aging.

CLINICAL RELEVANCE/APPLICATION
In the evaluation of diffuse fibrosis, age-related increase and regional variation of extracellular fraction of LV myocardium demonstrated in this study should be taken into consideration.

SSQ03-07  Age- and Gender-based Performance of Non-invasive Fractional Flow Reserve Computed from Coronary CT Angiography: Results from a Prospective International multicenter Trial

Jonathan A Leipsic MD (Presenter) *; Gilat Grunau PhD; Rekha Raju; Carolyn Taylor MD; Ryo Nakazato; Daniel S Berman MD *; Matthew J Budoff MD *; Cameron J Hague MD; James Min MD *.

PURPOSE
Fractional flow reserve (FFR) at the time of invasive coronary angiography (ICA) is the gold standard for determining lesion-specific ischemia. Non-invasive FFR computed from a resting coronary CT angiogram (FFRCT) enables measurement of lesion-specific ischemia with high concordance to invasive FFR. To date, the performance of FFRCT when stratified by age and gender, has not been examined.

METHOD AND MATERIALS
407 vessels from 252 patients (17 centers in 5 countries) underwent CT, FFRCT, ICA and invasive FFR, with all studies interpreted in blinded fashion by independent core laboratories. FFRCT and FFR =0.80 were considered hemodynamically significant, while CT stenosis =50% was considered anatomically obstructive. Stratified by age and gender, discrimination and diagnostic accuracy of FFRCT was assessed against FFR on a per-patient basis by area under the receiver-operating-characteristics curve (AUC) and accuracy.

RESULTS
Median age of the study population was 63±9 years (71% male). By FFR, ischemia was identified in 151 of 407 lesions (37%). FFRCT demonstrated similar per-patient discrimination for subjects >65 versus <65.

CONCLUSION
When compared to invasive FFR, FFRCT yields similar discrimination and accuracy for diagnosis of lesion-specific ischemia in older and younger patients, as well as in men and women.

SSQ03-08  Evaluation of Accuracy for Detection and Extent of Occult Myocardial Scars Using Delayed-enhancement CT in Patients with Asymptomatic Diabetes: Results from the ACCREDIT Study

Sung Min Ko (Presenter); Joon-Won Kang MD; Sang Il Choi MD; Tae-Hwan Lim MD, PhD

PURPOSE
To evaluate through an exploratory sub-study the accuracy of delayed-enhancement CT (DE-CT) for detecting occult myocardial scars (OMS) and to evaluate the transmurality of OMS using DE-CT compared with delayed enhancement MRI (DE-MRI) in asymptomatic patients with type 2 Diabetes.

METHOD AND MATERIALS
In this prospective, multicenter, and open-label study, 347 patients with type 2 DM were included with 2 or more risk factors of coronary artery disease. DE-MRI and DE-CT were respectively performed with Gadoterate Meglumine (Dotarem®) and Iobitridol (Xenetix®350) on 167 patients. Image quality of DE-CT was evaluated using 4-grading system, good, adequate, poor and null. The prevalence and the transmurality of OMS on both DE-MRI and DE-CT were evaluated at patient and segment levels. The sensitivity, specificity, positive and negative predictive values of DE-CT for detecting OMS was evaluated in comparison with DE-MRI both at patient and segment levels. The transmurality of OMS in DE-CT and DE-MRI for each scar was assessed in terms of over- or underestimation of DE-CT using 6-grade system, 0%, 1-25%, 26-50%, 51-75%, 76-99%, and 100% at segment level.

RESULTS
The image quality of DE-CT was good and adequate in 165 (98.8%) patients. The OMS was detected in 12 (7.3%) by DE-MRI and 7 (4.3%) by DE-CT of the 164 patients for whom a valid assessment was available. Of the 2788 segments, OMS was detected in 24 segments on DE-MRI and in 12 segments on DE-CT. The sensitivity of DE-CT for detecting OMS was 58.3%, specificity was 100%, positive predictive value was 100% and the negative predictive value was 96.8% at patient level. At segment level, the sensitivity, specificity, positive and negative predictive value of DE-CT for detecting OMS were 50%, 100%, 100%, and 99.6% respectively. The grade for transmurality of OMS between DE-CT and DE-MRI was matching at segment level in 41.7%, under-evaluation of transmurality on DE-CT was in 54.2%, and overestimation on DE-CT was 4.2%.

CONCLUSION
The sensitivity of DE-CT for detecting OMS is moderate, but the specificity is high. Under-evaluation of the transmurality of OMS is common using DE-CT.

CLINICAL RELEVANCE/APPLICATION
(dealing with delayed-enhancement CT (DE-CT) for detecting occult myocardial scars), the sensitivity of DE-CT for detecting OMS is moderate, but the specificity is high.

SSQ03-09  Relationship between Hyperemic Myocardial Blood Flow on Dynamic Dual-source Computed Tomography and Myocardial Perfusion Reserve Index on Magnetic Resonance Imaging

Federica Pirro (Presenter); Ermanno Capuano MD; Alexia Rossi MD; Steffen E Petersen; Lorenzo Bonomo MD; Francesca Pugliese MD, PhD

PURPOSE
To evaluate the relationship between regional hyperemic myocardial blood flow (MBF) estimated in absolute terms by computed tomography, and perfusion reserve index (PRI) on adenosine stress first-pass magnetic resonance imaging (MRI; reference standard) in a population of patients with stable chest pain.

METHOD AND MATERIALS
RESULTS
In total 102 vascular territories were available for comparison. On MRI, perfusion defects were found in 32/102 (31%) vessels in 16/34
PURPOSE
To compare pulmonary lesion detection, visibility of tiny structures and diagnostic acceptability in sparse-sampled CT data of sub-milliSievert chest CT (SpS-SmSv) reconstructed with Iterative Reconstruction Technique (IRT).

METHOD AND MATERIALS
Ten non-obese patients (BMI2, age range: 48-82 years) were scanned at standard-dose CT (SD) and at sub milli-sievert (SmSv at 0.9 mSv) dose on a Philips 256-slice CT scanner with double z-sampling in a prospective study. Sparse angular sampling data were reconstructed using 25% of the angular projections from the sub-mSv sinogram to reduce the number of views and radiation dose by about 4-fold (estimated ED 0.2mSv). Three image series were generated per patient (sparse sampled reconstructed with IRT: SpS-SmSv IRT; fully sampled: SmSv-FBP and SD-FBP). Two radiologists independently assessed these image series for detection of lung lesions, visibility of small structures and diagnostic acceptability. Objective noise was measured in thoracic aorta and noise spectral density (NSD) was obtained for SpS-SmSv IRT, SmSv-FBP and SD-FBP.

RESULTS
SpS-SmSv IRT resulted in 75%(0.2/0.9 mSv) and 92%(0.2/2.9 mSv) dose reduction, when compared to fully sampled submSv-FBP and SD-FBP, respectively. SpS-SmSv images displayed all 36 lesions (most < 1 cm, 31 lung nodules and 5 ground glass opacities) seen on SmSv-FBP and SD-FBP datasets. Lesion margins with sparse sampled data were deemed acceptable compared to both SmSv-FBP and SD-FBP. Overall diagnostic acceptability was maintained with SpS-SmSv IRT despite presence of minor pixilation artifacts in 3/10 cases. Interobserver agreement was statistically significant (kappa value 0.88; p<0.05). NSD showed that SpS-SmSv IRT gives a linear decrease over frequency in the semilog plot and an exponential decrease of noise power over frequency compared to submSv FBP and SD-FBP.

CONCLUSION
It is possible to reduce chest CT dose to fifth of a mSv for sparse-sampled CT images reconstructed with IRT while retaining lesion detection and diagnostic acceptability for evaluation of pulmonary findings.

CLINICAL RELEVANCE/APPLICATION
More than 90% dose reduction could be achieved with one fourth sparse-sampled and sub millisievert chest CT examination when reconstructed with iterative reconstruction technique.

SSQ04-02 • Lung and Nodule Perfusion Assessments on Dynamic First-pass Perfusion Area-detector CT: Capability of Adaptive Iterative Dose Reduction Using 3D Processing (AIDR 3D) for Radiation Dose Reduction as Compared with Filter Back Projection (FBP)

Yoshiharu Ohno MD, PhD (Presenter) *; Mizuho Nishio MD *; Takeshi Yoshikawa MD *; Sumiaki Matsumoto MD, PhD *; Yasuko Fujisawa MS *; Naoki Sugihara MENG *; Hisanobu Koyama MD; Shinichiro Seki; Maho Tsubakimoto MD; Tohru Murakami; Masakazu Kanzawa KT; Kazuro Sugimura MD, PhD *

PURPOSE
To directly compare the capability for radiation dose reduction on dynamic chest perfusion area-detector CT (ADCT) aiming lung and nodule perfusion assessments between adaptive iterative dose reduction using 3D processing (AIDR 3D) and filter back projection (FBP) methods.

METHOD AND MATERIALS
36 consecutive patients (25 male, 11 female; mean age 75 years) with 36 nodules underwent standard-dose perfusion ADCT (SDCT) using the following parameters: 320×0.5 mm collimation, 80kVp, 120mA, and 0.5 sec gantry rotation time. From SDCT raw data, low-dose perfusion ADCTs (LDCTs) at 80mA, 60mA and 40mA were computationally simulated. Then, SDCT and each LDCT were reconstructed by AIDR 3D and FBP methods. From each CT data, perfusion map was computationally generated. Then, image noises of lung parenchyma and nodule, lung and nodule perfusions were evaluated by ROI measurements. To determine the utility of AIDR 3D for radiation dose reduction, both image noises and perfusion parameters from all CT data were statistically compared each other by using Tukey's HSD test. Correlations of both perfusion parameters were evaluated between SDCT and others. Finally, to assess the radiation dose reduction capability between two methods, the limits of agreements (mean±1.96×standard deviation) of each parameter between SDCT and others was assessed by using Bland-Altman analysis.

RESULTS
When applied AIDR 3D, image noises of LDCTs at 80mA and 60mA were significantly lower than those by FBP (p CONCLUSION
AIDR 3D method has better potential for radiation dose reduction of chest perfusion ADCT than FBP method in routine clinical practice.

CLINICAL RELEVANCE/APPLICATION
When compared with FBP method, AIDR 3D method has better potential for radiation dose reduction of perfusion ADCT for lung and nodule perfusion assessments in routine clinical practice.

SSQ04-03 • Breast Dose Reduction during Thoracic CT: Comparison between Shielding and Low Kilovoltage for Various Breast Thicknesses

Marie-Pierre Revel (Presenter); Isabelle Fitton; Etienne Audureau; Marie Laure Chabi; Pascal Rousset MD
To compare breast dose and image noise on CT acquisitions performed with low kilovoltage or bismuth shielding, on a phantom study with different prosthetic breast thicknesses.

METHOD AND MATERIALS

Phantom study with 3 different breast thicknesses, defined as the distance perpendicular to the breast tangency line. Five consecutive 64-detector CT acquisitions (Light-speed VCT, GE) performed for each breast thickness at 120 kVp (reference acquisition), then at 100 kVp and 120kVp with shielding. Breast dose measured using two Optically Stimulated Luminescence Dosimeters (OSLD) placed both superficially and deep within the prosthetic breast. CT number standard deviation measured within 4 central ROIs at increasing depths for image noise evaluation.

RESULTS

Intraclass correlation coefficient for dose measurements was 0.825 [95%CI: 0.726 ; 0.923]

Considering all breast thicknesses, averaged breast dose (mean of superficial and deep measurements) was reduced by 42.1 % with shielding, compared to 33.0% at 100 kVp (p=0.009). Noise increase within the 2 deepest ROIs was less with shielding (19.0% vs 32.1%, p<0.03). For 1cm- breast thickness, breast dose was reduced by 46.5% and 29.7% (p=0.01) and in-depth noise increased by 19.5 % and 33.9 % (p=0.001) with shielding or at 100 kV, respectively. For 4cm- breast thickness, breast dose was reduced by 40.6% and 40.5% (p=0.95) and in-depth noise increased by 20.7% and 29.2% (p=0.02) (with shielding or at 100 kV, respectively).

CONCLUSION

For small breast thicknesses, breast dose reduction is greater with shielding. Shielding systematically provides less in-depth noise increase.

CLINICAL RELEVANCE/APPLICATION

For an equivalent or greater breast dose reduction, shielding provides less in-depth noise increase than the 100kVp option for CT acquisitions performed on GE equipments.
We recommend the same phantom test comparing the two directions, when chest CT scan program is set up in a machine. CLINICAL RELEVANCE/APPLICATION

10% in the four tested machines. With the same other scan parameters, craniocaudal scanning had consistently higher radiation dose than caudocranial scanning by up to two directions. The difference in DLP between the two directions was measured in terms of (craniocaudal DLP - caudocranial DLP).

For the four phantoms, the percentage difference in DLP ranged 8.6%-10.5%, 10.3%-10.8% 5.4%-7.4%, and 5.2%-6.4% for the GE, Toshiba, Siemens, and Philips machines, respectively. No notable difference was found in the overall image quality between the scanners. For the four phantoms, the percentage difference in DLP ranged 8.6%-10.5%, 10.3%-10.8% 5.4%-7.4%, and 5.2%-6.4% for the GE, Toshiba, Siemens, and Philips machines, respectively. No notable difference was found in the overall image quality between the scanners. For the four phantoms, the percentage difference in DLP ranged 8.6%-10.5%, 10.3%-10.8% 5.4%-7.4%, and 5.2%-6.4% for the GE, Toshiba, Siemens, and Philips machines, respectively. No notable difference was found in the overall image quality between the scanners.
METHOD AND MATERIALS
In two academic centers from the US and Europe, data were collected from 532 clinical thoracic CT examinations performed in women aged 17 to 95 years (498 supine and 34 prone scans. US=332, Europe=200). Inner and outer limits of breast tissue were determined by measuring their angles with respect to the isocenter of the gantry rotation. The percentage of women with breast tissue within and without the zone of decreased radiation.

RESULTS
In supine position, mean angles of external and of internal breasts limits were 79° (range, 75° to 86°) and 29° (range, 19° to 37°) for both breasts. In prone position, these angles were 66° (range, 62° to 70°) and 21° (range, 19° to 25°). In supine and prone position, respectively, 99% and 82% of women had at least one external breast limit in the increased dose zone. 14% of patients in supine position had their entire breasts in the increased dose zone. Increasing patient age was associated with increasing thoracic dimensions and with an increasingly lateral position of the breasts (r = 0.198 to 0.334).

CONCLUSION
In supine and in prone positions, respectively, 99% and 80% of women will have at least one breast in the zone of increased dose, as determined by OMBTC.

CLINICAL RELEVANCE/APPLICATION
Because most breasts are at least in their external part exposed to higher tube current, OMBTC may increase rather than decrease the radiation dose to the breast.

Emergency Radiology (Imaging Abdominal Emergencies)

Thursday, 10:30 AM - 12:00 PM • N226

SSQ05-01: Sonography of the Borderline Appendix: A Closer Look

Jason D Oppenheimer MD (Presenter) ; Rupesh H Kalthia MD ; Eric W Olcott MD ; R. Brooke Jeffrey MD *

PURPOSE
Some authorities diagnose appendicitis on ultrasound with an outer diameter criterion of >6 mm while others use a criterion of >7 mm. We evaluated the potential utility of secondary findings including hyperemia and hyperechoic fat in the diagnosis of patients whose appendices measured between 6 and 7 mm and thus were considered borderline by size criteria.

METHOD AND MATERIALS
We retrospectively reviewed 3,506 consecutive ultrasound examinations for suspected appendicitis in patients who presented to the emergency department at a tertiary care center over a 5-year period, with HIPAA and IRB compliance. Three radiologists blinded to final diagnoses identified 98 sonograms with non-compressible 6 to 7 mm diameter appendices and evaluated them for secondary findings of appendicitis including hyperemia, hyperechoic fat, loss of the submucosal layer echo, periappendiceal fluid and appendicoliths. Hyperechoic fat was defined as increased periappendiceal echogenicity greater than 1 cm in diameter. Fisher’s exact test and linear regression were used to compare secondary findings with final diagnoses made by surgical pathologic examination.

RESULTS
From 2007-2012, 98 ultrasound demonstrated appendices with diameters between 6 and 7 mm of which only 51 (52%) had appendicitis by surgical pathologic examination. Of the secondary signs in the 98 patients, hyperechoic fat had the highest individual positive predictive value and specificity for appendicitis (78% and 83%, respectively), which increased with the addition of hyperemia to 80% and 89%, respectively. Statistical modeling showed a linear direct correlation between the number of secondary signs present and values that increased to 100% in the presence of four secondary signs.

CONCLUSION
Hyperechoic fat and hyperemia increase the positive predictive value and specificity of sonography for appendicitis in patients with noncompressible appendices between 6 and 7 mm. Without secondary signs, a conservative approach should be followed as approximately half of such patients with borderline diameter appendices do not have appendicitis.

CLINICAL RELEVANCE/APPLICATION
Ultrasound reliably predicts appendicitis in borderline 6 to 7 mm diameter appendices when secondary characteristics are assessed.

SSQ05-02: Does Inclusion of Imaging in the Work Up of Patients with Clinically Suspected Appendicitis Reduce the Rate of Unnecessary Surgical Procedures?

Max Lahaye MD, PhD (Presenter) ; Doenja M Lambregts MD, PhD ; Eveline Mutsaers ; Alfonso Kessels ; Stephanie Breukink ; Regina G Beets-Tan MD, PhD

PURPOSE
Since February 2010 new Dutch guidelines have been implemented recommending the use of US or CT to confirm or refute clinically suspected appendicitis before (laparoscopic) surgery. For equivocal cases with US additional imaging (CT/MRI) is recommended. This study aimed to see whether these new guidelines lowered the percentage appendix sana.

METHOD AND MATERIALS
This retrospective study included all consecutive patients operated for clinically suspected appendicitis at our hospital from 2006 until 2013. The use of imaging (none versus US, CT and/or MRI) and its findings were recorded. Surgical and histopathological findings -where available- were notified. The primary study endpoint was the number of appendix sana before and after the guideline implementation.

RESULTS
745 patients were included, of which 475 were collected before the implementation of the guidelines and 270 after. During the pre-implementation period, 22.3% (106/475) of the patients received imaging focussed on the appendix. After implementation, 98.9% (267/270) of the patients received imaging before surgery. The average percentage of an appendix sana before the guidelines was 25% (119/475). After implementation, this average percentage dropped significantly to 5.9% (16/270), p < 0.001.

CONCLUSION
Use of preoperative imaging in all patients with suspected clinically appendicitis resulted in a significant reduction in the percentage of appendix sana. This suggests that the implementation of imaging in the work up of these patients could be an effective strategy to reduce the number of unnecessary surgeries.

CLINICAL RELEVANCE/APPLICATION
Preoperative imaging results in a significant reduction of unnecessary surgery and should thus be recommended for all patients clinically suspected for appendicitis.
SSQ05-03 • The Alvarado Score as a Method for Potentially Reducing the Number of Unnecessary CT Scans for Appendicitis When Appendiceal Ultrasound Fails to Visualize the Appendix

Robert Jones MD (Presenter) ; R. Brooke Jeffrey MD * ; Terry S Desser MD * ; Eric W Olcott MD

PURPOSE
To evaluate the Alvarado score as a means to reduce referrals to CT when ultrasound fails to visualize the appendix but is otherwise normal.

METHOD AND MATERIALS
With IRB and HIPAA compliance, 1241 consecutive appendiceal sonograms for suspected appendicitis were reviewed to yield 247 patients whose studies did not visualize the appendix but were otherwise normal and had CT within 48 hours. Of the 247 patients, 86 had Alvarado scores of 3 or less.

RESULTS
The incidence of appendicitis was 15.4% (38/247) for all 247 patients but less among the 86 with Alvarado scores of 3 or less, whether considering all 86 (2/86, 2.3%; p=0.001), females (0/59, 0%; P

CONCLUSION
Patients with non-visualization of the appendix and an Alvarado score of 3 or less are at particularly low risk for acute appendicitis and low risk for disorders requiring emergent surgery. Active clinical observation should be considered for them rather than direct referral to CT.

CLINICAL RELEVANCE/APPLICATION
Patients with non-visualization of the appendix but an otherwise normal ultrasound and an Alvarado score of 3 or less should be considered for active clinical observation rather than direct CT.

SSQ05-04 • Diagnosing Acute Appendicitis Using a Non-oral Contrast CT Protocol in Patients with a BMI of Less than 25

Vijay Ramalingam MD (Presenter) ; Jennifer W Uyeda MD ; David D Bates MD ; Kathy Zhao ; Marisa Roberts ; Lindsey Storer ; Jorge A Soto MD * ; Stephan W Anderson MD

PURPOSE
Evaluate the diagnostic accuracy and repeat CT scan rate for the diagnosis of appendicitis after the implementation of a non-oral contrast protocol in the Emergency Department setting in patients with a BMI of less than 25.

METHOD AND MATERIALS
This IRB approved study included 736 adult patients with a BMI of less than 25 over two 6 month time periods (August 2012- January 2013 and June 2008- November 2008) presenting to the ED with acute abdominal pain and a clinical suspicion of acute appendicitis. The earlier cohort underwent CT imaging with oral and intravenous contrast, per departmental protocol. The later cohort was imaged solely with intravenous contrast, per a modified departmental protocol. The electronic medical record was reviewed, recording the results of imaging reports, clinical outcomes, and surgical pathology results.

RESULTS
A total of 364 patients received a CT scan with the use of oral and intravenous contrast; there were 40 true positive cases of appendicitis and 1 false positive case. The sensitivity, specificity, PPV, and NPV for the diagnosis of appendicitis with both oral and intravenous contrast was 100 %, 99.7 %, 99.6 %, and 100 %, respectively. A total of 372 patients received the non-oral contrast, positive intravenous contrast protocol; there were 39 true positive cases of appendicitis and 1 false positive case of appendicitis resulting in a sensitivity, specificity, PPV, and NPV of 100 %, 99.7 %, 97.5 %, and 100 %, respectively. One scan was repeated with the use of oral contrast due to inadequate visualization of the appendix which was subsequently found to be negative for appendicitis.

CONCLUSION
Implementation of a non-oral contrast CT protocol in patients with a BMI of less than 25 demonstrates similar accuracy to a positive oral contrast protocol in patients with a BMI of less than 25 for the diagnosis of appendicitis.

CLINICAL RELEVANCE/APPLICATION
As ordering clinicians and emergency departments continue to seek ways to increase throughput, the continuing use of oral contrast in patients with smaller BMIs may no longer be needed.

SSQ05-05 • Improving the Role of CT in Diagnosing Complicated Appendicitis: Are there Occult Signs?

Mustafa Al Sultan MD (Presenter) ; Tarek Hegazi MBBS ; Caroline Reinhold MD, MSc ; Lawrence A Stein MD

PURPOSE
Retrospectively evaluate the accuracy of focal appendiceal wall enhancing defect and intra-luminal gas in predicting gangrenous and / or perforated appendicitis when not apparent on imaging in relation to surgical and pathological results.

METHOD AND MATERIALS
Patients with surgical / pathology-proven appendicitis who underwent preoperative IV contrast CT within 24 hours of surgical intervention over a 4-year period (n=187) were retrospectively reviewed. Variable clinical data and length of admission for each patient were also assessed. Two radiologists who were blinded from the clinical data and final surgical / pathology results assessed each scan for: diameter of appendix, intra- and extra-luminal appendicolith, intra- and extra-luminal gas, phlegmon, abscess, and focal enhancing wall defect. The results were compared against surgical and pathology findings and divided into 3 groups (perforated, gangrenous and simple). The perforated group was subsequently divided into 2 subgroups whether there was presence or absence of "classic CT" findings of perforated hollow viscus (i.e either / or abscess, extra-luminal gas, or extra-luminal appendicolith). Statistical significance, sensitivity and specificity for each finding were calculated. Interobserver agreement using kappa index was used for focal enhancing wall defect.

RESULTS
Simple, gangrenous and perforated appendicitis were present in 65.8%, 16% and 18.2% of the study cohort respectively. There was a good interobserver agreement (kappa = 0.78) for focal wall enhancing defect. Sensitivity and specificity of focal wall defect for diagnosing perforated appendicitis was 81.8% and 92.8% respectively, PPV = 71.0%, NPV = 95.9%. Sensitivity and specificity for Intraluminal gas was 45.3 % and 91.1% respectively, PPV = 72.5%, NPV = 76.2%.

CONCLUSION
"Classic CT signs" have been well-documented for diagnosis of perforated appendicitis, however, recognition of occult signs, as focal enhancing wall defect or intra-luminal gas in otherwise uncomplicated appendicitis at imaging increases suspicion of suggesting a perforated or gangrenous acute appendicitis.

CLINICAL RELEVANCE/APPLICATION
Focal wall defect and intra-luminal gas add more sensitive interpretation value in the diagnosis of image-occult complicated appendicitis and is recommended in routine evaluation of these cases.

SSQ05-06 • Low-tube-voltage High-pitch Dual-source Computed Tomography with Sonogram Affirmed Iterative Reconstruction Algorithm of the Abdomen and Pelvis: Initial Clinical Experience

Hao Sun MD (Presenter) ; Huadan Xue MD ; Zhengyu Jin MD ; Xuan Wang MD ; Yu Chen MD ; Yonglan He MD
METHOD AND MATERIALS
This institutional review board-approved prospective study included 64 patients who gave written informed consent for acquisition of additional abdominal and pelvic images on DSCT. The patients underwent standard CT scans (protocol 1) (tube voltage of 120kVp/pitch of 0.9/filtered back projection [FBP] reconstruction) followed by high-pitch CT scans (protocol 2) (100kVp/3.0/SAFIRE). The total scan time, mean CT number, signal to noise ratio (SNR), image quality, lesion detectability and radiation dose were compared between two protocols.

RESULTS
The total scan time of protocol 2 was less than that of protocol 1 (P=0.05). SNR on images of protocol 2 was higher than that of protocol 1 (all P < 0.05). SNR on images of protocol 2 was higher than that of protocol 1 (all P < 0.05).

CONCLUSION
The high-pitch DSCT with SAFIRE can reduce scan time and radiation dose while preserving image quality in abdominal and pelvic scans.

CLINICAL RELEVANCE/APPLICATION
The low-tube-voltage high-pitch DSCT with SAFIRE preserves good image quality, less scan time and radiation dose in routine abdominal and pelvic scans, especially useful in emergent patients.

SSQ05-07 • Simple or Solid? Prospective Clinical Evaluation of Iterative Reconstruction Using Dual-source Single-detector Reconstruction to Compare Renal Cyst Density on 50% Dose Images

Kris Lee MD (Presenter); Patrick McLaughlin FFRRCSI; Rekha Raju; Shamir Rai BSC; Sarah A Barrett MBCh; Charlotte J Yong-Hing MD, FRCPC; Alison C Harris MBChB; John R Mayo MD *; Savvas Nicolaou MD

PURPOSE
Many studies now demonstrate the utility of iterative reconstruction (IR) algorithms to generate acceptable abdominal CT images at lower radiation exposures than filtered back projection (FBP). In comparison there is a clear deficiency robust clinical studies examining the changes in appearance, density and conspicuity of pathology on low dose CT reconstructed with FBP and IR. The purpose of this study was to determine if the internal characteristics of renal hypodensities differed between 100% and 50% dose images generated using a dual source imaging protocol using FBP and IR.

METHOD AND MATERIALS
81 consecutive patients underwent contrast enhanced CT abdomen using a dual source 128-slice CT system (Definition FLASH; Siemens Healthcare, Germany). Raw data from detector A of the dual source (A+B) datasets was reconstructed to yield half dose images (AP50) using a validated technique. All images were reconstructed using FBP and a raw data based IR algorithm (SAFIRE). The size and mean hounsfield unit (HU) of renal hypodensities measuring greater than 1 cm was recorded on AP100-FBP, AP100-IR, AP50FBP and AP100-IR datasets. Hypodensities >20 HU were classified as solid and those between -20 HU and 20 HU was considered simple. AP100-IR images were chosen as the reference standard for the purposes of sensitivity and specificity analysis.

RESULTS

CONCLUSION
When compared to our chosen reference standard, 50% dose images reconstructed with FBP showed superior sensitivity and specificity to those reconstructed with IR for the correct classification of renal hypodensities.

CLINICAL RELEVANCE/APPLICATION
Approximately 20% of renal hypodensities are mischaracterized on the half dose images.

SSQ05-08 • Frequency of Previously Reported Ovarian Torsion Findings on Both Ultrasound and Computed Tomography

David W Swenson MD (Presenter); Ana P Lourenco MD; David J Grand MD

PURPOSE
Evaluate the frequency of imaging findings for ovarian torsion on ultrasound (US) and computed tomography (CT) studies performed in the emergency department (ED).

METHOD AND MATERIALS
20 adult females with surgically proven ovarian torsion underwent both pelvic US and CT between 3/1/2006 and 5/31/2010. Two radiologists reviewed all US and CT studies in consensus, measuring each torsed ovary in 3 axes, and grading each study for the presence or absence of the following previously described findings of torsion: (1) ovarian width >5cm, (2) ovarian volume > 20 mL, (3) ovarian stromal edema or marked heterogeneity, (4) numerous small peripheral follicles, (5) a twisted vascular pedicle or swirl sign, (6) small free fluid in the pelvis, (7) abnormal Doppler waveforms (US only), (8) para-ovarian fatty stranding (CT only), and (9) uterine deviation toward the torsed ovary.

RESULTS

CONCLUSION
An abnormally enlarged ovary is the most common finding of ovarian torsion on both US and CT. While US is often considered the optimal imaging modality for identifying torsion, in our series, CT was equal to or more successful than US in demonstrating most of the previously reported ancillary findings of torsion.

CLINICAL RELEVANCE/APPLICATION
Pelvic US is often described as the best imaging modality for evaluating ovarian torsion, however, CT may provide comparable diagnostic value and may be underappreciated in this regard.

SSQ05-09 • Diagnosing Acute Pancreatitis Using Attenuation Values in Patients with Unexplained Abdominal Pain, Apparently Normal CT Scans and Normal Serum Levels of Pancreatic Enzymes

Mahmood A Al Bahhar MD (Presenter); Soumia Senouci; Puskar Pattanayak MBBS, FRCR; Caroline Reinhold MD, MSc

PURPOSE
To evaluate the ability of pancreas CT attenuation values to diagnose acute pancreatitis in patients presenting with abdominal pain, normal serum levels of pancreatic enzymes, and no apparent CT scan finding to explain the patients’ pain.

METHOD AND MATERIALS
Out of 124 patients reviewed, 31 patients satisfied the inclusion criteria, including documented clinical suspicion of pancreatitis, three folds elevation of pancreatic enzymes and grade A or B pancreatitis by CT scan. Another 31 normal CT scans for trauma were included in the control group. The attenuation values, measured in Hounsfield Units (HU), of the spleen, aorta, portal vein and head, body and tail of the control group. The attenuation values, measured in Hounsfield Units (HU), of the spleen, aorta, portal vein and head, body and tail of the pancreas were not significantly different between the two groups.
the pancreas were measured in both arterial and portovenous phases for both cases and control groups. The threshold of the pancreatic attenuation and the pancreatic-splenic attenuation ratios for predicting acute pancreatitis were assessed with receiver operating characteristic curve analysis.

RESULTS
In both arterial and portovenous phases, there was statistically significant differences between the cases and control groups in regards to the attenuation values of the head and body of the pancreas. No such difference was seen in the tail. The mean HU of the pancreas was 76.04 HU in cases of pancreatitis, whereas in control cases it was 86.47 HU (p=0.05) ON PV phase. When considering the ratio between the pancreas and the spleen, the mean was 0.77 for patients and 0.88 for controls (p=0.02). A pancreatic-splenic ratio of 0.77 in the portovenous phase has a 76% positive predictive value (PPV) in diagnosing acute pancreatitis with a 85% specificity.

CONCLUSION
Our study demonstrates that when a patient presents with abdominal pain, normal pancreatic enzymes and no CT findings to explain the patient’s pain, a pancreatic-splenic attenuation ratio in the portovenous phase of 0.77 has a 76% PPV with a 85% specificity for diagnosis acute pancreatitis. These findings may allow a diagnosis of acute pancreatitis to be made in cases were early clinical and morphological imaging findings are non-diagnostic. This will help explain the cause of abdominal pain in some of patients and reduce the number of negative emergency CT scans.

CLINICAL RELEVANCE/APPLICATION
This finding may allow a diagnosis of acute pancreatitis to be made where early clinical, laboratory and morphological imaging findings are non-diagnostic, which could explain patient’s symptoms.

**SSQ06•GM**

**Assessment Based on Histopathologic Characterization**

Jeff L Fidler, MD *

**SSQ06-01**

**Gastrointestinal Keynote Speaker: Imaging of Crohns-Current Status and Future**

Jeff L Fidler MD (Presenter) *

**SSQ06-03**

**Evaluation of Dynamic Contrast Enhanced and Diffusion Weighted Imaging for Quantitative Crohn’s Disease Assessment Based on Histopathologic Characterization**

Jeroen Tielbeek MD (Presenter) ; Manon L Ziech MD ; Zhang Li ; Cristina Lavini DPhil ; Shandra Bipat MS ; Frans M Vos PhD ; Jaap Stoker MD, PhD *

**PURPOSE**
To prospectively compare conventional MRI, dynamic contrast-enhanced (DCE-)MRI and diffusion weighted imaging (DWI) sequences to histopathology of surgical specimens in Crohn’s disease (CD).

**METHOD AND MATERIALS**
3T MR enterography was performed in 25 consecutive CD patients scheduled for surgery within 4 weeks. A total of one to four sections per patient were chosen for detailed image analysis. Evaluated features including mural thickness, T1 signal ratio and T2 signal ratio and on DCE-MRI maximum enhancement (ME), initial slope of increase (ISI) and time to peak (TTP) and on DWI apparent diffusion coefficient (ADC), were compared to location matched-histopathologic grading of acute inflammation score (AIS) and fibrostenosis score (FS) by Spearman correlation, Kruskal Wallis and Mann-Whitney test.

**RESULTS**
Twenty patients (mean age 38 years, range 21-73, 12 females) were included and 50 bowel locations (35 terminal ileum, 11 ascending colon, 2 transverse colon, 2 descending colon) were matched to AIS and FS. Median AIS was 3 and median FS 1. Mural thickness, T1 signal ratio, T2 signal ratio, ME and ISI correlated significantly to AIS (r = 0.634, 0.392, 0.485, 0.526, 0.514, respectively; all p <0.01).

**CONCLUSION**
Quantitative parameters from conventional, DCE-MRI and DWI sequences correlate significantly to histopathologic scores of surgical specimens. DCE-MRI and DWI give comparable results but do not outperform conventional MRI parameters.

**CLINICAL RELEVANCE/APPLICATION**
DCE- and DWI-MRI can be used for quantitative evaluation of Crohn’s disease activity.

**SSQ06-04**

**Global Patient Assessment of Crohn’s Disease Severity: Is MaRIA Sufficient, or Does Length of Enteric Inflammation Matter?**

Benjamin D Spilseth MD (Presenter) ; Jeff L Fidler MD * ; David Bruining MD * ; Stephanie Hansel MD * ; William S Harmsen ; Jordi Rimola MD * ; David R Holmes PhD ; Alan Larson ; Shiva Pruthi ; Joel G Fletcher MD *

**PURPOSE**
The MaRIA score (MR Index of Activity) is a validated method for measuring the severity of Crohn’s disease enteric inflammation that is gaining widespread acceptance in the GI community, but does not take into account the length of enteric inflammation, which greatly impact patient function and disability. The purpose of our study was to determine if length of enteric inflammation improves the prediction of global and clinical Crohn’s disease severity scores compared to MaRIA alone.

**METHOD AND MATERIALS**
30 patients with known Crohn’s disease underwent MR enterography within 30 days of ileocolonoscopy. Using a dedicated computer workstation, five colonic segments and 3 small bowel segments were systematically evaluated by two radiologists, who measured the MaRIA score and length of enteric inflammation using semi-automated tools for all inflamed bowel segments. A global physician score (GPS) of Crohn’s disease severity (ranging from 0-3) was created by a panel of gastroenterologists using ileocolonoscopy records, biopsy results, imaging reports, Harvey-Bradshaw index (HBI) scores, and C-reactive protein (CRP) was used as a reference standard.

**RESULTS**
For each reader, both MaRIA scores and lengths of enteric inflammation were significantly correlated with GPS (p < 0.0001), CRP (p <0.0001).

**CONCLUSION**
Excellent correlation exists between global and clinical markers of Crohn’s disease severity and MaRIA scores and measured lengths of enteric inflammation. Because MaRIA scores are highly correlated with length of enteric inflammation, neither was independently predictive of global physician score for both readers in this small cohort. In larger patient cohorts, incorporation of length measurement will likely be useful in a future quantitative model.
SSQ06-05 • Diffusion-weighted MR Enterography for Evaluating Crohn’s Disease Activity: A Blinded Prospective Study of Diagnostic Performance Using Stratified Endoscopic Severity as the Reference Standard

Yedeaun Lee MD (Presenter) ; Seong Ho Park MD * ; Kyung Jo Kim ; Bo-Kyeyong Kang MD ; So Yeon Kim ; Seung Soo Lee MD

PURPOSE
To prospectively determine the performance of diffusion-weighted (DW) MR enterography (MRE) for evaluating bowel inflammation of Crohn’s disease

METHOD AND MATERIALS
17 men and 5 women with Crohn’s disease (mean age, 29.5 years) underwent conventional contrast-enhanced (CE) MRE and DW-MRE at b=900 s/mm² on a 3T system and ileocolonoscopy as the reference standard within 1-week interval. For precise location-by-location match between MRE and endoscopy, the terminal ileum, cecum and ascending colon, and rectum were only analyzed. CE-MRE and DW-MRE were reviewed independently blinded to each other except that the bowel segments were evaluated were pre-marked on DW-MRE by a third person given the lack of anatomical details on DW images. Hyperintensity of the bowel wall on DW-MRE comparable to the signal of mesenteric lymph nodes or the spleen (in the absence of lymph nodes); and presence of mural hyperenhancement, stricture, or T2 hyperintensity, perienteric infiltration, or comb sign on CE-MRE were considered positive findings. Endoscopic findings were stratified into 4 groups: normal or healed lesion (i.e. inactive) and three degrees of bowel inflammation including erythema/edema only, aphthoid lesions only, and overt ulcers. The sensitivity and specificity of DW-MRE and CE-MRE were compared.

RESULTS
A total of 64 bowel segments (22 with ulcers, 14 with aphthoid lesions, 2 with erythema/edema, and 26 inactive) were included. DW-MRE sensitivity was 86.4 (19/22), 57.1 (8/14), and 0% (0/2) for ulcers, aphthoid lesions, and erythema/edema, respectively, while the sensitivity of CE-MRE was 90.9 (20/22), 14.3 (2/14), and 0% (0/2), respectively, demonstrating no significant difference for ulcers albeit higher sensitivity in DW-MRE for all active lesions (71.1 vs. 57.9%). DW-MRE specificity (46.2% [12/26]) was significantly lower compared with CE-MRE (100% [26/26]). False-positive DW-MRE results occurred mostly in the colon (13/14) and was largely associated with undistended bowel (11/14).

CONCLUSION
DW-MRE was more sensitive than CE-MRE for non-ulcerative active bowel lesions but was less specific for excluding active inflammation, generating a high rate of false positives presumably related to undistended bowel.

SSQ06-06 • Does Abdominal Ultrasound Show Equivalence to Computed Tomography and Magnetic Resonance Enterography in Predicting Active Crohn Disease and Complications?

Saima Batool MBBS ; Aman Wadhwan BSC (Presenter) ; Kerri Novak MD * ; Stephanie R Wilson MD *

PURPOSE
To show the equivalence of abdominal ultrasound (US) with computed tomography (CT) or magnetic resonance enterography (MRE) /CTE, as gold standard imaging (GSI), in predicting active disease and intestinal complications in patients with crohn disease (CD).

METHOD AND MATERIALS
This retrospective review of 210 patients with CD compares US with temporally performed CT (n=70) or CTE (n=75)/MRE (n=65). Two independent reviewers, blinded to the final pathology, reviewed image files of all modalities for active disease predicted on the basis of wall thickening, hyperemia, and presence of mesenteric inflammatory fat. Complications were predicted based on their familiar morphologic appearances. Sensitivity (SN), specificity (SP), positive predictive value (PPV), negative predictive value (NPV), and accuracy (ACC) for active disease and complications visualized with US were calculated. In each instance, the advantages and disadvantages afforded by US relative to other modalities were documented.

RESULTS
In this selected population, a majority presented to Emergency with acute complications. A total of 138 patients had thick bowel, inflammatory fat, and hyperemia on GSI, with agreement on US in 134 (SN 97%, SP 95.8%, PPV 98.5%, NPV 92% and ACC 96.7%). Complications were present on US in 118/210 patients. Cumulative US interpretation correctly diagnosed these complications in 105/118 (SN 92.1 %, SP 95.8%, PPV 96.3% and NPV 92% and ACC 96.7%). Although fistulae and strictured segments were shown with equivalence between modalities (n=84), US has an advantage to suggest incomplete mechanical bowel obstruction on the basis of dysfunctional peristalsis and fixed bowel angulations. Localized perforations with phlegmons were more confidently identified with US although deep positioned abscess with large quantities of gas may be shown with superiority on CT scan. MR was superior for prediction of bowel wall edema and mucosal ulceration although the difference in determination of active disease between US and MR was inconsequential.

CONCLUSION
In our study US showed equivalent ability to predict active disease and a wide range of clinical complications, equal to and at times superior to that of either CT or CTE/MRE.

SSQ06-07 • Visualization of Bowel Motility Disorders in Patients with Inflammatory Bowel Disease by Development of an Automated Color-coding Algorithm in Cine MRI

Maria L Hahnemann MD (Presenter) ; Felix Nensa MD ; Sonja Kinner MD ; Guido Gerken ; Thomas C Lauenstein MD

PURPOSE
The aim of this study was to establish an automated algorithm for visualizing and quantifying bowel motion disorders in cine MRI.

METHOD AND MATERIALS
Thirty patients with suspected or diagnosed inflammatory bowel disease underwent MR examination on a 1.5T scanner (Avanto, Siemens). In addition to the standard MR enterography protocol, coronal T2-weighted cine MR images were acquired with a temporal resolution of 4.5s continuously over a time span of 150s. After affine 2D respiratory motion correction, bowel motility was estimated from cine MRI using an optical flow algorithm and the resulting motion vector magnitudes were color-coded into bowel motility maps.

RESULTS
The acquisition of color-coded maps of bowel motility was feasible in all 30 patients. Increased or decreased bowel movement visualized by motility-mapping allowed for the detection of segments of abnormal bowel motility. Particularly, inflamed bowel segments exhibited a decreased motility.

CONCLUSION
Color-coded motility mapping in T2w cine MRI is a feasible and promising new approach for the assessment of bowel motility disorders. In future, this method may improve the detection of pathological conditions or abnormalities in bowel segments without or with only subtle signs of inflammation on morphologic images.

CLINICAL RELEVANCE/APPLICATION
This new technology may help to increase diagnostic accuracy for the depiction of inflamed bowel segments.

SSQ06-08 • Pre-obstructive Changes in Small Bowel Motility in Strictureing Crohn’s Disease Appear Reversible on Investigation with MRE

Alex Menys (Presenter) ; Emma Helbren MBCh, FRCR ; Jessica Makanyanga ; David Atkinson ; Alistair Forbes ; Al Windsor ; Steve Halligan MD ; Stuart A Taylor MBBS

PURPOSE
To examine whether abnormal motility in pre-obstructive, dilated bowel is reversible.

METHOD AND MATERIALS
21 patients with strictureing Crohn’s disease (9 Male, mean age 31) undergoing two 1.5T MR enterography (MRE) examinations (mean 14 months apart), were retrospectively identified. Multiple True FISP coronal motility sequences were acquired during 20 second breath-holds (1 slice/0.8sec, TR 4ms, TE 1.7ms, slice thickness 10mm) to encompass the small bowel volume. On each of the two scans, a radiologist (5 years experience) placed an ROI in the dilated small bowel immediately upstream of the stricture, and in normal bowel remote from the diseased area. Using validated motility analysis software, measurements of small bowel motility (s.d of the pixel Jacobean determinant) and maximum diameter were made. The percent change in bowel diameter and motility between the two scans was calculated for each ROI position and analysed using Spearman’s Rho.

RESULTS
The mean percentage change in pre-structure bowel diameter and motility was -7% (range -70 to +65%) and -58% (range -625% to +89%) respectively. There was a negative correlation between the percentage change in diameter and motility (Spearman’s Rho coefficient -0.6, P = 0.007) i.e. as the diameter decreased, motility increased. There was no such correlation between diameter (mean change 3%, range -35% to 36%) and motility (mean change 11%, range -85% and 28%) in normal bowel (Spearman’s Rho 0.08, P = 0.94).

CONCLUSION
Motility changes in pre-stricture dilated bowel are fluid over time and different from normal bowel. As the bowel diameter decreases, motility increases and vice versa.

CLINICAL RELEVANCE/APPLICATION
Medical management could be favourable over surgery in some instances. Loss of function in the small bowel is potentially reversible.

SSQ06-09 • Comparison of Bismuth, Tungsten, and Tantalum Enteric Contrast Agents to Complement Iodine for Double Contrast Dual-energy CT Enterography

Samira Rathnayake (Presenter) ; John Mongan MD, PhD * ; Yanjun Fu PhD ; Andrew S Torres PhD * ; Dongwei Gao MD ; Margaret J Wong MENG, BS ; Wilbur Wang BA ; Benjamin M Yeh MD *

PURPOSE
To investigate the effectiveness of double contrast DECT obtained with iodinated intravenous and non-iodinated enteric contrast for small bowel wall and vasculature visualization, compared with conventional CT.

METHOD AND MATERIALS
Thirteen rabbits were imaged on a rapid kVp switching CT scanner with intravenous iohexol and an experimental positive enteric contrast agent: bismuth subsalicylate (n=5), tungsten oxide (n=4), or tantalum oxide (n=4). These enteric agents can be separated from iodine at DECT due to their relative high and low x-ray attenuation coefficients. DECT iodine-only density maps and conventional CT images were obtained from the thirteen studies to generate 94 pairs of small bowel and 34 pairs of vasculature image comparisons. Four sub-specialty trained abdominal imaging attending radiologists without prior DECT experience in independently viewed each comparison to record relative clarity of small bowel wall and abdominopelvic vasculature and completeness of enteric contrast subtraction using a visual analog scale (0%=contrast materials not distinguished to 100%=perfect separation). Significance of differences was determined by t-tests.

RESULTS
Small bowel wall was observed to be 44% (95% CI: 34%-47%, p value not stated) more clearly visualized at DECT due to their relative high and low x-ray attenuation coefficients. DECT iodine-only maps obtained with a tungsten- or tantalum-based enteric contrast agent were clearer than with a bismuth-based enteric agent.

CONCLUSION
Small bowel wall was observed to be 44% (95% CI: 34%-47%, p value not stated) more clearly visualized at DECT due to their relative high and low x-ray attenuation coefficients. DECT iodine-only maps obtained with a tungsten- or tantalum-based enteric contrast agent were clearer than with a bismuth-based enteric agent.

CLINICAL RELEVANCE/APPLICATION
Development of tantalum or tungsten enteric agents should enable clearer bowel wall and abdominopelvic vasculature visualization for double contrast DECT than conventional CT.
hematomas and 298 metastatic carcinomas) in 176 patients, noting tumor and ablation volumes, abutting vessels >3mm, procedure complications and recurrences. Complications were graded by the National Institutes of Health, Common Terminology of Complications and Adverse Events (CTCAE). Stress dose(s) of steroids were used in more recent procedures (n=68), which also limited ablation volume per session. Patients received CT or MRI at 1, 3, 6, 12, 18, 24 months and yearly thereafter.

RESULTS
All patients required only conscious sedation. Ablation zones and tumors averaged 5.2 and 2.9 cm, respectively. A total local recurrence rate of 9.8% (35/357) was noted. Differences in local recurrence rates showed no significance based on tumor size or vessel proximity for metastatic or HCC tumors. Grade >3 complications were associated with larger ablation volumes (>100cc margin) in earlier procedures and before steroid prophylaxis. A total of 25% patients also had low hemoglobin or platelets blood values prior to procedure yet still resulted in only 11/268 (4.1%) grade =3 total complications, again early in our series.

CONCLUSION
CT guided percutaneous hepatic cryotherapy provides a low morbidity alternative, especially for more central and peripheral tumors, where cryoablation produces minimal biliary damage and pain, respectively. Complications =3 did not occur in patients with tumors

CLINICAL RELEVANCE/APPLICATION
Appropriately delivered liver cryoablation, appears less susceptible to tumor size and peri-vascular location, with low recurrence rates, and now complication rates comparable to heat-based ablations.

SSQ07-02  •  Fusion Imaging-guided Percutaneous Radiofrequency Ablation of Hepatocellular Carcinomas with Local Tumor Progression

Jihye Min MD (Presenter) ; Min Woo Lee ; Hyunchul Rhim MD, PhD ; Sanghyeok Lim MD ; Tae Wook Kang MD ; Kyoung Doo Song MD ; Seo-Youn Choi MD ; Hyo Keun Lim MD

PURPOSE
To assess whether fusion imaging of real-time ultrasonography (US) with liver CT/ MR images for planning US of radiofrequency ablation (RFA) can improve conspicuity of lesions and reduce false positive detection of hepatocellular carcinomas (HCCs) with local tumor progression (LTP).

METHOD AND MATERIALS
This retrospective study was approved by the institutional review board and informed consent was waived. A total of 50 patients with at least one HCC with LTP (mean ± SD, 1.5 ± 0.6 cm; range, 0.5-3.0 cm) after prior RFA or chemoembolization were included. Planning US was performed by two radiologists using conventional US first and fusion imaging later in the same session. We assessed false positive detection rate on conventional US based on the results of fusion imaging. We also evaluated how many cases of initially invisible tumors on conventional US became visible after image fusion. True positive detection rate and conspicuity scores of the index tumors were compared between conventional US and fusion imaging.

RESULTS
On conventional US, 40 (80%) out of 50 HCCs with LTP were identified. However, false positive detection rate of conventional US was 12.5 % (5/40). Out of 10 initially invisible HCCs with LTP on conventional US, 6 (60%) became visible after image fusion. True positive detection rate on conventional US was 70% (35/50) whereas it was increased to 92% (46/50) after image fusion (P=0.0026).

CONCLUSION
Fusion imaging of real-time US with liver CT/ MR images can improve conspicuity of lesions and reduce false positive detection of HCCs with LTP.

CLINICAL RELEVANCE/APPLICATION
Fusion imaging of US and liver CT/ MR images is useful for guidance of percutaneous RFA of HCCs with LTP. It can improve the lesion conspicuity and decrease the rate of false positive detection.

SSQ07-03  •  The Diagnostic Accuracy of Dual Energy CT Performed within 24 Hours in the Detection of Residual Tumor Following RF Ablation

Steven Van Hedent MD (Presenter) ; Frederik Vandenbroucke MD ; Nico Buls DSc, PhD * ; Koennaad H Nieboer MD * ; Michel De Maeseneer MD ; Johan De Mey * ; Gert Van Gompel PhD

PURPOSE
To evaluate the diagnostic accuracy of single source dual energy CT (DECT) performed within 24 hours after RF ablation in the detection of residual tumor.

METHOD AND MATERIALS
Thirty-three patients with 38 malignant lesions (20 liver, 10 kidney, 8 lung) underwent DECT within 24 hours after RF ablation. DECT data were reconstructed as monochromatic 70 keV images, grayscale iodine (GI) density and color-coded iodine (CCI) density images. Two readers independently rated the presence of residual tumor. The gold standard for presence of residual tumor consisted of follow-up imaging after 8-10 weeks. Statistical analysis consisted of ROC analysis (multicase, multireader). A Bland-Altman plot was used to compare reader agreement and a t-test was performed to assess the significance of these results.

RESULTS
Ten of 38 (26.3%) lesions showed tumor progression at 8-10 weeks. The mean AUC for both readers and all lesions was 0.87 (CI: 0.72-0.96) for 70keV, 0.80 (CI: 0.63-0.91) for CCI and 0.70 (CI: 0.53-0.84) for GI images. Pairwise comparison for the 3 reconstructions showed no significant differences, but interreader variability was high for all three reconstructions (P for liver and lung lesions AUC values were higher on 70 keV images (0.89 and 0.88 respectively), than on CCI (0.81 and 0.69) and GI images (0.78 and 0.59). Pairwise comparison showed no significant differences (P>0.05).

CONCLUSION
1.DECT may be a promising method for detection of residual tumor within 24 h after RF ablation.
2. Our study suggests that no difference in accuracy exists between monochromatic 70 keV images, GI, and CCI.

CLINICAL RELEVANCE/APPLICATION
Detection of residual tumor after RF ablation is clinically important, and DECT may play a role in this setting.

SSQ07-04  •  Clinical Implications of Negative and Inconclusive Percutaneous Ultrasound-guided Biopsy of Focal Liver Lesions

Jason A Pietryga MD (Presenter) ; Alison J Kim MD ; Rendon C Nelson MD *

PURPOSE
To describe our clinical experience with ultrasound-guided biopsies of focal liver lesions and to determine if small lesion size (=3cm), patient body habitus, or history of cirrhosis affect the rate of inconclusive/negative biopsy results.

METHOD AND MATERIALS
This is an IRB-approved HIPAA-compliant study. A retrospective search identified 283 consecutive adults who underwent US-guided biopsy of a focal liver lesion with pathology results from 1/1/2011 to 7/31/2012. Medical records/PACS were reviewed to identify the lesion sizes, patients BMI, history of cirrhosis and prior malignancy, and biopsy results. Rates of inconclusive/negative biopsy results were compared between patients with lesions =3 vs. >3cm, obesity vs. no obesity, and cirrhosis vs. noncirrhosis. Correlation of results with history of prior malignancy was also performed. Statistical analysis of the comparisons was performed using a Fisher’s exact test with a p-value < 0.05 deemed significant.
RESULTS
15.5% (44/283) of the biopsies had inconclusive/negative results. 25% (11/44) of these patients went on to rebiopsy or excision of which 45% (5/11) were diagnostic of malignancy. 19.0% (29/153) of lesions = 3cm had inconclusive/negative results vs. 9.4% (124/1353) of lesions >3cm (p=0.02). 21.4% (18/84) of obese patients had inconclusive/negative results vs. 13.1% (23/176) of nonobese patients (p=0.063). 52.9% (9/17) of cirrhotic patients had inconclusive/negative results vs. 13.2% (35/266) of noncirrhotic patients. 20.7% (21/197) of patients with a known cancer were diagnosed with a new additional cancer (i.e. new primary).

CONCLUSION
A minority (15.5%) of patients who underwent US-guided biopsy of a focal liver lesion had inconclusive or negative results. Having a lesion >3cm or a history of cirrhosis increases the rate of inconclusive/ nondiagnostic results. Obesity may increase the rate of inconclusive or negative results. A significant minority of liver lesions in a patient with a known cancer represent disease from a new primary.

CLINICAL RELEVANCE/APPLICATION
A negative or inconclusive biopsy of either a small liver lesion or a lesion in a patient with cirrhosis should undergo further work-up as it is associated with a significant false negative rate.

SSQ07-05 • Usefulness of a Second Biopsy after a First Inconclusive One for the Diagnosis of Small Hepatocellular Carcinoma in Cirrhotic Patients

Christophe Aube MD, PhD *; Frederic Oberti MD; Benoît P Gallix MD; Olivier Seror; Aurore Caumont-Prim MSc; Valerie Vilgrain MD (Presenter)

PURPOSE
When radiological hallmarks of hepatocellular carcinoma (HCC) as defined by EASL-EORTC Clinical Practice Guidelines are not seen on imaging, biopsy of nodule larger than 1cm is recommended. The goal of our study was to determine the usefulness of a second biopsy when the first one is inconclusive.

METHOD AND MATERIALS
In a multicenter prospective study of 430 cirrhotic patients with nodules < 3 cm detected during surveillance, 152 patients (mean age = 61.95 +/- 8.86 years) with 165 nodules had a percutaneous biopsy of a nodule and adjacent liver using 18G-cutting needles. When the first biopsy was inconclusive (no pathologic diagnosis of nodules), a second biopsy was proposed.

RESULTS
The mean diameter of the nodules was 19.4 +/- 5.7 mm. At first biopsy, the diagnosis was HCC, dysplastic nodule and regenerative nodule in 105 (63.6%), 6 (3.6%) and 10 (6.1%), respectively. No lesion was found at pathology in 43 (26.1%) nodules. 17 (39.5%) of the nodules underwent a second biopsy after a first negative one. The mean diameter of nodules was 18.3 +/- 4.4 mm. At second biopsy, the diagnosis was HCC and dysplastic nodule in 12 (70.6%), and 2 (11.8%), respectively.

CONCLUSION
When a first biopsy of a small nodule developed on cirrhosis is inconclusive, a second biopsy is useful and rules in a diagnosis of HCC in more than 70% of HCCs that have been missed at the first biopsy.

CLINICAL RELEVANCE/APPLICATION
When a biopsy is required to confirm the diagnosis of a small HCC in cirrhotic patients, a second biopsy should be performed when the first one is inconclusive.

SSQ07-06 • Coagulation Profiles: Can We Safely Relax the INR and Platelet Parameters for Image-guided Percutaneous Liver Biopsy?

Doug R Kitchin MD (Presenter); Lucas Ludeman MD; J. Louis Hinshaw MD *

PURPOSE

METHOD AND MATERIALS
There was no significant difference in the laboratory profiles of the patients biopsied before guideline relaxation from those after (INR 1.08 ± 0.18, plt 213K ± 94K before; INR 1.07 ± 0.18, plt 221K ± 94K after), nor was there a change in hemorrhagic complication rate (1.9% vs 1.9%) or preprocedural platelet administration (4.2% before vs 1.0% after; p=0.0015). When categorizing patients on the basis of INR and platelet level alone, there was a significant increase in hemorrhagic complications in patients with INR>1.5 (12% vs 1.9%; p=0.003) and platelets< 25,000/uL (13.3% vs 1.9%; p=0.008). However, patients with INR levels initially greater than 1.5 who received FFP and were corrected (INR 1.46 ± 0.07) had a similar hemorrhagic complication rate (11.1%) as those whose INR levels were not corrected (INR 1.9 ± 0.33, 15.4%).

CONCLUSION
Based upon a review of the literature, we changed our coagulation guidelines for percutaneous liver biopsy to INR<1.5 (12% vs 1.9%; p=0.003) and platelets< 25,000/uL (13.3% vs 1.9%; p=0.008). However, patients with INR levels initially greater than 1.5 who received FFP and were corrected (INR 1.46 ± 0.07) had a similar hemorrhagic complication rate (11.1%) as those whose INR levels were not corrected (INR 1.9 ± 0.33, 15.4%).

CLINICAL RELEVANCE/APPLICATION
More relaxed coagulation guidelines result in decreased FFP administration and, while patients with INR>1.5 and platelets...

SSQ07-07 • CT-guided Percutaneous Drainage versus Surgical Repair of Gastrointestinal Anastomotic Leaks: Is There a Difference in Hospital Course or Overall Treatment Cost?

Lauren M Burke MD (Presenter); Mustafa R Bashir MD *; Carly S Gardner MD; Arthur A Parsee MD; Daniele Marin MD; David P Vermess MD; Syamal D Bhattacharya; Tracy A Jaffe MD

PURPOSE
To identify differences in hospital course and overall treatment cost when comparing CT-guided percutaneous drainage with open surgical repair for gastrointestinal anastomotic leaks.

METHOD AND MATERIALS

RESULTS
144 patients had radiographic evidence of a gastrointestinal anastomotic leak (esophageal, gastric, small or large bowel). 54 patients underwent surgical repair of their anastomotic leaks; 9 were excluded due to leak confidence scores.

CONCLUSION
Gastrointestinal anastomotic leaks managed by percutaneous drainage are associated with lower overall cost and shorter hospital stays compared with open surgical management.

CLINICAL RELEVANCE/APPLICATION
Evidence supporting the use of percutaneous CT-guided drainage for gastrointestinal anastomotic leaks over open surgical management.

SSQ07-08 • Fluoroscopically-guided Jejunal Extension Tube Placement through an Existing Gastrostomy Tube in Patients Requiring Nutrition beyond the Ligament of Treitz: Analysis of 391 Procedures Performed over 3 Years

Fluoroscopically-guided Jejunal Extension Tube Placement through an Existing Gastrostomy Tube in Patients

RESULTS
The procedure was well tolerated by all patients and was performed successfully in all cases. The median duration of the procedure was 30 minutes (range: 15-60 minutes). There were no procedure-related complications or hospital readmissions within 30 days after the procedure. The mean follow-up duration was 3 months (range: 1-6 months). No cases of tube dislodgement, leak, or infection were reported during follow-up.
PurPOSE
To evaluate outcomes of fluoroscopic placement of a jejunal admittance (J-arm) in patients with an already existing gastrostomy (G) tube.

METHOD AND MATERIALS
Retrospective review of 391 J-arm placements over a 3-year period was performed in 174 patients requiring nutrition post ligament of Treitz [M/F 94/80, age range 1-89 y (mean 55.9 y)]. IRB approval and HIPAA compliance were maintained. Indications for jejunal nutrition were aspiration risk (35%), pancreatitis (17%), gastroparesis (13%), gastric outlet obstruction/mass/leak (12%) and other (23%). Technical success, procedure-related complications, tube malfunction rate and tube patency were assessed. G-tube location, J-arm course and fluoroscopic time were correlated for success/failure. Full and partial technical success were defined as J-arm tip placement at or beyond the ligament of Treitz, and between the pylorus and ligament, respectively. Failure was inability to advance the tip out of the stomach. Procedure-related complications were periprocedural adverse events related to tube placement occurring within 7 days. Tube malfunction was defined as coiling/kinking/clogging and inadvertent removal requiring replacement.

RESULTS
Tube placement was successful in 303/391 (78%). Complications occurred in 3 (0.8%) (1 perforation (0.27%), 1 hematoma (0.27%), 1 hypotension (0.27%). Malfunction occurred in 197 (50%). Overall patency was 51 days (95%CI:[42,58 days]) following placement. There was no association between successful J-arm placement and G-tube position in the stomach (p=0.677) or indication for jejunal nutrition (p=0.349); between J-arm trajectory in the stomach and incidence of tube malfunction (p=0.365); and between risk of coiling/kinking in the stomach and G-tube position (p=0.173) or J-arm length (p=0.987). Fluoroscopy time placement was negatively associated with procedure success (p=0.01).

CONCLUSION
Fluoroscopic guided J-arm placement was safe, with low procedural complication rate. Fluoroscopy time was the only predictor of technical success. Tubes replaced after 90 days had higher rates of tube malfunction.

CLINICAL RELEVANCE/APPLICATION
Fluoroscopic guided J-arm placement is safe for patients requiring jejunal nutrition. Tubes should be replaced within 90 days.

SSQ07-09 • Biliary Drainage in 30 Patients with Undilated Bile Ducts Affected by Biliary Fistula due to Pancreatobiliary Surgical Treatment: Technique, Feasibility, Complications, and Clinical Outcome

Massimo Venturini MD (Presenter) ; Francesco A De Cobelli MD ; Stefano Cappio MD ; Marco Salvioni ; Giulia Agostini ; Alessandro Del Maschio MD

PurPOSE
To evaluate technique, feasibility, complications, and clinical outcome of percutaneous biliary drainage in 30 patients with undilated biliary ducts and normal bilirubin levels affected by biliary fistula due to pancreatobiliary surgical treatment.

METHOD AND MATERIALS
From 2006 to 2012, Percutaneous Transhepatic Colangiography (PTC) and placement of a percutaneous biliary drainage (8-French) was attempted in 30 patients affected by biliary fistula, demonstrated by the presence of bile in abdominal surgical drainage, with bilirubin normal levels and ultrasonographic evidence of undilated biliary ducts. Under ultrasonographic (and fluoroscopic) guidance, the puncture attempt with Chiba needle (21G) was performed using a right approach puncturing along the course of the sixth segment portal branch, or a left approach in case of aerobilia and adequate volume of the left hepatic lobe.

RESULTS
PTC was successfully performed in 28/30 patients (21 cases with right approach, 7 with left approach) with radiological demonstration of biliary fistula (direct opacification of the fistula adjacent to the biliary-digestive anastomosis and fluoroscopic demonstration of contrast material in the surgical drainage). Biliary drainage was placed in 27/30 patients (90%) at first attempt, in 1/30 patients (3.3%) at second attempt two days later, placing in 23 patients an external-internal drainage, in 5 patients an external drainage, obtaining complete resolution of the fistula in all cases. No periprocedural complications were recorded. In 2/30 patients, biliary drainage couldn't be placed: surgical retreatment was necessary in one case while in the other case biliary fistula spontaneously resolved.

CONCLUSION
Percutaneous biliary drainage under ultrasonographic/fluoroscopic guidance in patients with undilated biliary ducts affected by biliary fistula is feasible, effective, without significant periprocedural complications and represents the first choice of treatment; furthermore PTC is an accurate tool to confirm the diagnosis of biliary fistula after pancreatobiliary surgical treatment.

CLINICAL RELEVANCE/APPLICATION
PTC and percutaneous biliary drainage represent the first therapeutic option in case of biliary fistula due to pancreatobiliary surgery.
regard to tumor morphology (focal thickening, diffuse thickening, polyploid mass), tumor size, presence of gallstones, lymphadenopathy, carcinomatosis, and liver invasion/metastases.

RESULTS

There were 2 T1 tumors, 6 T2 tumors, and 10 T3 tumors. 10 patients were found to have lymph node metastases at surgery, with 4 of these identified during retrospective CT/MR review. 6 lesions presented as a discrete polyploid mass, 9 as focal wall thickening, and 3 as diffuse wall thickening. Of the 6 polyploid masses, the mean maximum diameter was 37 mm (range 15 - 61 mm). Of the 9 tumors with focal wall thickening, the average thickness was 9 mm (range 8 - 24 mm) over a length of 32 mm. CT correctly identified the malignancy prospectively in 12/18 cases, while ultrasound did not make the correct diagnosis prospectively in 2/3 cases. 5 cases demonstrated hepatic invasion and 4 cases demonstrated gallstones.

CONCLUSION

The cross-sectional imaging findings of early gallbladder cancer can be subtle: The most common appearance in this series was limited focal wall thickening, and even the polyploid masses were quite small. Not surprisingly, 1/3 of cases in this series were not correctly diagnosed prospectively on CT/MRI. Identification requires an understanding of the appearance of early gallbladder cancer and dedicated evaluation of the gallbladder in every case. Future investigations should evaluate the utility of MPRs for improving diagnostic accuracy.

CLINICAL RELEVANCE/APPLICATION

The findings of gallbladder cancer in its earliest stages can be extremely subtle, requiring a careful evaluation of the gallbladder in both the axial plane and using multiplanar reformats.

SSQ08-02 • The Yield of Magnetic Resonance Cholangiopancreatography (MRCP) for the Investigation of Dilated Bile Ducts in Patients with Normal Liver Function Tests (LFTs)

Shlomit R Tamir MD (Presenter); Ofer Benjaminov MD; Assaf Issachar MD; Marius Braun

PURPOSE

To evaluate the yield of MRCP for the investigation of incidental biliary duct dilatation in patients with normal as compared to those with elevated LFTs.

METHOD AND MATERIALS

This was a retrospective study conducted on MRCP scans of 113 consecutive patients referred to our tertiary medical center for the evaluation of biliary duct dilatation seen on previous imaging (CT, US). Biochemical data were collected from the medical records: ALT, AST, ALP, GGT and Bilirubin. Only patients with bile duct dilatation confirmed on MRCP were included in the study group. Pathology findings were compared between two groups of patients with bile duct dilatation: normal versus elevated LFTs.

RESULTS

Complete data was available for 68 patients. MRCP confirmed bile duct dilatation in 53 patients who therefore consisted our study group; 28 pts. had normal and 25 pts had elevated LFTs. MRCP demonstrated the cause of bile duct dilatation in 34 pts. (64%), more commonly in pts with elevated (n=18, 72%) than normal (n=16, 57%) LFTs. Pathologies which did not require further evaluation or treatment (periampullary diverticula, benign asymptomatic stricture) were demonstrated in 7 pts (25%) with normal LFTs. Pathologies which required further evaluation or treatment (space occupying lesion, cholechololithiasis, severe stricture) were more commonly seen in the elevated LFTs group (16/25, 64%) than in the normal LFTs group (9/28, 32%), (p < .01).

CONCLUSION

MRCP is a valuable tool in the workup of biliary duct dilatation even in the setting of normal LFTs, as the probability of an obstructing pathological finding is not negligible. However, it is less likely to find an obstructing pathology, or even a reassuring benign etiology, in patients with normal as compared to elevated LFTs.

CLINICAL RELEVANCE/APPLICATION

Appropriate criteria should be set for MRCP in patients with incidental biliary dilatation and normal LFTs, weighing the low but significant prevalence of obstructing pathology in these patients.

SSQ08-03 • T1 Mapping on Gadoxetate Disodium Enhanced MRI in Patients with Primary Sclerosing Cholangitis (PSC)

Kristina I Ringe MD (Presenter); Marcel Gutberlet DiplPhys; Frank K Wacker MD*; Hans-Juergen Raatschen MD

PURPOSE

To assess the value of T1 mapping of the liver on gadoxetate disodium enhanced MRI for evaluation of liver function and to determine a possible correlation with severity of disease.

METHOD AND MATERIALS

26 patients (17 males, 9 females; mean age 43 years) with confirmed diagnosis of PSC who underwent gadoxetate disodium enhanced hepatic MRI on a 1.5T system were included in this prospective IRB-approved study. T1 mapping of the whole liver was performed using a 3D spoiled gradient echo sequence with flip angles (5° and 15°) before (TP1) and approximately 17 minutes (TP2) after i.v. contrast injection. The findings of gadoxetate disodium enhanced MRI were compared (T-Test). Mean T1 changes (TP1-TP2) were calculated and correlated with liver function tests (Pearson), which were obtained within 24 hours of the MRI scan.

RESULTS

Significant changes of T1 relaxation times between non-enhanced and gadoxetate disodium enhanced MRI could be observed in all liver segments (p < .05).

CONCLUSION

On a segmental level, T1 relaxation times significantly decreased on gadoxetate disodium enhanced MRI in patients with PSC. Regarding the whole liver, the decrease of T1 relaxation times significantly correlated with bilirubin, alkaline phosphatase and cholinesterase levels, whereof fluctuations during the course of the disease are common.

CLINICAL RELEVANCE/APPLICATION

T1 mapping of the liver in patients with PSC may serve as a useful method to assess liver function and probably indirectly severity of the disease on a global as well as on a segmental level.

SSQ08-04 • Relapsed IgG4-related Sclerosing Cholangitis after Steroid Therapy: Image Findings and Risk Factors

Myung-Won You (Presenter); Jin Hee Kim MD; Jae Ho Byun MD; Seung Soo Lee MD; Hyoung Jung Kim MD; Myung-Hwan Kim; Moon-Gyu Lee MD

PURPOSE

To compare image findings of IgG4-related sclerosing cholangitis (IgG4-SC) between initial attack and relapse and to determine the risk factors associated with relapse of IgG4-SC.

METHOD AND MATERIALS

Of 99 patients with pathologically or clinically diagnosed IgG4-SC, 59 patients who had received steroid therapy and had been thoroughly followed up with imaging examinations were included. Among them, 23 were identified to have relapse of IgG4-SC. CT, MRCP, and ERCP at initial attack of all 59 patients and at the time of relapse of 23 patients were reviewed by two radiologists in consensus regarding the extent and degree of bile duct changes and extrabiliary organ involvement. The clinical data including patients’ age and gender, serology and pathology findings, if available, and steroid therapy regimen at initial attack were recorded. For 23 patients with relapsed IgG4-SC, image findings were compared between initial attack and relapse. To determine risk factors of relapse, image findings and clinical data at initial attack were compared between 23 patients with relapse and 36 patients without relapse using univariate and
SSQ08-07 • Clinical Utility of MR Cholangiopancreatography in the Assessment of Acute Cholecystitis in the Emergency Setting

Jennifer W Uyeda MD (Presenter); Vijay Ramalingam MD; Amrita P Devalapalli BS; Stephan W Anderson MD; Jorge A Soto MD

PURPOSE
To assess the utility of MRCP in the assessment of acute cholecystitis in the emergency setting with emphasis on patients in whom US and MRCP results are discordant.
METHOD AND MATERIALS
The institutional review board approved this HIPAA-compliant retrospective study. Informed consent was waived. 371 consecutive adults (120 males, 251 females) who presented to the emergency department with abdominal pain between 4/1/2010 and 2/28/2013 who underwent US and MRCP within a 48-hour period were included. MRCP was performed for further assessment of bile duct dilatation. US and MRCP reports were reviewed and were classified as positive, negative or equivocal for the diagnosis of acute cholecystitis. Electronic medical records were reviewed to determine subsequent management and pathology findings.

RESULTS
In 275 (74.1%) of 371 patients, the results of US and MRCP were concordant. 73 (19.7%) patients had negative or equivocal results for acute cholecystitis but MRCP was positive. Of these 73 patients, 52 (71%) underwent cholecystectomy and 3 underwent percutaneous drainage. Of the 52 patients who underwent cholecystectomy with negative or equivocal US findings but positive MRCP findings for acute cholecystitis, 22 (42%) were pathologically proven acute cholecystitis while the remaining 30 were pathologically proven chronic cholecystitis. Of the 371 US examinations, 23 (6.2%) were positive for acute cholecystitis on US but negative on MRCP, 14 (61%) of these 23 patients underwent cholecystectomy and 2 (9%) were pathologically proven acute cholecystitis; 12 were pathologically proven chronic cholecystitis.

CONCLUSION
US is the study of choice in patients with acute right upper quadrant suspected to have acute cholecystitis. MRCP provides additional information in select cases. However, MRCP has limitations in discriminating between acute and chronic cholecystitis.

CLINICAL RELEVANCE/APPLICATION
MRCP should be considered in the evaluation of patients suspected to have acute cholecystitis in the emergency setting, particularly when US has negative or equivocal findings.

SSQ08-08 • The Technologist-performed Sonographic Murphy’s Sign: Is It Really an Accurate Test?
Ronald O Bude MD (Presenter) ; Richard K. J. Brown MD * ; Ehab H Youssef MD, FRCR

PURPOSE
In our dept. the sonographic Murphy’s sign, performed by technologists who have not been physician-trained to elicit it, is generally considered the best ultrasound test for detecting acute cholecystitis. Technologist criteria for a positive test vary widely, from pain at probe contact of the RUQ skin to pain at probe palpation of the gallbladder in deep inspiration. We questioned the validity of this evaluation and performed a study to evaluate the test done this way.

METHOD AND MATERIALS
HIDA scan was the gold standard for detection of acute cholecystitis, due to the variability of our pathologists’ criteria (which varied from a few lymphocytes in the gallbladder wall to the need for transmural perforation) and the subjectivity and potential bias of the surgeons’ impressions at operation. All adults in a consecutive 3 year period fulfilling the following criteria were studied: unequivocal HIDA scan; US within one day of HIDA; recorded unequivocal sonographer’s Murphy sign evaluation. Timing of narcotic analgesia was noted. Sensitivities and specificities were calculated.

RESULTS
Study population: 383 patients. The Murphy’s sign is used in our dept. without taking narcotic analgesia or presence of gallstones into account. Used this way the sensitivity and specificity for detecting acute cholecystitis, respectively, were 45% (46/103) and 57% (159/280). Interestingly, 43% of patients (163/383) had narcotic analgesia within two hours before US, the sensitivity and specificity were still only 63% (20/32) and 60% (36/60), respectively. Sensitivities and specificities for other combinations of stones/no stones and narcotic timings were similarly unimpressive, but space limits giving them here.

CONCLUSION
The sonographic Murphy’s sign, when performed by technologists not trained in its performance, is neither sensitive nor specific for the detection of acute cholecystitis. It remains to be proven whether this test is useful when performed by physicians, or by ancillary personnel specifically trained in its performance, given the prevalence of narcotic analgesia.

CLINICAL RELEVANCE/APPLICATION
The sonographic Murphy’s sign, performed by technologists not specifically trained for it, is neither sensitive nor specific for the detection of acute cholecystitis.
Intravenous Radiocontrast of Contrast-induced Nephropathy

SSQ09-01 • Genitourinary Keynote Speaker
Richard C Semelka MD (Presenter)

SSQ09-02 • Safety of Gadobutrol in Renally Impaired Patients: Interim Results from a Prospective International Multicenter Trial after End of Recruitment

Henrik J Michaely MD (Presenter) *; Brigitte Lorenz *; Manuela Aschauer MD; Matthias Gutberlet MD, PhD; Ryan P Rebello MD; Georg M Bongartz MD *; Francesco A De Cobelli MD

PURPOSE
To prospectively investigate the safety and potential occurrence of nephrogenic systemic fibrosis (NSF) of gadobutrol in renally impaired patients in a prospective open label international multicenter observatory study (GRIP-gadovist in renally impaired patients) is being conducted of which interim-data after the end of recruitment are presented.

METHOD AND MATERIALS
The GRIP study is conducted at 62 sites in 9 countries (among them Australia, Canada, Germany, Italy and Korea) and is registered at clinicaltrials.gov under NCT00828737. Main inclusion criteria were a eGFR of = 65ml/min/1.7m², indication for imaging within the gadobutrol label, no administration of another MR-contrast agent within the last 6 months to prevent confounding and the willingness to participate in follow-up phone calls at 1, 3, 6, and 18 month post contrast administration as well as to come back for a physical examination 12 and 24 month post contrast administration. A baseline physical exam of the patient is the informed about the potential manifestations of NSF about which the patient will be interviewed telephonically at the above given follow-up dates. Recruitment was stopped on 12/31/2012.

RESULTS
928 patients (male/female 575/311, sex details missing 1, as per clinical database 28 Feb 2013 892 patients entered database, mean age 66.6 years, age range 19-94 years, mean weight 76.9 kg) were recruited. The mean gadobutrol dose administered was 9.3 ml (range 1.4-30 ml). Of the 928 patients 252 dropped out due to loss of follow-up and death and due to centrally assessed eGFR too high. The eGFR of the remaining 676 patients was =30ml/min/1.7m² in 203 patients and >30-65ml/min/m² in 473 patients. 280 patients have finished the 24 month follow-up period. 383 patients are still being followed up. So far, no changes indicative of NSF have been encountered in any of the patients.

CONCLUSION
Based on the limited available data from this prospective study, the application of gadobutrol in patients with impaired renal function has not led to a single case of NSF. The study will continue following up patients and is estimated to end 12/31/2014.

CLINICAL RELEVANCE/APPLICATION
No cases of NSF have occurred after administration of 0.1mmol/kg gadobutrol in this prospective study in renally impaired patients so far.

SSQ09-03 • High Serum Creatinine Variability Prior to Intravenous Contrast Material Administration May Confound a Diagnosis of Contrast-induced Nephropathy
Jennifer S McDonald PhD (Presenter) *; Robert J McDonald MD, PhD; Eric E Williamson MD *; David F Kallmes MD *

PURPOSE
Administration of iodinated contrast material has been associated with the development of acute kidney injury (AKI), termed contrast-induced nephropathy, however contrast-independent sources of AKI can confound this diagnosis. We sought to determine the effect of serum creatinine (Scr) variability prior to intravenous contrast exposure on the incidence of AKI.

METHOD AND MATERIALS
All contrast-enhanced and unenhanced abdominal, pelvic, and thoracic CT scans performed at our institution between 2000-2010 were identified. Patients were stratified by baseline Scr into < 1.5 mg/dL, 1.5 - 2.0 mg/dL, and > 2.0 mg/dL mg/dL subgroups. Patients with high pre-scan Scr variability (delta > 0.5 mg/dL in the 7 days prior to scan) were identified and subdivided into increasing Scr or decreasing Scr subgroups. The effect of pre-scan Scr on the incidence of post-scan AKI (Scr = 0.5 mg/dL over baseline in the 1-3 days post-scan) was assessed using Fisher’s Exact test.

RESULTS
A total of 49,421 scans performed on 29,422 patients met inclusion criteria. Incidence of high Scr variability increased with increasing baseline Scr (11% for baseline < 1.5 mg/dL, 42% for baseline 1.5-2.0 mg/dL, 75% for baseline > 2.0 mg/dL). Of the 4370 patients who developed AKI, 2417 (55%) had high pre-scan Scr variability. Patients who developed post-scan AKI were more than four times likely to have high pre-scan Scr variability compared to patients who did not develop AKI (23% versus 5%, OR= 5.51 (95% CI 5.17-5.88), p=0.000). The effect of pre-scan Scr on the incidence of post-scan AKI (Scr = 0.5 mg/dL over baseline in the 1-3 days post-scan) was assessed using Fisher’s Exact test.

CONCLUSION
Patients with elevated baseline Scr frequently demonstrate high Scr variability independent of intravenous contrast material exposure.

CLINICAL RELEVANCE/APPLICATION
A substantial percentage of AKI following intravenous contrast material exposure may be attributable to Scr variability instead of contrast-mediated renal injury.

SSQ09-04 • Short-term Variations in Serum Creatinine as a Novel Control to Assess the Risk of Nephropathy Caused by Intravenous Radiographic Contrast
Travis Stratford BA (Presenter); Jianhua Li; Firas Ahmed MD; Jeffrey H Newhouse MD

PURPOSE
Individual patients’ creatinine (Cr) levels vary from day to day; the more severe a patient’s background renal failure, the more severe the variations. If a patient who receives contrast subsequently has a Cr rise, the change may be erroneously attributed to the contrast. We assessed daily Cr variations in patients who later received intravenous contrast as controls to determine which post-contrast Cr variations might not be due to the contrast.

METHOD AND MATERIALS
A HIPAA-compliant IRB-approved review of our hospital’s electronic medical record identified patients who had Cr determinations on each day of a 7 or 9 day period, who also had intravenous contrast administered on the 4th or 5th day respectively of these periods, and who had no prior contrast for at least a week prior to the examined period. Using a threshold of a 0.5 mg/dL rise in Cr to identify ‘nephropathy,’ episodes of nephropathy pre-contrast (using the first day as baseline) and post contrast (using the contrast-receiving day as baseline) were determined. Percent of patients who experienced pre- and post-contrast nephropathy were compared after stratification by baseline Cr levels. The short duration of the observation periods minimized differences between control and post-contrast periods in prevalences of other factors which might have altered kidney function.

RESULTS
3953 patients were identified. The groups whose Cr rose to or beyond the nephropathy threshold increased as baseline Cr levels increased in both pre-contrast and post-contrast periods. There was no significant difference in nephropathy risk for baseline Cr up to 0.9 mg/dL. For baseline Cr values between 1.0 and 2.8 mg/dL, creatinine rises to or beyond the threshold occurred significantly more frequently after contrast (61% v. 39%; p<0.001).

CONCLUSION
Although most post-contrast acute rises in serum Cr are due to non-contrast-related natural variation, about 22% of these rises may be...
This study was approved by the local ethics committee; written informed consent was obtained. Between April 2011 and December 2012,

METHOD AND MATERIALS
An ongoing worldwide post-marketing study (PMS) is conducted to collect safety data in 1,000 patients (adults and children) with moderate to severe and end stage renal impairment, scheduled to undergo a routine contrast-enhanced magnetic resonance (MR) imaging using gadoteridol meglumine (Dotarem®). For each patient, risk factors at inclusion, indications for MR imaging, and occurrence of adverse events are recorded. Three follow up visits (between 3 months and 27 months after MRI) are performed in order to detect any suspicion or occurrence of NSF.

RESULTS
As of January 18, 2013, the cut-off date for the interim safety analysis, this ongoing PMS included data on 232 patients (mean age: 70.2 years (range: 21-92); male: 62.5%). The mean eGFR was 36.5 ±16.1 ml/min/1.73m² (range: 4.0-59.1) including 64.2% of moderate, 18.5% of severe, 14.2% of end stage renal insufficiency and 2.6% of kidney transplanted patients. CNS MR examinations accounted for nearly 25%. The first follow-up visit was done for 67 patients (29%) and no NSF occurred. Only 1 patient (0.4%) had two serious adverse events not related to gadoteridol meglumine.

CONCLUSION
This interim safety analysis already confirms the very good safety profile of gadoteridol meglumine in renal impaired patients.

CLINICAL RELEVANCE/APPLICATION
This study suggests that Gadoteridol can be safely administered in patients with Grade 3 renal failure without causing nephrogenic systemic fibrosis.

SSQ09-07 • NSeaFe Study: Observational Study on the Incidence of Nephrogenic Systemic Fibrosis in Renal Impaired Patients Following Gadoterate Meglumine Administration

Thomas Voigtlaender (Presenter)

PURPOSE
To prospectively estimate the incidence of NSF in patients with moderate to severe renal impairment after administration of gadoterate meglumine.

METHOD AND MATERIALS
An ongoing worldwide post-marketing study (PMS) is conducted to collect safety data in 1,000 patients (adults and children) with moderate to severe and end stage renal impairment, scheduled to undergo a routine contrast-enhanced magnetic resonance (MR) imaging using gadoterate meglumine (Dotarem®). For each patient, risk factors at inclusion, indications for MR imaging, and occurrence of adverse events are recorded. Three follow up visits (between 3 months and 27 months after MRI) are performed in order to detect any suspicion or occurrence of NSF.

RESULTS
As of January 18, 2013, the cut-off date for the interim safety analysis, this ongoing PMS included data on 232 patients (mean age: 70.2 years (range: 21-92); male: 62.5%). The mean eGFR was 36.5 ±16.1 ml/min/1.73m² (range: 4.0-59.1) including 64.2% of moderate, 18.5% of severe, 14.2% of end stage renal insufficiency and 2.6% of kidney transplanted patients. CNS MR examinations accounted for nearly 25%. The first follow-up visit was done for 67 patients (29%) and no NSF occurred. Only 1 patient (0.4%) had two serious adverse events not related to gadoterate meglumine.

CONCLUSION
This interim safety analysis already confirms the very good safety profile of gadoterate meglumine in renal impaired patients.

CLINICAL RELEVANCE/APPLICATION
Interim analysis showed a good safety profile of gadoterate meglumine in renal impaired patients.

SSQ09-08 • Functional Assessment of Early Renal Allograft Dysfunction with Blood Oxygenation Level-dependent MR Imaging and Diffusion-weighted MR Imaging at 3T

Woolim Kim (Presenter) ; Chan Kyo Kim MD, PhD ; Sung Yoon Park ; Jungmin Bae ; Byung Kwan Park MD ; Wooseong Huh ; Sung Ju Kim

PURPOSE
To evaluate the feasibility of blood oxygenation level-dependent (BOLD) MR imaging (MRI) and diffusion-weighted MR imaging (DWI) at 3T for functional assessment of early renal allograft dysfunction.

METHOD AND MATERIALS
This study was approved by the local ethics committee; written informed consent was obtained. Between April 2011 and December 2012,
RESULTS
In renal allografts, the medullary R2* and cortical ADCs demonstrated a moderate correlation with eGFR (correlation coefficient, 0.48/0.538; p < 0.01) and the cortical R2* of 16 echoes and medullary ADCs had a weak correlation (correlation coefficient, 0.31/0.365; p < 0.05). The cortical R2* of 6 echoes did not show a correlation with eGFR (p = 0.111). In both cortex and medulla, AR had significantly lower R2* and ADCs than normal renal allografts (p < 0.01). In both cortex and medulla, the R2* of ATN were significantly lower than that of normal renal allografts (p < 0.05), while the ADCs of ATN were not significantly different from normal renal allografts (p > 0.05). Between AR and ATN, there was no significant difference in both R2* and ADCs (p > 0.05).

CONCLUSION
BOLD MRI and DWI at 3T, as noninvasive tools, may demonstrate early functional state of renal allografts. However, current these techniques appear to have the limited capability for characterizing a cause of renal allograft dysfunction.

CLINICAL RELEVANCE/APPLICATION
As unenhanced functional imaging techniques, BOLD MRI and DWI at 3T may help to noninvasively assess functional state of patients with renal allografts.

SSQ09-09 • Potential Role of MDCT Spectral Imaging by Using Material Density Analysis on Virtual Unenhanced Images in Renal Insufficiency

Catherine Roy MD (Presenter); Philippe Host MD; Mickaël Ohanna; Isham Labani; Gauthier Bazille MD; Herve Lang MD

PURPOSE
To assess the potential role of quantitative assessment of water within the kidney parenchyma using MDCT Spectral Imaging in order to evaluate patients with renal insufficiency (RI).

METHOD AND MATERIALS
210 patients (no special recommendation for hydration) including 3 groups of 70 patients: a control group of normal patients, a group with moderate RI (GFR > 40 mL/min) and a group with severe RI (GFR < 40 mL/min) underwent an unenhanced acquisition using Helical CT (GE Discovery CT750HD 64-slice) scanner with Spectral Imaging single source fast switching. We used same helical pitch and detector collimation for all scans (1.375, 0.625mm). Among monochromatic CT images ranging from 40 to 140 keV, three levels were then reconstructed at 75 KeV, 55 KeV, 45 KeV. An identical ROI was drawn in the medium part of renal parenchyma on both kidneys. A Gemstone Spectral Imaging (GSI) Viewer, using material-density basis pairs provided values of water in mg/cc with standard deviation on unenhanced images and on virtual unenhanced images of the water-iodine pair for control group. Water values in mg/cc were correlated with GFR values using linear regression.

CONCLUSION
There was no difference of water content inside kidney parenchyma in different forms of renal impairment.

CLINICAL RELEVANCE/APPLICATION
There was no significant difference of water content inside kidney parenchyma in different forms of renal impairment.

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SSQ10-01 • IgG4-Related Renal Disease: MR Findings with Emphasis on the Usefulness of Diffusion-weighted Imaging

Bohyun Kim MD (Presenter); Jin Hee Kim MD; Seong Ho Park MD *; So Yeon Kim MD; Jae Ho Byun MD; Jeong Kon Kim MD

PURPOSE
To describe imaging characteristics of IgG4-related renal disease (IgG4-RD) on MR including diffusion-weighted imaging (DWI) and to evaluate the usefulness of DWI for lesion detection.

METHOD AND MATERIALS
We retrospectively identified 28 patients with pathologically or clinically diagnosed IgG4-RD who underwent MR covering the kidneys. Of 28 patients, 18 underwent DWI (b values of 0, 500, 1000 sec/mm²) and 19 underwent contrast-enhanced MR (CE-MR) with dynamic triple-phase including arterial, portal, and equilibrium phase (n=15) or single portal-phase (n=4) scanning. Two radiologists reviewed in consensus all MR images to assess the lesion location and number, and signal intensity (SI) of the lesions compared to the normal renal parenchyma on T1-weighted images (T1WI), T2WI, DWI, and CE-MR. The sensitivity of each sequence for lesion detection was obtained and the results were compared between T2WI, DWI, and dynamic CE-MR. The sensitivity of MR with DWI and without DWI was also compared. The ADC value of IgG4-RD (for the largest lesion, if multiple) and normal renal parenchyma was compared.

RESULTS
The most common findings of IgG4-RD on MR were bilateral (85.7%), multiple (92.9%), renal parenchymal (85.7%) lesions appearing iso-SI (96.4%) on T1WI, low SI (78.6%) on T2WI, high SI (100%) on DWI (b value of 1000 sec/mm²), and low SI (86.7%) in the arterial phase with progressive enhancement pattern on dynamic CE-MR. The sensitivity of DWI (100%) was higher than those of T2WI and CE-MR.
**SSQ10-02 • 10% Tumor Diameter Shrinkage on the First Follow-up CT Predicts Clinical Outcome in Patients with Advanced Renal Cell Carcinoma Treated with Angiogenesis Inhibitors: A Follow-up Validation Study**

Katherine M Krajewski MD (Presenter) *; Yoko Franchetti PhD; Mizuki Nishino MD; Nikhil H Ramaiya MD; Annick D Van Den Abbeele MD; Toni Choueiri MD

**PURPOSE**

Vascular Endothelial Growth Factor (VEGF)-targeted agents are standard therapies for metastatic renal cell carcinoma (mRCC), associated with variable tumor shrinkage. Response Evaluation Criteria In Solid Tumors (RECIST) is of limited utility in this setting, and other imaging changes are sought to reliably predict outcome early. We aim to validate 10% tumor shrinkage as the best early indicator of outcome.

**METHOD AND MATERIALS**

In this institutional review board-approved, HIPAA-compliant study, 66 mRCC patients with 165 lesions on clinical trials of VEGF-targeted agents underwent thoracic and abdominal CT at baseline and at first follow-up after therapy. Measurements were performed according to RECIST and Tumor Shrinkage of > 10% decrease in sum of the longest diameter (-10%SLD). Correlation with time-to-treatment failure (TTF) and overall survival (OS) were compared and stratified by response to the radiologic criteria. Receiver Operating Characteristics (ROC) analysis yielded the optimal threshold change in SLD defining patients with prolonged survival.

**RESULTS**

More than -10%SLD significantly differentiated responders from non-responders (median TTF 8.4 vs. 4.1 months, p = 0.001) while partial response by RECIST did not (median TTF 6.9 versus 5.5 months in responders vs. non-responders, p = 0.34). -10%SLD was also significantly predictive of OS (median OS 35.1 vs. 15.0 months in responders vs. non-responders, p = 0.003). ROC curve analysis yielded -9.3% in SLD as the optimal threshold for response/no-response.

**CONCLUSION**

Ten percent tumor shrinkage is validated as a reliable early predictor of outcome in mRCC patients receiving VEGF-targeted therapies and may provide a practical measure to guide therapeutic decisions.

**CLINICAL RELEVANCE/APPLICATION**

10% tumor shrinkage is validated as a reliable and reproducible early predictor of outcome applicable to mRCC patients receiving various VEGF-targeted therapies.

**SSQ10-03 • 3D Contrast Enhanced Ultrasound vs. Renal DTPA in the Detection of Perfusion Defects in Early Renal Transplants—Preliminary Findings**

Ben Stenberg MSc (Presenter); Simon T Elliott MBChB, FRCR *; Emma Tran BSc

**PURPOSE**

In the UK, technetium 99m renogam (DTPA) is the primary investigation for perfusion defects post-transplantation. It has high reported accuracy (up to 99% sensitivity), but time consuming, expensive and has the innate risks of an examination using ionising radiation. Contrast enhanced ultrasound (CEUS) is an emerging technology which may solve these issues, giving greater spatial and temporal resolution while having the potential to robustly quantify the degree of defect using 3D acquisition and stacked contour measurement system.

However, little research has been done to investigate whether CEUS has the ability to maintain the high sensitivity rates to replace DTPA as the primary investigation, is achievable in this patient group and can be quantified using 3D data sets.

**METHOD AND MATERIALS**

This project used a blinded, cross over trial using 105 renal transplant patients examined with CEUS and compared to the DTPA within the immediate post-surgical phase. The examinations were reported independently of each other. Each CEUS was performed using a side by side, low MI technique, with a bolus injection of 2.4mL Sonovue (Bracco, Italy). 1 minute of 2D capture was acquired to manually assess the kidney perfusion and to allow for the medullary filling phase. A 3D volume of the whole kidney was then acquired in contrast specific mode.

**RESULTS**

All 105 patients underwent CEUS and imaging of the kidney was achieved in 100% of the cases (74/31 male/female) (34/71 live/deceased donor). 97 patients underwent both tests. DTPA detected 9 perfusion defects in these patients. CEUS detected all of these defects and a further 14 not detected by DTPA. Subsequent clinical correlation with operation records showed that in 5 of these cases polar arteries had been tied in surgery. 3D CEUS was used to quantify these defects (ranging from 0.2% to 100% of total renal volume (TRV)). The largest defect seen by CEUS but missed by DTPA was 17%TRV.

**CONCLUSION**

CEUS is more sensitive in the detection of perfusion defects in early renal transplants and the high resolution and 3D data acquisition techniques allow for robust quantification of the global renal perfusion. This technique is considered 'off-label' by the FDA.

**CLINICAL RELEVANCE/APPLICATION**

CEUS is achievable and more sensitive in the detection of perfusion defects in early kidney transplants than DTPA and has the ability to quantify defects accurately using 3D stacked contours.

**SSQ10-04 • Assessment of Delayed Renal Allograft Function by Diffusion Tensor Imaging and Arterial Spin Labeled Magnetic Resonance Imaging**

Katja Hueper (Presenter); Marcel Gutterlet DipPhys; Frank Lehner MD; Nicolas Richter MD; Nils Hanke MD; Jan Becker MD; Matti Peperhove MD; Hermann Haller MD; Frank K Wacker MD *; Wilfried Gwinner MD; Dagmar Hartung MD; Antonia Zapf

**PURPOSE**

Delayed renal allograft function (DFG) is clinically defined as failure of serum creatinine to adequately decrease or need for dialysis during the first week after transplantation. DGF is associated with an increased risk for graft loss, acute rejection, and impaired long-term allograft function. In this study, we investigate whether diffusion tensor imaging (DTI) and arterial spin labeled (ASL) MRI allow assessment of DGF.

**METHOD AND MATERIALS**

The study was approved by the local ethics committee; written informed consent was obtained. Between July 2012 and February 2013 forty patients were examined between d4-d10 after kidney transplantation using a 1.5 T magnet. Echoplanar DTI (b=0,600 s/mm², 20
RESULTS
DGF was diagnosed in 19/40 patients and 9 patients had an acute rejection at histology. Mean medullary FA was significantly lower in patients with DGF (0.230±0.067) when compared to patients with normal initial graft function and with DGF and correlation analysis between MRI parameters and serum creatinine.

CONCLUSION
DTI and ASL by assessment of renal microstructure and perfusion enable detection of DGF and MRI parameters significantly correlate with renal allograft function. Thus, these techniques may be useful for risk stratification during the early post-transplantation period and may provide additional information to kidney biopsy.

CLINICAL RELEVANCE/APPLICATION
DTI and ASL can be used to non-invasively assess renal microstructure and perfusion and may help to early detect and characterize renal pathology associated with delayed renal allograft function.

SSQ10-05 • MR Renal Imaging Using a 3D T1-weighted Two-point Dixon Sequence at 3T: Is It an Efficient Alternative to Standard Fat Suppression Techniques?

Catherine Roy MD (Presenter) ; Philippe Host MD ; Guillaume Aleman MD ; Mickael Ohanna ; Herve Lang

PURPOSE
Standard fat suppression techniques such as 2D chemical shift (IP/OP) and spectral saturation sequences are a workhorse of renal MRI. However, they are vulnerable to field and RF inhomogeneities. A 3D two-point DIXON method delivers up to four contrasts in one measurement : IP/OP/water and fat images. The purpose was to assess whether DIXON can be an efficient alternative to standard techniques in terms of quality and examination time.

METHOD AND MATERIALS
158 patients referred for kidney MR examination (68 normal, 75 carcinomas, 15 angiomyolipomas) underwent on a 3T MR unit in addition to our routine protocol three axial T1w fat suppression techniques : Group A (spectral saturation FFE, 5 mm, 28 slices, 25 sec), Group B (2D chemical shift FFE, 5mm, 32 slices, two breathholds of 28 sec, IP/OP images) and Group C (3D two-point Dixon, 1.8mm, 100 slices, 15s) with IP/OP/W/F images.

RESULTS
On qualitative analysis, a statistically significant difference was found in overall image quality and fat suppression characteristics, with the DIXON (p=0.0009 for Group C against p=0.004 for Groups A and B). Both readers agreed that the degree of fat saturation was greater with Dixon without any displacement artifacts.

CONCLUSION
The 3D Dixon achieved superior image quality and fat saturation in a shorter time with four informations. It can replace in daily routine standard fat suppression techniques.

SSQ10-06 • ECG-triggered, Time-resolved Diffusion Weighted Imaging (DWI) of the Kidney: Assessment of Diffusion Parameters over the Entire Cardiac Cycle

Rotem S Lanzman MD (Presenter) ; Philipp Heusch MD ; Julia Weller ; Anja Lutz ; Gerald Antoch MD * ; Hans-Joerg Wittsack PhD

PURPOSE
The purpose of this study was to assess changes in renal diffusion properties over the entire cardiac cycle using ECG-gated, time-resolved diffusion-weighted imaging (DWI).

METHOD AND MATERIALS
20 healthy volunteers (10 males, 10 females) were investigated on a 1.5T MR scanner (Magnetom Avanto, Siemens AG, Erlangen, Germany) using a 6 channel body matrix coil combined with spine array coil integrated into the scanner table. Blood flow within the renal arteries was determined by ECG-gated phase contrast (PC) flow measurements. For time-resolved renal diffusion weighted imaging (DWI), an ECG-gated and respiratory-triggered coronal single-slice EPI-sequence was acquired at 14 defined time points over the cardiac cycle (20, 70, 120, 170, 220, 270, 320, 370, 420, 470, 520, 570, 620, 670, 720 ms after R-wave) using the following imaging parameters: 4 b-values (0, 50, 100, 300 s/mm²), 3 orthogonal diffusion directions, TR/TE = 3000ms/66ms, FOV=400mm², MxP =192x192, slice thickness 6 mm.

RESULTS
Image acquisition was completed successfully in all subjects. Mean blood flow in the renal arteries showed a minimal velocity of 16.9 ± 5.6 cm/s at the time-point of the R-wave raising to a maximum of 40.4 ± 10.6 cm/s about 142ms after the R-wave(p < 0.001). Calculated tissue contrast was significantly increased in Dixon for each corresponding image (0.85 vs 0.61 for Group A, 0.71 vs 0.55 and 0.48 vs 0.35 for Group B IP/OP, respectively).

CONCLUSION
The 3D Dixon achieved superior image quality and fat saturation in a shorter time with four informations. It can replace in daily routine standard fat suppression techniques.

CLINICAL RELEVANCE/APPLICATION
The 3D T1w Dixon technique can replace standard fat suppression techniques.

SSQ10-07 • Enhancement Characteristics of Kidney on Multi-phase Pancreatic MRI as Predictor of Acute Renal Injury in Patients with Acute Pancreatitis

Xing-Hui Li (Presenter) ; Xiao M Zhang MD, PhD ; Yifan Ji

PURPOSE
To investigate the relationship between presences of delayed nephrographic progression on MRI obtained within 72 hours of onset of AP
CLINICAL RELEVANCE/APPLICATION
(dealing with enhancement MRI and AKI in AP patients) RER may be useful in predicting AKI and determining the severity of AP on MRI.

RESULTS

Mean RER of renal medulla was significantly higher in patients with acute pancreatitis who later developed AKI than those who did not. RER may be useful in predicting AKI and determining the severity of AP on MRI.

CONCLUSION

Mean RER of renal medulla was significantly higher in patients with acute pancreatitis who later developed AKI than those who did not. RER may be useful in predicting AKI and determining the severity of AP on MRI.

METHOD AND MATERIALS

Studies of Polycystic Kidney Disease (CRISP) showed Total Kidney Volume (TKV) correlates with disease progression, detects change in individuals with normal labs, and can do so after as little as 12 months. However, ADPKD exhibits highly variable presentation, and TKV does not perform well in all cases. A novel physiologically relevant image feature called Cyst-Parenchyma Surface Area (CPSA) was developed to handle atypical cases. CPSA represents cyst surface area in contact with normal kidney parenchyma, excluding the external surface of exophytic cysts. We hypothesize that, while atypical cases with large exophytic cysts are often outliers in TKV correlations, our approach will correlate better with such cases.

METHOD AND MATERIALS

The standard conventional nephrostogram was performed immediately prior to the CEUS nephrostogram. The CEUS nephrostogram technique involved diluting 0.2ml of SonoVue with 40 ml of normal saline and introduced into the renal collecting system via the nephrostomy tube. Digital cine-clips and still images of the CEUS nephrostogram examination were recorded to allow accurate retrospective comparison by two independent reviewers to the reference standard.

RESULTS

Twelve nephrostomies in 10 patients (median age 64 yrs, range 29-91 yrs, 6 female and 4 male) were performed and reviewed. The causes of obstruction were ureteric calculus (n=3), ureteric stricture (n=2), malignancy (n=3), ureteric clot (n=1) and reflux (n=1). The renal pelvicalyceal system was visualized in both CEUS and fluoroscopic nephrostograms in 11/12 (92%) with one nephrostomy tube correctly identified by both methods as being misplaced. The entire ureter was visualized in 6/11 (55%) with a CEUS nephrostogram compared to 8/11 (73%) using traditional nephrostogram. Fluoroscopic nephrostogram showed drainage of contrast into the bladder in 10/11 (91%) cases compared to 9/11 (82%) using CEUS.

CONCLUSION

Preliminary results suggest that contrast enhanced ultrasound (CEUS) nephrostogram is a feasible method to confirm the correct positioning of the nephrostomy tube within the collecting system, to image the ureters and determine if there is satisfactory drainage into the bladder.

CLINICAL RELEVANCE/APPLICATION

CPSA nephrostogram is a suitable alternative for the traditional nephrostogram in children, patients with contraindication to iodinated contrast or if the procedure has to be performed at the bedside.
SSQ11-01 • Informatics Keynote Speaker: The Role of Natural Language Processing in Reporting
Scott Leroy Duvall PhD (Presenter) *

SSQ11-02 • Conforming to Best Practice Standards: Development of a Software System to Provide Radiologists with Point-of-Care Decision Support for Recommendations
Tarik K Alkasab MD, PhD (Presenter) ; H. B Harvey MD, JD ; David A Rosman MD * ; Keith J Dreyer DO, PhD * ; Daniel I Rosenthal MD ; Giles W Boland MD

CONCLUSION
Point-of-care CDS software tools can efficiently assist radiologists in the real-time application of standard imaging algorithms to achieve best practices.

Background
Evidenced-based algorithms exist that guide radiologists to make appropriate report recommendations. Yet, we have separately presented data suggesting poor compliance with these best practice guidelines. To address this problem, we have developed a workstation-integrated, point-of-care Clinical Decision Support (CDS) system that guides radiologists in applying best practices.

Evaluation
The CDS system is activated by radiologists when clinically appropriate and assists the radiologist to use structured descriptions and standardized recommendation language that conform to evidence-based guidelines. The system consists of three layers. First, at the server layer, a database-backed web application applies criteria-driven algorithms to case-specific imaging findings and applicable patient information, such as demographic data and clinical context extracted from the RIS and voice recognition system. Second, a client layer runs within a web browser to mediate the radiologist interaction with the system. Finally, a ‘glue’ layer integrates the system with the voice recognition software and inserts the standardized language into the Recommendation field. For the pilot trial, we deployed this CDS system on a subset of workstations in our abdominal imaging division and limited the application of the tool to consensus-backed criteria for adrenal and pulmonary nodules. Over the 23 week trial, radiologists used the tool to generate recommendations 330 times. Users reported that the CDS tool facilitated appropriate application of imaging criteria without negatively impacting efficiency.

Discussion
Point-of-care CDS software tools can efficiently assist radiologists in the real-time application of evidence-based algorithms and can be integrated into the reporting workflow. We expect that use of the tool will increase as more criteria-based algorithms are applied, resulting in improved consistency and accuracy of radiologist recommendations.

SSQ11-03 • Development of the ViSion Ontology for Structured Reporting
David J Vining MD (Presenter) * ; Usama I Salem MBCh, MSC ; Cihan Duran MD ; Cristian Popovici * ; Andreea Pitici * ; Liming Jiang MD ; Chengqian Xuanzi MD

CONCLUSION
ViSion is a multimedia structured reporting system that has the potential to become a global solution with its ability to operate in multiple languages and to provide an inexpensive method for coding radiologic observations/diagnoses for use in medical informatics applications.

Background
We describe an integrated ontology authoring tool that is used in a multimedia structured reporting solution, called ViSion, which is capable of automatically translating radiology reports to any language and coding reports for billing and data mining.

Evaluation
We developed a multimedia structured reporting solution, called ViSion, which allows a radiologist to capture key images, tag those images with metadata describing anatomical locations and radiological observations/diagnoses, and assemble a multimedia structured report with image findings organized by anatomical categories. The metadata used to tag image findings has been developed and maintained with an integrated ontology authoring tool. The anatomical terms in the ViSion ontology are organized in a hierarchy for each body section, and each anatomical term in this structure is associated with a pathology tree containing radiologic observations and diagnoses for that anatomical site. The pairing of an anatomy location with a radiologic observation/diagnosis comprises a specific diagnosis. Each diagnosis can be further described with secondary characteristics that provide granular detail. This ViSion ontology and its tree structures were assembled in English, but the ontology has been translated to multiple foreign languages including Chinese and Arabic. Furthermore, all of the diagnoses contained in the ViSion ontology have been cross-referenced to other standardized medical ontologies (e.g., RadLex, SNOMED, ICD-10-CM) to facilitate data mining and electronic billing operations.

Discussion
The ViSion ontology has been created and is maintained by an authoring tool integrated with the system. The ontology currently consists of 918 anatomy terms and 1424 pathology terms that combined form 12,046 unique observations/diagnoses. Each of the terms has been translated to foreign languages and cross-referenced to other standardized ontologies.

SSQ11-04 • Structured Radiology Reports Are More Complete and More Effective than Unstructured Reports
Peter A Marcovici MD (Presenter) ; Catherine Stamoulis PhD ; Stephan D Voss MD, PhD ; George A Taylor MD

CONCLUSION
Structured chest radiograph reports were rated to be more complete and more effective than unstructured chest radiograph reports, and calculated to be globally of higher quality.

Background
Radiology report completeness and effectiveness are important aspects of quality. Unstructured reporting involves dictating in a free-text manner, customizing content to each case. Structured reporting aims to standardize format and lexicon, which may increase completeness and/or effectiveness. Structured reporting may improve the communication of findings made, and may also improve the nature of exam interpretation itself. The goal of this study was to compare unstructured and structured chest radiograph reports, in terms of their completeness and effectiveness.

Evaluation
This study was approved by the institutional review board. Following an educational lecture on the background of structured reporting, radiology trainees were provided with a chest radiograph structured reporting template. For each of the twelve trainees who completed the study, five randomly selected unstructured and five randomly selected structured chest radiograph reports were independently scored by four blinded physician raters. Structured reports were rated as more complete than unstructured reports, on a 5-point scale (mean 4.42, SD 0.24 versus 3.99, SD 0.35, p < .001).

Discussion
This study blindly compared 60 unstructured to 60 structured chest radiograph reports, in terms of their completeness and effectiveness. Structured reports were found to be more complete and more effective, as well of overall higher quality. The use of structured reports may improve the communication of findings perceived by the radiologist. The use of structured reporting templates may also improve exam interpretation, converting it from a largely intuitive process, to one that is cognitively more rational.

SSQ11-05 • Automatic Integration of Joint Commission-required Critical Results Auditing into Institutional Peer Review Using a Software Tool
Tarik K Alkasab MD, PhD (Presenter) ; H. B Harvey MD, JD ; Gloria M Salazar MD ; Daniel I Rosenthal MD ; G. Scott Gazelle MD, PhD ;

CONCLUSION
Structured chest radiograph reports were rated to be more complete and more effective than unstructured chest radiograph reports, and calculated to be globally of higher quality.
CONCLUSION
We have created and deployed a tool to integrate critical results auditing into the peer review efforts in our large, academic department. The process, as implemented, meets the regulatory requirements of the Joint Commission.

Background
To address compliance requirements and ensure the quality and consistency of non-routine communication for critical results in our department, we sought to integrate critical results auditing into our department's on-going process of peer review. We created and deployed add-ons to the COGR software tool to seamlessly integrate routine critical results auditing.

Evaluation
Our departmental peer review process, known as consensus oriented group review (COGR), involves groups of radiologists regularly meeting to review randomly selected cases and record consensus on the acceptability of the issued report, supported by a software tool. The COGR software tool accesses data from the department's radiology information system (Centricity, GE Healthcare) and PACS workstations (Impax; AGFA Healthcare). We extended the COGR software tool to integrate additional case-specific questions regarding critical results reporting including, whether a critical result was present in the report and, if so, whether institutional guidelines for critical results communication were followed. Department administrators are able to generate automated reports to document compliance with critical results auditing requirements as needed.

Discussion
The software tool has enabled our department to perform regular critical results auditing as an automatic component of group peer review. The described model posed the critical results questions in association with every case undergoing peer review from July 2012 through March 2013, resulting in over 5,000 cases audited across all divisions. The current system engages radiologists to detect critical results and assess the appropriateness of the timing and method of non-routine communication, per Joint Commission requirements. Recognizing the unique value of a group of radiologists engaged in peer review, we hope to use this model to implement other types of auditing questions without unduly weighing down the peer review process.

SSQ11-06 • Application of ViSion Structured Reporting for C-RADS Reporting of CT Colonography Examinations

David J Vining MD (Presenter) *; Thomas Yang MD; Usama I Salem MBCh, MSC; Andreea Pitici *; Cristian Popovici *; Adrian Prisacariu *; Iulian Aghenitei *; Mihai Jurca; Radu Rosu *

CONCLUSION
The practice of radiology is undergoing a transition from narrative reporting to structured reporting. We have developed a unique structured reporting solution that has been modified for use in reporting CTC examinations. A benefit of structured data output is that it can facilitate data entry into national data registries such as the ACR's CTC Data Registry.

Background
Standardized reporting of CT Colonography (CTC) results is essential for the effective communication of diagnostic results and to support the American College of Radiology's (ACR) CTC Data Registry. Various image display and manipulation systems exist for analyzing CTC image data but apart from coding the results of these examinations with C-RADS criteria, no standardized reporting method exists today. We present a multimedia structured reporting solution, called ViSion, which it is applicable to CTC and can be used to facilitate data entry into the ACR's CTC Data Registry.

Evaluation
We developed a multimedia structured reporting solution, called ViSion, which performs screen captures from any CTC image processing system and tags those key images with metadata describing anatomical locations, radiologic observations, and disease metrics. The ViSion software runs in parallel with the CTC program to perform screen captures of the 3D rendered images and to record the radiologist's voice descriptions of the image findings. The screen capture and voice data are uploaded to a cloud-based server where it was processed to extract metadata from the voice descriptions to tag the key images in a database. The ViSion system organizes the findings onto a graphic of a patient illustrating where particularly lesions were found in relation to the patient's anatomy. We have modified the output of the ViSion reporting system to facilitate the automatic uploading of structured data into the ACR's CTC Data Registry.

Discussion
We applied the use of ViSion to 75 CTC cases performed at our institution to generate structured reports that were then used to upload data into the ACR's CTC Data Registry.

SSQ11-07 • Measuring How Perceived Meanings of Uncertainty Cues Differ with and without Sentence-level Context in Radiology Reports

Brian E Chapman PhD (Presenter); James Y Chen MD *; Asako Miyakoshi MD; Wendy Chapman PhD; Amlicare Gentili MD

CONCLUSION
Showing radiologists the cues in context did not significantly change their probability assignments, overall. However, assertion cues changed more than negation cues. Evaluating probability assignments for lexical assertion, negation, and uncertainty cues may not require displaying the cues in context.

Background
Understanding how uncertainty is expressed in radiology reports is a critical task for natural language processing applications. pyConTextNLP is a natural language processing (NLP) package that uses predefined cues to determine whether a finding is negated, asserted, or uncertain. We measured how radiologists understanding of these cues differed when presented without context and with sentence-level context.

Evaluation
We created a set of 241 linguistic cues from pyConTextNLP and from translations from a Swedish corpus. Sentences containing the cues were identified in a separate corpus of 4727 de-identified CTPA reports. Focusing on the Impression section, we randomly selected up to five sentences containing the cue, resulting in 321 sentences containing cues modifying findings. Three radiologist assigned the probability of the finding's existence based on the sentence. The radiologists had previously provided probabilities (single-point and ranges) for each cue isolated from contextual information. We measured inter-radiologist discordance scores between contextual and non-contextual probability assignments and between single-point probabilities and probability ranges.

Discussion
There was an insignificant positive shift of 0.024 in probabilities when viewed in context (paired t-test, p=0.35). Cues that showed high disagreement among radiologists when viewed without context also showed high intra-radiologist inconsistency when viewed in context (Pearson's R=0.36, p=0.0006). Assertion cues changed more than negation cues when seen in context (Pearson 0.26, p=0.016).

SSQ11-08 • Rapid Creation of a Structured and Itemized Radiology Report from a Brief and Disorganized Dictation

John Stewart MD (Presenter)

PURPOSE
To automatically convert a brief, disorganized radiology report into a high quality structured and itemized radiology report. This reduces dictation time while allowing the radiologist to focus their attention on the images under review rather than on the text of the dictation.

METHOD AND MATERIALS
A very brief header is inserted at the top of the dictation. The radiologist then dictates a report which consists of only pertinent positive
and pertinent negative findings. Each finding is placed on a line by itself to aid in report processing. The order of the findings is not important. The use of macros is allowed but not required. No negative findings are dictated unless they are pertinent negative findings. The radiologist uses two simple keywords while dictating. If no keyword is inserted at the end of a finding, the finding is considered incidental and not included in the impression. Otherwise the finding is either copied into the impression or new text is dictated for the impression which pertains to this finding. In this way, the finding order and impression section are created simultaneously. Once the brief, keyword-encoded report is dictated, the software processes the dictation on a line-by-line basis using anatomic queues to determine if the finding belongs to a particular organ system. The best practices radiology report templates provided by the RSNA Radiology Reporting Initiative are used to create the structure of the report and the RadLex lexicon is followed for any non-dictated normal findings which are automatically inserted. An error check is performed on the final report and the radiologist is warned if a possible error is found (such as laterality errors) or if the report does not contain certain reporting requirements.

**RESULTS**
The ratio of dictated text to the text present in the final report (D/R ratio) is less than 50% for most reports. For reports with few or no pertinent findings the D/R ratio is less than 10%. This reduces dictation effort and increases report quality through the creation of standardized and itemized reports.

**CONCLUSION**
The software described significantly increases radiologist efficiency and report quality and is compatible with almost any speech recognition or word processing application.

**CLINICAL RELEVANCE/APPLICATION**
High quality standardized and itemized reports can be created without decreasing radiologist efficiency or distracting them from the review of images.

**SSQ11-09 • Biochemical MRI with gagCEST (Glycosaminoglycan Chemical Exchange Saturation Transfer Imaging) of Finger Joint Cartilage in Rheumatoid Arthritis**

**Christoph Schleich** (Presenter) ; **Anja Lutz** ; **Benedikt Ostendorf** ; **Philipp Sewerin** ; **Gerald Antoch** MD * ; **Falk Miese** MD

**PURPOSE**
Rheumatoid arthritis (RA) frequently involves finger and hand joints. Joint damage may result in severe physical disability. gagCEST has recently been demonstrated to visualize biochemical alterations of cartilage in knee joints of patients following cartilage repair surgery as well as in intervertebral discs. The purpose of our study was to test the feasibility of gagCEST imaging in finger joint cartilage in healthy volunteers and patients with RA.

**METHOD AND MATERIALS**
Six volunteers (mean age 33; range: 21-45 years) and four patients (age 58; range: 52-64 years) were examined at a 3T MR scanner (Siemens Magnetom Trio) using two loop coils (4 cm diameter), one fixed on the palmar, the other on the dorsal side of the second metacarpophalangeal joint (MCP). For gagCEST imaging, CEST effects were prepared by a train of Gaussian RF pulses followed by signal readout with a 2D-SPGR-CEST sequence. The CEST curves were calculated for each pixel and were shifted for the water resonance to appear at 0 ppm of the Z-Spectrum. The MTR asymmetry curves were determined. The CEST effect of the cartilage was measured with the glycineaminoglycan saturation transfer [ST = CEST (+1.3 ppm) ◆ CEST (-1.3 ppm)]/CEST (+1.3 ppm)]. Joint space width (JSW) as a morphologic feature of cartilage integrity was measured.

**RESULTS**
Cartilage ST values were significantly lower in patients compared to healthy volunteers (13.58 ± 6.11 vs. 27.38 ± 4.52; p=0.011).
Cartilage CEST curves showed a decrease of CEST effect between 1.2 and 2.2 ppm, which corresponds to the resonance frequency of hydroxyl protons of glycosaminoglycans. There was no significant difference in JSW between healthy volunteers and RA patients.

CONCLUSION
CEST imaging revealed alterations in finger cartilage of RA patients compared to healthy controls in the absence of cartilage thinning. The decreased CEST effect in the spectral range of glycosaminoglycan resonances points towards depletion of glycosaminoglycans in RA.

CLINICAL RELEVANCE/APPLICATION
Biochemical imaging with gagCEST of cartilage composition is feasible at finger joints in RA.

SSQ12-02 ● Application of 59Fe Labeled Triglyceride-rich Lipoproteins for Quantitative Activity Measurements of Brown Adipose Tissue at 7T MRI

Caroline Jung (Presenter) ; Barbara Freund ; Markus Heine ; Michael G Kaul ; Jorg Heeren ; Harald Ittrich MD ; Gerhard B Adam MD

PURPOSE
The aim was to determine metabolic activity of brown adipose tissue (BAT) with MRI at 7T using radioactively labeled superparamagnetic iron oxide nanoparticles (SPIO) embedded into the lipoprotein layer for visualization of lipoprotein distribution and BAT metabolism after intravenous (iv) and intraperitoneal (ip) injection.

METHOD AND MATERIALS
59Fe labeled SPIOs were embedded into the lipid core of Triglyceride-rich lipoproteins (TRL; 59Fe SPIO-TRL). Cold exposed (24h), BAT activated mice (n=10) and thermoneutral control mice (n=10) were starved for 4 hours before 59Fe-SPIO-TRL application. MRI was performed before, 1 and 24 hours after ip (n=10) and iv (n=10) injection at a 7T small animal MRI using a T2*w Multiecho-GRE sequence (TR/TEfirst 400/2ms, ETL 12, ES 1ms, FA 25°, NSA 4, 10 slices, eff. voxel volume 160x160x600μm3). R2* and 7R2* in liver and BAT were estimated. Ex vivo the biodistribution of 59Fe-SPIO-TRL was analyzed using a large volume Hamburg whole body y counter (HAMCO). The amount of TRL in liver and BAT was calculated according to the results of percentage TRL accumulation arrived from activity measurements and correlated with MRI measurements. Uptake of TRL into tissue was confirmed by histological (Prussian blue) and TEM analyses.

RESULTS

CONCLUSION

SSQ12-03 ● Macrophage Tracking with Heteronuclear Proton MRI

Rebecca Schmidt MD (Presenter) ; Nadine Nippe ; Klaus Strobel * ; Max Masthoff ; Olga Reifscheider DIPLOPHYS ; Daniela Delli Castelli ; Cord Sunderkotter MD ; Uwe Karst PhD ; Silvio Aime ; Christoph B Bremer MD ; Cornelius Faber

PURPOSE
To explore the feasibility of imaging Thulium (Tm)DOTMA labeled cells in a murine inflammation model by ultra-short echo time imaging (UTE).

METHOD AND MATERIALS
Bone marrow derived macrophages (BMDM) were labeled with 15μmol TmDOTMA/10⁶ cells by incubation for 24h. Cell viability and activity were tested by determination of cell death, adhesion, phagocytosis and NO production. Fluorescence microscopy due to the self-fluorescence of TmDOTMA (ex. 253nm; em. 460nm) and MR spectroscopy determined labeling efficiency. Inflammation was induced by s.c. injection of 100μl polyacrylamide (PAG) gel in both flanks of 3 nude mice. To intensify inflammation, lipopolysaccharide (30μg/100μl PAG) was added to one PAG pellet per mouse. 3±6x10⁵ labeled BMDMs were injected i.v. 2±4h after gel implantation. MRI was performed on a Bruker Biospec 94/20 with a 35mm H volume coil over a period of 8 days using 3D UTE sequence. On day 8, PAG-pellets, livers and spleens were explanted. Selective macrophage staining (MAC 3) and laser ablation inductively-coupled plasma mass spectrometry (LA-ICP-MS) were performed for correlation with the MR data.

RESULTS
Neither cell viability nor activity were affected by TmDOTMA labeling. Fluorescence microscopy showed an intracellular uptake of the complex. MR spectroscopy of labeled cells revealed an average of 8.97 ± 0.85 x 10¹⁰ TmDOTMA molecules per cell. In vivo, TmDOTMA signal was detected in the bladder (day 1) and in liver, spleen and gel pellets over 8 days. Within 2h scan time, signal-to-noise values within the PAG-pellets ranged between 1.49 and 3.98. From a reference tube with a 0.25 mM TmDOTMA solution, the in vivo detection limit was estimated to be slightly below 10⁸ BMDMs. Origin of the signal from migrated BMDMs was confirmed by histology and LA-ICP MS showing both BMDMs and Tm around the injected gel.

CONCLUSION
The highly shifted signal of the equivalent methyl protons of TmDOTMA can be detected independently from the water signal by UTE resulting in an increased sensitivity. This approach of heteronuclear proton MRI may provide a versatile tool for MR cell tracking in vivo and thus facilitate the application of molecular MRI without the need for extra MR equipment.

CLINICAL RELEVANCE/APPLICATION
Detection and tracking of labeled cells by means of noninvasive molecular imaging has become essential part of both preclinical research and medical diagnostics related to cellular therapies.

SSQ12-04 ● In Vivo Ultrasound Imaging of Pancreatic Islets

Jose L Paredes MD (Presenter) ; George Gittes ; Jiamjung Wang ; Florideliza Villanueva

PURPOSE
Imaging and quantifying pancreatic islets in vivo could revolutionize the treatment of diabetes mellitus. Currently, insulin levels and hemoglobin A1C are our main methods for determining beta cell mass in diabetic patients. These insensitive measures are grossly inadequate for proper glucose control. An office-based, non-invasive method for determining islet mass serially in diabetics has long been sought-after, but with no success. Here we show that a sub-harmonic ultrasound probe, in conjunction with microbubble intravenous contrast, allows islet visualization in the mouse pancreas based on the increased blood flow compared to surrounding pancreatic tissue.

METHOD AND MATERIALS
RESULTS
The subharmonic ultrasound visualization rendered clearly delineated large blood vessels of the scanned region in the pancreas. We were also able to identify discrete, three-dimensional hyper-perfused areas that were of the size, number, and distribution of islets. To validate that these hyperperfused areas were indeed islets, we scanned the pancreas of transgenic mice that express GFP under the mouse insulin promoter.

CONCLUSION
Using a mouse model, we now have strong evidence to show the potential feasibility of using ultrasound combined with intravenous administration of microbubbles to visualize and quantify islet mass.
SSQ12-05  ●  Automated Analysis of Metastatic Involvement in Bone Using Anatomical and Functional Information from FDG PET/CT Images

Omer Demirkaya (Presenter); Abdulaziz Alsburgai MD; Mohel M Abouzied MD

PURPOSE
Although overall incidence of bone metastasis is not known, over half of people who die of cancer in the US each year are thought to have bone involvement. In this study we developed a method to quantify the metabolic and anatomic changes induced by bone metastases in cancer patients using PET/CT images. The quantitative parameters along with the structural changes seen by CT bone window may serve as a useful tool in assessing the response of bone metastases to therapy.

METHOD AND MATERIALS
Seventy-three patients with no prior history of chemo or radiotherapy who had bone metastases documented by PET/CT (Discovery ST, GE) and other conventional modalities were selected for the study. PET/CT images were resampled to the same pixel size. Then the bone structure was segmented using a threshold of 150 HU. After the segmentation, the 50% of the maximum SUV within the bone mask was used to identify bone lesions in each slice. Using the ROIs defined at 70% of the max, the lesion characteristics including the mean HUs were calculated from the PET/CT images. The lesions were subjected to the visual confirmation by an experienced PET/CT physician who also categorized them based on the appearances in the CT bone window as lytic, sclerotic, mixed, or no-change type. The lesion characteristics were compared using statistical methods.

RESULTS
340 lesions in 73 patients with different cancer types were analyzed. The lesions were categorized into four anatomical groups. The spine hosts the largest number of lesions, while thoracic cage bones had the least. The lumbar bones were the most preferential sites within the spine. Quantitatively, the mean SUVmax for the lytic, no-change, mixed and sclerotic lesions with no structural changes were 7.4, 6.1, 8.2 and 7.2, respectively. Comparison of SUVs showed that only no-change type was statistically different from the mixed type. Statistical comparison of CT values indicated that the difference between no-change and lytic types was significant. Uptake period did not seem to have an impact on no-change and sclerotic types as much as it did on the others.

CONCLUSION
The quantitative method for analysis of bone metastases may serve as a useful tool in monitoring and assessing therapy response.

CLINICAL RELEVANCE/APPLICATION
A quantitative method provides a convenient way to analyze the functional and structural characteristics of bone lesions and may serve as a useful tool for assessing the response to therapy.

SSQ12-06  ●  A Dual Isotope Hybrid MCT-PET System Reveals Functional Heterogeneity of Bone Lining Cells and Longitudinal Changes in Marrow from Local Radiation and Chemotherapy

Masashi Yagi (Presenter); Luke Arentsen BS, ARRT; Yutaka Takahashi PhD; Leslie Sharkey; Masahiko Koizumi MD, PhD; Cory Xian; Clifford J Rosen; Douglas Yee MD; Jerry W Froelich MD; Susanta K Hui PhD

PURPOSE
We report the skeletal and marrow response to clinically relevant local radiation and chemotherapy using ?CT-PET and reveal a potentially important role for bone lining cells in mediating the skeletal response to local and systemic injury.

METHOD AND MATERIALS
Mice were given systemic methotrexate (MTX, 2.5mg/kg, 3 days) or 16Gy local radiation to legs. Longitudinal FDG (days -4, 2) and NaF (days -3, 3, 7, 14, 29) ?CT-PET scans were performed. Eight skeletal regions were monitored. Distal femora were harvested for cellular histology.

RESULTS
We observed significant functional heterogeneity throughout the skeleton for bone mineral remodeling as measured by NaF (18F). Dual isotope ?CT-PET revealed functional heterogeneity of the skeleton in response to local radiation or chemotherapy. These studies demonstrate an important role for bone lining cells in mediating the skeletal and possibly the marrow response to injury. This methodology also establishes a translational model for studying the skeletal health of cancer survivors.

CONCLUSION
Dual isotope ?CT-PET revealed functional heterogeneity of the skeleton in response to radiation or chemotherapy and establishes a translational model to study the skeletal health of cancer survivors.
**SSQ12-08 ● Enhanced Delineation of Primary Pancreatic Adenocarcinoma Following Neoadjuvant Therapy Using -Ferumoxytol: Preliminary Findings with Histopathologic Correlation**

**Sandeep S Hedgire** MD (Presenter); **Mari Mino Kenudson** MD; **Carlos Fernandez-Del Castillo** MD; **Sarah Thayer**; **Ralph Weissleder** MD, PhD; **Mukesh G Harisinghmani** MD

**PURPOSE**
To evaluate role of MRI with ferumoxytol in delineating primary tumor in pancreatic adenocarcinoma patients undergoing neoadjuvant therapy.

**METHOD AND MATERIALS**
In institutional review board approved, HIPPA compliant prospective study, 10 patients with biopsy proven pancreatic adenocarcinoma were enrolled with the primary intention of detecting lymph node metastasis following administration of ferumoxytol. MRI scans were performed at baseline, immediate post and at 48 hrs time points with quantitative T2* sequences using single shot, monopolar, multiecho gradient echo (TE = 4.8, TR = 169 ms, thickness = 4 mm). The patients were categorized into those who received neoadjuvant therapy (group A) and those who did not (group B). The T2* of primary pancreatic cancer and adjacent parenchyma was recorded at baseline and 48 hrs time point in both groups and the difference between T2* values was calculated. After Whipple surgery, the primary tumors were assessed histopathologically for fibrosis and inflammation.

**RESULTS**
Five of the 10 (50 %) patients had presurgical neoadjuvant therapy. The mean T2* of tumor and adjacent parenchyma at 48 hrs in group A were 22.11 ms and 16.34 ms respectively. In group B, these values were 23.96 ms for tumor and 23.26 ms for adjacent parenchyma. The T2* difference between the tumor and adjacent parenchyma in group A was more pronounced compared to group B. The tumor margins were subjectively more distinct in the group A compared to group B. Histopathologic evaluation showed prominent fibrosis with scattered residual tumor glands with atrophic acini at the periphery of the lesion in the group A. Conversely, intact tumor cells/glands were present at the periphery of the tumor in the group B. Two patients didn't undergo Whipple surgery due to hepatic metastasis detected preoperatively.

**CONCLUSION**
Ferumoxytol may have potential application in depicting post neoadjuvant therapy induced fibrosis (especially at the periphery of the tumor) and thereby improving the ability for precise delineation of tumor margins.

**CLINICAL RELEVANCE/APPLICATION**
Indistinct tumor margin poses a challenge to the surgeon. MRI with ferumoxytol may be used for better delineation of the pancreatic cancer thereby affecting surgical planning and overall prognosis.

**SSQ12-09 ● Quantification of ADC and SUV Values in Tumors and Lymph Node Metastases of Patients with Cervical Carcinoma in a Simultaneous PET-MRI System**

**Philipp Brandmaier** MD (Presenter); **Sandra Purz** MD; **Martin Reinhardt** MD; **Henryk Barthel**; **Osama Sabri** MD; **Thomas Kahn** MD; **Patrick Stumpf** MD, PhD

**PURPOSE**
Previous studies have shown discrepancies between standard uptake value (SUV) and apparent diffusion coefficient (ADC) parameters of different tumor entities with non simultaneous measurements on examination modalities such as PET-CT and MRI. The objective of this study was the quantitative evaluation of SUV and ADC values in patients with primary and recurrent cervical cancer and suspiscious lymph nodes in a simultaneous PET-MRI system to exactly deteriorate an expectable correlation.

**METHOD AND MATERIALS**
We included 15 patients with histologically confirmed cervical carcinoma and lymph node metastases (total of 38 lesions; primary tumor n= 14; positive lymph nodes n=24) who all underwent a simultaneous whole body 18F-fluorodeoxyglucose (FDG) PET-MRI (T2-HASTE, TIRM, EPI-DWI with b values of 0 and 800 mm/s), EPI-DWI with b values of 0 and 800 mm/s with the M.gluteus maximus serving as reference tissue. Evaluation was performed by simultaneous analysis of specific lesions on a dedicated workstation (syngo.via, Siemens Medial Solutions , Erlangen, Germany). A value of $2$ was calculated.

**RESULTS**
Local tumor lesions and lymph node showed averaged SUVmean values of 12.7 (SE ± 1.63), respectively 9.4 (SE ± 1.59); corresponding ADCmean averages amounted to 0.05 x 10^-3 (SE ± 0.014) and 1.09 x 10^-3 (SE ± 0.12). A significant difference to reference tissue (SUV 0.72 ± 0, 17 SE, ADC 1.58 ± 0.12 SE) was seen.

**CONCLUSION**
The present work demonstrates the ability of acquisition of quantitative parameters (ADC and SUV) in a simultaneous PET-MRI system. Values of ADC and SUV in tumor tissue apparently show an opposite behaviour to ADC and SUV values in non-tumor tissue.

**CLINICAL RELEVANCE/APPLICATION**
Simultaneous quantification of SUV and ADC parameters in PET-MRI show an opposite behaviour which might be useful for evaluation of therapy response and effective tumor grading.
evaluate the degree of marrow vascular proliferation in MM patients comparing with age-matched control group.

METHOD AND MATERIALS
Fifty consecutive patients with known MM who underwent unenhanced pelvic MRIs were included in the study. Control group was composed of 50 patients with no known malignancy in the same age group. T1-W and T2-W fat suppressed axial and coronal images of the pelvis were reviewed. MRIs were reviewed for presence of marrow blood vessels (subtle, moderately prominent and very prominent), and red marrow. MRIs of MM patients were additionally evaluated for presence or absence of focal myeloma lesions.

RESULTS
There were 18 females and 32 males. Age range of the patients was 41 to 88 (average 61). In the MM group 6 patients had very prominent and 16 patients had moderately prominent bone marrow vascularity. Two MM patients had no appreciable marrow vascularity whereas 26 of patients had subtle vascularity. Four MM patients had completely fatty marrow and the remaining 46 had mild to moderate background of red marrow. In the control group, there were no patients with very prominent or moderately prominent bone marrow vascularity. Eight cases in the control group had no marrow vascularity visualized and 42 patients had subtle vascularity seen. Six patients in the control group had completely fatty marrow and the remaining 44 had mild areas of red marrow.

CONCLUSION
Prominent bone marrow vessels are evident on MRI in patients with known MM corresponding to this well known histologically well established finding.

CLINICAL RELEVANCE/APPLICATION
In patients with an established diagnosis of MM, large marrow vessels should not be mistaken for lesions of myeloma. In the patient without known MM, the observation of large vessels in elderly patient

SSQ13-02 • Vertebral Body Enhancement in Patients with Central Venous Obstruction
Debbie L Bennett MD (Presenter); Frank J Simeone MD

PURPOSE
There have been isolated case reports of vertebral body marrow enhancement on contrast-enhanced CT imaging in patients with central venous obstruction. Recognition of this phenomenon is important as these regions of enhancement can be confused with sclerotic metastatic disease. The purpose of this project is to determine the incidence of marrow enhancement in patients with central venous obstruction, as we hypothesize that this is an under-recognized phenomenon. Additionally, this project identifies various patterns of enhancement that can be seen in central venous obstruction.

METHOD AND MATERIALS
Using a departmental radiology report searching program, all chest CTs performed between 1/1/2000 and 12/15/2012 which mentioned the terms 'SVC obstruction,' 'SVC syndrome,' 'superior vena cava obstruction,' 'superior vena cava syndrome,' 'venous obstruction,' or 'central venous obstruction' were identified. Each CT was reviewed by consensus to determine whether central venous obstruction was present. Of the cases with central venous obstruction, the vertebral bodies were evaluated for the presence or absence of marrow enhancement. When vertebral marrow enhancement was present, the levels involved, portion of the vertebral body involved, and pattern of enhancement were recorded.

RESULTS
There were 357 chest CT reports which mentioned central venous obstruction; of these, 53 (15%) were found to have central venous obstruction. Of the 53 patients with central venous obstruction, 25 (47%) demonstrated vertebral body enhancement. The enhancement was classified as either linear (n=9, 17%), nodular (n=9, 17%) or both (n=7, 13%). Five cases (9%) of vertebral body enhancement were reported as metastasis or concerning for metastasis.

CONCLUSION
Vertebral body marrow enhancement can be seen in patients with central venous obstruction. Two distinct patterns of marrow enhancement were identified: linear and nodular. Nodular enhancement was at times confused with metastatic disease, a misinterpretation which could result in incorrect staging of known malignancies or unnecessary procedures in patients without known malignancy. Marrow enhancement should be considered when interpreting studies with central venous obstruction.

CLINICAL RELEVANCE/APPLICATION
Patients with central venous obstruction may demonstrate cervical and/or thoracic vertebral body enhancement in a pattern which can be confused for sclerotic osseous lesions.

SSQ13-03 • Single Bony Abnormality on Spine MRI of Cancer Patients during F-up: Metastasis or Not?
Seun Ah Lee MD (Presenter); Min Hee Lee MD; Sang Hoon Lee; Hye Won Chung MD; Myung Jin Shin MD

PURPOSE
To evaluate single focal bone abnormalities found on spine MRI of cancer patients during F-up in order to enhance diagnosis of metastasis.

METHOD AND MATERIALS
After scanning a database for patients who were diagnosed with primary cancer and received spine MRI for detecting metastasis during F-up from 2000 to 2012, 353 patients with abnormal bony lesions were identified. Those with more than two bony lesions and with unavailable pathologic confirmation were excluded. Finally, 46 patients with a single, focal bony abnormality seen on spine MRI and pathologically proven, were included. The primary cancer was from lung (15), GI tract (8), HCC (4), kidney (4), bladder (3), breast (3), cervix (2), lymphoma (2), bile duct (1), thyroid (1), osteosarcoma (1), MPNST (1), and trophoblastic tumor (1). Medical records were reviewed for pathology reports of bony lesions. MRI findings were evaluated for location (anterior or posterior element of vertebra, pelvic bone), disc involvement, margin, paravertebral soft tissue mass. Statistical significance was assessed using Fisher's exact test.

RESULTS
Of 46 bony lesions, metastasis (mets) was 27 (58.7%) cases. Non-metastasis were 19 (41.3%), including no tumor present (suggesting non-metastasis, 12), hematopoietic bone marrow (4), infection (1), radiation osteitis (1), inadequate tissue (1). On MR, margin was ill-defined in 6 (mets:1, non-mets:5), well-defined in 40 (mets:26, non-mets:14). Compared with hematopoietic marrow, ill-defined margin was found in all (4/4) hematopoietic marrow and only one (1/27) in mets, showing significant difference (p<0.05).

CONCLUSION
When a single, focal bony abnormality was detected on spine MRI of cancer patients during F-up, incidence of metastasis was greater than half, but not as high as expected. Although most MR findings may not be characteristic, margin of lesions can aid in differentiating metastasis from focal hematopoietic bone marrow.

CLINICAL RELEVANCE/APPLICATION
When a single, focal bony abnormality was detected on spine MRI of cancer patients during F-up, incidence of metastasis was greater than half, but not as high as had been expected.

SSQ13-04 • Evaluation of Lumbar Vertebral Body Using IDEAL MRI and Micro CT
Won C Bae PhD (Presenter); Reni Biswas; Mark Bydder PhD; Koichi Masuda MD; Jiang Du PhD; Christine B Chung MD; Eric Y Chang MD; Prema S Karunanithi

PURPOSE
Monoenergetic Datasets

Schmidt Holger Haubenreisser

Open system 0.25T MRI allows scanning of the lumbar spine in standing position; standing MRI, did not however, increase the correlation

CONCLUSION
Overall there was still only poor to mild correlation (r: 0.12 - 0.38) between clinical symptoms and MRI morphological changes. 0.42). Inter- and intraobserver agreement for dural sac cross-sectional area and grading stenosis were substantial (r: 0.61 - 0.73).

Dural sac cross-sectional area (mm2) was significantly lower in the standing (L3/4: 101.7: vs 142.2, p = 0.04; L4/5: 72.3: vs 108.2, p = 0.04; LS/5: 54.6 vs 79.4, p =0.04). The degree of lateral recess and foraminal stenosis was greater in the standing in supine (p: 0.22 to 0.42). Inter- and intraobserver agreement for dural sac cross-sectional area and grading stenosis were substantial (r: 0.61 . 0.73).

Overall there was still only poor to mild correlation (r: 0.12 . 0.38) between clinical symptoms and MRI morphological changes.

CONCLUSION
MRI in the standing position increases central canal, lateral recess and foraminal stenosis. Standing MRI, did not however, increase the correlation between patients symptoms and MR morphological changes, which remained low to modest.

CLINICAL RELEVANCE/APPLICATION
Open system 0.25T MRI allows scanning of the lumbar spine in standing position; standing MRI, did not however, increase the correlation between patient symptoms and MR morphological changes.

SSQ13-07 • Image Quality Optimization after Spinal Fusion Surgery Using Iteratively Reconstructed Dual Energy CT High keV Monoenergetic Datasets

Holger Haubenreisser (Presenter) ; Miriam Hahn ; Rene Schmidt ; Paul Apfaltrer MD ; Martin U Sedlmair MS * ; Bernhard Schmidt PhD * ; Stefan O Schoenberg MD, PhD * ; Thomas Henzler MD
PURPOSE
To prospectively evaluate the effectiveness of high keV dual-energy CT (DECT) in combination with sinogram-affirmed iterative reconstruction in the raw data space (IR) for metal artifact reduction after spinal fusion surgery.

METHOD AND MATERIALS
10 consecutive patients underwent spinal fusion surgery and were consequently examined using a non-contrast enhanced DECT protocol for postoperative evaluation of metal implants. DECT raw data was reconstructed with traditional filtered back projection (FBP) and IR. Both FBP and IR image datasets were then post-processed on a separate offline workstation. Monoenergetic datasets were generated from 60keV to 190keV in 10keV intervals. Objective image quality evaluation was performed measuring image noise and the maximum artifact area on all images in order to calculate the total artifact volume. In addition, two radiologists performed subjective image quality evaluation using a 5-point Likert scale.

RESULTS
A total of 28 datasets were reconstructed for each patient (14 FBP, 14 IR). Image noise was significantly lower in all IR datasets when compared to the corresponding FBP datasets (p

CONCLUSION
IR of DECT raw data leads to improved objective and subjective image quality of high keV monoenergetic datasets that allow valuable metal artifact reduction in patients after spinal fusion surgery.

CLINICAL RELEVANCE/APPLICATION
Iteratively reconstructed DECT raw data improves image quality of calculated high keV monoenergetic CT image data potentially leading to a more accurate assessment of the postoperative spine.

SSQ13-08 • Dual-energy CT in Detecting Bone Marrow Edema of Vertebral Compression Fractures

Aina O Venkataramy (Presenter); Jean-Claude Dosch; Stephane Kremer MD, PhD; Jean-Louis Dietemann MD; Guillaume Biery MD, PhD

PURPOSE
To prospectively evaluate the performance of virtual non-calcium (VNC) dual-energy CT (DECT) images for the demonstration of trauma-related abnormal marrow attenuation in vertebral compression fractures (VCF).

METHOD AND MATERIALS
Twenty patients (16 females, 4 males; age=69±14 years) presenting with benign VCF on radiographs were consecutively and prospectively included in this IRB-approved study, and underwent MRI and DECT of the spine. MR examination, evaluated by an independent reader, served as reference standard for edema (acute nature of fracture) assessment. Two other independent readers visually evaluated all vertebrae for abnormal marrow attenuation (CT edema) on VNC DECT images using a binary scale; specificity, sensitivity, predictive values, intra and inter-observer agreements were calculated. A last reader performed a quantitative evaluation of CT numbers, and cut-off values for CT edema were calculated using ROC analysis.

RESULTS
In the visual detection of CT edema, VNC DECT images had a sensitivity of 84%, a specificity of 97%, a PPV of 81% and a NPV of 97% compared to MR as a reference standard; intra- and inter-observer agreements were good to excellent, ranging from k= 0.74 to k= 0.90. CT numbers were significantly different between vertebrae with edema on MR and those without (p

CONCLUSION
VNC DECT images allowed an accurate demonstration of trauma-related abnormal attenuation in VCF, revealing the acute nature of the fracture.

CLINICAL RELEVANCE/APPLICATION
Thanks to its high sensitivity and predictive values, DECT technique can be seen as an interesting triage tool for the investigation of patients with suspected acute vertebral compression fracture.

SSQ13-09 • A Longitudinal CT Study of Lenalidomide and Bortezomib Treatment for Multiple Myeloma: Trabecular Microarchitecture and Biomechanics Assessed by a CT-based Finite Element Model

Miyuki Takasu MD (Presenter); Yoko Kaichi; Miho Ishikawa MD; Shuji Date; Masao Kiguchi RT; Kazuo Awai MD *; Yoshiaki Kuroda; Akira Sakai

PURPOSE
Lenalidomide and bortezomib have been successfully used in the treatment of multiple myeloma (MM), of which bone disease is a key feature. Bortezomib has been linked to increased bone formation and osteoblastic activity; however, the effect of lenalidomide on bones remains unknown. Therefore, in this study, trabecular microstructural analysis and biomechanics assessed by a clinical CT-based finite element model (CT/FEM) were used to investigate whether lenalidomide affects the microarchitecture of bones.

METHOD AND MATERIALS
Sixty-seven MM patients (male, n=37; mean age, 67.1±10 years; female, n=30; mean age, 68.6±10 years) were examined by 64-detector CT after a mean period of six months of either therapy with bortezomib- (n=33) or lenalidomide (n=19), or follow-up without treatment (n=15). Using a bone mineral calibration phantom and a 3D image analysis system, bone mineral content per tissue volume (BMC/TV), trabecular parameters, and mechanical properties of the third lumbar vertebrae were calculated. The statistical significance of the change with respect to baseline over time was assessed using a two-way analysis of variance with repeated measures. To investigate whether baseline geometric or biomechanical indices predict the subsequent response to treatment, the Spearman rank correlation test was performed for each baseline index with respect to post-treatment changes.

RESULTS
At the second CT examination, trabecular number, failure load and stiffness increased in the lenalidomide group (P

CONCLUSION
Lenalidomide treatment resulted in significant increases in BMC/TV, trabecular number and CT/FEM-derived estimates of bone strength, while failure load and stiffness decreased in the bortezomib group. Baseline BMC/TV and trabecular spacing predicted lenalidomide-induced bone changes.

CLINICAL RELEVANCE/APPLICATION
Lenalidomide treatment promoted significant increases in bone strength. Mechanical properties, assessed by a CT/FEM, provided useful information about treatment response in multiple myeloma.
**SSQ14-01 • Design and Prototyping of a Portable Solid State Head CT**

**Rajan Jain**, MD *

**Yuxuan Mao** MD, MS (Presenter) ; **Jing Shan** ; **Andrew Tucker** ; **Laurel Burk** ; **Pavel Chtcheprov** BS ; **Jianping Lu** * ; **Otto Zhou** PhD * ; **Yueh Z Lee** MD, PhD *

**PURPOSE**

This study describes the design of a novel carbon nanotube (CNT) based head CT. Current CT scanners are relegated to hospital use due to their size and moving gantry. CNT based x-ray sources allow novel gantry geometries unattainable by conventional sources. The lack of moving parts and ability to fit sources closely improve robustness and portability. A vehicle based CT scan to exclude hemorrhagic stroke enables early thrombolytic treatment, which is critical for better outcomes. Vehicle based CT scanners have already been demonstrated in limited applications. We evaluated a prototype CNT head CT scanner, with a conventional central and a novel 16-sided polygon geometry, using standard phantoms and cadaveric heads.

**METHODOLOGY AND MATERIALS**

Imaging was performed with a linear array of 75 CNT cone beam sources (80 kVp) placed 1 m opposite a digital detector. A rotation stage with either a Gammex 464 phantom, a skull phantom, or a cadaveric head was placed 25 cm from the detector. In the conventional CT setup, the object was rotated 200° while being scanned by a single source. In the 16-sided geometry (8 source-detector pairs), 20 sources in the array were fired in succession. The object was then rotated 22.5°. This was repeated 8 times until the object was scanned 200°. Exposures varied between 25-80 mAs. The reconstructed images were compared to those from a clinical Siemens Definition CT scanner using standard head protocol.

**RESULTS**

The SNR for Bone, Acrylic, Polyethylene, and Air elements of the Gammex 464 at 100 mAs were 10.4, 8.8, 7.6, and 4.0 respectively. CNR’s were 4.7, 1.0, 0.6, 4.2, and CT numbers were 898, 191, -106, and -799 respectively. lpm/cm was 10. Radiation dose was 17 mGy. This compared favorably to conventionally cone beam CT’s. The different geometries produced images using skull phantom and cadaveric heads with good osseous detail.

**CONCLUSION**

This study is the first demonstration of a CNT based CT scanner for clinical applications. The images produced are on par with conventional CT in quality and dose. This is also the first report of a novel polygon geometry producing clinically useful CT images with cadaveric heads, showing that polygon geometries are feasible in general.

**CLINICAL RELEVANCE/APPLICATION**

This study demonstrates the potential imaging utility of the carbon nanotube based x-ray sources in a clinical CT application.

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**SSQ14-02 • Paired, Low and High kV, Conventional Polychromatic Non-Enhanced Head CT in the Same Patients - Image Quality Analysis**

**Eliel Ben-David** MD ; **S. Nahum Goldberg** MD * ; **Jacob Sosna** MD (Presenter) * ; **Isaac Leichter** PhD ; **Reuven Levinson** MSc * ; **John M Gomori** MD *

**PURPOSE**

To determine whether low energy, 80kV, polychromatic, non-enhanced head CT has better image quality than standard high energy, 120kV, scans performed on the same patients.

**METHODOLOGY AND MATERIALS**

IRB waiver was obtained. A retrospective comparison and image quality analysis was made between non-enhanced head CT scans performed at 80kV and at 120kV between June 2006 and November 2012. 30 consecutive scans performed at both energy settings, at different times, were included in the study. We evaluated the cerebral hemispheres by measuring the gray and white matter signal (H), noise (sd) and contrast to noise ratio per dose (CNRD). The posterior fossa was evaluated using PFAI (posterior fossa artifact index). To evaluate whether time effects changes, a control group of 10 patients who had two scans performed at 120kV over a period of 1.5±1.2 years was selected. Data were analyzed using paired t-test.

**RESULTS**

At 80kV, average signal was 33.9±3.5HU for gray matter and 22.5±3.1HU for white matter; whereas at 120kV, average signal was 29.4±4.6HU and 21.6±4.6HU for gray and white matter, respectively (p<0.001). At 80kV, average CNR was 28.8±4.6, whereas at 120kV, average CNR was 22.5±6.2. At 80kV, average PFAI was 2.9±0.6, whereas at 120kV, average PFAI was 2.7±0.7. The signal for gray matter and white matter was significantly lower at 80kV (p<0.001) whereas CNR and PFAI were significantly higher at 120kV (p<0.001).

**CONCLUSION**

This compared favorably to conventional cone beam CT’s. The different geometries produced images using skull phantom and cadaveric heads with good osseous detail.

**CLINICAL RELEVANCE/APPLICATION**

80kV, non-enhanced head CT results in improved CNRD compared to 120kV, which potentially increases the conspicuity of gray-white matter differences, which is diagnostically important in acute stroke.

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**SSQ14-03 • Cerebral Computed Tomography Angiography Using a 70 kVp: Improved Vascular Enhancement or Reduced Contrast Medium Volume**

**Eun-Suk Cho** (Presenter) ; **Seungbo Lee** ; **Joo Hee Kim** ; **Jeong-Sik Yu** MD ; **Jae-Joon Chung** MD ; **Tae-Sub Chung** MD

**PURPOSE**

To prospectively compare cerebral computed tomography angiography (CTA) at 70 and 120 kVp for vessel contrast, image quality and radiation dose. In addition, to assess the feasibility of reducing contrast medium (CM) volume from 64 to 40 mL at 70 kVp protocol.

**METHODOLOGY AND MATERIALS**

Attenuation value and contrast-to-noise ratio (CNR) were determined in a head phantom with 70 and 120 kVp. For two volunteers, 64 mL CM was administered at 40 mL/s, 15 were scanned with 70 kVp and the other 15 with 120 kVp. The rest of the 12 volunteers were scanned with 70 kVp after administration of 40 mL CM at 2 mL/s. The Hounsfield unit (HU) of the internal carotid artery T junctions and CNR were assessed, and the volume CT dose index (CTDIvol) and effective dose were compared. Subjective arterial enhancement, sharpness of the arterial boundary and overall image quality were assessed by two radiologists using 5-point scale.

**RESULTS**

The mean arterial attenuation and CNR of 70 kVp protocol (718.4 ± 102.5 HU and 31.7 ± 7.9, respectively) were significantly higher than those of 120 kVp protocol (384.4 ± 76.1 HU and 24.7 ± 6.2, respectively) when 64 mL CM was administered. 70 kVp protocol allowed 38% volume reduction of CM, while improving arterial enhancement and maintaining CNR with a lower radiation dose.
SSQ14-04  •  Improved Image Quality for Improved Diagnostic Accuracy of Cranial Computed Tomography Using Sinogram-affirmed Iterative Image Reconstruction

Holger Haubenreisser (Presenter) ; Christian Fink MD ; Paul Apfaltrer MD ; Martin U Sedlmair MS * ; Bernhard Schmidt PhD * ; Stefan O Schoenberg MD, PhD * ; Thomas Henziier MD

PURPOSE
To prospectively compare image quality of contrast and non-contrast enhanced cranial computed tomography (cCT) with thin slice widths using traditional filtered back projection (FBP) and sinogram-affirmed iterative image reconstruction in the raw data space (IR).

METHOD AND MATERIALS
29 consecutive patients (19 men; 71.6 ± 16.6 years) referred for native cCT were prospectively included. 11 (38%) patients also received contrast-enhanced studies and were also included. Each cranial CT raw data set was reconstructed with FBP and sinogram-affirmed IR in the raw data space with decreasing slice widths (5 mm 1 mm). Objective image quality was assessed by measuring image noise in three predefined brain regions (white matter, thalamus, cerebellum) using identical regions of interests (ROIs). Subjective image quality was assessed by 2 experienced radiologists by scoring the reconstructed data sets with respect to subjective image noise, subjective image sharpness, diagnostic acceptability and the presence of artifacts.

RESULTS
Image noise was significantly lower in all IR images at identical slice widths when compared to images reconstructed with FBP (4.25 ± 0.49 HU vs. 7.56 ± 1.10 HU non-contrast enhanced, 4.30 ± 0.26 HU vs. 7.97 ± 1.43 HU contrast-enhanced, 1mm slice width; pb.5). Subjective image quality of IR images especially at thinner slice widths of 1 - 3 mm were consistently higher than those of FBP reconstructions (p)

CONCLUSION
Sinogram-affirmed IR significantly reduces image noise in contrast enhanced and non-contrast enhanced studies, while increasing objective and subjective image quality. In cCT this may be used to decrease slice width and thus reduce partial volume effects, which may lead to increased diagnostic accuracy of smaller lesions.

CLINICAL RELEVANCE/APPLICATION
IR techniques should be used routinely in cCT if thin slice reconstructions are required in order to improve image quality and potentially diagnostic accuracy of small lesions.

SSQ14-05  •  CT Angiography of Head with Dual-source CT: Comparison of Image Quality and Radiation Dose between Prospective ECG-triggered and Conventional Protocols

Nong Qian (Presenter) ; Yuejun Xue BEng, MD ; Changjie Pan

PURPOSE
Experiments were carried out to test the hypothesis that using prospective ECG-triggering acquisition, also called step-and-shoot (SAS) mode on head can reduce radiation dose without compromising image quality compared with using conventional dual energy CTA scan.

METHOD AND MATERIALS
Eighty-four patients with clinically suspected or confirmed cerebrovascular disease were randomly divided into 2 groups: Group A (43 patients) underwent prospective ECG-triggering combined with step-and-shoot acquisition) and Group B (41 patients, underwent conventional dual-energy scanning). Images were reconstructed at 60% R-R interval. All images were processed on workstation and the image qualities of these images were scored by two experienced radiologists. These image scores and radiation doses used in each group were subjected to statistical analysis using the paired-sample t-test.

RESULTS
The image quality score for group A was 4.72 ± 0.50 with a good rate of 97.7% (42/43) and 4.71±0.51 for group B with a rate of 97.6% (40/41). The difference in the scores of image quality, between two groups was not statistically significant (P = 0.903). The average effective dose was (0.216 ± 0.01) mSv in group A and (0.541 ± 0.04) mSv in group B. T-test results showed that the effective dose for the two groups are statistical different (P=0.000).

CONCLUSION
Compared with conventional mode, SAS mode with a narrow R-R interval can be applied to perform cerebral CTA with a dose reduction by 60.01% and produced similar image quality.

CLINICAL RELEVANCE/APPLICATION
When applying SAS mode and conventional model with a narrow R-R interval to perform cerebral CTA, SAS mode results in radiation dose reduction of approximately 60% without compromising image quality.

SSQ14-06  •  Application of a Novel Metal Artifact Correction Algorithm in Flat-panel CT after Coil-embolization of Brain Aneurysms: Intraindividual Comparison

Jan-Hendrik Buhk MD (Presenter) * ; Michael Groth ; Susanne Sehner ; Jens Fiehler ; Nils O Schmidt ; Ulrich Grzyska MD

PURPOSE
To evaluate a novel algorithm to correct for beam hardening artifacts caused by metal implants in computed tomography performed on a flat panel equipped c-arm angiography system (FP-CT).

METHOD AND MATERIALS
16 datasets of cerebral FP-CT acquisitions after coil-embolization of brain aneurysms have been reconstructed applying a soft tissue kernel with and without a novel reconstruction filter for metal artifact correction, resulting in high-resolution isotropic datasets. Image reading was performed in multiplanar reformations (MPR) in average mode on a dedicated radiological workplace in comparison to the preinterventional native multisecton CT (MS-CT) scan serving as anatomic Gold standard. Two independent radiologists performed image scoring following a defined scale in direct comparison of the image data with and without artifact correction. For statistic analysis, a random intercept model was calculated.

RESULTS
Inter-rater agreement was very high (ICC = 86 %). Soft tissue image quality at the level of the implants was substantially improved. The additional metal artifact correction algorithm did not induce impairment of the subjective image quality in all other brain regions.

CONCLUSION
Adding metal artifact correction to FP-CT in an acute postinterventional setting helps visualizing the close vicinity of the aneurysm at consistent overall image quality.

CLINICAL RELEVANCE/APPLICATION
Further development of reconstruction filters for perinterventional brain FP-CT will help spreading the applicability of this still relatively new technique into more clinical settings.

SSQ14-07  •  Cross-modalities Comparative Study of Post-SAH Cerebral Hemodynamics: CT Perfusion versus Flat Detector DSA

Jan-Hendrik Buhk MD (Presenter) ; Michael Groth ; Susanne Sehner ; Jens Fiehler ; Nils O Schmidt ; Ulrich Grzyska MD

PURPOSE
To evaluate a novel algorithm to correct for beam hardening artifacts caused by metal implants in computed tomography performed on a flat panel equipped c-arm angiography system (FP-CT).

METHOD AND MATERIALS
16 datasets of cerebral FP-CT acquisitions after coil-embolization of brain aneurysms have been reconstructed applying a soft tissue kernel with and without a novel reconstruction filter for metal artifact correction, resulting in high-resolution isotropic datasets. Image reading was performed in multiplanar reformations (MPR) in average mode on a dedicated radiological workplace in comparison to the preinterventional native multisecton CT (MS-CT) scan serving as anatomic Gold standard. Two independent radiologists performed image scoring following a defined scale in direct comparison of the image data with and without artifact correction. For statistic analysis, a random intercept model was calculated.

RESULTS
Inter-rater agreement was very high (ICC = 86 %). Soft tissue image quality at the level of the implants was substantially improved. The additional metal artifact correction algorithm did not induce impairment of the subjective image quality in all other brain regions.

CONCLUSION
Adding metal artifact correction to FP-CT in an acute postinterventional setting helps visualizing the close vicinity of the aneurysm at consistent overall image quality.

CLINICAL RELEVANCE/APPLICATION
Further development of reconstruction filters for perinterventional brain FP-CT will help spreading the applicability of this still relatively new technique into more clinical settings.
PURPOSE
Conventional digital subtraction angiography (DSA) helps to evaluate the severity of vascular spasm after subarachnoid hemorrhage (SAH). Being equipped with flat detector (FD), DSA is able to provide in-room assessment of peri-therapeutic cerebral hemodynamics and help tailoring endovascular treatments. The aim of current study is to compare the cerebral circulation time (CCT) that derived color-coded quantitative FD-DSA and CT perfusion (CTP) in SAH patients.

METHOD AND MATERIALS
Nineteen SAH patients entered our neurovascular service in 8 months interval and with available CCT derived from diagnostic FD-DSA and MDCT, were retrospectively recruited. The mean time interval between two examinations was 19 (4-36) hours. The CCT derived from FD-DSA was defined as the difference of Tmx (Time of maximum intensity) between the region-of-interest (ROI) of selected arteries and superior sagittal sinus (SSS). Four CCT were defined accordingly, namely, RA-CCT and LA-CCT (arterial ROI placed on the second portion of right and left anterior cerebral arteries), RM-CCT and LM-CCT (arterial ROI placed on the second portion of right and left middle cerebral arteries). RA-CCT from MDCT was defined as the difference of time-to-peak between corresponding arterial (RM, LM) and SSS ROI. For CCT of anterior cerebral artery, only the dominant was defined due to limited spatial resolution.

RESULTS
The mean of RA-CCT, LA-CCT, RM-CCT and LM-CCT defined by FD-DSA were 5.6±1.5, 6.0±1.8, 5.9±1.9, 6.0±2.3 seconds respectively. The mean of RA-CCT, LA-CCT, RM-CCT and LM-CCT defined by MDCT were 6.0±2.3, 5.9±2.3, 6.0±2.3 seconds respectively. The intraclass classification of CCT merited from FD-DSA between two observers ranged from 0.86-0.99, and those from MDCT between two observers ranged from 0.72-0.98. The correlations of RA-CCT, LA-CCT, RM-CCT, and LM-CCT between two modalities were 0.70, 0.76, 0.70, 0.80, respectively. The correlation got worse when the CCT became longer.

CONCLUSION
With no extra radiation dose, FD-DSA provides CCT of SAH patients with comparable results as CTP. It facilitates the feasibility of both in-room peri-therapeutic hemodynamic monitoring and tailoring endovascular treatments.

CLINICAL RELEVANCE/APPLICATION
The CCT measured by QDSA provides additional hemodynamic information in SAH patients in addition to vascular morphology. It confirms the reproducibility of intra-arterial hemodynamic models.

SSQ14-08 • Noise and Radiation Dose Reduction Using a Partial Temporal Profile Non-local Means (PATEN) Filter in CT Brain Perfusion
Zhobuo Li (Presenter) ; Lifeng Yu PhD ; Shuai Leng PhD ; Armando Mandauc PhD * ; Amy L Kotsenas MD ; David R De Lone MD ; Cynthia H McCollough PhD *

PURPOSE
To develop a 4 dimensional (3D spatial + 1D temporal) noise reduction filter that is not sensitive to patient motion and to perform a retrospective clinical evaluation on its performance in CT brain perfusion.

METHOD AND MATERIALS
A partial temporal profile non-local means (PATEN) filter was developed in our lab that uses redundant information to reduce image noise, in which the pixel value in the filtered image is a weighted average of similar pixels and the weight is calculated by comparing their partial temporal profiles. This approach can reduce noise in a time series of perfusion images, even when there is significant motion during the time-series scans. A feasibility test was performed using 5 brain perfusion cases acquired with our routine protocol (CTDivoi = 300 mGy). We intentionally selected those cases in which the patient moved substantially during the scan, making the data difficult to process with the commercial perfusion software, despite the fact that it already incorporates anatomic registration to compensate for patient motion. A validated noise insertion technique was used to simulate images at a low-dose level (25% of full dose). PATEN was applied to the low dose images. Image quality and perfusion parameter maps were compared among low-dose, low-dose+PATEN filter, and full dose images.

RESULTS
The PATEN filter achieved a 76.2 to 85.3% decrease in image noise. Radiologist evaluation revealed no spatial or motion blurring in the PATEN images. The mean perfusion parameters calculated from the PATEN images closely matched those determined from full dose data: Root mean square errors between the PATEN filtered data and full dose data for CBF, CBV and MTT were 6.32, 4.94 and 14.67% for healthy tissue, respectively. For tissues with pathology, the errors were 13.43, 20.84 and 13.76%. The PATEN filtered data were deemed to be clinically equivalent to those from the full dose data and much superior to those from the original low-dose images.

CONCLUSION
A newly developed PATEN filter can reduce radiation dose by 75% in CT brain perfusion while maintaining image quality without causing spatial or temporal blurring of anatomy, even when significant patient motion occurs during the scan.

CLINICAL RELEVANCE/APPLICATION
Dramatic radiation dose reduction can be achieved in CT brain perfusion by applying the PATEN filter, which is insensitive to patient motion.

SSQ14-09 • CT Image Quality Improvement and Dose Reduction Potential with Model-based Iterative Reconstruction Using Autopsy Imaging in the Brain: Evaluation of Image Noise and DOSE Estimation with Different Noise Index
Takashi Takahata RT ; Yue Dong (Presenter) ; Tomokatsu Tsukamoto ; Ye Ju ; Kelsuke Nishihara MD ; Hiroki Mori MD ; Kazunari Mesaki MD ; Katsuhide Ito MD

PURPOSE
To assess the dose reduction potential and image quality improvement with model-based iterative reconstruction algorithm (Veo) by comparing image noise and DOSE (DLP mGy-cm) with the adaptive statistical iterative reconstruction (ASiR) and the filtered back projection (FBP) reconstruction, using autopsy imaging.

METHOD AND MATERIALS
With institutional review board approval, 8 brain CT autopsy imaging (AI) cases with different noise index (NI: 2.8, 3.2, 4.5, 6.0, 8.5) were performed on Discovery CT750 HD. For comparison, 3 sets of 0.625mm slice thickness CT images were reconstructed with FBP, 50% ASiR and Veo. The image noise (SD) was measured with the same size of regions of interest at the same slice in 3 locations. The image noise reduction ratio was defined by SD (at NI8.5)/SD (at NI2.8). Using a 5-point score (1: poor; 3: diagnosis, 5 excellent), 3 radiologists independently and graded overall image noise and delineation of the head image.

RESULTS
For the comparison with same image slice thickness, the image noise reduction with Veo compared with FBP and 50%ASiR for the NI2.8, 3.2, 4.5, 6.0, 8.5 and the average were (15.0%, 22.2%, 35.4%, 42.9%, 50.5% and 53.2±14.5%), respectively. The noise reduction ratio (NI8.5/NI2.8) for the Veo, 50%ASiR and FBP were 1.7, 2.7 and 2.9, respectively. The average scoring for the Veo, 50%ASiR and FBP at NI3.2 were 3.7±0.7, 3.3±0.7, and 2.8±0.6, respectively. All the differences were statistically significant (p < 0.05).

CONCLUSION
Veo advanced reconstruction algorithm greatly reduced image noise over FBP and ASiR. With Veo reconstruction, it was possible to reduce dose (DLP) by 71.7% if the noise of the current FBP images was acceptable.
Arterial Remodeling of Intracranial Atherosclerosis: Detection and Characterization Using 3D High Resolution Black Blood MRI

Ye Qiao (Presenter); Jarunee Intrapiromkul MD; Zeeshan Anwar; Li Liu; Bruce A Wasserman MD

PURPOSE
To determine the ability and extent of intracranial arteries to accommodate plaque formation by outward (positive) remodeling using 3D high resolution black blood MRI (BBMRI).

METHOD AND MATERIALS
Thirty-one patients (22 male; mean age 57.6±12.2 years) with cerebrovascular ischemic events underwent 3D time-of-flight MRA and contrast-enhanced BBMRI examinations for intracranial atherosclerotic disease at 3T. The 3D BBMRI sequence was acquired using a volumetric isotropic TSE acquisition with the following parameters: TR/TE, 2000ms/38ms; TSE factor, 56 echoes; acquired resolution, 0.4x0.4x0.4 mm3; scan time, 7.5 minutes. Each identified plaque was classified based on location (i.e., posterior vs. anterior circulation). Lumen area (LA), outer wall area (OWA), and wall area (WA) at the most stenotic site and reference site were measured. Normalized wall index (NWI) was calculated as WA divided by OWA. Arterial remodeling index (RI) was calculated as OWA at the lesion site divided by OWA at the reference site, after adjusted for vessel tapering. Arterial remodeling was categorized as: positive if RI >1.05, intermediate if 0.95 <RI <1.05, and negative if RI <0.95.

RESULTS
One hundred and five plaques were identified in 31 patients, with multiple plaques seen in 23 patients. Forty-two were detected in the posterior circulation (basilar, 19; PCA, 6; and vertebral, 17), and 63 in the anterior circulation (ACA, 9; ICA, 34 and MCA, 20). Compared with anterior circulation plaques, posterior circulation plaques had larger NWI (i.e., plaque burden) (posterior vs anterior: 0.77±0.20 vs. 0.68±0.16, p=0.035), greater RI (posterior vs anterior: 1.22±0.56 vs. 1.04±0.27, p=0.042), and more frequently exhibited positive remodeling (posterior vs anterior: 50% vs.39%). Reliability for wall morphology measurements was excellent (ICCs ranged from 0.95 to 0.98).

CONCLUSION
Arterial remodeling of intracranial atherosclerosis appears to be geographic. Compared with anterior circulation arteries, posterior circulation arteries appear to have a greater capacity to remodel in response to plaque formation.

CLINICAL RELEVANCE/APPLICATION
These findings yield important information necessary for the interpretation of angiographic images, as posterior circulation plaques are probably underestimated by angiography.

An MRI Pulse Sequence for Whole-brain Bolus Tracking at High Frame Rates: RAZER (RAdial kZ-blipped 3D GRE-EPI for Whole-brain Perfusion)

Sumeeth V Jonathan MS (Presenter); Parmede Vakil PhD; Yong Jeong; Rajiv G Menon PhD; Sameer A Ansari MD, PhD; Timothy J Carroll PhD

PURPOSE
To measure cerebral perfusion, bolus tracking with DSC-MRI demands rapidly acquired T2*-weighted MR images. Current implementations of DSC-MRI are constrained by a temporal resolution of no more than 2’s (0.5 FPS) to adequately characterize a contrast agent bolus, with tradeoffs in SNR and spatial resolution. We introduce RAZER, a pulse sequence that obtains whole-brain DSC-MRI perfusion measurements at 6.2 FPS and 1.7 mm isotropic voxel resolution.

METHOD AND MATERIALS
RAZER uses in-plane radial sampling and through-plane 3D GRE-EPI Cartesian sampling to produce a cylindrical 3D volumetric k-space trajectory. Conventional radial k-space trajectories are constrained by the k-space Nyquist criteria and the requirement for zero phase error due to the uniform distribution of gradient directions. RAZER circumvents this by blipping the radial direction to allow for the rapid acquisition of T2*-weighted data. Compared to recent pulse sequences, RAZER allows for increased temporal resolution without compromising spatial resolution.
RESULTS
Figure 1 compares coronal, sagittal, and axial perfusion maps in RAZER (a) and the 2D GRE-EPI reference (b) with angiographic assessment (c) consistent with Moyamoya disease. Increased coverage in RAZER allows for finer resolution of the perfusion metrics in the through-plane direction while the reference is blurred. There is strong agreement in perfusion metrics using Bland-Altman correlation ($r^2 = 0.91$, mean bias in MTT measurements $= -0.01 \pm 0.89$ sec). Perfusion maps were coregistered prior to correlation using SPM.

CONCLUSION
RAZER obtains whole-brain perfusion measurements with good reference standard agreement. Sliding window view-sharing in $k$-space permits the use of a large temporal resolution for DSC-MRI without sacrifices in SNR and spatial resolution.

CLINICAL RELEVANCE/APPLICATION
RAZER is recommended for whole-brain MR perfusion study of central nervous system tumors, stroke, cerebrovascular occlusive disease, and Alzheimer's.

SSQ15-04 • In-Vivo Visualization of the PICA Perfusion Territories with Super-selective Pseudo-continuous Arterial Spin Labeling MRI

Nolan Hartkamp ; Laurens J De Cocker MD (Presenter) ; Michael Helle * ; Matthias Van Osch ; Jaap Kappelle ; Reinoud P Bokkers MD, PhD ; Jeroen Hendrikske MD

PURPOSE
To develop the first technique to visualize the cerebellar perfusion territories in-vivo.

METHOD AND MATERIALS
The perfusion territories of the vertebral arteries (VAs) were examined in 14 healthy subjects with four super-selective $p$-CASL MRI sequences (with labeling of both internal carotid arteries and both VAs). The following arterial perfusion territories in the cerebellum were distinguished: (1) territory exclusively fed by one vertebral artery (VA), namely the PICA territory in subjects with normal anatomy; (2) territory exclusively fed by the contralateral VA (contralateral PICA territory); (3) territory fed by both VAs after mixing in the basilar artery (bilateral AICA and SCA territories). The territorial perfusion maps were superimposed on anatomical T1WI and the PICA territories were manually outlined on the T1WI. The perfusion territories were also correlated with the arterial anatomy of the vertebobasilar system using time-of-flight MR angiography.

RESULTS
The vast majority of PICA perfusion territories could be identified. In 10 out of 14 subjects, both PICA perfusion territories could be distinguished. One subject had a missing VA, and one subject had a missing or hypoplastic PICA on one side. Two subjects did not have a discernible PICA territory on one side, either secondary to tiny anastomoses between the PICA and AICA, or either secondary to insufficient mixing of blood in the basilar artery.

CONCLUSION
We postulate that a selective labeling of each vertebral artery (VA) allows distinguishing the cerebellar territories that are exclusively fed by one VA (PICA in subjects with normal vascular anatomy) from those territories supplied by the basilar artery (AICA and SCA).

CLINICAL RELEVANCE/APPLICATION
The ability to link a cerebellar infarct with a particular perfusion territory may yield information on infarct pathogenesis and may refine treatment planning.

SSQ15-05 • 4D Flow MRI Indicates Changes in Intracranial Hemodynamics in Arteries Supplying Arteriovenous Malformations

Amir R Honaramand MD (Presenter) ; Biraj M Patel MD ; Can Wu ; Susanne Schnell ; Pegah Entezari MD ; Parmede Vakil PhD ; Michael C Hurley MBBCh ; Bernard Bendok MD ; Ali Shaibani MD ; Timothy J Carroll PhD ; Michael Markl PhD ; Sameer A Ansari MD, PhD

PURPOSE
To evaluate peak velocity (PV) and net flow (NF) in arteries supplying intracranial arteriovenous malformations (AVMs) using 4D flow MRI.

METHOD AND MATERIALS
With IRB approval, baseline 4D flow MRI was performed at 1.5T or 3T MR systems for a prospective study. Flow quantification was performed using ECG gated three-directional velocity encoding with full 3D coverage of the AVM nidus, feeding and draining vessels, and contralateral equivalent normal arteries. 4D flow MRI was acquired in an axial oblique 3D volume using flip angle of 15º, VENC: 100 cm/s, spatial resolution = (1.2-1.6) mm$^3$, and temporal resolution: 44 ms. Data analysis included 3D visualization of the velocity data and flow quantification using time integrated 3D pathlines positioned orthogonal to the vessel by a commercially available software (Ensight, CEI, Inc. Apex, NC). AVM Spetzler-Martin (SM) grade and nidus volume ($\pi/6 \cdot X \cdot Y \cdot Z$ dimensions) were obtained. Paired sample t test, one-way ANOVA, univariable, and stepwise multiple regression analysis were performed to build predictive models.

RESULTS
Ten patients (7M/3F) with mean age of 40.7 (10-66) years were studied. Hemodynamic parameters of 17 arteries (5 ICAs, 9 MCAs, 2 PCAs, and 1 ACA) supplying the AVM nidus, normal contralateral equivalent arteries, and corresponding sinuses draining the AVM were quantified. PV and NF were significantly higher in AVM arterial feeders (AFs) compared with normal contralateral equivalent arteries (EA) (mean: 0.96 Vs. 0.66 m/s, $P=0.001$; 5.2 Vs. 3.0 ml/cycle, $P=0.004$, respectively). No significant difference was observed between AFS$^\text{PV}$ and NF, and arterial parameters of normal arteries: (P=0.09, P=0.1, P=0.4, respectively). Stepwise multiple regression and univariable models identified nidus volume and EA$^\text{PV}$ as positively correlated with PV in AFS ($P=0.01, r=0.6$; $P=0.003, r=0.7$, respectively). NF was the significant factor for predicting PV in EAs ($P=0.001, r=0.7$). Positive direct correlation was observed between AFS$^\text{PV}$ and sinuses PV ($P=0.01, r=0.6$).

CONCLUSION
4D flow MRI is feasible for monitoring of cerebral AVM hemodynamic parameters and illustrates subtle, but distinct hemodynamic changes in arterial feeders compared to a normal equivalent arteries.

CLINICAL RELEVANCE/APPLICATION
These findings may have implications in novel characterization schemes for risk stratification based on quantitative flow analysis.

SSQ15-06 • Diagnosis of Carotid Artery Dissection with CT: Does the Contrast Material Really Help?

Luca Saba MD (Presenter) ; Eytan Raz MD ; Mario Piga ; Roberto Montisci MD ; Eugenio A Genovese MD

PURPOSE
The purpose of this work was to evaluate if the use of contrast material in the MDCTA study of carotid artery dissection (CAD) modify the
METHOD AND MATERIALS
One hundred patients (61 men, 39 women; mean age, 51 years; range, 25–78 years) 40 with and 60 without CAD, that underwent MDCTA for suspected CAD formed the study cohort. In this study patients from three different groups were included (patients with MR confirmation of CAD, n = 40; patients with MR confirmation of CAD absence, n = 20; patients that underwent MDCTA of carotid arteries for atherosclerosis analysis, n = 40). Three blinded observers with different level of expertise analyzed the randomized basal scan and after 3 months the observers evaluated the same datasets by using basal scans (BS) and after administration of contrast material (CM). Statistical analysis included Receiver Operating Characteristics (ROC) curve analysis and the Cohen weighted test.

RESULTS
The ROC curve analysis showed that for the 3 observers the use of BS versus BS and CM produced an improvement of the diagnostic confidence with AUC values from 0.884 to 0.926 (p value = 0.91) ; from 0.856 to 0.879 (p value = 0.365); and from 0.819 to 0.982 (p value = 0.01). The Cohen kappa analysis showed no significant difference in concordance with the use of BS versus BS and CM. The prevalence of uncertain findings was in 16%, 20.5% and 33% in the BS and 15%, 17.5% and 29% in BS and CM for observer 1, 2 and 3 respectively.

CONCLUSION
Results of our study suggest that the use of BS instead the classic BS and CM determines a small reduction in the diagnostic confidence of the readers, that is statistically significant in the only the junior one. Therefore the use of the only BS in the suspect of CAD may help in reducing cost and risk related to the administration of contrast material.

CLINICAL RELEVANCE/APPLICATION
Results of our study suggest that the use of the only basal in the suspect of CAD can be used and this approach may help in reducing cost and risk related to the administration of contrast material.

SSQ15-07 • Carotid Artery Stenosis: Comparison of 3D Time-of-Flight MR Angiography and Contrast-enhanced MR Angiography at 3.0T

Ivan Platzek MD (Presenter) ; Dominik A Sieron MD ; Philipp Wiggermann ; Michael Laniado MD

PURPOSE
To compare 3D time-of-flight MR angiography (TOF MRA) and contrast-enhanced MR angiography (CEMRA) for quantification of carotid artery stenosis at 3.0T.

METHOD AND MATERIALS
Twenty-three patients (5 f, 18 m; mean age 61 y, age range 45-78 y) with external carotid artery stenosis detected with Doppler ultrasonography were examined on a 3.0T MR system. The MR examination included both 3D TOF MRA and CEMRA of the carotid arteries. MR images were evaluated independently by two radiologists. Stenosis evaluation was based on a four-point scale: 0 = normal, 1 = mild stenosis, less than 50%; 2 = moderate stenosis, 50-69%; 3 = severe stenosis, more than 70% but less than full occlusion, 4 = occlusion). TOF MRA and CEMRA were evaluated separately, with a four-week time interval between evaluation sessions. While evaluating TOF MRA, the readers were blinded for CEMRA images and vice versa. Furthermore, the readers were blinded for other imaging or clinical data. In cases of interreader differences concerning the same MR angiography type, stenosis grade was determined by the readers in consensus. Stenosis grades determined by TOF and CEMRA were compared using the Wilcoxon test. Cohens Kappa was used to evaluate interrater reliability.

RESULTS

CONCLUSION
At 3.0T, 3D TOF MRA should not be used as replacement for contrast-enhanced MRA of the carotid arteries, as it results in significantly higher stenosis grades, and may lead to inadequate therapy.

CLINICAL RELEVANCE/APPLICATION
The current results imply that TOF MRA at 3.0T should not be used as a replacement for CEMRA, which itself is well validated by comparison with digital subtraction angiography in previous studies.

SSQ15-08 • Intraplaque Hemorrhage on Routine 3D-Time-of-Flight MR Angiography Is Strongly Associated with Symptomatic Status in Carotid Artery Stenosis

Hediyeh Baradaran MD (Presenter) ; Hooman Kamel MD ; Atul Mangla MD ; Ankur Pandya PhD, MPH ; Allison Dunning ; Vito Fodera MD ; Pina C Sanelli MD ; Ajay Gupta MD

PURPOSE
Intraplaque hemorrhage (IPH) in carotid artery atherosclerosis is strongly associated with previous and future stroke. Carotid plaque imaging has previously relied on high-resolution imaging using dedicated surface coils or MRI sequences not routinely obtained to measure stenosis. Recent reports suggest 3D-time-of-flight (TOF) imaging can accurately predict IPH compared to histopathology. We investigated the association between IPH determined on routinely acquired, 3D-TOF MRA neck images and prior stroke or TIA in patients with high-grade carotid stenosis.

METHOD AND MATERIALS
Subjects were screened after review of consecutive MRA neck exams performed from 8/2009 through 8/2012. Patients were included if they had high-grade carotid artery stenosis (70-99%) on non-contrast 3D-TOF MRA and documentation of prior stroke/TIA and vascular risk factors. All was determined by a validated technique assessing carotid plaque signal 50% more hyperintense than adjacent muscle. Assessments were made by two independent, blinded neuroradiologists with a third used as a tie-breaker. Clinical data was determined by consensus of two stroke neurologists. Statistical analysis was performed using univariate and multivariate logistic regression analysis with adjustment of statistically significant covariate risk factors.

RESULTS
After reviewing 4895 consecutive neck MRAs, 51 subjects with 53 carotid arteries met inclusion criteria. Vascular risk factors were not significantly different between groups. IPH was present in 24 carotid arteries. Of patients with IPH-positive exams, 15 had prior events (10 strokes, 5 TIA). Of those with negative exams, 4 had prior events (3 strokes, 1 TIA). In the univariate logistic regression analysis, the OR of the association of IPH to any prior ischemic event was 14.5 (95% CI 3.6-57.6) and the age- and sex-adjusted OR was 14.2 (95% CI 3.3-60.5). The association was preserved across magnet field strengths.

CONCLUSION
Our study demonstrates a strong association between ischemic events and IPH as determined on widely available, standard, large field-of-view neck coils using a 4-minute MRA sequence which is commonly used for screening exams.

CLINICAL RELEVANCE/APPLICATION
With prospective validation of our findings, regular reporting of IPH on neck MRA studies can be used as a risk stratification tool to complement measures of luminal diameter stenosis.

SSQ15-09 • CTA vs. 3T Black-Blood MRI for Identification of Symptomatic Carotid Plaques: A Comparative Study

Jochen M Grimm MD (Presenter) ; Andreas Schindler ; Florian Schwarz MD ; Clemens C Cyran MD * ; Martin Dichgans MD ; Tobias Saam MD * ; Tobias Freiling ; Maximilian F Reiser MD ; Konstantin Nikolaou MD * ; Fabian Bamberg MD, MPH * ; Chun Yuan PhD *
**Purpose**
The purpose of this prospective comparative study was to evaluate CT angiography (CTA) and black-blood 3T-MRI (bb-MRI) regarding their respective ability to identify symptomatic carotid plaques.

**Method and Materials**
20 patients with unilateral symptomatic carotid disease who underwent extensive clinical workup at our stroke unit to exclude other causes of ischemic stroke underwent standard CTA and bb-MRI with TOF, pre- and post-contrast fsT1-w, fsT2-w, and fsPDw-sequences within 7 days of symptom onset. Both symmetric and contralateral asymptomatic sides were evaluated. By bb-MRI, plaque morphology and composition and prevalence of complicated type VI lesions (AHA-LT6) with haemorrhage, thrombus and/or ruptured fibrous cap were evaluated. By CTA, plaque type (soft, mixed, hard), plaque density in HU and presence of ulceration and thrombus were evaluated. Sensitivity (SE), specificity (SP), positive and negative predictive value (PPV, NPV) were calculated using a two-by-two table.

**Results**
For identifying the symptomatic side AHA-LT6 was the best bb-MRI variable and presence of plaque ulceration was the best CTA variable, resulting in a SE, SP, PPV and NPV of 80%, 80%, 80% and 80% for AHA-LT6 as assessed by bb-MRI, 40%, 95%, 65% and 71% for plaque ulceration as assessed by CTA. The SE, SP, PPV and NPV for the combination of AHA-LT6 as determined by bb-MRI and ulceration as determined by CTA was 85%, 75%, 77% and 83%, respectively.

**Conclusion**
Bb-MRI delivered a better sensitivity, NPV and PPV compared to CTA at identifying the symptomatic side, while CTA offered an excellent specificity at the cost of low sensitivity and moderate PPV and NPV. Results were only slightly improved over bb-MRI when combining both techniques.

**Clinical Relevance/Application**
This study shows that bb-MRI is better suited to detect symptomatic carotid plaques than CTA. A combination of both techniques is only marginally superior to bb-MRI alone.

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**ISP: Nuclear Medicine (Neurologic Imaging)**

**Thursday, 10:30 AM - 12:00 PM • SSQ05AB**

**SSQ16 • AMA: 1.5 • ARRT:1.5**

Moderator
Satoshi Minoshima, MD, PhD *
Alexander Drzezga, MD *

**SSQ16-01 • Nuclear Medicine Keynote Speaker: State-of-the-Art Molecular Neuroimaging**
Alexander Drzezga MD (Presenter) *

**SSQ16-03 • Does Computer Aided Diagnostic (CAD) Software Decrease Inter-reader Variability of Florbetapir PET Brain Scan Interpretation?**

Ameya Nayate MD (Presenter) *; Jacob G Dubroff MD, PhD *; James E Schmitt MD, PhD; Rekha I Kishore MD *; Ilya M Nasraiah MD, PhD; David A Mankoff MD, PhD; Daniel Pryma MD *

**Purpose**

**Method and Materials**
29 patients enrolled in the Alzheimer’s disease neuroimaging initiative (ADNI 2) were included. Readers classified each case using a binary system, positive or negative for significant beta amyloid deposition. Each case was interpreted twice by each reader, once qualitatively and once with the aid of SUVr measurements generated by Scenium software (Siemens Medical). Cases were randomly assigned to 4 reading sessions separated by a washout period and interpreted by 5 blinded, board certified and Florbetapir-interpretation trained readers. No case was repeated within an individual session. To quantify inter-rater agreement, a kappa coefficient was calculated for the raters with and without the use of Scenium.

**Results**
When Florbetapir PET brain studies were read qualitatively, there was inter-reader disagreement in 8/29 cases. When the same Florbetapir PET studies were read with SUVr, there was inter-reader disagreement for only 1 case. The kappa coefficient for the studies read with SUVr (0.94) was statistically significantly higher compared to the qualitatively only read studies (0.71), p < 0.005.

**Conclusion**
The use of semi-quantitative indices (SUVr) to aid the interpretation of Florbetapir images improves inter-reader agreement. Further study is needed to confirm the impact on the accuracy of interpretation.

**Clinical Relevance/Application**
Computer aided diagnostic software can decrease inter-reader variability of F-18 Florbetapir PET brain scan interpretation.

**SSQ16-04 • A Novel Metric of Volumetric Statistical Amyloid Burden by Comparison to a Database of Health Controls**

Jon W Piper BEng (Presenter) *; Aaron S Nelson MD *; Sara Pirozzi BS *; Zhilei Shen

**Purpose**
Statistical parametric mapping allows voxelwise comparison between florbetapir PET brain images with reference to a database of cognitively normal subjects, after having registered each brain into a stereotactic brain atlas space. Here, we propose a metric, Volumetric Statistical Amyloid Burden (VSAB) computed as the volume of gray matter that exceeds a z-score threshold when compared to a database of young healthy controls.

**Method and Materials**
Consensus reads among three readers for 130 Florbetapir scans, as described in Fleisher et al (2011), were classified as either amyloid+ or amyloid-. MIMneuro 5.6 was used without intervention to deformally register each scan to a common atlas space with reference to 3 florbetapir PET templates. Z-scores were computed for every voxel in each Florbetapir scan, as compared to 74 young healthy controls. A gray matter mask, defined as the VOI encompassing the high uptake voxels of an average of many amyloid+ patients and excluding the high uptake voxels of an average of many amyloid- patients, was used to only consider gray matter burden in computing the final VSAB metric. Z-score thresholds from 3 to 7 were considered for the computation of VSAB, defined as the percentage of voxels within the gray matter mask that exceeded the z-score threshold.

**Results**
The Kappa statistics for agreement with consensus reads for VSAB computed with z-score thresholds 3, 4, 5, 6, and 7 were 0.90, 0.90, 0.92, 0.94, and 0.97, respectively. The VSAB used were 30.0%, 12.8%, 4.0%, 1.4%, and 0.7%, respectively.

**Conclusion**
Volumetric Statistical Amyloid Burden shows promise as an additional metric for distinguishing amyloid+ from amyloid-. Additionally, the agreement of this metric with visual assessment suggests that there may be value in computing voxel-level z-scores for amyloid images. Further work will investigate even more robust methods for gray matter mask definition and will compare VSAB with updated visual assessment methods.

CLINICAL RELEVANCE/APPLICATION
Incorporation of quantitative and statistical analysis of functional neuroimaging has shown to increase the accuracy and confidence of visual interpretation of these studies.

**SSQ16-05 • High Resolution PET Scanner Optimized for Neurological Imaging**
David Beylin MS, MBA (Presenter) *; Pavel Y Stepanov MS *; Stephen Schaeffer BS *; Irving N Weinberg MD, PhD *; Valera Zavarzin MS *

**PURPOSE**
Dementias and movement disorders such as Alzheimer’s disease (AD) and Parkinson’s disease (PD) present a huge societal and economic burden. Accurate, early diagnosis of these disorders using biomarkers is a research and clinical priority. Recent development of Positron Emission Tomography (PET) radiopharmaceuticals for evaluation of Alzheimer’s disease, and other dementias such as F18-florbetapir, F18-FDDNP, F18-florbetaben, F18-flutemetamol, and F18-AV-133, and others – position PET as a key diagnostic modality in evaluation of dementia and other brain disorders. Currently available PET scanning infrastructure relies on bulky Whole Body PET (WB PET) machines developed for oncology applications. While WB PET machines can acquire acceptable brain images, large-scale deployment of WB PET scanners to accommodate estimated volume of brain imaging procedures will be inefficient and costly. There is a clear need for a high-resolution, small-footprint, inexpensive PET scanner focusing on neurological applications.

**METHOD AND MATERIALS**
We constructed a dedicated brain PET scanner with a bore diameter of 25 cm and a 20 cm axial field of view. The intrinsic spatial resolution of the detector block is 1.9 mm. The bore and the head-support system are constructed to ensure that the scanner gantry does not obstruct the patient’s line of sight, which is important for claustrophobic patients and patients with neurological or psychiatric conditions, who may need to be in visual contact with the caregiver or healthcare staff at all times. The scanner performance was evaluated using various phantoms, including point sources, uniformity phantom, and Hoffman brain phantom.

**RESULTS**
The measurements demonstrated spatial resolution of 2-3 mm across the field of view, energy resolution of less than 13% for all detector blocks, image uniformity of better than 15%. Quantitative accuracy is better than 10% after calculated attenuation correction as benchmarked against the whole-body PET scanner.

**CONCLUSION**
Novel dedicated brain PET imaging device provides an acceptable alternative to whole-body PET machines at reduced cost to the healthcare facility. The device does not obstruct patient line of sight and could, potentially, eliminate claustrophobia.

**CLINICAL RELEVANCE/APPLICATION**
New PET imaging device could be used for F18-FDG and F18-florbetapir imaging in evaluation of Alzheimer’s disease, and clinical neuroscience research with novel CNS radiotracers.

**SSQ16-06 • Quantitative Analysis of FDG PET Hypometabolism in Pre-operative Identification of Seizure Foci Not Detected on Routine MR and Qualitative PET**
Bhawana Rathore MD (Presenter); Vina Ravichandran BA; Pearce Korb MD; James R Gait PhD; Robert E Gross; David M Schuster MD; Bruce J Barron MD *; Larry Olson; Jonathon Nye PhD *; Hamilton E Reavey MD

**PURPOSE**
Approximately 30% of patients with epilepsy are refractory to medications and may require resective brain surgery. Identification of candidate regions of seizure onset is crucial to successfully guide resection or placement of surgically implanted electrodes for intracranial electroencephalography (iEEG). However, many patients do not have visually identifiable lesions on brain MRI or PET making it a challenge for surgical planning. The primary aim of this proof of concept study is to determine if the most hypometabolic regions of the interictal brain PET using quantitative analysis software correlates with the seizure onset zone determined by subsequent iEEG.

**METHOD AND MATERIALS**
Eighteen interictal PET-CT scans of brain in patients who had also undergone iEEG were retrospectively reviewed. All patients originally had MR and qualitative PET interpreted as negative. The studies were then processed with quantitative analysis software (MimNeuro 5.6; Cleveland, Ohio) which compares PET images to a normal database. The 10 most hypometabolic foci were recorded on a scale of 1-10 with 1 being most hypometabolic. Foci which corresponded to white matter or cerebellum on co-registered CT were eliminated from analysis since these are rare locations for origin of seizures. Candidate foci based on rank order of hypometabolism were then compared to the actual location of the seizure onset zone as identified on iEEG.

**RESULTS**
Mean (±SD) age was 43.6 (±11.7); range 24-60 years. Ten patients were male and 8 female. For all 18 patients the seizure onset zone from the iEEG correlated with one of the hypometabolic foci on the quantitative PET analysis. Mean (±SD) rank order of hypometabolism for the seizure onset zone was 1.7 (±1.1); range 1-5. In 10 out of 18 patients (56%) the most hypometabolic focus correlated with the proven seizure onset zone on iEEG.

**CONCLUSION**
Quantitative analysis of PET hypometabolism may be useful in identifying candidate seizure onset zones and guiding placement of intracranial electroencephalography electrodes even in patients with negative MR and unrevealing qualitative PET. Further analyses with a larger sample size and co-registration of PET and MR is warranted to determine diagnostic performance.

**CLINICAL RELEVANCE/APPLICATION**
Quantitative analysis of PET hypometabolism may bring added value to pre-operative identification of seizure foci not detected on routine MR and qualitatively interpreted PET thereby improving outcomes.

**SSQ16-07 • PET/CT versus PET/MR for the Clinical Evaluation of Patients with Dementia: Comparison of Visual Interpretation by Two Experienced Readers**
Kent P Friedman MD (Presenter); Rajan Rakheja; Timothy M Shepherd MD, PhD; Rachel Bartlett PhD; Yu-Shin Ding PhD; Fernando Boada

**PURPOSE**
Simultaneous PET/MR is a new technology that may be used in the evaluation of dementia patients. There are few data in the literature regarding quantitative differences between PET data obtained at PET/CT versus PET/MR and how this may impact image interpretation. This study compared the PET interpretation of PET/CT versus PET/MR by two independent experienced nuclear medicine physicians.

**METHOD AND MATERIALS**
Forty-five minutes following injection of 10 mCi of FDG, 19 patients with clinically-suspected dementia underwent a 15-minute clinical brain PET/CT. Simultaneous PET/MR scanning was subsequently performed (60 minute list-mode) at approximately 90 minutes post-injection. Two experienced nuclear medicine physicians blindly interpreted the PET portion of all PET/CT scans, attributing a specific diagnosis (normal, AD, FTD, LBD, other dementia, mixed phenotype or unspecified disease) and severity scale (mild, moderate or severe abnormality). The readers then blindly interpreted the PET data obtained from PET/MR. Concordance between PET/CT (reference
RESULTS
Reader A classified 12 PET/CT scans as AD, 5 as unspecified dementia, 1 as LBD and 1 as normal with a mean severity score of 2.0. Reader B classified 10 PET/CT scans as AD, 3 as unspecified, 1 as LBD and 5 as normal with mean severity score of 2.1. PET/MR interpretations with comparison to PET/CT yielded an 84% (16/19) intra-reader concordance of diagnosis, with 95% (18/19) of severity scores varying by one point or less. Reader B exhibited 84% intra-reader concordance of dementia pattern diagnosis, with 89% (17/19) of all scores varying by one point or less.

CONCLUSION
Our preliminary analysis in clinically-suspected dementia patients showed a relatively high concordance of intra-reader assignment of diagnosis and severity of findings between PET/CT and PET/MR when evaluated by two blinded experienced nuclear medicine physicians. These results suggest PET/MR brain scans acquired on hybrid PET/MR are of diagnostic quality and interpretation results compare favourably to PET/CT.

CLINICAL RELEVANCE/APPLICATION
Prior to widespread implementation of PET/MR for dementia evaluation; PET results obtained by PET/MR need to be validated and compared to PET/CT.

SSQ16-08 • A Novel MR Atlas-based Method Outperforms the Silver-standard CT Segmentation-based Method in PET Attenuation Correction

Meher Juttukonda (Presenter) *; Yasheng Chen PhD; Yueh Z Lee MD, PhD *; Felipe Espinoza; Weili Lin PhD; Dinggang Shen PhD; David Lalush; Hongyu An DSc

PURPOSE
Since MR signal depends on proton (not electron) density and tissue relaxation, MR-based attenuation correction (AC) for MR/PET imaging is challenging. In this study, we have developed an atlas-based MR method for PET AC and have evaluated its accuracy using simulations.

METHOD AND MATERIALS
In a group of 10 patients with paired MR and CT images, 3 AC maps were generated for each patient. First, gold-standard maps (CTSC) were derived using bilinear scaling of their CT images. Second, nonlinear registration was performed to generate a T1w-MR and CT atlas. A hidden Markov random field method was then used in a leave-one-out scheme to derive a pseudo-CT (pCT) for each patient using the atlas and their MR image. These pCTs were then scaled to obtain MR-based AC maps (MRAC). Last, the original CTs were segmented into 3 classes (bone, air, soft tissue) and each class was assigned its attenuation value to yield a third AC map (CTSEG). The CTSEG method is considered the silver standard because it represents the best possible outcome of using an MR-segmentation-based AC method. Realistic, patient-specific PET simulations were then conducted to evaluate the performance of MRAC and CTSEG in the 10 patients for two cases: 1) normal brain and 2) brain with a focal lesion added. Attenuation was applied at the sinogram stage using the CTSC map and was corrected for using CTSEG and MRAC. The results were reconstructed and a percent-error analysis against the gold standard was performed.

RESULTS
The MRAC method resulted in a lower average whole-brain absolute percent-error (WBAE) across patients of 1.84% compared to the 4.57% achieved by the CTSEG method (p

CONCLUSION
We have developed a MR T1w-based AC method that outperforms the silver standard. In addition, the presence of a focal lesion does not affect the accuracy of the proposed method.

CLINICAL RELEVANCE/APPLICATION
An accurate MR-based AC method allows the MR/PET to become quantitatively reliable and opens the door for simultaneous quantitative-PET and MR applications.

SSQ16-09 • Serial Brain SPECT Imaging Using Neurogram Software to Monitor Treatment Response to Stem Cell Therapy in Patients with Cerebral Palsy

Parul Mohan MBBS, MD (Presenter); Geeta Shroff MBBS, MD; Harsh Mahajan MD, MBBS

PURPOSE
Hypoxic brain injury is one of the major causes of cerebral palsy. Stem cell therapy has shown promise in clinical trials and is sought by many parents of children with cerebral palsy (CP). Brain perfusion studies with single photon emission computed tomography (SPECT) have been applied in children with CP and have been evaluated either by visual interpretation or using semiquantitative analysis. Several processing protocols for 3D voxel-by-voxel analysis of brain perfusion SPECT have been applied, mainly the three-dimensional stereotactic surface projection (3DSSP) and the statistical parametric mapping (SPM) and recently the NeuroGam software. Although many studies have been published dealing with brain perfusion abnormalities in various neurological disorders, there is negligible literature concerning the interval changes in perfusion in cortical functional areas, pre and post therapy. The present study was to evaluate the treatment response (improvement or deterioration) in perfusion of specific areas of the brain cortex using Tc-HMPAO brain SPECT.

METHOD AND MATERIALS
Sixty three patients (49 boys, 14 girls; age range 1 yr to 31 yr) with clinical manifestations of cerebral palsy underwent brain SPECT after intraventricular injection of Tc-HMPAO.

RESULTS
The results were elaborated as mild improvement when 10%-30% changes were noted, moderate improvement when 30%-60% changes were noted and significant improvement when 60%-90% changes were noted. Thirty six patients had a normal brain SPECT after treatment. Seventeen patients had minimal residual hypoperfusion after treatment. The rest showed significant improvement after treatment with mild to moderate hypoperfusion. None of the patient in the series showed deterioration or no improvement.

CONCLUSION
Brain SPECT is an extremely useful tool in monitoring the treatment response to stem cell therapy in patients of cerebral palsy. It showed changes at the molecular level, hence indicating improvement even before the clinical changes were manifested.

CLINICAL RELEVANCE/APPLICATION
Brain SPECT showed changes at the molecular level, hence indicating improvement even before these changes became clinically apparent.
SSQ17-01 • Assessment of White Matter Integrity Using Tract-based Spatial Statistics in Lennox-Gastaut Syndrome

Mina Park MD ; Injoong Kim (Presenter) ; Kwon Joon Ho MD ; Yoon Seong Choi MD ; Na-Young Shin MD ; Kyung-Eun Kim MD ; Jinna Kim MD ; Seung-Koo Lee MD, PhD

PURPOSE
Lennox-Gastaut syndrome is a severe form of epilepsy with childhood onset, accompanying with moderate to severe cognitive dysfunction. However white matter disruption of the patients remains unclear. The aim of this study was to evaluate white matter integrity by using DTI in patients with Lennox-Gastaut syndrome without morphologic abnormalities in conventional imaging.

METHOD AND MATERIALS
In a retrospective study, diffusion tensor images from 11 patients of Lennox-Gastaut syndrome without morphologic abnormalities on conventional MRI were processed. Eleven clinical control subjects were matched for age, sex, and scanning parameters. Paired TBSS was performed to evaluate differences in FA.

RESULTS
In patients with Lennox-Gastaut syndrome, FA value clusters in the white matter was significantly decreased compared to the healthy controls. Significant FA values reduction in patients with Lennox-Gastaut syndrome were found in the right middle frontal gyrus, left superior frontal gyrus, bilateral anterior thalamic radiations, corpus callosum, external and internal capsules, inferior fronto-occipital fasciculus, and corticospinal tracts.

CONCLUSION
Despite qualitatively normal-appearing white matter tissues, patients with Lennox-Gastaut syndrome have widespread microstructural changes measurable with quantitative DTI. Although the pathologic-anatomic correlation of these findings remains, these regions are strongly suggested to be related to cognitive impairments in these patients.

CLINICAL RELEVANCE/APPLICATION
Fractional anisotropy evaluated using tract-based spatial statistics can be used to show abnormalities in the patients with Lennox-Gastaut syndrome who have normal findings at conventional MR imaging.

SSQ17-02 • Functional Connectivity in Children with Sickle Cell Anemia and Normal Brain MRI

Kathleen J Helton MD (Presenter) ; Diana Fridlyand BS ; Matthew Scoggin PhD ; Ping Zou PhD ; Jane Hankins MD ; Banu Aygun MD ; Jane Schreiber PhD ; Robert J Ogg PhD

PURPOSE
Children with sickle cell anemia (SCA) are at risk for cognitive impairment, but the etiology of cognitive dysfunction in patients without visible evidence of brain injury remains unknown. We have shown that intelligence quotient in children with SCA is associated with altered blood-oxygenation level dependent (BOLD) functional MRI response to visual stimulation, findings that suggest chronic anemia alters the neural-hemodynamic coupling that supports healthy brain function. We used BOLD fMRI to test the hypothesis that cognitive dysfunction in SCA is associated with altered brain network connectivity.

METHOD AND MATERIALS
Following IRB-approval and written informed consent, 15 untreated children (12.37±3.39 years) with SCA underwent fMRI (resting-state and Nback) and neuropsychological testing (IQ, Wechsler Intelligence Scale for Children, 2003). After realignment, slice time correction, spatial normalization and smoothing(SPM8, http://www.fil.ion.ucl.ac.uk/spm/), spatially independent brain regions with correlated temporal patterns of activity (components) were identified with independent component analysis (ICA) of resting and task data (GIFT link?). Adjacency matrices were constructed based on pair-wise correlation of component time courses. Networks metrics (modularity, cost-integrated average degree, cost-integrated average local efficiency, cost-integrated global efficiency) were analyzed in relation to published healthy normal (N) values, age, and IQ.

RESULTS
Global efficiency (SCA=0.4, N=0.6) and modularity (SCA= 0.16, N=0.4-0.6) were lower than normal, and global efficiency was negatively correlated with modularity (p

CONCLUSION
Decline of IQ with age shows adverse affects of disease on cognitive function. Network analysis revealed altered organization of brain networks in children with SCA, and graph-theoretical network metrics reflected abnormal age-related decline in IQ. The connectivity patterns observed may help to elucidate the mechanism of cognitive dysfunction in SCA.

CLINICAL RELEVANCE/APPLICATION
Functional connectivity analysis holds great promise as a clinical adjunct in future studies of patients with SCA to assess effectiveness of treatment in improving neurocognitive function.

SSQ17-03 • 3T Apparent Kurtosis Coefficient (AKC) in Pediatric Brain: Preliminary Results

Marzia Mortilla MD (Presenter) ; Antonio Ciccarone MD, PhD ; Marco Esposito ; Claudio Fonda MD

PURPOSE
Our purpose was to identify a MRI method for quantifying the degree to which water diffusion in biologic tissues is non-Gaussian. DWI depends on the the b-values used during acquisition. At b-values lower than 500/s/mm2 the signal attenuation is bi-exponential and it is influenced by both diffusion and perfusion. At b-values higher than 1000 s/mm2 the signal attenuation is influenced by restricted water diffusion and hence allows a non-Gaussian distribution. Diffusion Kurtosis Imaging (DKI) provides quantifiable information about the deviation from Gaussian distribution in water diffusion processes. Our aim was to use DKI in different pediatric brain pathologies in order to evaluate its feasibility in detecting those pathologies.

METHOD AND MATERIALS
The method is an extension of conventional DWI that requires higher b-values. We used 5 b-values: from 0 to 2500 s/mm2 with step 500. Fitting all b-values we were able to discriminate Diffusion and kurtosis parameters. We modified image post-processing procedure and we developed home made software for post-processing and DWI, ADC, AKC maps. We have examined 47 children (aged 15 days - 14yrs) with different pathologies (12 tumors, 4 vascular, 9 metabolic, 7 cognitive defects) and with no pathology (15).

RESULTS
AKC maps revealed additional information for tissue characterization. For example in hypoxic-ischemic lesions AKC revealed more details about pathologic tissue changes and provided some information about prognosis. In brain tumors, AKC maps were used for discriminating low-grade from high grade lesions showing more accuracy than conventional diffusion parameters. The 15 patients with no pathology were used to create a set of normal values for specific anatomic regions.

CONCLUSION
AKC and AKD are non invasive methods to study brain lesions in pediatric patients. Our results suggest that these maps provide a more detailed characterization of neural tissue in clinical context. The post-processing required to generate maps is more time consuming than traditional DWI maps (2 min for each slice) but this acquisition and post-processing method provide more complete characterization of water displacement inside parenchyma in DWI.

CLINICAL RELEVANCE/APPLICATION
SSQ17-04 • Alteration of Regional Low-frequency Fluctuation in Very Young Autistic Children: A Sedated-state fMRI Study

Hua Cheng MD (Presenter); Jishui Zhang; Hao Huang PhD; Gaolang Gong; Yun Peng MD

PURPOSE
So far, it remains largely unknown how the regional functional patterns are altered in very young autistic children. The present study aims to determine if there are functional changes in social cognition-associated brain areas in autistic patients at very young stage.

METHOD AND MATERIALS
Sedated-state fMRI data of 33 treatment-naive male autism (2-6 years) and 26 age-matched controls collected from a 3T clinical scanner using EPI sequence. The patients were diagnosed according to the ADI-R. Amplitude of low-frequency fluctuations (ALFF) and fractional ALFF were calculated using the REST software and analyzed in two different frequency bands (slow-5=0.016-0.078 Hz; fast-4: 0.027-0.073 Hz). To detect the group difference of ALFF or fALFF between autistic children and controls, a general linear model was applied to all voxels in grey matter. Statistical significance were determined by a cluster extent threshold of p<0.05.

RESULTS
We have found significant differences of frequency-dependent ALFF/fALFF in multiple brain regions between autistic children and controls (Supplementary Figure) which are associated with social cognition. Compared to controls, the patients showed similar decreased patterns in ALFF of both frequency bands and in fALFF of slow-5 band. Interestingly, ADI-R scores showed significant negative correlation with ALFF of slow-4 band in left temporal gyrus (p=0.01) (Supplementary Figure).

CONCLUSION
Our study reveals the abnormalities of functional activity of very young autistic children in multiple brain regions, which possibly underlies core symptoms of autism. The ALFF in left temporal lobe could be an imaging marker for autism evaluation. Therefore, the ALFF/fALFF analysis based on S-fMRI can be utilized as a potential method to evaluate brain functional development in very young children.

CLINICAL RELEVANCE/APPLICATION
The ALFF under sedated state could be a new imaging marker for evaluating functional abnormalities of autism in very young age.

SSQ17-05 • Biotin-responsive Basal Ganglia Disease (BBGD): Neuroimaging Features before and after Treatment

Hassan Kassem MD; Sari s Alsuhibani MBBS, MD (Presenter); Sherif Abdelfattah MD, PhD; Fahad Alsheikh; Ayman H Gaballah MD, FRCR

PURPOSE
The purpose is to assess the clinical and neuroimaging features of a biotin-responsive basal ganglia disease before and after treatment of a subacute encephalopathy and to compare the disease with the other basal ganglia diseases of childhood

METHOD AND MATERIALS
We retrospectively reviewed the clinical, laboratory and neuroimaging features of fifteen (15) genetically proven cases of biotin-responsive basal ganglia. All patients were of Arab ancestry and have consanguineous parents. Recessive genetic defect was detected in all cases. The chemical tests for organic and inorganic toxic compounds were normal in all cases. All patients were presented with recurrent subacute encephalopathy leading to seizures, extrapyramidal symptoms and coma. MRI of the brain was done in all cases at the onset of symptoms and within a few days after the administration of high doses of biotin (5-10 mg/kg/d).

RESULTS
The brain MRI showed bilateral lesions in the caudate heads in all cases with complete or partial involvement of the putamen. The globus pallidus and cerebellum were spared in all patients. In 12 cases, discrete abnormal signal changes were observed in the mesencephalon, cortical-subcortical regions and thalami. In 8 cases when the disease was advanced, patchy white matter disease was found. The high signal abnormality of the mesencephalon and cortical-subcortical areas were disappeared after treatment with biotin and thiamine while the caudate and putamen necrosis remained unchanged in all patients including those who became asymptomatic.

CONCLUSION
The neurological features, control of the disease with biotin and the distinctive MRI features should lead to the diagnosis of BBGD. It is important to check for the presence of this disease in children with acute onset extrapyramidal symptoms as therapeutic trial of biotin and thiamine can be lifesaving.

CLINICAL RELEVANCE/APPLICATION
It is important to check for the presence of this disease in children with acute extrapyramidal symptoms or subacute encephalopathy as it can be managed without further neurological deterioration.

SSQ17-06 • Does Ultrasound Texture Analysis of Periventricular White Matter Predict the Periventricular White Matter Injury in Preterm Infants?

Sun Kyoung You MD (Presenter); Young-Hun Choi; Sang-Joon Park BA; Jung-Eun Cheon MD; Woo Sun Kim MD; In-One Kim MD

PURPOSE
Periventricular leukomalacia(PVL) is the major cause of neurodevelopmental problems encountered in survivors of premature birth. The aim of this study was to evaluate the ultrasound texture analysis as a potential imaging tool for quantitative assessment of periventricular white matter (PVMW) injury in preterm infants.

METHOD AND MATERIALS
73 preterm infants (median gestational age; 28wks, median birth weight; 905.2g) who were treated in the neonatal intensive care unit and had serial cranial US and brain MR obtained at near term period (38.0 ±3.7wks) were included in our study. Periventricular echogenicity (PVE) on serial cranial US were evaluated qualitatively by visual grading as grade 1, 2, and 3 compared to echogenicity of the choroid plexus. The patients showed similar decreased patterns in ALFF of both frequency bands and in fALFF of slow-5 band. Interestingly, ADI-R scores showed significant negative correlation with ALFF of slow-4 band in left temporal gyrus (p=0.01) (Supplementary Figure).

RESULTS
All GLCM features did not show statistically significant difference between two groups, although mean value of ASM and IDM were higher in group 1 than those of group 2 (ASM p-value; 0.176, IDM p-value; 0.52). Contrast (degree of heterogeneity) and entropy (degree of randomness) were lower in group 1 than those of group 2 (contrast p-value; 0.68, entropy p-value; 0.221). IDM and entropy values of PVE grade 1 (less than choroid plexus) showed statistically significant difference between two groups. (IDM p-value; 0.006, entropy p-value).

CONCLUSION
Texture analysis using GLCM matrix method may serve as a complementary tool for quantitative assessment of PVE in selected cases of increased PVE. It is still questionable whether US screening of PVMW in premature infants can be a sensitive predictor of the PVMW injury in preterm infants.

CLINICAL RELEVANCE/APPLICATION
The application of DKI in pathological conditions in a pediatric population provides additional information about microstructural tissue changes, differential diagnosis and prognosis.
Low-dose temporal bone CT scans allow an accurate evaluation of middle and inner ear structures in children though reduced image

**SSQ17-08**  •  Amide Proton Transfer MR Imaging of the Brain in Children at 3T: A Preliminary Study

**Hong Zhang** MD (Presenter); **Jinyuan Zhou** PhD; **Na X Zhao** PhD; **Yun Peng** MD

**PURPOSE**
Amide Proton Transfer (APT) imaging is able to extend the achievable magnetic resonance imaging (MRI) contrast to the protein level. The aim of this study was to investigate APT effect in healthy children.

**METHOD AND MATERIALS**
A prospective study of 4 children with normal cranial sutures and 13 children with a clinical diagnosis of craniosynostosis was conducted following initial investigation of the "Black Bone" sequence in an animal model. Normal cranial sutures were assessed by measurement of suture widths with reference to normative data. "Black Bone" datasets in the 13 children with craniosynostosis were compared to CT and clinical findings. Blinded review of 12 "Black Bone" datasets from children was completed by 3 assessors, grading each cranial suture on a scale of 0 to 2. To provide comparable imaging to CT and enhance visualisation of the cranial sutures, techniques were developed to produce three-dimensional rendered images of the craniofacial skeleton.

**RESULTS**
Patent cranial sutures were consistently identified on the "Black Bone" datasets as areas of increased signal distinguished from the signal void of the cranial bone. In children with craniosynostosis the affected suture was absent, whilst the remaining patent sutures could be visualised. These findings were consistent with those on CT. On independent review, synostosed sutures received the lowest mean scores. Three-dimensional rendered images permitted visualisation of the cranial sutures throughout their course.

**CONCLUSION**
Patent cranial sutures appear as areas of increased signal on "Black Bone" MRI clearly distinguished from the cranial bone. The sequence accurately differentiates the normal suture from the prematurely fused, demonstrating considerable clinical potential as a non-ionising alternative to CT in the investigation of craniosynostosis.

**CLINICAL RELEVANCE/APPLICATION**
"Black Bone" MRI offers a non-ionising alternative to CT in the investigation of craniosynostosis, with the ability to produce three-dimensionally rendered images to enhance diagnostic capabilities.

**SSQ17-09**  •  Low-dose Temporal Bone CT in Children: Feasibility and Image Quality

**Hui Zheng** (Presenter); **Yuhua Li**; **Wenjun Cao**; **Ming Liu**; **Dengbin Wang** MD, PhD

**PURPOSE**
To evaluate the visualization of the temporal bone using low-dose 256-slice CT, we scanned one exsomatized cadaveric head at multiple levels of mAs and kV. This optimized protocol was used to examine pediatric patients. We analyzed the feasibility of low dose temporal bone CT in children and evaluate the image quality and radiation dose of a low-dose versus.

**METHOD AND MATERIALS**
One exsomatized cadaveric head was scanned repeatedly at three levels tube tensions from 120 to 80kV. And at every kV, multiple mAs were used from 250mAs until the image quality was insufficient. Noise was measured as the standard deviation in HU within the region the brain stem. All databases were subjectively evaluated by 2 experienced radiologists. The visibility of 16 anatomical landmarks was scored using a five point scale. The noise and effective dose were compared with each other. The optimized low dose protocol was used to examine 27 consecutive children. We retrospectively analyzed 36 examinations under a standard temporal bone CT acquired with 120kV, 250mAs. The image quality and the effective dose were analyzed. Image quality score frequencies were calculated for each group. The children were then divided into 5 groups according to age-specific effective dose conversion coefficient. The effective dose of different age groups were compared in both low and high protocol. And then we compared the effective dose between the two protocols at the same age.

**RESULTS**
CT radiation dose was significantly reduced when the parameters was selected 100kV, 70mAs. Most of the anatomical landmarks were delineated no significantly difference though the increased noise. The frequency of score 5 was significantly lower for the low-dose scans versus high, however the frequency of 4 was significantly higher. The frequency of the scores 1 and 2 was none for both protocols.

**CONCLUSION**
Low-dose temporal bone CT scans allow an accurate evaluation of middle and inner ear structures in children though reduced image
quality compared with that in high-dose scans. The radiation dose was 5–6 times below standard protocol used in daily work. The effective dose for infants is higher than the older children underwent the same protocol.

### CLINICAL RELEVANCE/APPLICATION

Postoperative CT of cochlear implants should provide information on the precise localization of the implant and its individual electrode.

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### SSQ18-01 • Patient-Specific CT Dose Maps (CTDM) and Patient-Specific Dose Estimates (PSDE) for Pediatric CT: Preliminary Results in Comparison with the CTDIvol and Size Specific Dose Estimate (SSDE)

**Dianna M Bardo** MD (Presenter) *; **Jeffrey H Yanof** PhD; **Donna M Stevens** MS; **Efrat Shefer** PhD *; **Galit Kafri** PhD *; **Jens Wiegert** PhD *

**PURPOSE**

This study aims to investigate PSDE which considers individual body habitus, attenuation/absorption characteristics of tissue and material included in pediatric CT using a Monte-Carlo simulation tool. Another aim is to devise a method to determine CT dose from scatter radiation and the proportion of scatter to displayed CTDIvol. Measures of all components of CT radiation: direct beam, over-ranging, and scatter are made with improved accuracy to produce a PDSE dose profile and compared to SSDE and CTDIvol.

**METHOD AND MATERIALS**

IRB approval was granted to review 15 pediatric CT and CTA exams, 8 male, 7 female, ages 6 days to 15 years. HU of each image voxel was used to categorize tissues into 6 material classes based on physical composition and chemical stoichiometry. PSDEs were computed from voxelized CTDMs using the Monte-Carlo method, integrating dose or energy in individual patients, taking into account tissue density. A Student’s paired t-test was used to compare the mean values of CTDIvol-normalized PSDE and SSDE for chest and abdomen regions.

**RESULTS**

CTDMs show that dose generally increases with decreasing patient size. The general trend of average normalized dose vs. patient size tends to agree with the SSDE. The calculated PSDE dose profile is greater in smaller diameter patients. Patient specific dose profiles of PSDE vary along the z-axis indicating variation of dose throughout the irradiated volume which depends on effective diameter, tissue type and position within the irradiation field. PSDE values for infant chest/cardiac CTA exams were greater than CTDI-normalized SSDE. In older/larger patients, increased diameter, which increases attenuation of x-rays, skews the PSDE less than the SSDE.

**CONCLUSION**

PSDE provides an accurate and individualized measure of radiation dose imparted during CT scan. CTDMs depict dose distribution within each slice. CTDMs and PSDE enable understanding of dose in different tissues, using varied scan protocols and are especially important in understanding imparted CT dose in infants.

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### SSQ18-02 • Reduction of Radiation Exposure, Effective Dose and Organ Dose in Pediatric Body CT Using BMI-based kVp Adjustment

**Vana M D erderian** BS (Presenter) *; **Jenifer W Siegelman** MD, MPH; **Choonsik Lee** PhD; **Elizabeth C Jones** MD; **Mahadevappa Mahesh** MS, PhD *; **Les R Folio** DO, MPH

**PURPOSE**

Understanding organ dose from CT in the context of age and body size is evolving. As part of efforts to balance CT radiation risk and its diagnostic benefit, we assessed the effectiveness of a BMI-based (Body Mass Index) kVp adjustment on dose in a pediatric cohort over time. We compared exposure and calculated patient-specific organ and effective dose from long z-axis exams in children before and after kVp reduction.

**METHOD AND MATERIALS**

To evaluate the effectiveness of BMI-based kVp adjustment, we retrospectively reviewed all kVp-adjusted CT scans in children (2012: n=358). Scans with kVp-adjusted Chest, Abdomen and Pelvis (CAP) or CAP with neck with one or more scans covering the same region prior to 2011 (program implementation) were included (n=13). Technical parameters (kVp, mAs, automatic exposure control (AEC) use) as well as exposure data (CTDIdvol, DLP) from four CT units extracted from Radiance/PACS were compared with SSDE (Size Specific Dose Estimate) effective diameter at the middle slice, organ and effective doses at two time points (2010 and 2012). Computational phantoms representing six different age groups (newborn to adult) and two genders were used for Monte Carlo simulation of organ dose. Radiologists and ordering physicians monitored studies for clinically relevant (subjective) reductions in quality. Repeat rate due to inadequate quality was collected.

**RESULTS**

Comparing 2012 with 2010 as baseline, CTDIdvol, DLP, and SSDE in 2012 were 22% (p=0.082), 20% (p=0.2982), and 26% (p=0.012) lower on average. Organ doses in 2012 were on average 26% (p=0.012) lower than baseline, similar to the reduction seen in SSDE. Urinary bladder and active marrow showed the maximum (28%) and minimum reduction (25%), respectively. No studies were repeated; no additional costs were incurred.

**CONCLUSION**

SSDE and average organ doses were, on average, 26% reduced after BMI-dependent kVp adjusted scans in 13 children. Use of BMI-based kVp adjustment is an economical dose reduction method that can maintain quality.

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### SSQ18-03 • High-pitch Dual Source Computed Tomography of Pediatric Abdomen

**Eray Atli** MD (Presenter); **Erhan Akpınar** MD; **Berna Sayan Oguz** MD; **Mithat Haliloglu** MD

**PURPOSE**

High-pitch Dual Source Computed Tomography of Pediatric Abdomen
To assess radiation dose reduction and image quality with high-pitch dual-source CT (DSCT) in comparison with standard pitch with conventional pediatric abdominal CT.

METHOD AND MATERIALS
A total of 48 patients (median age, 51.8 months) underwent high-pitch abdominal CT in this institutional review board-approved HIPAA-compliant prospective study. High-pitch (value:3) mode CT was performed with 64-slice DSCT. This was compared to a group of 37 patients (median age, 60.7 months) who underwent conventional pediatric abdominal CT (pitch: 1).

RESULTS
Both patient groups were similar with respect to age, ADP, LD, ED and SL. Mean ST of high-pitch abdomen CT was 1.56 sec, while it was 9.94 sec in standard pitch mode CT. In comparison with conventional pitch mode, high pitch mode of DSCT reduced radiation exposure by 67% (5.18 vs. 1.7 mGy, SSDE according to ED); CTDIvol, DLE and SSSE parameters were significantly lower in high pitch mode (p<0.05).

CONCLUSION
The use of high pitch DSCT significantly decreases scan times and radiation exposure when compared to conventional CT. Image quality and diagnostic confidence, however, is still similar in both imaging techniques.

CLINICAL RELEVANCE/APPLICATION
In pediatric abdominal imaging, high pitch DSCT provides fast scanning, less motion artifacts and significant reductions in radiation exposure without adversely affecting image quality.

SSQ18-04 • Dose Reduction in Pediatric Body-CT due to Fully-integrated-Digital 'Stellar®' Detector
Jennifer L Cullmann (Presenter) ; Khoschy Schawkat MD ; Daniel Ott MD ; Stefan Puig MD, MSc

PURPOSE
To evaluate the potential reduction of radiation dose in pediatric body CTs after implementation of a new fully-integrated-digital detector (Stellar®, Siemens Healthcare, Germany) compared with a conventional Ultra-Fast-Ceramic® (UFC) solid-state-detector.

METHOD AND MATERIALS
152 routine CT examinations (112 thoracic, 8 abdominal and 32 thoracoabdominal) of 114 children (58 male, 56 female) between 1 day and 16 years of age were included in the analysis. The following parameters were recorded: age, scan length, maximum body diameter, and CTDIvol, dose-length-product (DLP). The effective radiation dose (ED) was estimated from the DLP and an organ weighting factor (k): ED = k × DLP × (mGy × cm). All examinations were performed on a single dual source multi-detector CT (Somatom Definition Flash; Siemens Healthcare, Erlangen, Germany), 93 examinations before the exchange of the detector unit, with a UFC solid-state-detector, and 59 with the new digital Stellar®-detector. The scanning protocols were kept the same before and after replacement of the detector unit. Independent two-sample t-tests were used to assess statistical differences, the level of significance was defined as p = 0.05.

RESULTS
Age and body diameter did not show significant differences in both groups. The mean CTDIvol was about 16% lower after detector change (1.77 vs. 1.52 mSv). However, this difference was statistically not significant (p=0.3). The mean ED was significantly lower with the digital Stellar detector (0.74 mSv ± .6) compared with the previous UFC solid-state-detector (1.09 mSv ± 1.3) (p=0.02). This was obviously mainly achieved due to a significantly lower mean scan-length of 270 mm ± 123.6 vs. 231mm ± 89.5 (p=.3) resulting in a significantly lower DLP: 70.2 mGy × cm ± 88.4 vs. 45.2 mGy × cm ± 41.6 (p=.02).

CONCLUSION
Fully digital Stellar®-detector may achieve a mild reduction of radiation in pediatric patients. However, the main difference of the DLP was due to differences of the scan length before and after exchange of the detector unit.

CLINICAL RELEVANCE/APPLICATION
There may be some radiation dose reduction due to fully digital detectors. However, other factors such as scan length still have a major influence on radiation dose.

SSQ18-05 • Pediatric CT Radiation Dose Variability: Affecting Factors at a Large Academic Institute

Runish D Khawaja MBBS, MD (Presenter) ; Sarabjeet Singh MD ; Beth Vettiyil MBBS ; Sarvenaz Pourjabbar MD ; Atul Padole MD ; Mannudeep K Kalra MD * ; Diego A Lira MD

PURPOSE
Children are more susceptible to radiation-induced carcinogenesis because of greater organ radiosensitivity and a longer life-span. Since children have a wide variability in their body sizes and expected variations in radiation doses, we aimed to compare pediatric CT radiation doses across different body weight groups and across scanners, operators and body regions in pediatric CT.

METHOD AND MATERIALS
In an IRB-approved study, 544 consecutive pediatric (= 18years) chest (C) and abdomen-pelvis (AP) CT (nC=204; nAP=340; M:F=309:235) were assessed with a web based dose monitoring software (Exposure, Radimetrics) from 1/2011 to 1/2013. Demographics of patient (age, sex, body weight, and body diameter); body regions; age, sex, training experience of CT technologist, scanner type (availability of Iterative Reconstruction IR®), off-centering, and estimated effective dose (EED) were recorded. Corresponding EED values were also recorded for adult CT (n=14,000; C=6,000; nAP=8,000) for comparison. Analysis of variance (ANOVA) was used to evaluate differences in ED across above variables. P

RESULTS
Mean EED (ICRP-103) in pediatric cohort was 6.9±6.5 (EEDC: 4.7±5.3; EEDAP: 8.1±6.8; mean age:12.0±5.0 years). Compared to adults mean EED was 7.4±4.1 (EEDC: 4.6±2.7; EEDAP: 10.2±5.5). Mean EED for pediatric abdominal CT was significantly low compared corresponding adult dose (p

CONCLUSION
Mean EED varies considerably across scanners, body regions and with BW in pediatric patients. Mean ED varies significantly in children weighing 27-100Kg across scanners. This variability is low for lightweight.

CLINICAL RELEVANCE/APPLICATION
In our experience of pediatric CT, the only modifiers that affect the radiation dose variability include CT exam performed on IR versus non-IR scanners, and body weight of patient.

SSQ18-06 • Is Wide-detector Better than Helical Acquisition in Children Undergoing Torso CT Imaging?
Robert F Buchmann DO (Presenter) ; S. Bruce Greenberg MD

PURPOSE
We have shown a 45% reduction in radiation exposure with no loss in image quality for torso CT imaging of children by shifting from filtered back projection to Adaptive Iterative Dose Reduction (AIDR 3D). Our purpose was to evaluate if additional dose reduction or improved image quality variability could be obtained by changing from helical to wide-detector technique.

METHOD AND MATERIALS
The study groups include 100 children who had undergone helical torso CT and 50 who had undergone wide-detector torso CT.

Wide-detector technique is a step and shoot technique that allows for up to 16cm of coverage per rotation with stitching of multiple rotation acquisitions. The helical group average age was 9.4 years (SD 5.7) and the wide-detector group 10.0 years (SD 5.9) which was not significantly different (p = 0.54). Size-Specific Dose Estimates (SSDE) were calculated for each study. Image noise was used as a proxy for image quality. Three 1.0 cm² round regions of interest (ROI) were created, two in the right paraspinal muscles at the levels of the right pulmonary artery and the right kidney and one in the right gluteus maximus muscle. The standard deviation in each ROI

Page 415 of 528
RESULTS
The results are summarized in the table. No significant difference in the SSDE was present between the two study groups (p = 0.58). Children less than 7 years old undergoing wide-detector acquisition had a mean SSDE of 2.8 mGy (SD 0.5) while those undergoing helical acquisition had a mean SSDE of 3.2 mGy (SD 0.9). This difference was not significant (p = 0.09) but showed a trend towards reduced dose in younger children. Image noise in the abdomen was improved by wide-detector technique, but the difference was not significant (p = 0.18). A 7% reduction in pelvis image noise by wide-detector technique was significant (p = 0.04).

CONCLUSION
Radiation exposure was not significantly improved by the use of wide-detector scanning, but a trend towards modest improvement in younger, smaller children was observed. Pelvis image quality was significantly improved and a trend towards improvement in the abdomen was observed. Helical images are likely to have increased noise compared to wide-detector technique due to inherent smearing associated with helical technique.

CLINICAL RELEVANCE/APPLICATION
The information acquired allows for optimization of computed tomography in children.

SSQ18-07 • Usefulness of Large Beam-shaping Filters at Different Tube Voltages of Pediatric CT
Takanori Masuda (Presenter); Yoshinori Funama PhD; Naoyuki Imada; Takayuki Oku; Satoshi Inada; Kazuo Awai MD *

PURPOSE
As children are more susceptible to radiation-induced damage than adults it is necessary to use a lower radiation dose at pediatric CT. An effective reduction methods is the selection of large beam-shaping filters. We compared the radiation dose with small and large beam-shaping filters at different tube voltages and document the usefulness of large beam-shaping filters at pediatric CT.

METHOD AND MATERIALS
We used a 15-cm diameter cylindrical water phantom and inserted a 10-cm long pencil ionization chamber into the phantom center. Helical CT acquisitions were on a 64-detector CT scanner (VCT, GE Healthcare). The tube voltage was 80-, 100-, or 120 kVp; the beam pitch and gantry rotation time were 1.375 and 0.4 sec. The tube current was automatically set with automatic exposure control (noise index: 10 HU). The field-of-view (FOV) was 15- and 50 cm with small and large beam-shaping filters, respectively. Scans with a 50-cm FOV were reconstructed at a 15-cm display FOV. The radiation dose and image noise (SD of the CT number) were compared on all reconstructed images.

RESULTS
The radiation dose with the small beam-shaping filter was 2.08 mGy at 80-, 2.07 mGy at 100-, and 2.24 mGy at 120 kVp, respectively. With the large filter it was decreased to 1.9, 1.94, and 1.77 mGy at 80-, 100-, and 120 kVp. At each tube voltage the radiation dose was lower with the large- than the small filter. The image noise was 8.42 HU at 80-, 8.34 HU at 100-, and 8.26 HU at 120 kVp with the small filter, respectively; with the large filter it was 8.52, 8.23, and 8.45 HU. There was no significant difference in image noise between small and large beam-shaping filters at all tube voltages (p>0.05).

CONCLUSION
The use of a large beam-shaping filter facilitates, radiation dose reductions by 10-20% without image quality degradation at pediatric CT.

CLINICAL RELEVANCE/APPLICATION
Large beam-shaping filters help to reduce the radiation dose at 64-detector CT, eliminating the need for investments in new technology.

SSQ18-08 • Organ and Effective Doses in Dual-energy CT of Pediatric Contrast-enhanced Examinations: Comparison to Single-energy CT Using Low Tube Potential
Juan Carlos Ramirez Giraldo PhD (Presenter); Marilyn J Siegel MD *; R Bankwitz *; Marga Leuthe *; Bernhard Schmidt PhD *

PURPOSE
To evaluate the organ and effective doses of dual-energy CT (DECT) in pediatric-sized phantoms in comparison to low tube potential single-energy CT (SECT) with the same radiation output.

METHOD AND MATERIALS
Two anthropomorphic phantoms simulating a 1 year-old and a 5 year-old that had inserted thermoluminescent dosimeters (TLDs) were scanned using a dual-source 128-slice CT system operated with conventional SECT at low tube potential and also DECT at 80/140 kVp with tin filtration. The scan range included both abdomen and pelvis. For the SECT scans, the tube potential and corresponding tube current were selected by using an automated tube potential selection tool (CARE kV), using 120 kVp and 150 mAs as reference, with optimization for CT angiography. The scanner output, as measured by the volume CT dose index (CTDIvol), was recorded and used to adjust the mAs in the DECT scans such that CTDIvol was the same as the SECT scan. Organ doses in mGy were measured and the effective dose in mSv was calculated by summing the absorbed doses (mGy) of individual organs considering ICRP103 weighting factors.

RESULTS
The resulting CTDIvol values were 0.67 mGy and 2.73 mGy for the 1 year-old and 5 year-old phantoms, respectively. The calculated effective doses were 1 and 1 mSv (1 year-old), and 3 and 3 mSv (5 year-old) for the 80 kVp and 80/140 kVp scans, respectively. In the 1 year-old phantom, organ doses were statistically the same with average difference of 0.11 mGy (P=0.07) between 80 kVp and 80/140 kVp. In the 5 year-old phantom, organ doses were also statistically the same with average difference of 0.35 mGy (P=0.15) between 80 kVp and 80/140 kVp.

CONCLUSION
At matched radiation scanner output, organ and effective doses of DECT scans are comparable to those from conventional SECT at a low tube potential of 80 kVp.

CLINICAL RELEVANCE/APPLICATION
The ability of DECT to achieve comparable organ and effective doses relative to optimized low-tube potential CT angiography in pediatrics, is a pre-requisite for consideration of its use clinically.

SSQ18-09 • The Optimal Dose Reduction Level in Chest CT with 640-slice CT Volume Scan Mode Using Iterative Reconstruction (AIDR 3D) in Little Swine Model
Qin Liu MA, BA (Presenter); Yang Hou MD; Pengfei Zhao; Qiyong Guo MD

PURPOSE
To evaluate the radiation dose and image quality (IQ) of an iterative reconstruction (AIDR 3D) in combination with SureExposure3D on a 640-slice CT and determine the optimal dose reduction using AIDR 3D for neonates and children chest CT that can provide IQ comparable to filtered back projection (FBP).

METHOD AND MATERIALS
29 normal swines whose weight ranged 3-12kg (7.62±2.67) underwent 640-slice MDCT chest CT(Aquilion one, Toshiba) for 5 times with 80kVp and different mAs. SureExposure3D technique were used and the index of noise were set to SD10 (Group A, routine dose),...
SD12.5, SD15, SD17.5, SD20 (Group B-E) to reduce dose successively. Group A were reconstructed with FBP, Group B-E were reconstructed using AIDR 3D (strong level). Two radiologists graded subject image quality in both lung and mediastinal images using a 5-point scale in a blinded manner. Object IQ parameters of image noise, signal-to-noise (SNR) were measured in each group. A receiver-operating characteristic (ROC) analysis was performed to establish a radiation reduction threshold up to which comparable IQ (score=4) was maintained.

RESULTS
Group B, C, D has significantly lower noise, better SNR than Group A/P

CONCLUSION
Using AIDR 3D technique, 80kvp with SureExposure3D (SD17.5) can provide comparable or even better IQ compared with routine dose with FBP reconstruction, and reduce 43% dose in little swine model.

CLINICAL RELEVANCE/APPLICATION
The results of little swine model may be applied to reducing radiation dose of chest CT in neonates and children with serious lung infections.

### Physics (MRI Techniques III)

**Thursday, 10:30 AM - 12:00 PM • S403B**

**SSQ19 • AMA PRA Category 1 Credit ™ • ARRT Category A+ Credit:1.5**

**Moderator**

Savannah C Partridge, PhD *

**Moderator**

Yi Wang, PhD

### SSQ19-01 • Accurate Temperature Measurements in the Presence of Field Inhomogeneities for MR Guided Thermal Therapies

**Chang-Sheng Mei** PhD (Presenter); **Renxin Chu** PhD; **W. Scott Hoge** PhD; **Lawrence P Panych** PhD; **Bruno Madore** PhD *

**PURPOSE**
The present study aimed at developing an MRI-based temperature monitoring strategy capable of providing accurate temperature measurements even in the presence of field inhomogeneities. Such inhomogeneities commonly occur near air-tissue transitions, for example, around the sphenoid sinuses, and can significantly degrade the accuracy of temperature measurements.

**METHOD AND MATERIALS**
The use of a multi-pathway steady-state sequence is proposed here to help detect and correct for susceptibility-induced temperature measurement errors. The two different signal pathways sampled by the sequence lead to temperature errors of different polarity, +7° and -7°, making it possible to detect and correct for such errors. These two pathways correspond to the so-called fast imaging with steady-state precession (FISP) signal and the inverse-FISP (PSIF) signal. The heating curve from both signal pathways can be measured, on a pixel-by-pixel basis, and a single-variable equation can be solved to evaluate the temperature errors, allowing them to be corrected for. The method was tested in gel phantoms and in a rabbit model.

**RESULTS**
Measurement errors of several °C were observed and corrected for in controlled phantom experiments where known field inhomogeneities were intentionally introduced by de-adjusting high-order shim settings. Temperature errors were also observed and corrected for in a rabbit model, where field inhomogeneities were unavoidably present despite shimming, due to nearby air-tissue interfaces. After the proposed correction scheme was applied on a pixel-by-pixel basis, agreement was obtained between both FISP and PSIF measurements. Errors by up to about 20% in temperature elevation (overestimation by 5 °C on a 25 °C peak temperature elevation) have been observed and avoided.

**CONCLUSION**
We have demonstrated a method for detecting and correcting for susceptibility-induced temperature measurement errors. The method allows accurate temperature measurements to be performed even near air-tissue interfaces, with potential benefits in prostate, uterus, and brain MR-guidance applications.

**CLINICAL RELEVANCE/APPLICATION**
The proposed thermometry method allows susceptibility-induced temperature errors to be detected and corrected for. As a result, improved MR guidance may be achieved, during thermal therapies.

### SSQ19-02 • Improving Reconstruction Speed for Dynamic MRI Using Parallel Imaging with Combined Coil Compression and Direct Virtual Coil

**Kang Wang** PhD (Presenter); **Scott N K Nagle** MD, PhD *; **Harald Kramer** MD; **Tao Zhang**; **Philip Beatty**; **Mahdi Rahimi**; **Courtney K Morrison**; **Frank R Korosec** PhD *; **Scott B Reeder** MD, PhD; **Dan W Rettmann** BS *; **Ersin Bayram** PhD *

**James H Holmes** PhD *

**PURPOSE**
Coil-by-coil (CBC) data-driven auto-calibrating parallel imaging has become more widely used for dynamic MR applications, such as dynamic contrast-enhanced (DCE) MR angiography (MRA). However, for high spatial resolution, high parallel imaging factors and high channel count coil array protocols, the image reconstruction time can be clinically unacceptably long. This work demonstrates an initial comparison of combining Coil Compression and Direct Virtual Coil (CCDVC) to significantly reduce reconstruction times vs. the currently used conventional method of CBC in the setting of dynamic contrast enhanced peripheral runoff MR angiography.

**METHOD AND MATERIALS**
Twenty-four volunteers (7 healthy, 17 with pathology) were imaged and informed consent was obtained prior to all scanning. All scans were conducted on a clinical scanner (3.0T MR750, GE Healthcare), with 48cm FOV, 1.0mm isotropic resolution, 32-channel coil array and parallel imaging factor of 3 (phase) × 2 (slice) = 6. Temporal view-sharing was used to generate raw data for each time frame. The same raw data sets were then reconstructed twice: once with CBC and once with CCDVC. Time-resolved images reconstructed using CBC and CCDVC were randomized and blindly scored by two radiologists using a 5-point scale: image 1 much better (clinically significant); image 1 slightly better (not clinically significant); equivalent; image 2 slightly better (not clinically significant); image 2 much better (clinically significant).

**RESULTS**
The reconstruction times for CCDVC were about 18× faster than the conventional CBC method (17 sec vs. 311 sec per phase on an offline computer) in the parallel imaging synthesis/FFT/coil combination module. One radiologist scored 18 cases as equivalent, 3 cases as CCDVC slightly better, and 3 cases as CBC slightly better; the second radiologist scored 17 cases as equivalent, and 7 cases as CCDVC slightly better.

**CONCLUSION**
The combined CCDVC technique was shown to significantly reduce the reconstruction time for high spatial and temporal resolution peripheral MRA, with no significant loss in image quality.
CONCLUSION

The apparatus was designed to exercise the VL with subjects in supine position with a dual-tuned 1H-31P TX/RX surface coil strapped to the thigh. PCr depletion levels and recovery times were measured for 8 minutes following a 5 min period of exercise. Slice-selective 31P-MRS was performed on 5 subjects (4 male, 15-56 y.o.) with TR=3000 ms, NSA=2, BW=2200 Hz. The time for return of PCr values to their half-maximum (T-half) was used as an index for the rate of ATP synthesis. PCr recovery data were fit to the function PCr(t) = PCr(0) + D[1-exp(-bt)] using the Marquardt-Levenberg algorithm (nlsLM function) in the R statistical package, where D and b were the fitted variables.

RESULTS

The data support the use of repetitive TMS as a safe adjuvant therapy to surgery and pharmaceuticals in the treatment of neurological movement and major depressive disorders.

CLINICAL RELEVANCE/APPLICATION

Noninvasive, reproducible measures of mitochondrial function by a well-characterized in-vivo biomarker can provide insights for the characterization and treatment of metabolic diseases.

SSQ19-03 • Exercise System for Using 31-phosphorus MR Spectroscopy to Monitor Phosphocreatine Recovery from Exercise as Index for Mitochondrial Metabolism

Floyd Settles (Presenter) ; Geoffrey D Clarke PhD

PURPOSE

Measurement of mitochondrial function is relevant to aging, diabetes, and sports medicine. Phosphorus-31 magnetic resonance spectroscopy (31P-MRS) can be used to evaluate the rate of phosphocreatine (PCr) recovery following exercise as a noninvasive index of the rate of ATP synthesis. The project’s aim is to develop a reproducible measurement technique using an exercise apparatus to quantify PCr recovery in the vastus lateralis muscle (VL).

METHOD AND MATERIALS

The apparatus was designed to exercise the VL with subjects in supine position with a dual-tuned 1H-31P TX/RX surface coil strapped to the thigh. PCr depletion levels and recovery times were measured for 8 minutes following a 5 min period of exercise. Slice-selective 31P-MRS was performed on 5 subjects (4 male, 15-56 y.o.) with TR=3000 ms, NSA=2, BW=2200 Hz. The time for return of PCr values to their half-maximum (T-half) was used as an index for the rate of ATP synthesis. PCr recovery data were fit to the function PCr(t) = PCr(0) + D[1-exp(-bt)] using the Marquardt-Levenberg algorithm (nlsLM function) in the R statistical package, where D and b were the fitted variables.

RESULTS

The prototyped apparatus is a compact, single-piece PVC assembly with little mass (CONCLUSION

The apparatus works, supporting and immobilizing the thigh and surface coil during baseline, dynamic flexion exercise and recovery phases of the protocol. Spectral data acquired consistently demonstrated PCr depletion and recovery in VL across all subjects. Predictable extension of the lower leg is obtained with a constant resistance without the use of large weights.

CLINICAL RELEVANCE/APPLICATION

Noninvasive, reproducible measures of mitochondrial function by a well-characterized in-vivo biomarker can provide insights for the characterization and treatment of metabolic diseases.

SSQ19-04 • Transcranial Magnetic Stimulation-Induced Heating of Deep Brain Stimulation Implants: An Empirical Specific Absorption Rate Evaluation Using a Tissue Equivalent Phantom

Goldie R Boone MS (Presenter) ; Geoffrey D Clarke PhD

PURPOSE

Transcranial magnetic stimulation (TMS) uses electromagnetic induction to generate weak electric currents by application of rapidly changing magnetic fields to depolarize or hyperpolarize neurons in the brain. The potential for induced heating of brain tissues located near bilaterally implanted deep brain stimulation (DBS) electrodes during application of single pulse and repetitively pulsed TMS was investigated. This study provides empirical evidence for the reasonable assurance of safety in the FDA’s classification of TMS as a Class II (special controls) device.

METHOD AND MATERIALS

TMS was conducted using the MagPro R30 system (MagVenture, Denmark) with a liquid cooled butterfly coil (model Cool-B65). TMS-induced heating was measured using a proprietary phantom and a clinical/research stimulation protocol. Fiber optic thermometry probes acquired real-time temperature measurements of the induced heating at the surface of the metallic DBS electrodes during TMS. The three specific aims of this study were to evaluate the 1) spatially localized temperature increase, 2) spatially localized specific absorption rate (SAR), and 3) the average head SAR in the phantom in the absence and presence of the DBS implant over a 6 minute averaging period in saline and gelled-saline solutions at stimulation frequencies of 1 and 5 Hz. The differences in the average temperatures in the presence and absence of bilateral DBS implants were analyzed by ANOVA (p = 0.05, power = 0.80) with Bonferroni correction.

RESULTS

In the clinical/research stimulation orientation, no evidence of induced heating effects was observed above the thermal noise. However, stimulation of the lead loops at 5 Hz in gelled saline at a distance of 0.5 cm from the coil’s surface and peak intensity region resulted in temperatures that tripled the spatially localized temperature limit and SAR values that doubled the spatially localized SAR limit. TMS-induced heating effects of this nature may result in localized tissue damage.

CONCLUSION

The observations in this research study support the use of repetitive TMS of patients with a bilateral DBS device implant provided prior knowledge is used to guide surgical lead configuration and careful coil placement during stimulation.

CLINICAL RELEVANCE/APPLICATION

The data support the use of repetitive TMS as a safe adjuvant therapy to surgery and pharmaceuticals in the treatment of neurological movement and major depressive disorders.

SSQ19-05 • How to Improve the Quality and Speed of 3T MR Imaging in Cervical and Lumbar Spine by Multiple RF Transmission?

Chuan Shuai Tian (Presenter) ; Bing Zhang PhD ; Fei Chen MS ; Bin Zhu ; Haiping Yu ; Ming Li ; Danyan Li ; Huiting Wang MS ; Weibo Chen MSc ; Queenie Chan PhD

PURPOSE

We aimed to study how to improve the quality and speed of cervical and lumbar imaging by TX technology compared with single transmission (without TX).

METHOD AND MATERIALS

Thirty-seven healthy volunteers (seventeen (5 male and 12 female), aged 21-55yr (mean 38.47±13.02yr) for cervical; twenty (8 male and 12 female), aged 20-64yr (mean 29.25±8.48yr) for lumbar) were scanned at 3.0T scanner (Achieva TX, Best, the Netherlands), acquiring the T2WI and T1WI images of the cervical and lumbar with and without TX. We compared the parameters, as well as the average signal intensity in different region of interest (ROIs) between the cervical and lumbar MRI with and without TX (Fig.a,b). P values less than 0.05 were considered statistically significant by Paired t-test.

RESULTS

TR was shortened by 1224ms(26.67%) on T2WI, and 97ms (17.64%) on T1WI in lumbar MRI. Packages reduced by 1.5±1 (37.5%), scanning time is shortened by 97.2±31.15s (44.02%). On T2WI of the cervical, the average signal intensity of ROIs 3/4/9 for vertebrae, ROIs 10/11 for fat were increased, ROIs 6/7 for the spinal cord, ROI 12 for the pons were decreased (P 0.05 have no statistical significance. On T1WI, the average signal intensity of ROIs 1/2 for vertebrae, ROIs 5-8 as the spinal cord, ROI 12 for the pons, ROI 13 for the cerebellum were reduced, ROIs 10/11 for fat were increased (P 0.05 have no statistical significance. On T2WI of the Lumbar, the average signal intensity of ROIs 1-6/10 for vertebrae, ROI 9 (on the same level of lumbar 5 ) for fat were reduced; ROI 8 (on the same level of lumbar 1) for fat was increased (P 0.05, no statistical significance. On T1WI, the average signal intensity of ROIs 2-6/10 for vertebrae, ROI 7 for the spinal cord were reduced; ROI 8 for fat was increased (P 0.05 have no statistical significance.

CONCLUSION
SSQV-06 • High B-value Diffusion Weighted Imaging in Defining the Infiltration Zone of Cerebral Glioma

Chunhui Jiang BMedSc, MMedSc ; Jian Wang (Presenter)

CONCLUSION
It is demonstrated in this study that DWI may be useful in defining the infiltration zone of glioma, especially with high B-values. Larger studies are needed to prospectively validate the utility of ADC from high B-values DWI scan as a noninvasive imaging biomarker for quantitatively measuring the infiltration zone of glioma.

Background
To evaluate the role of the ADC value in patients with glioma (WHO II-IV) using high B-value diffusion weighted imaging (DWI), as a potential noninvasive quantitative index in defining the boundary of glioma.

Evaluation
18 cases of surgical pathologically confirmed glioma underwent the DWI scan with b=1000 and 3000s/mm² respectively in a 3T MR scanner. The ADC values of the glioma substantial zone, cerebral parenchyma within 0-10/10-20mm radius and the cerebral parenchyma of the opposite sphere are statistically analyzed by SPSS17.

SSQV-07 • Comparison of Signal as a Function of Position for a 1H/31P Surface Coil Used in Exercise Studies

Erika Ripley (Presenter) ; Geoffrey D Clarke PhD

PURPOSE
MRI-compatible exercise studies are reported in the literature for measuring phosphorus-31 (31P) metabolites in the vastus lateralis muscle (VL). For these studies the thigh is positioned at an angle with respect to the main magnetic field to allow leg movement, which is a non-optimal orientation for the MRS coil. This study determines the performance degradation in the RF coil due to orientation.

METHOD AND MATERIALS
A dual-tuned rigid TX/RX surface coil (Rapid Biomedical, Rimpark, Germany) was used on a 3T MRI system (TIM Trio, Siemens, Malvern, PA) to collect 31P spectra from a leg phantom (15 cm diameter, 4 L plastic cylindrical jug with 10 mM H3P04) and a small standard (6 mL plastic vial with a 850 mM concentration of methylenediphosphonic acid (MDP)). The standard was positioned on the surface coil and a 1-pulse 31P sequence was performed (TR 8000 ms, 4 NSA, 4 prep scans, BW=3000 Hz). Spectra were taken with the MDP vial at the center of the coil, 5 cm, 8 cm and 10 cm away from the center in the R/L and H/F directions. Measurements were repeated with the leg phantom flat on the table parallel to θ (0°) and secured to the exercise device at an angle of 38.9° with respect to B0. Spectra were analyzed using JMRUI software to determine the area under each peak. Paired t-tests were used to evaluate the statistical significance (p RESULTS
The areas of the MDP peaks were plotted with respect to position. For both orientations, the signal from right to left was symmetric about the center of the coil with the highest signal at ±8 cm. The signals across the coil R/L were reduced by 30% (p=0.015) at 38.9° compared to 0°. Along the z-axis, the signal from the portion of the VL muscle that is near the knee-end of the leg was reduced by 60% (p=0.038) compared to 0°.

CONCLUSION
Signal intensity changes from the acquired phantom data suggest that over 60% of the total signal is lost at the 38.9° angle. Most of the signal will come from the VL muscle that is near the knee-end of the leg. To evaluate the role of the ADC value in patients with glioma (WHO II-IV) using high B-value diffusion weighted imaging (DWI), as a potential noninvasive quantitative index in defining the boundary of glioma.

SSQV-08 • Cerebrospinal Fluid Flow in the Ventricular System in Idiopathic Normal Pressure Hydrocephalus

Naoki Ohno MS (Presenter) ; Toshiaki Miyati PhD ; Mitsuhiro Mase MD ; Noam Alperin PhD * ; Harumasa Kasai MSc ; Shinnosuke Hiratsuka ; Makoto Kawano ; Yuta Shibamoto MD, PhD ; Toshifumi Gabata MD ; Osamu Matsui MD

PURPOSE
We have reported that temporal changes in the brain parenchyma's apparent diffusion coefficient (ADC) during the cardiac cycle (7ADC) reveal the degree of fluctuation of water molecules likely resulting from arterial inflow (volume loading) during systole, and this information potentially facilitates the diagnosis of idiopathic normal pressure hydrocephalus (iNPH). However, we assessed the ADC change only in white matter. Moreover, several studies have shown that analysis of intraventricular CSF flow can provide the intracranial condition in iNPH. We therefore determined the temporal change in ADC over the cardiac cycle in the ventricular system of iNPH.

METHOD AND MATERIALS
On a 1.5-T MRI, ECG-triggered single-shot diffusion echo planar imaging (b = 0 and 1000 s/mm²) was used with sensitivity encoding and half-scan techniques to minimize the bulk motion. Then ADC image of each cardiac phase were made. Next, a normalized-ADC image was calculated from all cardiac phase ADC images (20 phases) on a pixel-by-pixel basis using the following equation: Normalized-ADC = (ADCmax - ADC) / (ADCmax - ADCmin), where ADCmax and ADCmin represent the maximum and minimum ADC during the cardiac cycle, respectively. We assessed normalized-ADC and ADC values in the three ventricular regions, i.e. the anterior and posterior horns of the lateral ventricles and the third ventricle, and compared those values among the iNPH (n=14), atrophic ventricular dilatation (atrophic VD group; n=9), and healthy volunteers (control group; n=8).

RESULTS
Normalized-ADC was significantly higher in iNPH compared with the control and atrophic VD groups, whereas there were no significant differences for normalized-ADC in the other regions among the groups. This result can be explained by the fact that large compression on the ventricular system increases the fluctuation of the water molecules. However, there were no significant differences in ADC of all ventricular regions among the groups.

CONCLUSION
Normalized-ADC analysis as a fluctuation MRI in the ventricular system makes it possible to noninvasively obtain more detailed information on the intracranial condition in iNPH and thereby possibly assist in the diagnosis.

CLINICAL RELEVANCE/APPLICATION
Fluctuation analysis of the intraventricular CSF makes it possible to noninvasively obtain more detailed information on the intracranial condition in iNPH and thereby possibly assist in the diagnosis.

SSQV-09 • Accurate T1 Relaxivities (r1) of Gadolinium-based Magnetic Resonance Contrast Agents (GBCAs) in Human Whole Blood at 1.5T and 3T

Yaqi Shen PhD, MD ; Christopher G Snyder BS ; Frank L Goerner PhD (Presenter) * ; Regina Moritz ; Val M Runge MD *

PURPOSE
Multiple-transmit parallel RF transmission can improve the image quality and reduce scanning time.

CLINICAL RELEVANCE/APPLICATION
Multiple-transmit parallel RF transmission can improve the image quality and reduce scanning time.
The current available values for $T_1$ relaxivity ($r_1$) of Gadolinium based MR contrast agents (GBCAs) at 1.5T and 3T are either provided for non-clinically relevant scenarios or in only a portion of the available GBCAs. This is likely due to the complex nature of obtaining these values. This study determines and compares the $r_1$ values of eight commercially available GBCAs in human whole blood at 1.5T and 3T.

**METHOD AND MATERIALS**

**RESULTS**

**CONCLUSION**

**CLINICAL RELEVANCE/APPLICATION**

The results of this experiment are the most relevant $r_1$ measurements to a clinical scenario. This will give clinicians a more accurate idea of the enhancement of each GBCA in MR imaging.

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**Physics (CT Reconstruction)**

**Thursday, 10:30 AM - 12:00 PM ● S404AB**

**SSQ20** • **AMA PRA Category 1 Credit™**:1.5 • **ARRT Category A+ Credit:1.5**

**Moderator**

Xiaochuan Pan, PhD *

Bruno De Man, PhD *

**SSQ20-01 ● Proper Weighting of Redundant Data in Cardiac Reconstruction Enables Repeatable Quantitative Imaging at Large Cone Angles**

Brian E Nett PhD (Presenter) *; Zhye Yin *; Jed Pack *

**PURPOSE**

To assess the performance of a new image reconstruction algorithm, which properly weights redundant data, for the case of a half-scan type temporal weighting function.

**METHOD AND MATERIALS**

The most common method to achieve half-scan type temporal weighting for cone-beam tomography is to extend the standard Parker type weighting function which accounts for redundancies in sinogram space (P-FDK). This weighting is exact in the central slice but leads to data mishandling away from the central slice. More recent methods have been developed which properly account for redundant data (e.g. application of Katsevich framework for exact reconstruction to a single arc source trajectory). In this work a method which properly weights redundant frequency data is evaluated for repeated quantitative imaging. The effect of the reconstruction algorithm is studied in isolation from other physical effects by using a monoenergetic simulation of an anthropomorphic phantom (ie. the XCAT phantom). The central view angle of the image reconstruction was sampled in 15 deg intervals over 360 deg.

**RESULTS**

The standard deviation of reconstruction values as a function of central view angle was computed in order to visually demonstrate the strong angular dependence of standard methods. Automated regions of interest (ROIs) were defined for myocardium and fat tissue types in the phantom and measured as a function of cone-angle. For cone angles greater than +/-2 deg the percentage of voxels which had a std. w.r.t. central view angle of greater than 10 HU was [P-FDK] (96.9%, 96.4%), [improved recon] (0.14%, 1.4%) for myocardium and fat ROIs respectively.

**CONCLUSION**

New image reconstruction methods indicate that repeatable quantitative imaging is possible for CT acquisitions with a large cone angle.

**CLINICAL RELEVANCE/APPLICATION**

Advanced image reconstruction techniques can improve repeatable quantitative reconstruction for half-scan reconstruction.

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**SSQ20-02 ● Image-based Partial Scan Artifact Reduction for Dynamic Contrast Enhanced CT**

Adam M Alessio PhD (Presenter) *; Aaron So PhD; Ting-Yim Lee MSc, PhD *

**PURPOSE**

Partial scan (PS) CT acquisitions lead to artifacts due to inconsistencies from scatter contributions and inexact cone-beam reconstruction. Dynamic cardiac studies, which benefit from PS acquisitions and require high CT number fidelity, require corrections for these view-angle dependent shading artifacts. PS artifact reduction methods have been proposed based on raw projections, images, or combinations of projection and temporal information. We propose a PS artifact reduction (PSAR) method requiring only access to images to reduce the influence of cone-beam and scatter induced artifacts.

**METHOD AND MATERIALS**

The cone-beam issues are mitigated with an error term derived from the error-reduction-based algorithm (ERB, Zeng et al, 2004). In addition, the scatter contribution is estimated based on the convolution of pencil-beam scatter distribution and a forward scatter model. These two components are iteratively estimated through successive cone-beam forward projections and Feldkamp reconstructions of the original artifact-present images. The proposed PSAR algorithm was tested with simulations of a 64-slice CT acquisition of a thoracic phantom. The view-angle dependent error was evaluated in simulations and verified with measured images from DCE-CT porcine studies.

**RESULTS**

Simulation studies revealed that for a realistic thoracic morphology, CT numbers in slices at the edge of the axial field of view (from large cone-angles) vary by 30 HU as a function of the center view angle of the PS acquisition. Scatter alone causes variations of ~6 HU at different view angles. PS’s from porcine studies confirmed HU variations in soft-tissue regions of 29 HU as view angle varied. In simulations, the application of the PSAR algorithm reduced the RMSE in the myocardial region from 14.5 HU to 6.3 HU across all slices and view angles.

**CONCLUSION**

PSAR reduced view-angle dependent artifacts in PS acquisitions. This method benefits from not requiring access to raw projection data or full-scan information, offering a practical method for artifact reduction in DCE-CT studies.

**CLINICAL RELEVANCE/APPLICATION**

The proposed PSAR method reduces scatter and cone-beam artifacts in partial scan acquisitions to improve the quantitative information from these fast, lower-dose dynamic cardiac CT acquisitions.

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**SSQ20-03 ● Performance Evaluation of a CT Iterative Reconstruction Algorithm in Detection and Discrimination Tasks Using Model Observer**

Yi Zhang (Presenter); Shuai Leng PhD; Lifeng Yu PhD; Cynthia H McCollough PhD *
METHOD AND MATERIALS

11 lesion-mimicking rods were placed in a 35 × 26 cm torso-shaped water phantom and scanned on a 128-slice CT scanner (Definition Flash, Siemens) with 120 kV at 4 different mAs settings: 120, 240, 360 and 480 quality reference mAs (CAREDose4D), each repeated 100 times. CT images were reconstructed using FBP and IR (SAFIRE) methods available from the scanner. 3 rods had -15 HU contrast to mimic low contrast lesions. The other 8 rods had a relative higher contrast (2 shapes × 2 contrasts × 2 sizes), which were used to construct shape discrimination tasks, in which hexagon and circle rods were displayed side-by-side in a randomized order. A total of 5600 2-alternative forced-choice trials were analyzed using CHO with Gabor filters (6 passbands, 5 orientations and 2 phases) and percent correct (PC) was calculated for each task. Internal noise was added to test variables to estimate the variation of PC.

RESULTS

For the low-contrast lesion detection task, CHO didn't predict improved performance with SAFIRE for most dose and size settings. The only improvements were observed for 3 mm lesion at 360 mAs, from 96±2% to 98±1% (p < 0.005).

CONCLUSION

Image quality and performance improvement of IR depends on diagnostic tasks. A previously validated CHO predicted that there is a significant improvement of performance with IR for lesion shape discrimination task but not for low-contrast lesion detection task.

CLINICAL RELEVANCE/APPLICATION

IR could be used to improve performance or reduce dose, with the amount of dose reduction dependent on lesion size and contrast, as well as the diagnostic task.

SSQ20-04 • Prior-based Artifact Correction in Computed Tomography

Thorsten Heuser (Presenter); Marcus Brehm; Ludwig Ritsch; Stefan Sawall DIPLENG; Marc Kachelriess PhD

PURPOSE

To improve image quality in x-ray computed tomography (CT) in cases of missing or corrupt data.

METHOD AND MATERIALS

CT image quality often suffers from artifacts due to missing or corrupt data. Numerous approaches to reduce these artifacts have been published. These approaches typically use inter- or extrapolation techniques specific for the kind of artifact investigated and in many cases tend to introduce new artifacts. Often, however, prior data are available which can, potentially, be used to better compensate for the missing or corrupt data and thereby to help reduce artifacts without introducing new artifacts. These prior data may be images from a different scan of the same patient, e.g., a planning CT, or images of a similar patient taken from a patient database. We propose a prior-based artifact correction (PBAC) algorithm, a generalized correction method for prominent artifacts in CT resulting from missing or corrupt data. To compensate for differences in patient shape and position PBAC performs a non-rigid registration to match the prior with the patient, and it accounts for differences in the CT values by histogram matching. The registered prior is forward projected and its obtained projection data results in the corrected image. PBAC is evaluated using several data sets measured with a clinical spiral cone-beam CT device (Somatom Definition Flash, Siemens Healthcare, Forchheim, Germany).

RESULTS

Compared to the uncorrected CT images PBAC reduces the artifacts by 79% in case of metal pedicle screws in a thorax scan, by 99% for a hip patient with 12.2 cm truncation, and by 67% in case of a head scan with a limited scan angle of 150°. In all cases PBAC significantly outperforms the conventional correction methods which achieve artifact reduction values of only 42%, 90%, and 5%, respectively.

CONCLUSION

PBAC is a highly effective method to correct for CT artifacts resulting from missing or corrupt data by making use of prior knowledge. It significantly increases the image quality and preserves the patient-specific anatomy to allow for reliable medical diagnosis.

CLINICAL RELEVANCE/APPLICATION

PBAC is relevant for clinical CT which often suffers from metal artifacts, and it is relevant for flat detector CT which additionally suffers from truncation or limited angle artifacts.

SSQ20-05 • Clinical Evaluation of Coronary Artery Image Quality with Second Generation Iterative Model Reconstruction

Ethan J Halpern MD (Presenter); Eric L Gingold PhD; Hugh White MD; Katrina M Read MS

PURPOSE

Iterative Model Reconstruction (IMR), as implemented in the second generation Philips software for multislice CT, is a knowledge-based reconstruction with marked reduction in image noise. The purpose of this study was to evaluate image quality with the application of IMR to coronary CT angiography (cCTA).

METHOD AND MATERIALS

We evaluated 20 consecutive cCTA cases acquired with a 256-slice ICT scanner, following reconstruction with traditional filtered back projection (FBP), first generation iterative reconstruction (iDose) and second generation IMR (Philips Medical Systems; Cleveland, OH). Each case was reconstructed in a diastolic phase (75% of the R-R interval) and evaluated by two independent reviewers. The mean and standard deviation (sd) of pixel values were computed in a standardized region of interest in the left ventricle and left main coronary artery. Subjective rating scores were obtained from each reviewer (1-5 scale for poor-excellent) for definition of 1) contours of small coronary arteries (CABG), 2) an intravascular region of interest in the left ventricle was reduced by a factor of 1.5 from FBP to iDose (sd=123 vs 80, p<0.001). There was no significant difference in mean pixel intensity among FBP, iDose and IMR (p>0.8). However, image noise within a contrast-enhanced region of interest in the left ventricle was reduced by a factor of 1.5 from FBP to iDose (sd=123 vs 80, p<0.001). There was no significant difference in mean pixel intensity among FBP, iDose and IMR (p>0.8). However, image noise within a contrast-enhanced region of interest in the left ventricle was reduced by a factor of 1.5 from FBP to iDose (sd=123 vs 80, p<0.001). There was no significant difference in mean pixel intensity among FBP, iDose and IMR (p>0.8). However, image noise within a contrast-enhanced region of interest in the left ventricle was reduced by a factor of 1.5 from FBP to iDose (sd=123 vs 80, p<0.001). There was no significant difference in mean pixel intensity among FBP, iDose and IMR (p>0.8).

CONCLUSION

Image quality and performance improvement of IBR depends on diagnostic tasks. A previously validated CHO predicted that there is a significant improvement of performance with IBR for lesion shape discrimination task but not for low-contrast lesion detection task.

CLINICAL RELEVANCE/APPLICATION

IBR is relevant for clinical CT which often suffers from metal artifacts, and it is relevant for flat detector CT which additionally suffers from truncation or limited angle artifacts.

SSQ20-06 • Iterative Metal Artifact Reduction in Computed Tomography

Andreas Krauss PhD (Presenter); Rainer Raupach PhD; Bernhard Schmidt PhD; Thomas G Flohr PhD

PURPOSE

To quantitatively evaluate the performance of a novel algorithm for metal artifact reduction in computed tomography (CT).

METHOD AND MATERIALS

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The proposed iterative metal artifact reduction algorithm starts with standard CT reconstruction. Metal pixels are then identified through HU thresholds and a metal sinogram is generated by forward projection. A prior image is calculated from the initial image by assigning soft tissue pixels (identified by upper and lower HU thresholds) to 0 HU. Then normalized sinogram interpolation is performed: The prior image is forward projected and the original rawdata is normalized pixelwise with the prior sinogram. In the normalized sinograms, pixels within the metal trace are replaced by linear interpolation from the edges of the metal trace. The interpolated sinogram is de-normalized and standard reconstruction of the corrected sinogram is performed. The procedure is repeated iteratively with the output of the previous iteration used as input for prior image calculation. Finally, a frequency split is performed to preserve valid edge information of the non-corrected images: The high frequency part of non-corrected images is merged with the low frequency part of MAR-corrected images. The algorithm was applied to 10 hip replacement cases.

RESULTS
Streak artifacts from hip prostheses as well as the typical dark band between bilateral hip prostheses were almost completely eliminated. Pelvic soft tissue and organ structure was restored. Typical drawbacks of previous MAR algorithms such as introduction of new artifacts or compromised bone structure close to the prostheses were minimal due to iterative normalized interpolation and frequency split, respectively. Between bilateral hip prostheses, mean HU values within regions of interest located inside the bladder (expected to be water, i.e. 0 HU) were improved from -440 HU to -7 HU on average; the maximum improvement was from (-732 ± 252) HU to (-7 ± 38) HU.

CONCLUSION
The proposed algorithm substantially reduces artifacts from hip prostheses.

CLINICAL RELEVANCE/APPLICATION
The proposed algorithm strongly facilitates the visualization of pelvic anatomy. Due to the recovery of HU values, improvements for radiotherapy treatment planning are expected.

SSQ20-07 • Optimization-based Image Reconstruction with Variable Resolution in Diagnostic CT
Zheng Zhang MA, BS (Presenter) ; Junguo Bian PhD ; Xiao Han MSc ; Daxin Shi PhD * ; Alexander Zamyatin PhD * ; Emil Y Sidky PhD ; Xiaochuan Pan PhD*.

PURPOSE
In diagnostic computed tomography (CT) imaging, it is often of interest to obtain detailed information within a region of interest (ROI), while rough knowledge outside the ROI may be sufficient. This novel imaging approach leads to an image reconstruction problem that requires voxels of different sizes within and outside the ROI. In this work, we develop and investigate an optimization-based algorithm to reconstruct images with variable spatial resolution, that is, images with non-uniform voxel sizes.

METHOD AND MATERIALS
We used a Toshiba 320-slice diagnostic CT scanner to collect data from a patient and a swine using a circular geometry. Both data sets were acquired at 1200 views over 2? . We performed image reconstruction by using a modified adaptive-steepest-descent-projection-onto-convex-sets (ASD-POCS) algorithm, which is specifically adapted to accommodate image arrays with variable resolution. Using this modified algorithm, we performed reconstruction on a variable-resolution array, which consists of voxels of size 0.06 cm within a selected ROI, and voxels of size 0.12 cm outside the ROI. We then carried out additional reconstructions by further increasing the voxel size outside the ROI to 0.24 and 0.48 cm. As references, we also applied ASD-POCS algorithm to reconstructing images on uniform-resolution arrays, consisting of voxels of sizes ranging from 0.06 cm to 0.48 cm.

RESULTS
By visual comparison, we observed that in the variable-resolution images, as the ratio of voxel size outside the ROI to that within the ROI increased from 1 to 8, although the region outside the ROI becomes progressively coarser, the image quality within the ROI remains virtually identical to that of the reference image reconstructed with uniform voxels of size 0.06 cm.

CONCLUSION
The results demonstrate that by employing an optimization-based algorithm tailored to variable-resolution images, we are able to reconstruct images within ROI of quality comparable to that obtained with uniform, high-resolution arrays.

CLINICAL RELEVANCE/APPLICATION
Variable-resolution optimization-based reconstruction can reduce computation time and memory consumption. It may also have potential impact on ROI images reconstructed from data containing truncation.

SSQ20-08 • Mitigation of Windmill Artifacts at Large Cone Angles
Hye Sun Na (Presenter) * ; Akira Hagiwara * ; Brian E Nett PhD *. 

PURPOSE
To assess windmill artifact mitigation performance for a new reconstruction algorithm at large cone angles

METHOD AND MATERIALS
Windmill artifacts are caused by insufficient sampling in the z-direction and objects with high z-gradient. In this work, a new reconstruction algorithm is evaluated for correction of windmill artifacts which occur at large cone angles in axial scans. A phantom was simulated with wires at a slope of 41°, axial to transaxial, to assess the severity of windmill artifacts and to measure z-axis spatial resolution before and after the correction is applied. The images were reconstructed with a pixel size of 0.375mm.

RESULTS
A windmill artifact metric was developed, which is the sum of the image after applying a mask and a Sobel edge filter. The mask was created by applying two dilations from the ground truth image. A 20x20 pixel matrix was used as the structuring element for the first dilation to mask out the wire and a 140x140 pixel matrix was used for the second dilation to mask out regions beyond where the artifacts are generated around the wire. In this manner, images with severe windmill artifacts will receive a higher value for this metric. In the FDK images the level of artifact increases as the cone angle increases; the ratio of the mean artifact metric values for central (= ±1.5°) to outer cone angles (+3.1-6°) is 0.23. In the improved recon the artifact level in the outer cone angles is lower than the artifact level in the central cone angles of the FDK images. The ratio of the mean artifact metric for outer cone angles [improved/FDK] is 0.18. Additionally, the improved recon reduces artifacts in the central cone angle case. The ratio of the mean artifact metric [improved/FDK] is 0.15. These results were maintained for all truncation locations. With the new recon the mean MTF50% and MTF10% is 100% and 99% of the FDK recon and varies from 96.2%-105.0% and 97.9%-102.7%, respectively.

CONCLUSION
At large cone angles, a new reconstruction algorithm reduces windmill artifacts without significantly degrading z-resolution.

CLINICAL RELEVANCE/APPLICATION
A new reconstruction algorithm, which reduces windmill artifacts in clinical head CT scans at large cone angles, is an enabling technology for single axial scans which cover all neuro anatomy.

SSQ20-09 • Performance Evaluation of a New Analytic Reconstruction Algorithm for Axial CT with Large Cone-angle Coverage
Zhihua Qi PhD (Presenter) ; Brian E Nett PhD *.

PURPOSE
There are a number of emerging clinical applications for computed tomography from systems which collect axial scan data with a large cone angle. The clinical use of these systems, faces challenges from cone beam artifacts caused by: data insufficiency, data mishandling, etc.
and data truncation associated with an axial cone beam CT scan. This study aims to evaluate the performance of a newly developed analytical algorithm, referred to here as the improved algorithm, with a focus on cone beam artifact evaluation, for axial cone beam CT in cardiac imaging.

METHOD AND MATERIALS
Numerical simulations of an anthropomorphic phantom (i.e XCAT) were performed with a total coverage of 14.6 deg. Images were reconstructed by both the traditional FDK algorithm and the improved algorithm for both full-scan and cardiac modes. Then three types of tissue: cardiac muscle, soft tissue, and lung, were segmented and separately analyzed for the effect of cone beam artifacts. The severity of cone beam artifacts for a certain type of tissue in different slices is evaluated using the metric of mean CT# deviation from the ground truth.

RESULTS
For both full-scan and cardiac acquisitions, the mean CT# deviation in the images reconstructed with the improved algorithm remains significantly lower than the FDK type algorithm for all slices and all tissues. For a full-scan acquisition the images reconstructed with the improved algorithm, compared with the FDK reconstruction, show a reduction of the mean CT# deviation of 52%±16%, 39%±21%, and 53%±19%, for cardiac muscles, soft tissues, and lungs, respectively, over the studied cone angle coverage. For a cardiac acquisition, the reductions of the mean CT# deviation from FDK to WC reconstructed images for the three tissue types are 79%±24%, 77%±20%, and 79%±17%, respectively.

CONCLUSION
Compared to the traditional FDK-type algorithm, the newly developed Wide-Cone algorithm substantially reduces the cone-beam artifacts without degrading the other image quality aspects.

CLINICAL RELEVANCE/APPLICATION
A new analytic reconstruction algorithm for large cone-angles can enable quantitative imaging of whole organs such as the heart.
Overall Survival for PVT Patients

**SSQ21-06**  •  **Yttrium-90 Radioembolization for Neuroendocrine Tumor Liver Metastases**

**Katherine Y Fan** BS (Presenter)  ;  **Aaron T Wild** BA  ;  **Vivek Gowdra Halappa** MD  ;  **Rachit Kumar** MD  ;  **Susannah Yovino** MD  ;  **Timothy Pawlik** MD  *  ;  **David O Cosgrove** MB BCH, FR CR  *  ;  **Inab R Kamei** MD, PhD  *  ;  **Joseph M Herman** MD, MSc  ;  **Jean-Francois H Geschwind** MD  *

**PURPOSE**

Surgical resection remains the only curative option for neuroendocrine tumor liver metastases (NETLM). However, 90% of patients have unresectable disease. Limited data currently exists for yttrium-90 (Y-90) radioembolization, an emerging treatment option for unresectable NETLM. This study evaluates the efficacy, tolerability, and prognostic factors of Y-90 radioembolization in NETLM patients.

**METHOD AND MATERIALS**

Thirty-eight patients underwent glass-based Y-90 radioembolization for NETLM at a single institution between April 2004 and February 2012. Patients were assessed radiographically (using magnetic resonance imaging), serologically, and clinically at 1 month and then every 3 months post-treatment for tumor response, toxicity, and survival outcomes.

**RESULTS**

Median length of follow-up was 17 months (IQR, 9-37). Median survival was 29 months. On imaging follow-up, 3 patients (9%) had a complete response (CR), 6 (17%) had a partial response (PR), 21 (60%) had stable disease (SD), and 5 (14%) developed progressive disease (PD). Multivariate analysis with backward elimination revealed 2 factors to be independently associated with good tumor response (CR/PR): histological subtype (p = 0.037) and hepatic tumor burden (p = 0.038). Inferior overall survival (OS) was observed in patients requiring more than one Y-90 treatment (HR 7.384, p = 0.003) and in patients with = 1 ECOG performance status (HR 3.539, p = 0.04) on multivariate proportional hazards regression models for OS. Development of grade 3 serologic toxicities was observed in only 2 patients (one with elevated bilirubin, the other elevated alkaline phosphatase) after treatment. Grade 3 non-serologic toxicities experienced included abdominal pain (11%), fatigue (11%), nausea/vomiting (5%), ascites (5%), dyspnea (3%), and peripheral edema (3%).

**CONCLUSION**

Our institutional experience demonstrates Y-90 radioembolization to be an efficacious, safe, and tolerable treatment for NETLM.

**CLINICAL RELEVANCE/APPLICATION**

Y-90 radioembolization can safely and effectively target liver metastases from neuroendocrine tumors and is recommended for patients with unresectable liver metastases.

**SSQ21-04**  •  **Intratumoral Vascular Shunting: The Missing Link between Circulating Tumor Cells and Metastasis?**

**Amy R Deipolyi** MD, PhD (Presenter)  ;  **Patrick D Sutphin** MD, PhD  ;  **Siddharth Govindan** MD  ;  **Suvranu Ganguli** MD  *  ;  **Rahmi Oklu** MD, PhD

**PURPOSE**

Colorectal carcinoma is a leading cause of cancer mortality mostly due to metastasis. It is unclear how large circulating tumor cells (CTCs) shed from the tumor traverse capillary beds to establish distant lesions. Intratumoral vascular shunting, however, may provide a conduit for CTCs to access distant sites. To determine whether intratumoral shunting is associated with metastasis, we assessed how tumor shunting related to the presence of disseminated disease and to clinical outcome.

**METHOD AND MATERIALS**

61 colorectal cancer patients with liver metastases (30 F, 31 M; mean age 63 yr) were evaluated for selective internal radiation therapy (SIRT) from 3/07 to 3/12. Following transcatheater injection of radioactive particles (99mTc-MAA), lung shunt fractions (LSF) were calculated reflecting the amount of intratumoral shunting of MAA particles, which can measure up to 150 microns. Medical records were reviewed for other metastases and the size of liver lesions before and after SIRT, the time between SIRT and disease progression, and patient survival after SIRT. Liver tumor size was estimated using the largest dimension of the largest lesion. The relationship of LSF and estimated tumor size to outcomes was assessed using linear regression and student's t test.

**RESULTS**

Patients with lung metastases at the time of SIRT had significantly higher LSF (mean 9.2%) than patients without lung metastases (mean 6.1%) (p < 0.01). LSF may be a more robust marker of metastatic potential than tumor size. Increased LSF due to vascular shunting within liver metastasis is an indicator of distant lesions and is associated with more rapid disease progression after SIRT. Intratumoral shunting may provide a conduit for CTCs to access more remote organs, bypassing filtration by liver parenchyma and may be an important factor in metastatic potential of colorectal cancer.

**CONCLUSION**

Vascular shunting in liver metastases from colorectal cancer is a robust indicator of more distant metastases and future disease progression, and may be a more useful clinical marker than tumor size.

**SSQ21-06**  •  **Boosted Selective Internal Radiation Therapy (B-SIRT) Using 90Y-loaded Glass Microspheres Induces Prolonged Overall Survival for PVT Patients**

**Etienne Garin** MD (Presenter)  *  ;  **Laurence Lenoir**  ;  **Julien Edeline**  ;  **Eveline Boucher**  ;  **Yan Rolland** MD, PhD  *

**PURPOSE**

Evaluation of the response rate and survival of hepatocellular carcinoma PVT patients treated with Therasphere using the boost concept.

**METHOD AND MATERIALS**

Therasphere was administered in 40 PVT hepatocellular carcinoma patients (main = 11, lobar = 23, segmental = 6). MAA SPECT/CT quantitative analysis was used for the calculation of the tumour dose (TD), the healthy injected liver dose (HLD) and the injected liver dose (LD). Response was evaluated at 3 months using EASL criteria. OS was evaluated using Kaplan and Meyer tests.

**RESULTS**

Mean 90Y-loaded microspheres injected activity was 3.1±1.5 GBq. Mean LD was 143±49 Gy. Mean TD was 316 Gy for responding lesions versus 133 Gy for non responding lesion (p = 0.05). Mean OS was 12 months [3-8] for patients with main PVT versus 21.5 months [12-28.7] for patients segmental or lobar PVT (ns). Finally OS was 23.2 months for patients with a TD>205 Gy and a good PVT targeting (ns = 34).
CONCLUSION
Boosted selective internal radiation therapy using 90Y-loaded glass microspheres induces prolonged overall survival for PVT patients without increasing liver toxicity.

CLINICAL RELEVANCE/APPLICATION
Boost selective internal radiation therapy using 90Y loaded glass microsphere allows a fully customized oncological therapy for PVT patients inducing prolonged survival.

SSQ21-07  •  Sorafenib versus Y90-radioembolization in Cirrhotic Patients with Hepatocellular Carcinoma (HCC): Cohort and Nested Control-case Study with Propensity Analysis

Alberta Cappelli MD (Presenter); Cristina Mosconi; Annagiaulia Gramenzi; Sara Marinelli; Alessandro Granito; Virginia Erroi; Silvia Fiumana; Mauro Bernardi; Luigi Bolondi; Franco Trevisani; Rita Golferi MD

PURPOSE
Sorafenib and Transarterial Y90-radioembolization (TARE) are treatments currently available for advanced (BCLC stage C) HCC not amenable or resistant to curative options and transarterial chemoembolization (TACE). No study comparing the outcome of these patients (pts) is yet available. We performed a case-control, retrospective study to compare the survival in both groups comparing the two treatments after patients' matching for the independent prognostic factors.

METHOD AND MATERIALS
RESULTS
67 Sorafenib pts and 63 TARE pts were selected. The two groups did not significantly differ for gender, aetiology, previous HCC treatments, portal vein thrombosis, Child-Pugh class, MELD score, BCLC stage, alpha-fetoprotein levels, ascites, creatinine, platelet count. Median survival did not differ between Sorafenib (13.1 months; 95% CI: 3.1-23.2) and TARE (13.2; 6.1-20.2; \( P=0.854 \)) and mortality rate at 1, 2 and 3 years was respectively 48%, 70% and 86% vs 48%, 73% and 80%. Propensity model matched 34 pts for independent non co-axial prognostic factors: PS, MELD, portal thrombosis, tumour gross pathology. Median survival was 13.1 months (1.3-25.0) for Sorafenib and 9.0 months (3.7-14.3) for TARE (\( P=0.214 \)).

CONCLUSION
In advanced HCC not otherwise treatable, Sorafenib provides, after adjustment for the confounding factors, a not statistically significant better survival than TARE.

CLINICAL RELEVANCE/APPLICATION
In advanced HCC treated with Sorafenib or TARE, the propensity analysis demonstrates that median survival is better after Sorafenib but not statistically different (13.1 vs 9.0 months: \( P=0.214 \)).

SSQ21-08  •  A New Model to Estimate Prognosis after Yttrium-90 Radioembolization in Patients with Hepatocellular Carcinoma

Thomas C Lauenstein MD (Presenter); Judith Ertle; Stefan P Mueller MD *; Andreas Bockisch; Guido Gerken; Joerg Schlak

PURPOSE
A prognostic model to estimate the survival in hepatocellular carcinoma (HCC) patients treated with transarterial hepatic selective internal radiotherapy (SIRT) is not fully characterized. We aimed to establish a new scoring model including assessment of both tumor responses and therapy-induced systemic changes in HCC patients to predict survival at an early time point post-SIRT.

METHOD AND MATERIALS
149 HCC patients treated with SIRT (TheraSphere, MS Nordion, Canada) were included into this study. CT images and biomarkers in blood tested at one month post-SIRT were analyzed and correlated with clinical outcome. Tumor responses were assessed by RECIST 1.1, mRECIST, and Choi criteria. Kaplan-Meier methods were used to estimate survival curves. Cox regression was used in uni- and multivariable survival analyses and in the establishment of a prognostic model.

RESULTS
A new model including imaging and non-imaging parameters may predict survival of HCC patients at an early time point after SIRT. In this model, Choi criteria should be applied rather than RECIST or mRECIST.

CLINICAL RELEVANCE/APPLICATION
Efficacy of SIRT can be predicted one month after therapy.

Breast Imaging (Issues in Screening)

Friday, 10:30 AM - 12:00 PM • E450B

SSQ21-01  •  Mammography Outcomes by Screening Interval: Does Biennial Screening Affect Prognosis?

Laura Billadello MD (Presenter); Riti Mahadevia; Paula M Grabler MD; Ellen B Mendelson MD *; Lilian Wang MD

PURPOSE
In 2009, the U.S. Preventative Services Task Force announced the recommendation for biennial screening mammography for women aged 50-74 years, despite evidence of mortality reduction with annual screening mammography beginning at age 40, as supported by the American College of Radiology (ACR), Society of Breast Imaging (SBI), and American Cancer Society (ACS). The purpose of this study is to use secondary endpoints of tumor size and lymph node positivity to compare the efficacy of screening mammography performed at various time intervals.

METHOD AND MATERIALS
Under IRB approval, a retrospective review of all screen-detected breast cancers between 2007-2010 was performed. Patients were divided into groups 1-3 based on time interval between screening mammograms, defined as 3 years. The three groups were controlled in terms of age, breast density, high risk status, and family history of breast cancer. Audit data as outlined by ACR BI-RADS, including % stage 0 or 1 cancers, % minimal cancer, and % positive axillary lymph nodes, were compared for the three groups. The size of invasive cancers was also compared.

RESULTS
There were 419 screen-detected cancers during the study period. 34 patients were excluded due to unknown screening interval or lack of...
There were 419 screen-detected cancers during the study period. 34 patients were excluded due to unknown screening interval or lack of surgical pathology and 24 patients were excluded for cancer detection on baseline mammography. To adjust for differences in age between groups, patients >75 years were excluded. This resulted in 332 patients, 207 in group 1, 73 in group 2, and 52 in group 3. There was no significant difference in age, breast density, high risk status, family history, or index histology between groups. The % stage 0 or 1 cancer and % minimal cancer did not differ between the groups (p=0.057 and p = 0.498, respectively). The size of invasive cancers was also not statistically different between the three groups (ANOVA, p=0.165). However, lymph node positivity was lowest in group 1, which was a statistically significant difference (8.7% vs. 20.5% and 15.4%, p = 0.002).

CONCLUSION
Screening mammography performed at an interval
CLINICAL RELEVANCE/APPLICATION
Screening mammography performed at an interval less than that recommended by the USPSTF significantly reduces the rate of lymph node positivity, thereby improving patient prognosis.

SST01-02  •  Incidental Breast Lesions: Factors Associated with Increased Risk of Malignancy and Lack of Follow-up

Eniola T Obadina MD (Presenter) ; Roberta M Strigel MD,MS ; Richard J Bruce MD * ; Alejandro Munoz Del Rio PhD ; Frederick Kelcz MD, PhD

PURPOSE
To evaluate the rate of malignancy of incidental breast lesions (IBLs) detected on non-breast imaging examinations, factors associated with malignancy, and compliance with recommended follow-up.

METHOD AND MATERIALS
Following IRB approval, a retrospective review of the electronic medical record using keyword search was performed to identify all patients (pts) without a known history of breast cancer who had an IBL detected on a non-breast imaging examination from 9/2008 to 8/2012. Outcomes were determined by follow-up with dedicated breast imaging and results of biopsy, if performed. Imaging modality of detection, IBL size, pt age and location at the time of the exam, follow-up and final outcome were recorded. Rates of imaging follow-up and malignancy were calculated. Kruskal-Wallis and Fisher’s exact tests were used to identify factors associated with malignancy and compliance with follow-up.

RESULTS
293 pts were identified and ranged in age from 14 to 100 years (mean 59.6 years). 36/293 (12%) of pts were in the Emergency Department (ED) at the time of their non-breast imaging exam, 49/293 (17%) were inpatients, and 208/293 (71%) were outpatients. IBLs ranged in size from 0.4 to 7.2 cm (mean 1.53 cm). 242 pts had IBLs detected on CT (83%), compared to 25 pts with MRI-detected IBLs (8.5%) and 25 pts with PET-detected IBLs (8.5%). One pt had an IBL detected on a myocardial perfusion stress test.

121/293 (41%) pts underwent follow-up with dedicated breast imaging. There was a significantly increased rate of noncompliance with follow-up in ED pts (30/36; 83%), compared to 32/49 (65%) inpatients and 110/208 (53%) outpatients (p<0.001).

CONCLUSION
Incidental breast lesions ultimately diagnosed as breast cancers are not rare (21%) and were most likely to represent malignancy if discovered on PET imaging. IBLs discovered as part of an ED visit were the most likely not to undergo follow-up.

CLINICAL RELEVANCE/APPLICATION
Incidental breast lesions identified on non-breast imaging exams represent malignancy in up to 21% of cases, emphasizing the need for dedicated breast imaging follow-up of these incidental findings.

SST01-03  •  Surveillance of Women with Personal History of Breast Carcinoma Using MRI

Haiquan Liu (Presenter) ; Yanqing Hua MD ; Huadong Miao ; Weijun Peng MD

PURPOSE
To determine the capability of MRI in detecting the second breast carcinoma among women with a personal history of breast carcinoma.

METHOD AND MATERIALS
This retrospective review of breast MRI examinations performed from 2007 to 2011 yielding 798 women who had a personal breast history. Of the 798 patients, 445 had adequate follow up data and 348 had MRI, mammography and ultrasound within 6 months intervals. The sensitivity, specificity of MRI in detecting the second breast carcinoma was calculated. The recall rate and PPV of MRI was also calculated.

RESULTS
Of the 798 patients, 49 second breast carcinoma was found and the incidence of the second breast carcinoma was 6.1%. Forty-five breast carcinomas were detected by MRI. The sensitivity and specificity of MRI in detecting the second breast carcinoma was 91.8% and 92.2%, respectively. The specificity was 95.3%, 93.4% and 95.9%, respectively.

CONCLUSION
We found that breast MRI surveillance of women with a personal history of breast cancer was clinically valuable in finding malignancies with a reasonable recall rate and PPV.

CLINICAL RELEVANCE/APPLICATION
For woman with history of breast carcinoma, breast MRI examination is valuable, especially when a patient has equivocal Clinical and Imaging Findings.

SST01-04  •  Sensitivity, Specificity and Recall Rates for An Abridged Breast MRI Protocol in a Pure High-risk Screening Population

Laura Heacock MS, MD (Presenter) ; Amy N Melsaether MD ; Kristine M Pysarenko MD ; Samantha L Heller MD, PhD ; Ana P Klaatu Leite MD ; Linda Moy MD

PURPOSE
To evaluate the sensitivity, specificity and recall rates for an abridged MRI protocol.

METHOD AND MATERIALS
A retrospective review of 128 asymptomatic women with 195 findings who had a screening MRI was performed by 2 readers. Each reader was trained with 100 cases with a known cancer in an abridged protocol. Initially they evaluated the precontrast T1, first post-contrast T1 and first subtraction T1 post-contrast images blinded to the history and prior films. Then they assessed the images given the above information of findings. MRI was performed at 3T on a GE system.

RESULTS
Of 128 women, 22 (17.2%) BRCA carriers, 1 (0.8%) chest radiation, 73 (57%) family history, 20 (15.6%) personal history of breast cancer, 12 (9.4%) had atypia. Mean age was 48 years, range 25-82 years. Mean lesion size was 1.2cm (range 0.3 8cm). Of the 128 exams, 20 (15.6%) were originally assessed as BIRADS 1, 62 (48.4%) as BIRADS 2, 24 (18.8%) as BIRADS 3, 22 (17.2%) as BIRADS 4. Using the abridged protocol, 26 (20.3%) exams were assessed as BIRADS 0, 25 (19.5%) as BIRADS 1, 19 (14.8%) as BIRADS 2, 28 (21.8%) as BIRADS 3, (23.4%) as BIRADS 4. Sensitivity was 100%, 3 cancers (2 DCIS and one invasive cancer) were identified by
the readers. However, the specificity was 58% and an additional 31 findings were identified by the readers. Mean time for interpretation for readers was 50 secs (range 0.33 - 4.5 minutes). Both readers showed a significant increase in confidence (p < 0.001).

CONCLUSION
An abridged breast MRI in a pure screening population had a high sensitivity but low specificity and high recall rates. The addition of T2 images and prior films helped decrease the recall rate.

CLINICAL RELEVANCE/APPLICATION
In an abridged screening breast MRI exam, the number of sequences necessary to decrease the false-positive findings needs to be further evaluated.

SST01-05 • Screening Breast MRI in Patients Previously Treated for Breast Cancer: Diagnostic Yield for Cancer and False Positive Interpretation Rate

Catherine S Giess MD (Presenter) ; Patricia S Poole MD ; Sona A Chikarmane MD ; Dorothy A Sippo MD ; Robyn L Birdwell MD

PURPOSE
To determine the cancer detection rate and rate of false positive interpretation of screening breast MRI in women previously treated for cancer.

METHOD AND MATERIALS
IRB approved, retrospective review of the breast MRI database from 2009-2011 identified 3297 contrast enhanced screening exams, 1498 (45.4%) in women previously treated for breast cancer. MRI reports were reviewed to determine MRI findings, BI-RADS assessments and patient demographics. The longitudinal medical record was reviewed to determine outcomes of short interval surveillance, biopsy results and cancers detected. False positive studies were considered BI-RADS 3 assessments with no evidence of cancer on follow up or BI-RADS 4/5 assessments benign on biopsy.

RESULTS
Patient age ranged from 26-88, mean 54 years. 10.1% (152/1498) exams were performed in known genetic mutation carriers. 11.2% (168/1498) screening exams were assessed as abnormal, including 79/1498 (5.3%) BI-RADS 3 and 89/1498 (5.9%) BI-RADS 4/5. Follow up data on BI-RADS 3 exams included 40 (50.6%) without malignancy by imaging and/or clinical follow up, 24 months, 27 (34.2%) with <24 months stability, and 12 (15.2%) upgraded to BI-RADS 4/5, with 5 (41.7%) cancers. Cancer rate for BI-RADS 3 lesions was 6.3%; 3 of 5 upgraded lesions occurred in mutation carriers. BI-RADS for BI-RADS 4/5 exams were available in 81 lesions, with 22 (27.2%) cancers. Overall, 27 (1.8%) of 1498 screening MR exams had malignancy diagnosed during the study period. Average time interval from original cancer diagnosis was 7.8 years (range 1-23 years). 24/27 cancers had negative mammograms within 6 months prior to new cancer diagnosis. 7/27 (22%) of cancers were diagnosed in mutation carriers; an additional 8/27 (29.6%) were diagnosed in women with a positive family history.

CONCLUSION
Screening breast MRI in women previously treated for breast cancer detected cancer in 1.8% examinations, with a minority of exams requiring short term surveillance or biopsy, and positive predictive value of 27.2% for biopsies recommended. Nearly half of screen detected cancers in this population occurred in women without a genetic mutation or a positive family history of breast cancer.

CLINICAL RELEVANCE/APPLICATION
Screening breast MRI in women previously treated for breast cancer detects mammographically occult cancers, with acceptable positive predictive values and low false positive interpretation rates.

SST01-06 • Breast MRI Screening in Women Who had Undergone Breast Conserving Therapy for Cancers

Hye Mi Gweon MD (Presenter) ; Nariya Cho MD ; Ann Yi MD ; Woo Kyung Moon

PURPOSE
The American Cancer Society reports insufficient evidence to recommend for or against MRI in surveillance of asymptomatic women with a personal history of breast cancer. The purpose of this study, therefore, was to retrospectively investigate the outcomes of the first round of MRI screening in women who had undergone breast conserving therapy for breast cancers.

METHOD AND MATERIALS
Between January 2008 and March 2012, 808 women who had undergone breast conserving therapy for breast cancers and subsequent screening breast MRI were identified. All women had an annual screening mammography prior to beginning MRI screening and all the results were negative. Women without at least 12-month follow-up data (n=102) and had metastatic disease (n=2) were excluded. A total of 706 women (median age 48, range 20-72 years) (initial stage 0: 27.3%, stage I: 37.2%, stage II: 30.3%, stage III: 5.3%) with 1069 screening breast MR examinations (one round: 389, two rounds: 265, three rounds: 50) formed our study group. The reference standard was based on biopsy and/or 12-month follow-up. The cancer detection rate, sensitivity, specificity, and positive predictive value (PPV) based on biopsy performed at the first round screen were analyzed. Median follow-up duration was 18.5 months (range, 12-53 months).

RESULTS
Of the 704 women, cancer was detected at MRI in 10 women (1.4%) at a median interval of 33 months (range, 14-56 months) between surgery and detection. The ten cancers included 7 (70%) invasive cancers and 3 (30%) DCIS and were found in 6 (60%) ipsilateral and 4 (40%) contralateral breasts and were 100% node negative among those staged. The median histologic size of the invasive cancers was 0.8 cm (range, 0.4-1.4 cm). Two (0.3%) interval cancers were found 6 months later by mammography and ultrasound, respectively. The sensitivity, specificity, and PPV of MRI were 83.3% (10 of 12), 98.0% (678 of 692), and 41.7% (10 of 24).

CONCLUSION
A single MRI screening in women who had undergone breast conserving therapy for cancers detected 14 mammographically occult, node-negative breast cancers per 1000 women.

CLINICAL RELEVANCE/APPLICATION
Previous history of breast cancer therapy is a reasonable indication for breast MRI screening.

SST01-07 • Foci Detected on Screening MRI: Can They Be Safely Followed or Is Biopsy Required?

Dipti Gupta MD ; Raman Verma MD ; Morgan R Goldberg MD (Presenter) ; Erin I Neuschler MD ; Angelique C Floerke MD ; Riti Mahadevia ; Ellen B Mendelson MD *

PURPOSE
While breast MRI has been established as the most sensitive tool for detecting breast malignancy, the increasing number of studies performed has led to an increasing number of MRI-guided biopsies. Previous studies demonstrate a highly variable positive predictive value of biopsy, ranging from 3% to 28%. This study attempts to evaluate the malignancy rate of suspicious focal identified on screening MRI and to determine if short-term follow-up can be safely performed in lieu of biopsy.

METHOD AND MATERIALS
In this IRB approved, HIPAA compliant retrospective study, 188 MRI-guided core biopsies of foci performed between January 2006 and March 2013 were retrieved from the report search system and reviewed. Suspicious foci identified during screening of the contralateral breast on MRI performed for extent of disease as well as suspicious foci on high-risk screening MRI were included. A focus was considered suspicious if it showed washout or plateau delayed phase kinetics, was the only enhancing focus in that breast or was more prominent than the background parenchymal enhancement. Foci biopsied in the breast ipsilateral to a known malignancy were excluded.
RESULTS
117/188 foci biopsied were in the ipsilateral breast as the known malignancy on MRI performed for extent of disease and were excluded. A total of 71/188 eligible patients were identified, which included 43 suspicious foci in the contralateral breast on MRI performed for extent of disease and 28 foci on high-risk screening MRI. 4/71 (5.6%) suspicious foci were positive for malignancy while 20/71 (28%) were high-risk lesions. Among suspicious foci on high-risk screening MRI, 3/28 (11%) were malignant and 5/28 (17%) had a high-risk pathology. 1/43 (2.2%) foci were malignant in the contralateral breast on extent of disease studies and 15/43 (35%) were high-risk lesions. The malignant and high-risk lesions are more likely to have type 2 and 3 kinetics (p=0.004) compared to benign biopsy.

CONCLUSION
The malignancy rate of foci is low in the contralateral breast on MRI performed for extent of disease. Given this, it may be reasonable to follow foci in the contralateral breast, instead of recommending biopsy.

CLINICAL RELEVANCE/APPLICATION
As the rate of malignancy for a focus in the contralateral breast on extent of disease MRI is 2.2%, short interval follow up instead of biopsy may be reasonable.

SST01-08 • Impact of the Transition from Screen-film to Digital Screening Mammography on Interval Cancer Characteristics and Treatment-A Population based Study from the Netherlands

Joose Nederend MD (Presenter) ; Lucien Duijm MD, PhD ; Marieke W Louwman ; Frits H Jansen MD ; Adri C Voogd

PURPOSE
In most breast screening programs screen-film mammography (SFM) has been replaced by full-field digital mammography (FFDM). We compared interval cancer characteristics at SFM and FFDM screening mammography.

METHOD AND MATERIALS
We included all 297 screen detected and 104 interval cancers in 60,770 SFM examinations and 427 screen detected and 124 interval cancers in 63,182 FFDM examinations, in women screened in the period 2008-2010. Breast imaging reports, biopsy results and surgical reports of all cancers were collected. Two radiologists reviewed prior and diagnostic mammograms of all interval cancers. They determined breast density, described mammographic abnormalities and classified interval cancers as missed, showing a minimal sign abnormality or occult.

RESULTS
The referral rate and cancer detection rate at SFM were 1.5% and 4.9\% respectively, compared to 3.0% (p

CONCLUSION
FFDM resulted in a significantly higher cancer detection rate, but sensitivity was similar for SFM and FFDM. Interval cancers are more likely to be occult at prior FFDM than at prior SFM screening mammography, whereas their tumor characteristics and type of surgical treatment are comparable.

CLINICAL RELEVANCE/APPLICATION
Data on the impact of this transition on mammographic characteristics and tumor characteristics of interval breast cancer detected cancers are very limited.

SST01-09 • Breast Imaging Utilization Trends in the Medicare Population from 2005 to 2011

Richard E Sharpe MD, MBA (Presenter) ; David C Levin MD * ; Vijay M Rao MD ; Laurence Parker PhD

PURPOSE
This study aims to describe the utilization trends in screening mammography, diagnostic mammography, breast US and breast MR in the Medicare population from 2005 to 2011.

METHOD AND MATERIALS
The Medicare Part B Physician/Supplier Procedure Summary Master Files from 2005 through 2011 were used to determine the annual utilization rate of screening mammography, diagnostic mammography, breast ultrasound, and breast MR. Procedure volume counts were determined by tabulating global and professional component claims. Utilization rates per 1,000 women beneficiaries were calculated by dividing volume counts by the number of Medicare women beneficiaries for each year. Utilization rate and compound annual growth rate (CAGR) trends were evaluated.

RESULTS
For the 2005-2009 period, screening mammography utilization increased from 312 per 1,000 women in 2005 to 323 in 2009 (CAGR from 2005-2009=+0.9\%); it then decreased to 311 in 2011 (CAGR for 2009-2011: -1.9\%). Diagnostic mammography utilization decreased from 96 in 2005 to 92 in 2009 (CAGR= -1.3\%); it further decreased to 86 in 2011 (CAGR: -3.4\%). Breast US utilization rate increased from 1.4 in 2005 to 3.9 in 2009 (CAGR=+28.4\%); it then decreased to 3.6 in 2011 (CAGR=-3.7\%). Breast US utilization increased from 37 in 2005 to 43 in 2009 (CAGR=+4.3\%); it then increased to 45 in 2011 (CAGR=+1.7\%).

CONCLUSION
For all breast examinations, the rate of change from 2005 to 2009 compared to 2009 to 2011 in all cases decreased, either going from a positive growth to a less positive rate, a positive to a negative rate, or from a negative to a more negative growth rate. Decreases in screening mammography, diagnostic mammography and breast MR utilization in recent years may be in part attributable to changes in the USPSTF recommendations. Continued increases in breast US utilization, albeit at a slower rate after 2009, may be secondary to whole breast US techniques and interest in US evaluation of women with mammographically dense breasts.

CLINICAL RELEVANCE/APPLICATION
In recent years, there has been negative growth in the utilization of all breast imaging examinations.
The purpose of this study was to compare image quality of a Cardiac CT angiography (CCTA) utilizing Adaptive Iterative Dose Reduction 3D (AIDR 3D), an iterative reconstruction technology on a Toshiba CT scanner, and compare it with standard filtered back projections (FBP).

**METHOD AND MATERIALS**

59 consecutive patients were scanned with the Toshiba Aquilion ONE 320-slice MDCT scanner using a low-dose CCTA protocol. Two datasets for each patient were generated, one with iterative reconstruction (AIDR 3D) applied to the original dataset, and the other was unaltered as a FBP dataset. The two datasets were compared with regards to signal and noise measures of cardiac vascular structures. Qualitative image quality of the cardiac structures and coronary segments were assessed using a 4-point grading scale (1: non diagnostic - 4: excellent).

**RESULTS**

Patient and scan characteristics did not differ significantly between both study groups. Mean heart rate during image acquisition was 52 ±5 bpm in both groups. There was no significant difference in mean image quality, slightly favoring image acquisition during breath holding (see figure). Due to a smaller amount of injected contrast medium signal intensity was little but not significantly lower in free breathing patients (435 ±123 HU vs. 473 ±117 HU; p=0.648). Mean effective radiation dose was 0.92 ±0.42 mSv in breath holding patients and 0.94 ±0.41 mSv in free breathing patients (p=0.741).

**CONCLUSION**

Interobserver Variability of Coronary Atherosclerotic Plaque Characteristics Using a Semiautomatic Plaque Analysis Software

**SST02-02 • High-pitch Coronary CT Angiography in Dual-source CT during Free Breathing vs. Breath Holding**

**Bernhard Bischoff MD (Presenter)**; **Felix G Meinel MD**; **Maximilian F Reiser MD**; **Hans-Christoph R Becker MD**

**PURPOSE**

Usually, coronary CT angiography (CCTA) is performed during breath hold to reduce motion artifacts caused by respiration. However, some patients are not able to follow the breathing command sufficiently due to deafness, hearing impairment, agitation or pulmonary diseases. The aim of this study was to evaluate the potential of high-pitch CCTA in free breathing patients when compared to breath holding patients.

**RESULTS**

The mean effective radiation dose for the CCTA was 1.97 mSv. When comparing FBP vs. AIDR 3D, there was higher signal in the FBP dataset vs. AIDR 3D in the aorta and coronary arteries (677.33 HU vs. 657.33 HU; p

**CONCLUSION**

The mean effective radiation dose was 0.92 ±0.42 mSv in breath holding patients and 0.94 ±0.41 mSv in free breathing patients (p=0.741).

**CLINICAL RELEVANCE/APPLICATION**

AIDR 3D improves qualitative visualization of cardiac anatomy in CCTA through iterative reconstruction in both raw and image data space. This enables CCTA scans to be performed at reduced radiation exposure to patients while producing images that are of diagnostic quality.

**SST02-03 • The Effect of Iterative Reconstruction on Quantitative CT Analysis ofCoronary Plaque Composition**

**Ricardo A Takx MD (Presenter)**; **Martin J Willemin MD**; **Ricardo P Budde MD, PhD**; **Arnold Schilham PhD**; **Pim A De Jong MD, PhD**; **Tim Leiner MD, PhD**

**PURPOSE**

To compare CT assessment of coronary plaque volume and composition using three levels of iterative reconstruction (IR) and filtered back projection (FBP) as the reference reconstruction.

**METHOD AND MATERIALS**

Two datasets for each patient were generated, one with iterative reconstruction (AIDR 3D), an iterative reconstruction technology on a Toshiba CT scanner, and compare it with standard filtered back projections (FBP). The purpose of this study was to compare image quality of a Cardiac CT angiography (CCTA) utilizing Adaptive Iterative Dose Reduction

**RESULTS**

Application of IR to CCTA exams significantly improves objective image quality, and does not alter quantitative analysis of coronary plaque volume, composition and luminal area.

**CONCLUSION**

Iterative reconstruction has the potential to reduce radiation exposure without affecting analysis of coronary plaque composition.

**SST02-04 • Interobserver Variability of Coronary Atherosclerotic Plaque Characteristics Using a Semiautomatic Plaque Analysis Software**

**Azien Laqmani (Presenter)**; **Thorsten Klink MD**; **Marcus Quitzke**; **Gerhard B Adam MD**; **Gunnar K Lund MD**

**PURPOSE**

To evaluate the interobserver variability (IOV) of a dedicated semiautomatic plaque analysis software for the characterization of coronary atherosclerotic plaques.

**METHOD AND MATERIALS**

The dedicated semiautomatic plaque analysis software allows for a reproducible characterization of coronary atherosclerotic plaques. However, the IOV significantly deteriorates when the observers adjust the plaque segmentation based on individual experience.

**CLINICAL RELEVANCE/APPLICATION**

A standardized concept is essential for coronary plaque analysis in order to maintain reproducible plaque dimensions.
SST02-05 • Image Quality and Radiation Dose of Coronary Computed Tomography Angiography with Automatic Tube Potential Selection Technique

Ying Wang MD (Presenter) ; Huishu Yuan MD

PURPOSE
To investigate the image quality and the radiation dose of automatic tube potential selection technique (ATPS) in dual-source computed tomography (DSCT) coronary computed tomography angiography (CCTA).

METHOD AND MATERIALS
325 patients (153 men and 172 women) consecutively enrolled in CCTA were randomly assigned into group A (n = 172) and group B (n = 153). The group A used ATPS (Care kV), and group B used conventional tube current modulation at 120 kV. All patients were scanned with prospectively ECG-triggered high-pitch helical mode or sequential mode according to the heart rate. The mean image quality score, attenuation, image noise, signal-to-noise ratio (SNR), contrast-to-noise ratio (CNR), volume CT dose index (CTDIvol), and effective dose (ED) were compared between the two groups with the 2-tailed Student t test or Mann-Whitney U test. A P-value < 0.05 was considered statistically significant. The interobserver variability of image quality scoring was determined by Kappa statistics.

RESULTS
The mean image quality score was not significantly different between group A and B (3.86 ± 0.23 vs. 3.85 ± 0.20, P>0.05). Imaging noise was significantly higher in group A than group B (25.6 ± 7.6 vs. 15.8 ± 4.0 HU, P=0.001). PPVol and ED were both significantly lower in group A than group B (CTDIvol: 5.82 ± 6.85 vs. 10.32 ± 10.05 mGy; ED: 1.25 ± 1.24 vs. 2.19 ± 1.77 mSv, PKappa=0.59).

CONCLUSION
The use of ATPS for CCTA significantly reduced radiation dose while maintaining image quality.

CLINICAL RELEVANCE/APPLICATION
Automatic tube potential selection technique can maintain diagnostic image quality of coronary CTA as well as reduce radiation dose.

SST02-06 • Multi-detector Computed Tomography Angiography (MDCTA) in Asymptomatic Adults with Low and Intermediate Coronary Artery Disease Risk: Atherosclerotic Plaques Features

Radwa A Noureldin MD, MSc (Presenter) ; Riham H El Khouli MD, PhD ; Roderic I Pettigrew MD, PhD ; Ahmed M Gharib MBChB

PURPOSE
MDCTA has a developing role in evaluating coronary artery disease (CAD) & ruling out significant stenosis non-invasively, yet it is not recommended for cardiovascular risk assessment in asymptomatic adult regardless of their risk score. We conducted this prospective study to evaluate the value of MDCTA examination in asymptomatic patients with low & intermediate risk for CAD.

METHOD AND MATERIALS
For our IRB approved study, we scanned 129 consecutive asymptomatic adults scanned with at least 64 detectors MDCTA scanner. Coronary arteries were categorized according to AHA 17-segment model. Number, size, quality of plaques & the degree of stenosis in each segment were assessed. Cardiac risk factors were evaluated & correlated to coronary arteries findings. Logistic regression & ROC curve analysis were performed.

RESULTS
Of 119 asymptomatic adults, 113 were included in the study (58 were females & 55 males), with mean age of 55±11. 73% (82/113) have low risk, 19.5% (22/113) intermediate risk, & only 5% (6/113) had high risk for CAD according to Framingham risk. 153 patients (153 men and 172 women) consecutively enrolled in CCTA were randomly assigned into group A (n = 172) and group B (n = 153). The group A used ATPS (Care kV), and group B used conventional tube current modulation at 120 kV. All patients were scanned with prospectively ECG-triggered high-pitch helical mode or sequential mode according to the heart rate. The mean image quality score, attenuation, image noise, signal-to-noise ratio (SNR), contrast-to-noise ratio (CNR), volume CT dose index (CTDIvol), and effective dose (ED) were compared between the two groups with the 2-tailed Student t test or Mann-Whitney U test. A P-value < 0.05 was considered statistically significant. The interobserver variability of image quality scoring was determined by Kappa statistics.

RESULTS
The mean image quality score was not significantly different between group A and B (3.86 ± 0.23 vs. 3.85 ± 0.20, P>0.05). Imaging noise was significantly higher in group A than group B (25.6 ± 7.6 vs. 15.8 ± 4.0 HU, P=0.001). PPVol and ED were both significantly lower in group A than group B (CTDIvol: 5.82 ± 6.85 vs. 10.32 ± 10.05 mGy; ED: 1.25 ± 1.24 vs. 2.19 ± 1.77 mSv, PKappa=0.59).

CONCLUSION
The use of ATPS for CCTA significantly reduced radiation dose while maintaining image quality.

CLINICAL RELEVANCE/APPLICATION
Automatic tube potential selection technique can maintain diagnostic image quality of coronary CTA as well as reduce radiation dose.

SST02-07 • Reduction of the Total Injection Volume of Contrast Material at Half Flow Rate in the First Four Seconds for 320-detector Row CT Coronary Angiography

Zhao-Hui Xian (Presenter) ; Xiang-Ran Cai ; Wen-Cai Yang ; Xu-Kai Mo ; Xiao-Bai Wang

PURPOSE
To investigate the feasibility of half flow rate in the first 4 seconds to reduce the total injection volume of contrast material (CM) for 320-detector row computed tomography coronary angiography (CTCA).

METHOD AND MATERIALS
Ninety patients who underwent 320-detector row CTCA with heart rate =70 bpm and body weight =80 kg were recruited consecutively. They were randomly divided into two groups with a fixed injection of CM duration of 10 seconds: receiving 0.8 mL/kg body weight at a single flow rate (group 1; n=45), or receiving half flow rate in the first 4 seconds to reduce the total injection volume of CM by 20% (group 2; n=45). The concentration of CM was 350 mg of iodine per milliliter. All patients then received 30 ml of saline chaser with the same flow rate as the administration of CM. The groups were compared with respect to the attenuation values of the pulmonary trunk (PT), ascending aorta (AA), proximal and middle segments of the coronary artery, left anterior descending artery and left circumflex artery (p>0.05). However, the mean attenuation value in the CS for group 1 was higher than that for group 2 (p<0.05).

CONCLUSION
It was feasible to achieve sufficient and reliable evaluation of the coronary arteries in 320-detector row CTCA using half flow rate in the first 4 seconds, which could reduce the injection volume of CM by 20% compared to the single flow rate for 10 seconds.

CLINICAL RELEVANCE/APPLICATION
Variable flow rate of CM injection protocol contributes to achieving sufficient and credible evaluation of the coronary arteries, while reducing possible confounding of the coronary vein.

SST02-08 • Expanding the Role of 256-row Multidetector CT Coronary Angiography with Prospective ECG-gating and Iterative Reconstruction Algorithm in the Assessment of Coronary Artery Bypass: Evaluation of Dose Reduction and Image Quality
PULPOSE
To evaluate the diagnostic performance of high speed 256-row computed tomography coronary angiography (CTCA) in the follow-up of patients with coronary artery bypass grafting (CABG), using low-kV CT angiography protocol combined with prospective ecg-gating technique and iterative reconstruction algorithm (Idose4) compared with standard retrospective protocol.

METHOD AND MATERIALS
Thirty-seven non-obese patients with known advanced coronary disease treated with artery bypass grafting were prospectively enrolled in our study. All the patients underwent 256MDCT (Brilliance iCT, Philips) CTCA using low-dose protocol (100kV; automated tube current modulation; rotation time: 0,375s) combined with prospective ECG-triggering acquisition protocol and 4th generation iterative reconstruction technique (Idose4; Philips,Best,Netherlands), and all the length of the bypass graft was included in the evaluation. A total of 21 similar patients were enrolled in the control group and evaluated with a standard retrospective ECG-gated CTCA (120kV; 350mAs). Dose-length product (DLP) was directly provided by the scanners. On both CT scans regions of interest (ROIs) were placed in coronary arteries, in order to calculate standard deviation (SD) of pixel values and intravessel density (HU). Diagnostic quality was also evaluated using a 4-point scale (4 excellent, 3 good, 2 acceptable, 1 low).

RESULTS
Two radiologists performed a double blind reading of the exams (all considered diagnostic) and maximum intensity projection, curved planar reformatted images and volume rendering reconstructions were generated in both groups. Despite the statistically significant reduction of radiation dose (51% lower in the study group with a P-value Qualitative analysis did not reveal any significant difference in diagnostic quality of the two groups.

CONCLUSION
The development of high-speed multidetector CT scans combined with modern iterative reconstruction allows the use of low dose prospective CTCA protocols also in patients with CABG, maintaining high diagnostic performance despite the significant reduction in radiation dose.

CLINICAL RELEVANCE/APPLICATION
High speed CT scans combined with Idose4 allow an accurate evaluation of CABG with prospective ECG-gating protocols in a single breath-hold, obtaining a significant reduction in radiation dose.

SST02-09 • Resident Interpretation of On-Call “Triple-Rule-Out” CT Studies in Patients with Acute Chest Pain
Kevin G Garrett MD (Presenter) ; Justin R Silverman ; Aleksander Krazinski ; Lucas L Geyer MD * ; Carlo Nicola De Cecco MD ; U. Joseph Schoepf MD * ; Gary F Headden ; Philip Costello MD ; Felix G Meinel MD ; Pal Suranyi MD, PhD ; James G Ravenel MD

PURPOSE
To evaluate the agreement between preliminary Radiology resident and final subspecialty attending interpretation of on-call, emergency Triple-Rule-Out (TRO) CT studies in patients with acute chest pain.

METHODOLOGY AND MATERIALS
Our department uses peerVue to track agreement between preliminary trainee and final subspecialty attending interpretation of on-call emergent imaging studies. This system enables grading preliminary resident reports as Concur, Minor Discrepancy (not affecting patient management), and Major Discrepancy (affecting patient management). During a 24 month sample period from April 2011 through March of 2013, 617 TRO studies were performed in an on-call setting, were initially evaluated by the on-call upper level resident and had peerVue data available. peerVue TRO grades were analyzed and compared with resident performance on 697 emergent non ECG-synchronized routine chest CT cases from the same period. In cases of flagged discrepancies, patient records were reviewed to determine eventual patient management and outcome.

RESULTS
There was agreement (Concur) between preliminary Radiology resident and final subspecialty attending interpretation in 88.5% (n=546) of TRO cases. 10.4% (n=64) were graded as Minor Discrepancy and 1.1% (n=7) as Major Discrepancy, with possible significance for patient management. In the interpretation of non ECG-synchronized routine chest CT cases (89.8% [n=547] Concur-rate), there were significantly (p<0.001) more Concur interpretations. On-call resident interpretation of TRO CT studies in patients with acute chest pain is congruent with final subspecialty attending interpretation in the overwhelming majority of cases. Discrepancies are rare and did not affect patient management or outcome in our cohort. Resident performance in this domain is similar to performance in the interpretation of emergent non ECG-synchronized routine chest CT.

CONCLUSION
With appropriate training, on-call resident interpretation of ECG-synchronized TRO CT studies is safe and trainee performance does not differ from more traditional interpretative tasks.

Cardiac (Anatomy and Function II)

Friday, 10:30 AM - 12:00 PM • S504AB

SST03 • AMA PRA Category 1 Credit ™:1.5 • ARRT Category A+ Credit:1.5
Moderator
James C Carr , MD *
Moderator
Jeremy D Collins , MD *

SST03-01 • Should All Patients Undergoing Pulmonary Vein Isolation Have a Trans-esophageal Echocardiogram to Rule out Thrombus in the Left Atrial Appendage?
Saurabh Jha MD (Presenter) ; Sahar J Farahani MBBS

PURPOSE
Patients with atrial fibrillation (AF) undergoing pulmonary vein isolation (PVI) for catheter-guided ablation nearly always have a pre-procedural cardiac CT for 3D guidance. These patients are at increased risk for thrombus in the left atrial appendage (LAAT), which results in cancellation of the procedure. This is a cost analysis to determine the optimal method of excluding LAAT, with the assumption that for patient convenience imaging is performed on the same day as the PVI.

METHODOLOGY AND MATERIALS
A simple diagnostic model was constructed on Tree Age Pro (2012). Patients with AF undergoing PVI were assumed to require pre-procedural cardiac CT. Two diagnostic strategies were explored for the detection of LAAT. The first was intracardiac US for LAAT flagged on cardiac CT. The second was TEE for all patients. Both TEE and intracardiac US were assumed to be perfect tests. If the patient...
had a positive TEE or a positive intracardiac US for LAAT the procedure would be abandoned. The outcomes included costs from a payer’s perspective, number of cases of missed LAAT and number of procedures cancelled. The data were abstracted from published meta-analysis and varied with sensitivity analysis. Medicare fee for schedule was used for the costs of procedures.

RESULTS
Assuming a prevalence of LAAT in AF of 9% and sensitivity and specificity of cardiac CT of 96% and 92%, the selective intracardiac US strategy was cheaper ($417.93) than the strategy of TEE for all patients ($503.20). In a cohort of 10,000 patients with AF requiring PVI there would be 36 missed cases of LAAT using the cheaper strategy. The incremental cost incurred in detecting an additional case of LAAT was $23,868. If efficiency is desired such that patients must have imaging on the same day as the procedure then in a cohort of 10,000 patients there will be 864 cancellations with the cheaper strategy and 900 cancellations with the more expensive strategy.

CONCLUSION
In patients with AF undergoing PVI and same day imaging the strategy of selective intracardiac US on patients with cardiac CT positive for LAAT costs $85.27 less than subjecting all patients to TEE; at the expense of missed LAAT such that the incremental cost of picking up an additional patient with LAAT is $23,868.

CLINICAL RELEVANCE/APPLICATION
LAAT has a high prevalence in patients with AF and this affects the management of the condition.

SST03-02 • The Myocardial Cut-off Sign: A Finding of Left Ventricular Pseudoaneurysm

Clint E Jokster MD (Presenter); Travis S Henry MD *; Constantine A Raptis MD; Cylen Javidan-Nejad MD; Fernando R Gutierrez MD; Pamela K Woodard MD *

PURPOSE
The purpose of this study is to describe/define the ‘myocardial cut-off’ sign and compare its sensitivity and specificity to other imaging findings which help distinguish left ventricular pseudo-anneuysms (LV PSA) from left ventricular true aneurysms (LV aneurysm).

METHOD AND MATERIALS
Retrospective chart review of patients who had undergone left ventricular repair at our institution was performed. Patients who had pre-operative cardiac imaging with either CT or MRI were identified and divided into 2 groups, those with surgically or pathologically proven LV aneurysms (n=15) and those with surgically or pathologically proven LV PSAs (n=15). The thickness of the sac wall was measured at the aneurysm neck and 1 and 2 cm distal to the neck. A decrease of 50% or more between the neck measurement and sac wall measurement was called a positive myocardial cut-off sign; a decrease of less than 50% was called negative. These measurements were made during diastole (when applicable) on images oriented in a plane perpendicular to the axis of the aneurysm/PSA in an effort to quantify how quickly the wall of the sac tapered. 2 measurements were obtained for each patient, one on either side of the neck. In addition, other imaging findings associated with LV aneurysms and PSAs were evaluated. Some of these included location, presence of pericardial enhancement, presence of thrombus, ratio of neck diameter to maximum sac diameter, and ratio of neck diameter to maximum sac depth. Sensitivities and specificities for these signs and findings were calculated.

RESULTS
The sensitivity and specificity of the myocardial cut-off sign measured 1 cm from the sac neck was 90% and 96.4% respectively. Apical location was 66.6% sensitive and 80% specific for LV aneurysms. Pericardial enhancement was 77.8% sensitive and 88.9% specific for LV PSAs. Thrombus was 93.3% sensitive and 73.3% specific for LV PSAs. The mean ratio of neck diameter to maximum sac diameter and to maximum sac depth was 1:1.1 and 1:0.7 for LV aneurysms; 1:2.3 and 1:1.9 for LV PSAs.

CONCLUSION
The myocardial cut-off sign is a sensitive and specific sign of LV PSA when measured at 1 cm from the sac neck. * more in-depth statistical evaluation will occur prior to presentation!

CLINICAL RELEVANCE/APPLICATION
The myocardial cut-off sign is sensitive and specific for LV PSA. This is an important diagnosis to make as LV PSA is a surgical emergency and can be difficult to distinguish from LV aneurysm.

SST03-03 • Systematic Comparison of CT Scan and Retrograde Venography for Depicting the Cardiac Venous System Prior to Cardiac Resynchronisation Therapy

Marie-Michele Theriault MD (Presenter); Maria De La Paz Ricapito MD; Felix paredes MD; Patricia Díez Martinez MD; Paul Farand; Gerald Gahide MD, PhD

PURPOSE
To assess the value of cardiac CT in comparison to retrograde venography for depicting the presence of a cardiac vein suitable to implant a left ventricular lead for Cardiac Resynchronization Therapy.

METHOD AND MATERIALS
Cardiac CT was performed in 41 consecutive patients (75.6% men) prior to Cardiac Resynchronisation Therapy procedure. Cardiac veins were systematically described by two readers (Inferior Interventricular Vein, Posterior Vein(s), Lateral Vein(s)) and compared to retrograde venography findings. The coronary sinus diameters, atrium area and distance between coronary sinus ostium and right atrium lateral wall were measured.

RESULTS
An inferior interventricular vein was demonstrated in all patients (41) on CT scan and in 41.5% patients (17) on venography. A posterior vein was demonstrated in 73.2% (n=30) of patients on CT scan and in 61% (n=25) on venography. A lateral vein was observed in 73.2% (n=30) on CT scan and in 61% (n=25) on venography. In comparison to venography, CT scan sensitivity for detecting cardiac veins was 100%. CT scan demonstrated significantly more veins than retrograde venography (p2 (IQR: 17.5 $\pm$ 26.9 cm$^2$). There was a good inter-observer agreement for the measures of coronary sinus ostium antero-posterior diameters (r: 0.83 ; p

CONCLUSION
Cardiac CT is an efficient tool for non-invasively depicting cardiac venous system tributaries suitable for Cardiac Resynchronisation Therapy. Its sensitivity for depicting those veins is significantly higher than retrograde venography.

CLINICAL RELEVANCE/APPLICATION
Cardiac CT could non-invasively help choosing patients with suitable veins for Cardiac Resynchronisation Therapy.

SST03-04 • Comparison of Rapid Left Atrial Volume Determination: Gated Multidetector CT vs. Transthoracic Echo

Daniel A Moses MBBS, FRANZCR (Presenter); Minh Truong MBBS, FRANZCR; Liza Thomas MBBS, PhD; Suzanne Eshoo MBBS, PhD

PURPOSE
As CCTA become more ubiquitous, rapid LA volume estimation is desirable. We compared multidetector CT rapid volume estimation with transthoracic echo measurements.

METHOD AND MATERIALS
Retrospective study examining 51 patients undergoing retrospectively gated CCTA evaluation. Gated MDCT and TTE assessments were performed within 48 hours when there was no change in the patients clinical status. The CT images were reconstructed to reflect standard views from the TTE. The following measurements were obtained from the CT images (radiologists) and TTE (cardiologists), both at left ventricular end-systole and end-diastole.
1. Parasternal long axis (PLAX): AP LA diameter.
2. AP 4-chamber view: maximum LA length and width, maximum and minimum left atrial area.
Measurements were compared using Pearson’s correlation and Bland-Altman analysis.

Left atrial volume was calculated by the area-length and prolate ellipse methods (and indexed to BSA).

RESULTS
Comparison measurements were as follows: PLAX: TTE $3.7 \pm 0.51$ cm; MDCT $3.94 \pm 0.56$ cm; 4-CH max length: TTE $5.22 \pm 0.59$ cm; MDCT $5.38 \pm 0.54$ cm; 4-CH area-length: TTE $55.43 \pm 19.12$ cm$^2$; MDCT $76.82 \pm 27.32$ cm$^2$; 4-CH min area: TTE $11.33 \pm 3.65$ cm$^2$; MDCT $12.87 \pm 3.81$ cm$^2$; MDCT $21.85 \pm 4.46$ cm$^2$; Prolate ellipse volume: TTE $41.12 \pm 12.79$ cm$^3$; MDCT $52.52 \pm 17.37$ cm$^3$; When adjusted for surface area: 4-CH area-length: TTE $29 \pm 10$ mL/m$^2$; MDCT $40 \pm 14$ mL/cm$^2$; Prolate ellipse volume: TTE $21 \pm 6$ mL/m$^2$; MDCT $27 \pm 9$ mL/cm$^2$. There was modest correlation between measurements on MDCT and TTE: PLAX $r = 0.57$; max area $r = 0.54$; area length $r = 0.55$; prolate ellipse $r = 0.53$. TTE measurements were systematically less than CT for all methods. Bland-Altman plots demonstrate there was less agreement on larger LA sizes.

CONCLUSION
The systematically lower volume estimates by TTE likely relate to the reduced image spatial resolution and foreshortening on TTE when compared to MDCT. Anatomical landmarks (including the precise location of the LA wall and mitral valve) are much more easily appreciated on MDCT. Also the ability to manipulated the data set and achieve the desired imaging view is easier on MDCT.

CLINICAL RELEVANCE/APPLICATION
TTE is the most common modality for estimate of LA volume. Knowing how these relate to similar estimations of LA size on gated MDCT scan is important clinical information.

SST03-05 • Presence of Myocardial Fibrosis in Right Ventricle Detected on ECG Gated 320 Slice CT Might Be a Predictor of a Short Term Poor Prognosis in Subjects with Pulmonary Hypertension
Koya Ozawa MD (Presenter); Nobusada Funabashi MD, PhD; Akihisa Kataoka MD; Noriyuki Yanagawa MD; Nobuhiro Tanabe; Koichiro Tatsuji; Yoshihiko Kobayashi

PURPOSE
To evaluate significance of presence of myocardial fibrosis (MF), as represented by abnormal late enhancement on CT, in right ventricle (RV) in subjects with pulmonary hypertension (PH), we undertook ECG gated enhanced 320 slice CT.

METHOD AND MATERIALS
A total of 56 PH subjects confirmed on right heart catheterization (RHC) (15 males, mean age 57 ± 15 years, 33 chronic thromboembolic PH (CTEPH), 21 pulmonary arterial hypertension (PAH), and 2 others) underwent ECG gated 320 slice CT (Aquilion one, Toshiba Medical) to evaluate pulmonary artery, RHC and transthoracic echocardiogram (TTE) within 3 months without any clinical incident. Prospective ECG gating was added and if there was abnormal enhancement in RV myocardium, we regarded this as MF. Subjects were followed for a median of 17 months.

RESULTS
Adverse events (AE) occurred in 11 subjects (5 males, mean age 60 ± 10 years); cardiac death (3), heart failure (6), cerebral hemorrhage (2). MF in RV was detected in 16 subjects (5 males, mean age 56 ± 2 years, 9 CTEPH, 6 PAH and 1 other). Comparing subjects with and without MF, only cardiac output (l/min) calculated on TTE was significantly lower in subject with than without MF (P < 0.05). However, there were no significant differences between groups in other factors, especially hemodynamic state parameters, on CT, TTE and RHC. Significant differences between subjects with and without MF were seen at each time point when whole follow up period was compared by further Kaplan Meier analysis and log rank test (P = 0.031).

CONCLUSION
Presence of MF in RV detected on ECG gated 320 slice CT may have a short term poor prognosis in PH subjects, even though there were no significant differences in hemodynamic state parameters acquired from CT, TTE and RHC (except cardiac output) on TTE between subjects with and without MF. In contrast to hemodynamic state parameters, which tend to change, presence of MF in RV is a permanent morphological parameter which may be useful for accurately predicting prognosis of PH subjects.

CLINICAL RELEVANCE/APPLICATION
Presence of MF in RV detected on ECG gated 320 slice CT may be useful for accurately predicting prognosis of PH subjects.

SST03-06 • Volumetric and Flow Measurements in Patients with Repaired Tetralogy of Fallot: Comparison of Transverse versus Short-axis Cine-MRI and Echocardiography
Juliane Schelhorn MD (Presenter); Ulrich Neudorf; Kai Nassenstein; Thomas W Schlosser MD

PURPOSE
Patients with corrected tetralogy of Fallot (TOF) are prone to develop dilatation and dysfunction of the right ventricle resulting in long-term complications. For right ventricular (RV) volumetry MRI is the gold standard but it remains controversial whether axial or short-axis (SA) planes should be used forRV analysis. The aim of this study was to compare both algorithms for the assessment of RV function. Additionally we compared volumetric and flow data in MRI and echocardiography (Echo).

METHOD AND MATERIALS
31 MRI studies of 27 patients with TOF were retrospectively studied. End-systolic volume (ESV), end-diastolic volume (EDV), stroke volume (SV) and ejection fraction (EF) of the left and right ventricle and left myocardial mass were measured in axial and SA planes. Furthermore the inner diastolic right ventricular diameter (RVIDdiast) in Echo and pulmonary valve peak velocity (PVPV) were acquired in MRI and Echo.

RESULTS
Good correlation between axial and SA orientation was found for left ventricular ESV, EDV, myocardial mass and SV and for right ventricular ESV, EDV and SV in MRI (p=0.001). For right ventricular volumetry no systematic difference between both stack orientations was found. RVIDdiast in Echo and right EDV in SA and in axial orientation in MRI correlated well (p=0.001). Good correlation was found between PVPV in MRI and Echo (p=0.001).

CONCLUSION
For right ventricular volumetry in MRI axial and SA slices provide comparable results with no systematic error. Due to its good correlation with right EDV in MRI the RVIDdiast in Echo can be recommended as practicable follow-up tool in clinical routine.

CLINICAL RELEVANCE/APPLICATION
We wanted to evaluate whether axial or short-axis planes for right ventricular volumetry in MRI in patients with corrected tetralogy of Fallot are more appropriate.

SST03-07 • Fusion of Body Surface Mapping and Imaging for the Assessment of Cardiac Arrhythmias
Hubert Cochet MD (Presenter); Frederic Sacher; Meleze Hocini; Bruno Quesson; Pierre Jais; Michel Montaudon MD; Michel Haissaguerre; Francois H Laurent MD

PURPOSE
Non-invasive imaging with cardiac MDCT and delayed-enhanced (DE) MRI gives access to cardiac anatomy and myocardial substrate. Body surface mapping (BSM) enables a non-invasive assessment of cardiac activation. We evaluated the feasibility of BSM/imaging fusion for the assessment of cardiac arrhythmias.

METHOD AND MATERIALS
24 patients referred for electrophysiological procedure in the context of ventricular tachycardia (VT, N=10), Wolf-Parkinson-White syndrome (WPW, N=2), atrial fibrillation (AF, N=10) and scar-related ventricular fibrillation (VF, N=2) were studied. All patients underwent BSM and non-invasive imaging with MDCT (N=9) and/or DEMRI (N=18). When both MDCT and DEMRI had been performed, datasets were fused using landmark registration. BSM was performed using a 252-electrode vest enabling the computation of epicardial electrogarms from body surface potentials. The epicardial geometry on which electrical activation was calculated from BSM acquisition was then registered to the geometry segmented from imaging, using an iterative coupled points algorithm. The output was a 3-dimensional cardiac model integrating cardiac anatomy (cardiac chambers, epicardium, coronary vessels, phrenic nerve), myocardial substrate (fibrosis from DEMRI, myocardial hypodensity or wall thinning from MDCT), and epicardial activation from BSM.

RESULTS
Acquisition, segmentation, and registration was feasible in all patients. In patients referred for VT, this enabled a non-invasive assessment of the earliest epicardial exit of the VT circuit, and its location with respect to myocardial substrate, coronary vessels, or phrenic nerve. In WPW patients, this helped understanding accessory pathway locations of unusual location, or resistant to prior ablation. In AF and VF patients this enabled a non-invasive analysis of rotor trajectories with respect to myocardial substrate. In 14 patients (10 VT, 1 WPW, 3 AF), 3-dimensional models were successfully integrated in navigation systems and used to guide mapping/ablation.

CONCLUSION
By combining information on anatomy, substrate and electrical activation, BSM and imaging fusion enables a comprehensive non-invasive assessment of cardiac electrical disorders. This might have applications for diagnosis, prognosis, or ablation targeting.

CLINICAL RELEVANCE/APPLICATION
Body surface mapping can be fused with other non-invasive cardiac imaging modalities to provide a comprehensive assessment of cardiac arrhythmias.

SST03-08 • Biventricular Myocardial Strain Analysis in Patients with Arrhythmogenic Right Ventricular Cardiomyopathy (ARVC) Using Cardiac Magnetic Resonance Feature Tracking
Philipp Heermann (Presenter) ; Dennis Hedderich MD ; Walter L Heindel MD ; Matthias Paul MD ; David C Maintz MD ; Alexander C Bunck

PURPOSE
Fibrofatty degeneration of myocardium in ARVC causes detectable wall motion abnormalities. The aim of this study was to examine whether cardiac magnetic resonance (CMR) based strain analysis using feature tracking (FT) can serve as an observer-independent and quantifiable measure to confirm global and regional ventricular dysfunction in ARVC patients and support the detection of early signs of ARVC.

METHOD AND MATERIALS
We enrolled 20 patients diagnosed with ARVC, 30 with borderline-ARVC and 22 subjects with a positive family history but no signs of a manifest ARVC. 10 healthy volunteers (HV) served as controls. ARVC patients received genotyping for plakophilin-2 mutation (PKP-2), of which 8 were found to be positive. Cine MR datasets of all subjects were assessed for myocardial strain using FT (TomTec Diogenes Software). Global and segmental strain in radial, circumferential and longitudinal mode were assessed.

RESULTS
CMR based strain analysis using FT is an objective and useful measure for quantification of wall motion abnormalities in ARVC. It allows differentiation between manifest or borderline-ARVC and HV, even if ejection fraction is still normal.

CONCLUSION
Importance of quantitative parameters in ARVC diagnosis is underlined by the modification of the Task Force Criteria 2010 and CMR-based strain promises to be a powerful measure to objectively diagnose ARVC.

SST03-09 • Morphological and Functional Evaluation of Right Ventricle on ECG-Gated 320 Slice CT Can Predict a Short Term Poor Prognosis in Subjects with Pulmonary Hypertension
Koya Ozawa MD (Presenter) ; Nobusada Funabashi MD, PhD ; Akihisa Kataoka MD ; Noriyuki Yanagawa MD ; Nobuhiro Tanabe ; Koichiro Tatsumi ; Yoshiro Kobayashi

PURPOSE
To evaluate the morphological and functional parameters of right ventricle (RV) in subjects with pulmonary hypertension (PH) by electrocardiogram (ECG)-gated enhanced 320 slice computed tomography (CT).

METHOD AND MATERIALS
56 PH subjects (15 males, mean age 57 ± 15 years, 33 chronic thromboembolic PH, 21 pulmonary arterial (PA) hypertension and 2 others) underwent retrospective ECG-gated 320 slice CT (Aquilion one, Toshiba Medical). To obtain not only images of the whole heart including RV and coronary arteries, but also images of the PA, all CT scans were obtained using a dual volume conventional scan with retrospective ECG-gating with a 0.5 mm slice thickness with a downward direction. Tube voltage was set at 120 kV and tube current was set at 580 mA with tube current modulation. We injected 60 ml of contrast material (350 mgI/ml) at 3.5 ml/s, followed by injection of a saline-to-contrast material mixture (40 ml contrast material at 2 ml/s and 30 ml saline at 1.5 ml/s), followed by injection of 20 ml pure saline at 1.5 ml/s. CT images were reconstructed every 5% from 0-95% of ECG R-to-R interval and 4 dimensional (4D) images were obtained. Subjects were followed for a median of 17 months.

RESULTS
Adverse events (AE) occurred in 11 subjects (5 males, mean age 60 ± 10 years); Cardiac death (3), heart failure (6), cerebral hemorrhage (2). Receiver operating characteristic (ROC) curves of RV end-diastolic volume (RVEDV) and end-systolic volume (RVESV) on CT showed area under curve (AUC) of 0.646 and 0.590, respectively, and best cutoff points of 125.2 mm3 (sensitivity 72.7%, specificity 60%) and 113.5 mm3 (sensitivity 54.5%, specificity 80%), respectively, to distinguish subjects with and without AEs. By Kaplan Meier analysis, there was significant differences in incidence of AEs between = and < 125.2 mm3 of RVEDV on CT (P=0.032). In a similar analysis, there was not significant differences in incidence of AEs between = and < 113.5 mm3 of RVESV on CT (P = 0.651).

CONCLUSION
Quantitative and qualitative morphological and functional evaluation of RV on 4D images of ECG gated 320 slice CT showing RVESV can predict short term poor prognosis in PH subjects.

CLINICAL RELEVANCE/APPLICATION
Presence of RVESV dilation on ECG-gated 320 slice CT should be considered for poor prognosis in PH subjects.
Lung Density
Multidetector Row CT: Comparison to Threshold-based Methods in Expiration and the Expiratory to Inspiratory Ratio of Mean
SST04-01 •

Katherine R Birchard
Yoshiharu Ohno
Moderator

abnormality, centrilobular nodularity and airway wall thickening. The decreased emphysema index found in current cigarette smokers is not fully explained by visual findings such as ground glass opacity, centrilobular nodularity and airway wall thickening.

RESULTS
Univariate analyses tested the relationship of smoking status to visual CT findings. To test whether the effect of smoking status can be attributed to visual findings, a multivariate model for %LAA-950HU was constructed containing previously described confounders in addition to the visual components associated with smoking status.

CONCLUSION
Current smokers displayed 23% less visual emphysema, 19% more AWT, and 188% more CN than former smokers (all p values on inspiration and expiration. For Exp and DM, the ratio of the detected air trapping area (ATA) and the segmented total lung volume (TTLV) seen on CT were compared to the ratio of the residual volume (RV) and the total lung capacity (TLC) on pulmonary function tests. RV/TLC beyond the 95th percentile of predicted was considered as pathologic. Detection of pAT was performed using Spearman rank correlation, receiver operating characteristic (ROC) analysis and the area under the ROC curve (AUC).

CLINICAL RELEVANCE/APPLICATION
Density mappings might be used as an imaging biomarker for the detection and quantification of pathologic air trapping.

SST04-02 • Dynamic Oxygen-enhanced MRI: Capability for Pulmonary Functional Loss Assessment and Clinical Stage Classification in Asthmatics as Compared with Quantitative Thin-section CT

Yoshiharu Ohno MD, PhD (Presenter) *; Shinichiro Seki MD; Mizuho Nishio MD *; Hisanobu Koyama MD; Maho Tsubakimoto MD; Takeshi Yoshikawa MD *; Sumiaki Matsumoto MD, PhD *; Makoto Obara *; Marc Van Cauteren PhD *; Nobukazu Aoyama RT; Akiko Kusaka RT; Kazuho Sugimura MD, PhD *

PURPOSE
To prospectively and directly compare the capability of dynamic oxygen-enhanced MR imaging (O2-enhanced MRI) and quantitative CT for pulmonary functional loss assessment and clinical stage classification in asthmatics.

METHOD AND MATERIALS
Thirty consecutive asthmatics (17 men and 13 women; age range 27-78 years) underwent dynamic O2-enhanced MRI, thin-section MDC and pulmonary function tests (FEV1% and FEV1/FVC%). All asthmatics were classified into three stages (Mild [n=12], Moderate [n=12] and Severe [n=6]) according to the Global Initiative for Asthma guideline. All dynamic O2-enhanced MRI were obtained by using respiratory-triggered inversion-recovery 2D HASTE sequence. From signal intensity-time course curves, relative enhancement ratio and wash-in time maps in each subject were generated by pixel by pixel analyses. Then, ROIs were placed over the lung, and averaged to determine mean relative enhancement ratio (MRER) and mean wash-in time (MWIT) in each subject. On quantitative CT in each subject, ratios between wall area and total area of bronchus in right apical and anterior basal bronchi was averaged as WA%, and mean lung density (MLD) of the entire lung was also measured. To compare the capability of dynamic O2-enhanced MRI and quantitative CT for pulmonary functional loss assessment, MRER, MWIT, MLD and WA% were correlated with FEV1% and FEV1/FVC%. To determine the capability of two modalities for clinical stage classification, MRER, MWIT, MLD and WA% were statistically compared among three clinical stages by means of Fischer's PLSD test.

RESULTS
FEV1%/FVC% had significant and moderate correlations with MRER (r=0.50, p=0.005), MWIT (r=0.65, p<0.01) also had significant and moderate correlations with MRER (r=0.60, p=0.0005), MWIT (r=0.68, p<0.01). Dynamic oxygen-enhanced MR imaging has better capability for pulmonary functional loss assessment and clinical stage classification in asthmatics than quantitative CT.

CLINICAL RELEVANCE/APPLICATION
Dynamic oxygen-enhanced MR imaging has better capability for pulmonary functional loss assessment and clinical stage classification in asthmatics than quantitative CT.

SST04-03 • Relationship between Current Smoking, Visual CT Findings, and Emphysema Index in Cigarette Smokers

Sungshick Jou (Presenter); Kunihiro Yagihashi MD; Jordan Zech; David A Lynch MBCh *

PURPOSE
Quantitative CT (QCT) measures of emphysema are significantly lower in current smokers than in those that quit, even after adjustment for severity of COPD. The purpose of this study is to evaluate whether visual CT findings could account for the current smoker effect.

METHOD AND MATERIALS
500 current and former smokers were evaluated (50% current smokers, 53% male, 80% non-Hispanic white, mean age 62.8 ± SD 8.6). The cohort included 100 smoking controls, and 100 subjects within each of the GOLD stages 1-4. Subjects underwent high resolution volumetric CT at full inspiration. Following automated lung segmentation, extent of emphysema was defined as % voxels with attenuation values =-950 Hounsfield Units (HU) on inspiratory CT (%LAA-950HU). Each CT scan was visually scored by two radiologists for presence and extent of emphysema, ground glass opacity (GGO), centrilobular nodularity (CN), and airway wall thickening (AWT) within each lobe. Univariate analyses tested the relationship of smoking status to visual CT findings. To test whether the effect of smoking status can be attributed to visual findings, a multivariate model for %LAA-950HU was constructed containing previously described confounders in addition to the visual components associated with smoking status.

RESULTS
Current smokers displayed 23% less visual emphysema, 19% more AWT, and 188% more CN than former smokers (all p<0.005). Current smokers have less emphysema, more airway wall thickening and centrilobular nodularity than former smokers. QCT emphysema index is reduced in current smokers, even after adjustment for physiologic severity and visual findings.

CLINICAL RELEVANCE/APPLICATION
The decreased emphysema index found in current cigarette smokers is not fully explained by visual findings such as ground glass abnormality, centrilobular nodularity and airway wall thickening.
Relationships between QCT Airway Measures and Outcomes of Exacerbations

Alexander McKenzie BS (Presenter); David A Lynch MBCh *; John D Newell MD *; Douglas Stinson; Joyce D Schroeder MD *; Douglas C Everett PhD; Stephen Humphries; Jordan Zach; Melian K Han *; Carla G Wilson; Eric A Hoffman PhD *

PURPOSE
Volumetric CT with quantitative analysis yields numerous measures of airway lumen and airway wall. The purpose of this study was to determine which airway measures are best associated with exacerbation frequency.

METHOD AND MATERIALS
8043 inspiratory CT scans from the COPDGene study were examined. Airway measures included inner diameter, inner area, outer area and airway wall thickness, in upper and lower lobes (segmental in all cases, subsegmental and sub-subsegmental in 330 cases). Ratios of upper and lower lobe airway parameters (e.g. RB1/RB10, LB1A/LB10A) were examined. Exacerbation outcome was defined as either one severe exacerbation requiring hospitalization, or more than one mild or moderate exacerbation. Univariate logistic regression was used to determine odds associated with exacerbation. Multivariate logistic regression included age, smoking history and status, % emphysema and FEV1 percent predicted.

RESULTS
On univariate analysis, measures of inner bronchial diameter and inner luminal area were consistently associated with significantly increased risk of exacerbation (odds ratios 1.05 to 3.15). Odds ratios increased as airway generation increased from the segmental to the subsegmental but remained consistent between the subsegmental and the sub-subsegmental. Multivariate regression decreased the odds ratios, but odds were consistently higher at higher generation airways (subsegmental, sub-subsegmental). Inner diameter of segmental airways in the upper lobes proved to be the most consistently high predictor of exacerbation (LB1 OR = 1.48, RB1 OR = 1.35).

Exacerbations were better predicted when inner diameter measures were taken at the sub and sub-subsegmental level. Additionally, the inner diameter ratio of upper to lower lobe airways was strong predictors of exacerbation at the subsegmental level (LB1A/LB10A OR = 2.08, RB1A/RB10A OR = 2.86).

CONCLUSION
Quantitative airway measures can all be used to predict exacerbation, and odds increase in more distal airways. Upper to lower lobe ratio of airway inner diameter is a strong predictor of exacerbation at the subsegmental level.

CLINICAL RELEVANCE/APPLICATION
Quantitative evaluation of airway wall thickness may permit risk stratification and prophylaxis for COPD exacerbation, an important cause of morbidity and mortality in COPD.

SST04-05 • Is Bronchial Imaging Affected by Temporal Resolution? Comparative Evaluation at 140 and 75 ms in 90 Patients

Nunzia Tacelli MD (Presenter); Antoine Hut MD; Teresa Santangelo; Colm F Murphy MD; Martine J Remy-Jardin MD, PhD *; Jacques Remy MD *

PURPOSE
To evaluate the influence of temporal resolution (TR) on cardiac motion artifacts at the level of bronchial walls.

METHOD AND MATERIALS
90 consecutive respiratory patients (mean age: 50.2 yr, mean heart rate: 81.2 bpm) underwent a noncontrast chest CT examination on a second-generation 128-slice dual-source CT System (Somatom Definition Flash, Siemens Healthcare, Forchheim, Germany). The examinations were obtained with dual-source, single-energy using the following parameters: collimation: 32x2x0.6 mm; rotation time: 0.28 s; weight-adapted selection of the kilovoltage (100 kVp -120 kVp); reference tube current-time product: 64 ref mAs; 4D dose modulation and a pitch of 2.0. Two series of images were systematically reconstructed using data from both tubes on a prototype workstation with a TR of 75 ms (i.e., optimized TR) (Group 1) and 140 ms (i.e., standard TR) (Group 2). Using a 4-point scale, two radiologists independently analyzed the presence and severity of cardiogenic artifacts at the level of 8 target bronchi, i.e., right (R) and left (L) B1, B5, B7 and B10 (total number of bronchi examined: n = 720).

RESULTS
Cardiogenic artifacts were significantly less frequent and less severe in Group 1 than in Group 2 (p = 0.0001). At 75 ms, most of bronchi can be depicted without cardiogenic artifacts.

CLINICAL RELEVANCE/APPLICATION
Quantitative estimation of bronchial morphometry should integrate the influence of cardiac motion artifacts, themselves dependent on the temporal resolution of data acquisitions.

SST04-06 • Comparison of CT Findings between Th2 Asthma and Non-Th2 Asthma: Can CT Findings Characterize Molecular Mechanism Based Phenotypes in Severe Asthma

Kwang Nam Jin MD (Presenter); Chang Hyun Lee MD, PhD; Hye-Ryun Kang; Sujeong Kim; Sang Min Lee MD; Young Eun Bahn MD; Kyunghee Lee MD; Hyun-Ju Lee MD, PhD; Jin Mo Goo MD, PhD *

PURPOSE
Recent studies suggest that asthma can be divided into at least 2 distinct phenotypes defined by degree of T helper type 2 (Th2) cell inflammation. The purpose of this study was to compare the CT findings between Th2 (eosinophilic) and non-Th2 (non-eosinophilic) driven asthma.

METHOD AND MATERIALS
We enrolled 29 patients who have severe asthma with molecular based identification of the phenotype and underwent chest CT. Th2 type asthma was diagnosed in 21 patients and non-Th2 in 8. Two radiologists blinded to clinical information performed visual analysis in consensus for the extent and severity of bronchial wall thickening (BT), mucus plugging (MP), and the extent of bronchiectasis (BE). The extent of BT, MP, and BE was assessed as the number of involved lobes (range, 0-5) and the severity of BT and MP was evaluated as 4-point scores (range, 0-3). Quantitative analysis was available for the low lung attenuation with threshold -950 HU (LAA-950HU), LAA-856HU, and bronchial wall (thickness, inner luminal diameter, and wall area %; RB1, LB1+2, RB10, LB10) in 16 CT scans (13 Th2 vs 3 non-Th2).

RESULTS
In the qualitative analysis, Th2 type showed more extensive BT (Th2, 3.1 ± 2.2 vs Non-Th2, 1.1 ± 1.4, p = 0.02) and MP (Th2, 1.9 ± 1.8 vs Non-Th2, 0.5 ± 0.8, p = 0.03). BE was equally observed in both types (Th2, 1.4 ± 1.9 vs Non-Th2, 0.4 ± 0.7, p = 0.19). Severity of BT and MP between Th2 and Non-Th2 types was not significantly different (Th2, 1.3 ± 1.0 vs Non-Th2, 0.6 ± 0.7, p = 0.15; Th2, 0.8 ± 0.8 vs Non-Th2, 0.5 ± 0.8, p = 0.67) but Th2 type was given slightly higher mean severity scores. LAA-950HU was not significantly different between Th2 and Non-Th2 types (Th2, 9.9 ± 14.5 vs Non-Th2, 9.1 ± 9.1, p = 0.46), however, LAA-856HU was significantly higher in Th2 type (Th2, 43.6 ± 40.0 vs Non-Th2, 37.8 ± 20.3, p = 0.002). Quantitative analysis of the segmental bronchial wall (RB1, LB1+2, RB10, LB10) showed no significant difference in the BT, inner luminal diameter and wall area % between Th2 and Non-Th2 (p < 0.05).

CONCLUSION
In severe asthmatics, Th2 associated asthma showed more extensive bronchial wall thickening, mucus plugging, and air-trapping than non-Th2 asthma.
Tests in Patients with COPD

SST04-07 • 3D Lung Motion and Destruction Assessments from Inspiratory and Expiratory Thin-section MDCT: Utility for Pulmonary Functional Loss and Clinical Stage Evaluation in Smokers

Hisanobu Koyama MD (Presenter) ; Yoshiharu Ohno MD, PhD * ; Yasuko Fujisawa MS * ; Shinichiro Seki ; Mizuho Nishio MD * ; Takeshi Yoshikawa MD * ; Sumiaki Matsumoto MD, PhD * ; Naoki Sugihara MENG * ; Hitoshi Yamagata PhD * ; Kazuuro Sugimura MD, PhD *

PURPOSE
To evaluate the utility of three-dimensional (3D) lung motion and destruction assessments from inspiratory and expiratory CT for pulmonary functional loss and clinical stage evaluation in smokers.

METHOD AND MATERIALS
Forty-four consecutive smokers (36 men and 8 women, mean age 76.6 years) underwent inspiratory and expiratory thin-section MDCTs and pulmonary function tests. According to the GOLD guideline, all smokers were divided into four clinical stages as follows: ◆ without COPD (n=6) ◆ mild COPD (n=5) ◆ moderate COPD (n=22) ◆ very and very severe COPD (n=11). 3D motion vector map was generated from inspiratory and expiratory CT in each smoker. Then, regional motion magnitudes were measured at the following three axes: horizontal, X-axis; ventrodorsal, Y-axis; and craniocaudal, Z-axis. Then, all mean magnitudes within the entire lung (MML, MMLy, MMLz) were normalized by lung volume from expiratory CT. Moreover, CT-based functional lung volume (FLV) on inspiratory CT was also assessed from total and low attenuation lung volumes in each subject. To evaluate the capability for pulmonary functional loss assessment, all indexes were correlated with FEV1 % and %DLCO/VA. Then, principal component analysis (PCA) was performed for discriminating clinical stages by means of all indexes.

RESULTS
FEV1 % had significant correlation with MMLy (r=0.67, pZ (r=0.38, pCO2/VCO2 had significant correlation with MMLz (r=0.40, p=0.89): the first component called ‘maintained structure and diaphragm motion’ determined by FLV and MMLy, the second component called ‘asynchronous chest wall motion’ determined from MMLy and MMLy and the third component called ‘synchronous chest wall motion’ determined from MMLx and MMLy.

CONCLUSION
3D lung motion as well as destruction assessments is considered as a useful indicator for pulmonary functional loss and clinical stage evaluation in smokers.

CLINICAL RELEVANCE/APPLICATION
3D lung motion as well as destruction assessments from inspiratory and expiratory CT data is considered as a useful indicator for pulmonary functional loss and clinical stage evaluation in smokers.

SST04-08 • Radiation-induced Lung Injury (RILI) after Stereotactic Body Radiation Therapy (SBRT) in Patients with Emphysema: A Quantitative Analysis of CT Changes

Abraham Knoll MD (Presenter) ; Mary M Salvatore MD ; Miriam Knoll MD ; Ren-Dih Sheu PhD ; Sarah L Kerns PhD, MPH ; Yeh-Chi Lo PhD ; Kenneth E Rosenzweig MD *

PURPOSE
While lung Stereotactic Body Radiation Therapy (SBRT) is the standard of care for medically inoperable patients with early stage lung cancer, there is often concern regarding the development of radiation induced lung injury (RILI) in patients with COPD due to their compromised lung volumes. We compared the volume of RILI on CT exams in patients with and without radiographic evidence of emphysema.

METHOD AND MATERIALS
A review of patients treated with lung SBRT in our department was performed and pre-treatment CT was reviewed by a Diagnostic Radiologist for evidence of emphysema. Patients were scored by number of pulmonary lobes with emphysema and severity of emphysema in each lobe (mild, moderate or severe). Each patient’s baseline smoking history was recorded. The RILI was contoured by a Diagnostic Radiologist and Radiation Oncologist and total volume of observed fibrosis was recorded.

RESULTS
37 lung lesions were treated in 15 patients with emphysema and 17 patients without. A total of 37 FU-CT’s were reviewed. At a median of 6 months after treatment (range 3 to 7 months), the mean volume of fibrosis in patients with and without emphysema was 35.4 mm3 and 99.2 mm3, respectively. The presence and severity of emphysema was significantly inversely proportional to the total RILI (p=0.024 and p=0.003, respectively). Age was not significantly associated with RILI (p=0.441). The number of total lung lobes with emphysema was not significantly associated with RILI (p=0.276). Smoking status was also not significantly correlated with RILI, although only 3 patients were never-smokers.

CONCLUSION
Patients with radiographic evidence of emphysema who are treated with lung SBRT have significantly decreased RILI on post-treatment FU-CT, as compared with patients without emphysema. Within the subset of patients with emphysema, those with increased severity had significant decreases in RILI.

CLINICAL RELEVANCE/APPLICATION
Patients with COPD who are treated with SBRT for lung cancer have overall less RILI compared to those who do not have emphysema.

SST04-09 • Association Study between Quantitative Measurement of Diaphragm Using Volumetric CT and Pulmonary Function Tests in Patients with COPD

Sang Min Lee MD (Presenter) ; Yongjun Chang ; Jangpyo Bae MS ; Namkug Kim PhD ; Joon Beom Seo MD, PhD ; Sang Young Oh MD

PURPOSE
To evaluate the relationship between quantitative morphological parameters of the diaphragm with three-dimensional reconstruction using CT and pulmonary function tests in patients with COPD.

METHOD AND MATERIALS
Non-contrast, inspiration volumetric CT of thirty patients (M:F=28:2; mean age, 62.2 years) with COPD (n; mild = 3, moderate = 15, severe = 12 very severe = 5) were included. Pulmonary function tests (PFT) were performed in all patients with in 1 week of CT imaging. Using in-house software, upper margin of diaphragm were segmented automatically. Based on initial diaphragm segmentation, quadratic 3D surface fitting was used to measure morphological parameters of the diaphragm including the diaphragm lengths on x, y, z axes (XDL, YDL, ZDL), quadratic fitting diaphragm lengths on z axis (FZDL), height from apex and base plane (H), shape index at apex (SIA), average curvature (C), curvature on apex (CA) and surface area (SA). In addition, the correlation between morphological parameters of diaphragm, emphysema index (EI) and PFT were assessed with Pearson correlation test.

RESULTS
Measured morphological parameters of diaphragm, EI and PFT were as follows: XDL=129.80±11.66mm, YDL=163.19±13.45mm, ZDL=71.27±17.52mm, FZDL=61.59±16.98mm, H=28.08±56.58mm, SIA=0.849±0.052, C=0.0081±0.0017, CA=0.0095±0.0025,
SA=34381±6680mm², E2=22.1±11.68, Dic=15.78±5.41, FEV1=55.9±20.88 and FEV1/FVC = 47.68±16.2. Measured ZDL, SIA, C, CA, and SA were negatively correlated with EI (r = -0.421, -0.382, -0.384, -0.411, -0.415, respectively). And, XDL, ZDL, FZDL, SIA, C, CA, and SA were positively correlated with DLOC (r = .489, .540, .531, .496, .415, .469, .637, respectively) and CA was positively correlated with FEV1/FVC (r = .402).

CONCLUSION
The several quantitative morphological parameters of diaphragm decrease in relation to the progression of emphysema and decrease of PFT in COPD.

CLINICAL RELEVANCE/APPLICATION
Detailed analysis of morphological diaphragm changes is possible using volumetric CT and dedicated software. It may be helpful in the understanding of diaphragm changes in COPD.

### Gastrointestinal (Small and Large Bowel Imaging)

Friday, 10:30 AM - 12:00 PM • E353B

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#### SST05-01 • CT Findings of Bowel Ischemia in Closed-loop Small Bowel Obstruction

Kazuki Nakashima (Presenter) ; Hideki Ishimaru MD ; Toshifumi Fujimoto ; Takashi Mizowaki ; Yohjiro Matsuoka MD ; Masataka Uetani MD ; Seigo Kimura ; Sachie Yotsumoto ; Kazunori Mitarai ; Kei Kitamura

**PURPOSE**
Closed-loop small bowel obstruction (CL-SBO) is associated with a high risk for vascular impairment and considered as a surgical emergency, however, when the bowel is viable, preservation of the bowel is feasible. The aim of this study was to characterize contrast-enhanced CT (CECT) findings predicting bowel necrosis and ischemia in CL-SBO.

**METHOD AND MATERIALS**
Thirty five patients with CL-SBO confirmed by laparotomy (n = 34) or multiplanar reconstruction of thin slice CT images (n = 1) were included. On the basis of the surgical findings, these patients were classified into three groups: necrosis group, (n = 16) and ischemia without necrosis (ischemia group; n = 11), and no ischemia (n = 8). One patient recovered only with conservative management was also included in no ischemia group. Two blinded radiologists retrospectively reviewed CECT including multiplanar reconstruction images, and evaluated 12 CT findings previously reported to be associated with bowel ischemia: (1) wall thickening, (2) target sign, (3) high attenuation of the wall at precontrast CT, (4) wall enhancement, (5) mesenteric edema, (6) whirl sign, (7) enhancement of mesenteric artery and (8) vein, (9) engorgement of the mesenteric veins, (10) small bowel feces, (11) ascites, and (12) intraperitoneal air. Sensitivity and specificity of each finding were compared among the three groups, and logistic regression analysis was performed.

**RESULTS**
Intrapertitoneal air, high attenuation of the wall, reduced enhancement of mesenteric arteries and small bowel feces sign showed high specificities of 100%, 100%, 89% and 89%, however low sensitivity of 25%, 31%, 44%, 31%, respectively, to predict bowel necrosis in CL-SBO. On multivariate logistic regression analysis, reduced wall enhancement, reduced enhancement of mesenteric veins and lack of the engorgement of the mesenteric veins were significant for predicting bowel necrosis or ischemia (p

**CONCLUSION**
Reduced enhancement of wall and mesenteric vessels were reliable findings to detect ischemia. On the contrary, engorgement of the mesenteric veins was predictor of viable bowel.

**CLINICAL RELEVANCE/APPLICATION**
Evaluation of engorgement of mesenteric vein and enhancement of wall and mesenteric vessels would help us to predict bowel ischemia or necrosis in the closed-loop small bowel obstruction.

#### SST05-02 • Dual Energy CT Improves Visibility of Early Small Bowel Ischemia Compared to Conventional CT in a Swine Model

Theodora A Potretzke MD (Presenter) ; Christopher L Brace PhD * ; Meghan G Lubner MD ; Lisa A Sampson * ; Bridgett J Willey * ; Fred T Lee MD *

**PURPOSE**
To compare dual-energy CT (DECT) to conventional CT for the detection of early bowel ischemia in a swine model.

**METHOD AND MATERIALS**
Ischemic bowel segments (n=7) were created in swine (n=4) by surgically occluding distal mesenteric vasculature. Ischemia was confirmed grossly and with Doppler ultrasound. DECT and conventional CT were performed in arterial, portal venous, and delayed phases on a single-source fast-switching dual-energy CT scanner. ROIs of bowel wall attenuation were used to compare contrast-to-noise ratios (CNR) between ischemic and perfused segments on iodine material density and monospectral images at 51keV, 65keV (approximates 80kVp), and 80keV (approximates 120kVp). ANOVA and post-hoc t-tests compared pixel intensities and CNR among segments and imaging groups.

**RESULTS**
Ischemic bowel exhibited significantly lower attenuation than perfused segments on DECT-iodine material density and 51keV images (P

**CONCLUSION**
DECT significantly improves the visibility of early bowel ischemia compared to conventional CT images. DECT may offer earlier and more confident diagnosis of bowel ischemia especially in the absence of late secondary signs. It may increase the sensitivity and specificity of CT for bowel ischemia.

**CLINICAL RELEVANCE/APPLICATION**
Mortality from bowel ischemia is high and increases with delay in diagnosis. Dual-energy CT increases the conspicuity of differential enhancement and may allow earlier diagnosis of bowel ischemia.

#### SST05-03 • Small Bowel Transplantation: MDCT Features of Wall Thickening with Pathologic Correlation

Michael Bazylewicz MD (Presenter) ; Christine Chan ; Sandra J Allison MD ; Angela D Levy MD

**PURPOSE**
To determine if MDCT features of bowel wall thickening allows differentiation between normal bowel, ischemic bowel, rejection, post transplant lymphoproliferative disease (PTLD), and infection in patients with small bowel transplants.
METHOD AND MATERIALS
CT scans (n=57) from isolated and multivisceral small bowel transplant patients (ages 1-62, mean 26) were retrospectively reviewed with consensus reading by two radiologists blinded to pathology results. Patients had endoscopic biopsy within 3 days of CT scanning. Small bowel was assessed for wall thickening, attenuation and enhancement pattern, feces sign, pneumatosis, dilatation, mesenteric edema and adenopathy, ascites, anasarca, vascular patency, and whether the scan was done with oral or IV contrast. Demographic data obtained: age, gender, race, and transplant type. Kappa power analysis determined a goal of 20 patients per group would show at least a 60% correlation exists between groups. For the continuous variable, the differences in the averages were tested and the non-parametric Kruskal Wallis test was used since normality assumptions were not satisfied. Chi-square and Fisher's exact tests were used to investigate the differences for categorical variables. A p-value of

RESULTS
No statistical differences in age (0.69 pediatric, 0.2 adult), race (0.6), or transplant type (0.56). Significant difference between the normal ischemia subgroup was observed in gender (0.04). No difference was observed in wall thickening (0.29), attenuation (0.66), bowel enhancement pattern (0.66), feces sign (0.1), pneumatosis (0.67), dilatation (0.11), mesenteric edema (0.8), mesenteric adenopathy (0.5), anasarca (0.89), vascular patency (0.5), those with oral contrast enhanced scans (0.23), or those with IV contrast enhanced scans (0.59). A general difference between the 5 categories was noted in the category of ascites (0.03), however specific analysis of normal vs. the four abnormal subgroups demonstrated no significant difference (ischemia 0.28, rejection 0.052, infection 0.55, PTLD 0.39).

CONCLUSION
There is no correlation between small bowel wall thickening in patients with small bowel transplant and the common complications including ischemia, rejection, PTLD, and infection.

CLINICAL RELEVANCE/APPLICATION
Small bowel wall thickening on MDCT in small bowel transplants is likely non-contributory in determining an underlying pathologic condition.

SST05-04  •  Cine MR Enterography Grading of Small Bowel Peristalsis: Evaluation of the Antiperistaltic Effectiveness of Sublingual Hyoscyamine Sulfate

Peter M Ghobrial MD; Flavius F Guglielmo MD (Presenter); Donald G Mitchell MD *; Ilana Neuberger MD; Laurence Parker PhD; Christopher G Roth MD *; Sandeep P Deshmukh MD; Patrick O’Kane MD *; Allison Borowski MD

PURPOSE
To use a cine MR enterography (cine-MRE) pulse sequence to assess the effectiveness of a sublingual (SL) antiperistaltic agent, hyoscyamine sulfate.

METHOD AND MATERIALS
IRB approval was granted with an exemption for informed consent in this HIPAA compliant retrospective single-institution study. Of the 288 MR enterography exams performed between October 1, 2007 and January 15, 2011, 92 using SL hyoscyamine sulfate for antiperistalsis were included for review, each with cine MRE pre and post medication. These 184 cine MRE sequences were randomized, blinded for treatment, and independently reviewed by five attending abdominal radiologists, who rated the degree of bowel motility of each cine MRE sequence on a five point scale. Pre- and post-medication mean peristalsis ratings, standard deviation, mean difference, and treatment effect sizes were calculated. A repeated measures analysis of variance (ANOVA) test was performed, using a significance threshold of p<0.05.

RESULTS
Mean peristalsis ratings ranged from 2.63 to 3.34 before, to 2.36 to 3.03 after medication administration. The mean differences ranged from 0.22 to 0.46, which are treatment effect sizes of 0.10 to 0.18. The decrease in peristalsis observed by the five reviewing radiologists after SL hyoscyamine sulfate administration was significant (df 1/182, f=7.35, p

CONCLUSION
While cine MRE sequences show decreased bowel peristalsis after use of SL hyoscyamine sulfate, the small size of the observed treatment effect is likely insufficient to justify its use for MR enterography.

CLINICAL RELEVANCE/APPLICATION
While it is possible to detect and quantify decreased bowel peristalsis caused by a sublingual anti-spasmodic agent during cine MRE, the decrease is likely too small to be of clinical significance.

SST05-05  •  Ischemic Colitis: Is There a Relationship between the CT Findings, the Different Etiologies and the Timing of the Disease? A Clinical Study

Francesca Iacobellis MD (Presenter); Daniela Berritto MD; Maria Paola Belfiore; Giuliano Gagliardi; Mariano Scaglione MD; Maria A Mazzei MD; Roberto Grassi MD

PURPOSE
To define the CT findings of ischemic colitis (IC), according to the different etiologies and timing of the disease.

METHOD AND MATERIALS
A computerized search of all medical records was used to retrospectively identify 130 patients who were admitted with the suspected diagnosis of IC over a five-year period. From these, 52 patients with IC proven by endoscopy with biopsies or surgical pathology were considered for the enrollment in the present study. Among 52 patients, 32 subjects (17 men and 15 women; median age 74, range 51-94 years) that underwent at least one CT examination, constituted the object of the analysis. Their medical history and CT examinations were retrospectively reviewed

RESULTS
Among the 32 CT examinations performed in the acute phase in 62.5% no defects or occlusion of the superior mesenteric artery (SMA) or inferior mesenteric artery (IMA) was found whereas in 37.5% IMA occlusion was detected. In acute phase in 100% of patients the presence of pericolic fluid was found, undergoing progressive resorption from acute to sub-acute phase if an effective reperfusion occurred; the bowel wall thickening was observed in 28.1% patients in acute phase and in 86.4% patients evaluated in sub acute phase. The unthickened colonic wall was found in all conditions where ischemia is not followed by effective reperfusion, 71.9% of cases, and it was never found in chronic phase, when the colon appears irreversibly thickened.

CONCLUSION
The results of this study showed that particular attention should be paid in the diagnosis of non-occlusive mesenteric ischemia (NOMI) before reperfusion representing the more difficult form of IC to detect at imaging, diagnostic difficulties may also be encountered in sub acute forms where the colon wall thickening could be misdiagnosed as normal wall with collapsed lumen, and in chronic forms where the irregular thickening of large bowel could be misdiagnosed if the patient’s clinical history is unknown. CT has a crucial role, it allows to define the morpho-functional alterations associated with the IC distinguishing among acute, sub acute and chronic phases and allows to estimate the timing of the ischemic damage.

CLINICAL RELEVANCE/APPLICATION
The definition of the CT findings of ischemic colitis in relationship with the etiology and the timing of the disease has a crucial role to ensure a correct diagnosis and an appropriate treatment.

SST05-06  •  Double Contrast-enhanced Ultrasonography Diagnosis of Rectal Lesions with Pathologic Correlation

Man Lu PhD (Presenter); Zhiqing Cai; Jun Song; Bin Song MD
Recently, transabdominal ultrasonography with a gastrointestinal contrast agent has been used widely in China to detect digestive disorders. Double Contrast Enhanced Ultrasonography (DCUS) combines both a gastrointestinal luminal contrast agent with an intravenous contrast agent for imaging of lesions. The purposes of this pilot study were to assess the value of DCUS in the preoperative diagnosis of rectal lesions.

METHOD AND MATERIALS

RESULTS

Of the 227 patients examined, there were 232 rectal lesions (72 rectal adenocarcinomas, 45 adenomas and 15 inflammatory mass). The study using DCUS showed unique vascular patterns in different rectal lesions. Rectal adenocarcinoma revealed earlier AT and TP compared with normal rectal tissue (p < 0.05), earlier AT and higher PI with adenoma, earlier TP and lower PI with inflammatory mass. Rectal adenoma had lower PI compared with normal rectal tissue (p < 0.01). Rectal inflammatory mass had higher PI and earlier AT compared with normal rectal tissue.

Conclusions: DCUS is a valuable technique for differential diagnosis of benign and malignant rectal lesions in patients with pathology diagnosis. The parameters of the enhancement curves reflect the different perfusion status of the rectal lesions.

CONCLUSION

DCUS is a valuable technique for differential diagnosis of benign and malignant rectal lesions in patients with pathology diagnosis.

CLINICAL RELEVANCE/APPLICATION

DCUS is a valuable technique for differential diagnosis of benign and malignant rectal lesions in patients with pathology diagnosis.

SST05-07 • Neurogenic Bowel Dysfunction in Spinal Cord Injury Patients - Diagnostic Using Functional MRI. A Feasibility Study

Celine DAlt MD (Presenter); Cornelia Putz; Cornelia Hensel; Bjoern Wagner; Norbert Wagner; Hans-Juergen Gerner; Hans-Ulrich Kauczor MD *; Lars Grenacher MD

PURPOSE

Neurogenic bowel dysfunction represents a common clinical problem in spinal cord medicine, which severely affects the quality of life following spinal cord injury (SCI). The aim of this study was to evaluate functional MRI as a diagnostic tool to visualize neurogenic bowel dysfunction in SCI patients.

METHOD AND MATERIALS

In this prospective study, 20 Th1-10 SCI patients (AIS A) given written informed consent and the study proposal was approved by the local ethics committee. Examination was performed at a 3T scanner in lateral position with angled legs. The rectum was filled with ultrasonic gel. The protocol included T2w TRUSPI sequences in tree planes at rest and in sagittal plane during defecation (30 measurements) and T2w turbo spin echo images in sagittal and axial plane. Evaluation included the hiatal width (H-line), the M-line, the anorectal angle (ARA) and the anorectal junction (ARJ). The rectal filling volume and the maximum rectum diameter were noted, until defecation procedure started.

RESULTS

CONCLUSION

MR-Defecography is feasible in SCI patients and may help to differentiate between different types of neurogenic bowel dysfunction.

CLINICAL RELEVANCE/APPLICATION

Dynamic MRI may serve as a diagnostic tool to guide therapeutic decision making in SCI patients suffering from neurogenic bowel dysfunction.

SST05-08 • MR Imaging of Perianal Fistulas: Value of Using a Balloon Rectal Double Channel Catheter

Shuohui Yang MD (Presenter); Fang Lu MD; Songhua Zhan MD; Wenli Tan MD; Qiong Zhu MD

PURPOSE

To investigate the value of using balloon rectal double channel catheter (BRDCC) for the diagnosis of perianal fistula patients in conventional MRI studies.

METHOD AND MATERIALS

18 perianal fistula patients with BRDCC and 18 patients without BRDCC underwent MR scans with a body coil. The number of fistulas, the internal openings, extensions and abscesses were counted. All MR findings were utilized to evaluate for the classification of the fistulas and compared with the surgery results.

RESULTS

CONCLUSION

By using BRDCC, conventional MRI can provide more information of the fistulas and their routes.

CLINICAL RELEVANCE/APPLICATION

Providing evidences of internal openings, extensions and abscesses of the anal fistula diagnosis and directing the operation of anal fistula.

SST05-09 • Rectal MRI of Fistula-in-ano: Diagnostic Values of Diffusion-weighted Imaging (DWI)

Minho Park MD (Presenter); Sung Kyoung Moon; Seong Jin Park MD, PhD; Joo Won Lim; Dong Ho Lee MD; Young Tae Ko MD, PhD

PURPOSE

To investigate the diagnostic performance of DWI in fistula-in-ano.

METHOD AND MATERIALS

This study included 46 patients who underwent rectal MRI to evaluate fistula-in-ano from March 2011 to March 2012. A history of Crohn’s disease (CD) and fistulocytosis were reviewed. Two radiologists retrospectively reviewed rectal MRI with consensus three times at 2-week intervals. The first review assessed the presence of perianal lesions, fistula type, and lesion conspicuity with T2WI. The second review assessed fistula conspicuity with CE-FS-T1WI and T2WI. The third assessed fistula conspicuity with DWI with a b-value of 1000 and T2WI. Lesion conspicuity was scored from 1 to 4 as follows: 1, unclear fistula tract; 2, visible fistula tract with unclear margin; 3, distinct fistula tract with partial obscuration; and 4, distinct fistula without obscuration. The lesion conspicuity was compared between CE-FS-T1WI and DWI using the Wilcoxon rank-sum test. Lesion conspicuity according to the clinical history was assessed using the Mann-Whitney U-test.

RESULTS

Of the 46 patients, 39 had perianal lesions in rectal MRI: 30 patients with CD and 9 without. Nine patients (23.1%) had fistulocytosis histories. There were 14 complex fistulas (35.90%), 12 intersphincteric fistulas (30.76%), 5 trans-sphincteric fistulas (12.82%), 4 perianal abscesses (10.26%), and 4 anal fissures (10.26%). The mean lesion conspicuity score of T2WI, CE-FS-T1WI, and DWI with a b-value of 1000 was 3.11±0.689, 3.29±0.732, and 3.55±0.724, respectively. There was no significant difference between CE-FS-T1WI and DWI (p=0.096). Lesion conspicuity was significantly better with DWI than T2WI (p=0.010). With DWI, lesion conspicuity was
CONCLUSION
The lesion conspicuity of DWI with a b-value of 1000 was similar to that of CE-FS-T1WI, and significantly better in the patients with CD.

CLINICAL RELEVANCE/APPLICATION
DWI with a high b-value could help to inform clinicians about fistula shape and type.

**Gastrointestinal (MR Technique)**

Friday, 10:30 AM - 12:00 PM  •  E353C

**SST06-01 • Image Quality on Liver CT Based on Sinogram Affirmed Iterative Reconstruction Algorithm**

**Boris Schulz**, MD (Presenter); **Boris Bodette**, MD; **Petra Siebenhandl**, MD; **Martin Beeres**, MD; **Firas Al-Butmeh**, MD; **Claudia Freilesen**, MD; **Thomas J Vogl**, MD, PhD

**PURPOSE**
To evaluate efficiency of sinogram affirmed iterative reconstruction technique, regarding noise and image quality on contrast enhanced computed tomography (CT) of the liver.

**METHOD AND MATERIALS**
CT examinations were performed upon 32 patients (128 slice CT, 120kV, 180mAs, activated tube current modulation, 0.6mm collimation). Each examination was reconstructed at standard filtered back projection (FBP) and 5 different SAFIRE strengths in 5mm images in transversal direction with soft tissue kernel. Image noise was defined as standard deviation (SD) of Hounsfield units (HU) in air, and signal to noise ratio (SNR) of the liver was defined as mean liver HU per liver SD. Subjective image quality was evaluated by three raters using a 5-point scale (1=non-diagnostic image quality, 5=excellent image quality).

**RESULTS**
Average image noise was 6.2HU (FBP), vs. 5.7HU (SAFIRE 1), vs. 5.0 (SAFIRE 2) 4.4HU (SAFIRE 3), 3.8HU (SAFIRE 4), 3.1HU (SAFIRE 5). SNR of the liver consecutively increased when using the iterative reconstruction algorithms from 8.4 (FBP) to 9.3 (SAFIRE 1) to 10.4 (SAFIRE 2) to 12.2 (SAFIRE 3) to 15.1 (SAFIRE 4) to 17.5 (SAFIRE 5). The differences in image noise and SNR of each SAFIRE-strength to FBP was statistically significant (p<0.001).

**CONCLUSION**
Sinogram affirmed based iterative reconstruction technique significantly reduces image noise and increases SNR for examinations of the liver. However subjective image quality decreases with strong iterative strengths.

**CLINICAL RELEVANCE/APPLICATION**
Since subjective image quality decresed slightly with iterative reconstructive techniques, mild iterations are recommended to enhance image quality on liver CT.

**SST06-02 • The Clinical Utility of Diffusion-weighted-Imaging of the Abdomen with Ultra-high B-values**

**Melissa Ong**, MD (Presenter); **Johannes Budjan**, MD; **Stefan Haneder**, MD; **Stefan O Schoenberg**, MD, PhD; **Ulrike I Attenberger**, MD; **Henrik J Michaely**, MD

**PURPOSE**
To evaluate the clinical utility of diffusion-weighted-imaging (DWI) of the abdomen with ultra-high b-values.

**METHOD AND MATERIALS**
In this retrospective IRB approved study 46 consecutive patients (30 women, 16 men, mean age 54±17.5) who underwent abdominal MR-exams including a DWI-EPI sequence with b-values of 50, 800 and 2000 s/mm² on a 3T MRI-system (Siemens Skyra) were included. Overall image quality with regard to detection of pathology and degree of artifacts as well as lesion conspicuity in the b800 and b2000 images were compared by two board-certified radiologists (1: preferring b2000; 2: preferring b800; 0: no difference). Quantitative analysis included determination of signal-to-noise ratio of sample tissues including the kidneys and the ventral and dorsal subcutaneous fat.

**RESULTS**
Reader 1 preferred the b2000 image in 30 (67%) patients, reader 2 in 32 (71%) patients. The b800 image was preferred in only 2 (4%) patients by both readers. Interobserver agreement was κ=0.706 for overall image quality. Lesion conspicuity was rated better in the b2000 images in 31 (69%) patients and the b800 images in 1 (2%) patient by reader 1, in 27 (60%) and 2 patients (4%) by reader 2. Measure of agreement was κ=0.494 for lesion conspicuity. There were no differences observed regarding artifacts. The signal-to-noise ratio measured 37.47 (±14.96) vs. 15.74 (±4.07) and 41.46 (±16.21) vs. 16.90 (±5.52) in the b800 and b2000-images for the left and right kidney, 9.22 (±3.18) vs. 12.05 (±3.75) and 9.80 (±2.52) vs. 12.14 (±2.93) for the ventral and dorsal fat, respectively.

**CONCLUSION**
DWI imaging of the abdomen with ultra-high b-values of 2000 s/mm² is feasible for lesion detection with good to acceptable image quality.

**CLINICAL RELEVANCE/APPLICATION**
Ultra-high b-values should be used in a clinical routine as a feasible tool for lesion detection.

**SST06-03 • Multiphasic Contrast Enhanced Free Breathing 3D Imaging and Liver Perfusion Mapping Using Through-time 3D Spiral GRAPPA Acceleration**

**Yong Chen**, Gregory R Lee; **Katherine Wright**, PhD; **Mark A Griswold**, PhD; **Nicole Seiberlich**, PhD; **Vikas Gulani**, MD, PhD (Presenter)

**PURPOSE**
The goal of this work is to demonstrate high spatiotemporal resolution quantitative DCE liver MRI using a 3D stack-of-spirals acquisition, through-time non-Cartesian GRAPPA reconstruction, non-rigid body motion correction, and application of a dual-input single compartment model for quantitative perfusion mapping.

**METHOD AND MATERIALS**
MRI experiments were performed on a Siemens 3T Skyra scanner with normal volunteers (N = 4), and 0.1 mmol/kg Gadobenate (Multihance, Bracco, NJ) was given. T1-weighted 3D volumes were acquired using a stack-of-spirals gradient echo sequence. 120 volumes were acquired with a temporal resolution of 1.6~1.9 seconds, while the subjects were breathing freely. To accelerate the acquisition,
RESULTS
Images with high spatial resolution of 1.9x1.9x3 mm\(^3\) are obtained with whole liver coverage. With the high imaging speed of less than 2 sec/volume, a free-breathing scan is achieved, and subtle dynamic changes in contrast enhancement are captured. The free-breathing 3D images were registered with almost no residual motion in liver tissue. Quantitative whole liver 3D perfusion maps were obtained and the perfusion parameters are all in good agreement with published literature from CT and MR.

CONCLUSION
In this study, a high spatiotemporal resolution 3D liver imaging technique was developed using a stack-of-spirals acquisition and through-time non-Cartesian GRAPPA acceleration. This technique allows fast imaging of the whole liver during free breathing and accurate quantification of liver perfusion.

CLINICAL RELEVANCE/APPLICATION
Free-breathing abdominal scans with through-time spiral GRAPPA can provide diagnostic images from patients with difficulty breath-holding and additional quantitative information of liver perfusion.

**SST06-04** • 4D Flow MRI with k-t GRAPPA in the Quantitative Assessment of PV Hemodynamics in Patients with Advanced Liver Cirrhosis: Initial Results and Comparison to Age-matched Controls

Zoran Stankovic MD (Presenter) ; Edouard Semaan ; Michael Markl PhD ; Marie Wasielewski ; Maria Carr ; Robert J Lewandowski MD * ; Riad Salem MD, MBA * ; James Carr MD * ; Jeremy D Collins MD *

PURPOSE
To qualitatively and quantitatively evaluate blood flow hemodynamics in the portal venous (PV) system of patients with advanced liver cirrhosis compared to age-matched controls at non-contrast 4D flow MRI with contrast-enhanced 4D flow MRI as the standard of reference.

METHOD AND MATERIALS
In an ongoing study, time-resolved 4D flow MRI was applied at 3T (venc=50cm/sec, spatial resolution=2.1x2.5x3.0mm\(^3\)) with and without a blood pool contrast agent in 20 datasets representing 5 patients with advanced liver cirrhosis (age=55±6years) compared to 5 healthy age-matched controls (age=53±4years). k-t GRAPPA was used with an acceleration factor R=5 to reduce scan time. 3D PV flow visualization based on 3D streamlines and time-resolved particle traces. Flow quantification was performed in the PV system with retrospective extraction of time-resolved peak velocities and net flow over the cardiac cycle. Bland Altman (BA) analyses compared the datasets before and after contrast application (mean bias±2SD).

RESULTS
Qualitative image analysis was successfully performed in the PV system with clear resolution of all branches except the superior mesenteric vein in one patient. Quantitative analyses demonstrated similar results before and after contrast for peak velocities (BA:0.012±0.029), while net flow values demonstrated a -7% bias for the non-contrast analysis (BA:±0.141±0.412). Comparing patients with liver cirrhosis and age-matched controls significant differences for peak velocities were seen only in the intrahepatic portal vein before and in the right intrahepatic portal vein branch after contrast application (p<0.05).

CONCLUSION
4D flow MRI enabled quantification of comprehensive 3D flow characteristics in the portal venous system in patients with liver cirrhosis and visualized abnormal blood flow hemodynamics. Non-contrast 4D flow MRI analyses demonstrated similar peak velocity assessment compared to a contrast-enhanced acquisition, although net flow was underestimated by 7%; field inhomogeneities may have accounted for the bias in net flow.

CLINICAL RELEVANCE/APPLICATION
4D flow MRI may improve quantification of altered liver blood flow hemodynamics in patients with advanced liver cirrhosis enabling quantitative analysis without Gadolinium based contrast media.

**SST06-05** • Quantification of Hepatic Blood Flow, ADC and Stiffness in Fasting and Post-prandial Conditions: Prospective Study at 3T

Guido H Jajamovich PhD (Presenter) ; Hadrien Dyvorne PhD ; Ersin Bayram PhD * ; Claudia Donnerhack ; Richard L Ehman MD * ; Bachir Taouli MD *

PURPOSE
Techniques such as MR Elastography (MRE), phase contrast (PC) and diffusion-weighted imaging (DWI) have potential for non-invasive detection of liver fibrosis, cirrhosis and portal hypertension. Since portal flow and liver stiffness (LS) may be altered by food intake, changes in LS, portal vein (PV) flow, PV velocity and liver ADC might be observed and may lead to decreased reproducibility. This prospective study quantifies reproducibility (in fasting conditions) and post-prandial changes in PV flow/velocity, LS, and liver ADC at 3T.

METHOD AND MATERIALS
11 healthy volunteers and 7 patients with HCV cirrhosis were enrolled in this prospective IRB approved study. All subjects underwent 3T MRI (MR750, GE Healthcare), including 2D PC (pulse triggered, VENC=50 cm/s, slice perpendicular to portal vein), axial SS EPI DWI (free breathing, 16 b-values from 0 to 800 mm\(^2\)/s) and MRE (4 slices through the liver). All subjects were initially scanned twice after 6 hours of fasting to assess reproducibility of each technique, and then scanned again 20 minutes after a 700 Kcal liquid meal. To quantify PV flow and velocity, a ROI was drawn in the PV on PC images. Mean LS and liver ADC were obtained by placing a ROI in the right hepatic lobe on LS maps and diffusion images. The coefficients of variation (CV) were computed for the two scans in fasting state. Wilcoxon paired tests and Mann-Whitney U tests were performed to assess differences in these metrics before and after caloric intake (average of the 2 fasting scans was used for comparison) and differences between patients and volunteers, respectively.

RESULTS
PV flow, PV velocity, liver ADC and LS showed good to excellent reproducibility in fasting state, with CVs ranging from 3.6%-11.8%. PV flow, PV velocity and LS were all significantly higher in postprandial state (p<0.05). These results indicate that caloric intake is a factor to consider in interpreting PC-based PV flow/velocity and MRE-based hepatic stiffness measurements. LS can be used to separate cirrhotic patients from healthy volunteers.

CLINICAL RELEVANCE/APPLICATION
Liver blood flow and metabolism (portal venous flow/velocity and liver stiffness) are altered significantly in the postprandial state, showing the importance of undergoing MRI in a controlled state.

**SST06-06** • Start of Hepatocyte Uptake in Gadoxetate Disodium (Gd-EOB-DTPA) Enhanced MRI in Normal Liver Parenchyma

Hanke Schalkx MD (Presenter) ; Marijn Van Straalen PhD ; Kenneth Coenenegrachts MD ; M.A.A.J. van den Bosch ; Wouter B Veldhuis MD, PhD ; Maarten S Van Leeuwen MD, PhD

PURPOSE
To evaluate the enhancement pattern of normal liver parenchyma in contrast-enhanced (CE) magnetic resonance imaging (MRI) using gadoxetate disodium, with special emphasis on the start of the hepatocyte uptake.

METHOD AND MATERIALS
data were undersampled in-plane with a reduction factor of 6, and reconstructed using through-time non-Cartesian GRAPPA. The reconstructed volumes were registered using FMRIB’s Non-linear Image Registration Tool (FNIRT). A dual-input single-compartment model was established to retrieve liver perfusion parameters from DCE-MRI data.
Gadobenate Dimeglumine Enhanced Liver MRI: Quantitative Analysis of Hepatobiliary Phase According to Incremental Flip Angle

Eun Jung Kim MD

Purpose
To evaluate effects on hepatobiliary phase with using gadobenate dimeglumine (BOPTA) enhanced 3D T1-weighted (T1) gradient echo sequence (GRE) magnetic resonance imaging (MRI) during increasing the flip angle.

Method and Materials
A total of 43 patients, who had a BOPTA enhanced MR exam for evaluation of focal lesion in the liver, were enrolled during three months. Hepatobiliary phase fat suppressed 3D T1 GRE sequences with 10°, 20°, 30° flip angles (FAs) were obtained at 90 min. Signal intensity (SI) of the liver in precontrast phase and hepatobiliary phase with each FAs was measured using region-of-interest (ROI), as large as possible, 2 times measurement at each hemiliver. Noise estimates were derived by recording three times the standard deviation of the noise measured anterior to the liver, outside of the body. SI of each hepatic lesions (long axis = 10 mm) in hepatobiliary phase with each FAs was also measured using ROI, as large as possible. The relative enhancement (RE) of liver parenchyma at hepatobiliary phase with each FAs was calculated, as following: RE = (SI-post - SI-pre)/SI-pre. The signal to noise ratio (SNR) of liver parenchyma at hepatobiliary phase with each FAs was calculated, as following: SNR = SI-liver / SI-noise. The lesion-to-liver contrast to noise ratio (CNR) at hepatobiliary phase with each FAs was calculated, as following: CNR = (SI-lesion - SI-liver) / SI-noise. Analysis of variance with the Sheffe method was used to evaluate statistical significance of the differences in RE, SNR and CNR values, according to the each FAs.

Results
The RE values of hepatic parenchyma was significantly different in each FAs (10°, RE=0.73; 20°, RE=0.65; 30°, RE=0.52; p=0.002). The SNR of hepatic parenchyma values was not significantly different in each FAs (10°, SNR=26.3; 20°, SNR=25; 30°, SNR=23.3; p=0.093). Twenty five patients out of all patients had 41 lesions, which were consisted with 5 benign lesions and 36 malignant lesions. The CNR of lesions was not significantly different in each FAs (10°, CNR=-5.9; 20°, CNR=-7.9; 30°, CNR=-8.1; p=0.223).

Conclusion
Increasing the FA on hepatobiliary phase of BOPTA enhanced MRI affects only hepatic parenchyma enhancement.

Clinical Relevance/Application
Hepatobiliary phase with high degree of flip angle on BOPTA enhanced MRI decreased only hepatic parenchyma enhancement and didn't affect contrast noise ratio of the lesion.

Respiratory Motion Artifact Affecting Arterial-phase Imaging—Comparison of Gadoxetate Disodium and Gadobenate Dimeglumine and Exam Recovery Using Multi-arterial Phase Acquisitions

Jason A Pietryga MD (Presenter); Lauren M Burke MD; Tracy A Jaffe MD; Mustafa R Bashir MD *

Purpose
To compare the rates of moderate/severe respiratory motion artifact on arterial-phase magnetic resonance imaging (MRI) when using gadoxetate disodium versus gadobenate dimeglumine intravenous contrast, and to assess if obtaining multiple arterial phases salvages some studies with motion.

Method and Materials
This is an IRB-approved HIPAA-compliant study. A retrospective search identified consecutive outpatients who had undergone contrast-enhanced MR imaging of the abdomen using either gadoxetate disodium or gadobenate dimeglumine over a period of three months using identical imaging protocols. Three board-certified radiologists (blinded to the contrast agent used) independently reviewed the following T1-weighted series for motion artifact: precontrast, three rapid arterial phases obtained in a single breath hold, portal venous phase, and late dynamic phase. Scores were scored for severity of respiratory motion on a scale of 1 (none) to 5 (nondiagnostic), and timing of each arterial phase was assessed. Motion scores were compared between exams obtained with the two contrast agents for: number of exams with new (not present on precontrast phase) moderate (motion = 3) or severe (=4) motion on at least one arterial phase, and exams where at least one well-timed late arterial phase had less than severe (motion <3).

Results
275 qualifying examinations were identified (166-gadoxetate/109-gadobenate). Exams performed with gadoxetate had higher rates of new moderate (42.8% vs. 16.8%, p<0.001). Transient moderate and severe motion artifact in the hepatic arterial phase occurs at a higher rate with gadoxetate disodium than with gadobenate dimeglumine. A multi-arterial phase acquisition scheme can recover a proportion of those examinations partially affected by arterial phase motion.

Conclusion
Increased rates of significant motion artifact are seen when imaging the liver in the arterial phase with gadoxetate contrast vs. dimeglumine. Multi-arterial phase acquisition may salvage some exams.

Liver MRI with Gadofosveset Trisodium

Laurent Milot MD, MSc (Presenter); Shoiqet Martin MD; Helen Cheung MD; Caitlin T McGregor MD; Megan Snyer; Masoom A Haider MD *; Liang Zeng; Chirag Patel MBBS, MRCP; George Tomlinson; Calvin Law MD, FRCPC

Purpose
To illustrate the benefits and limitations of liver imaging performed with an intravascular blood pool agent Gadofosveset Trisodium (Gadofos) compared with an extracellular Gadolinium (EcGd) agent Gadobutrol.
CONCLUSION
Enhancement pattern of background vessels/liver parenchyma and benign lesions is similar for both agents but Ablavar does not accumulate in metastatic lesions over time, a key differentiating feature. Pitfall may exist in some cases of NET.

CLINICAL RELEVANCE/APPLICATION
Enhancement of background vessels/liver parenchyma and enhancement of benign lesions is similar for both agents. Pitfall may exist in some cases of NET.

METHOD AND MATERIALS
A retrospective analysis of the dedicated contrast enhanced pelvic MRI examination performed for 146 female patients with pudendal neuralgia demonstrated the feasibility and diagnostic potential of 7 T contrast-enhanced MR imaging of the female pelvis.

RESULTS
For the T1w sequences, 2D FLASH imaging was rated with higher scores for all assessed structures than 3D FLASH MRI, with highest scores for overall image quality (mean contrast-enhanced 2D FLASH 4.80) and tissue contrast (mean contrast-enhanced 2D FLASH 4.90). T2w TSE imaging yielded a moderate to high delineation of the zonal anatomy of the uterus with mean scores ranging from 3.60 for endometrium to 4.75 for myometrium. Overall image impairment due to artifacts was rated strongest for T2w MRI (2.90) and least for 2D FLASH MRI (mean 4.05).

CONCLUSION
This pilot study of dedicated 7 Tesla MRI of the female pelvis demonstrates the feasibility and diagnostic potential of in vivo ultra-high-field pelvic imaging, providing good overall image quality and transitioning the associated higher SNR into high spatiotemporal resolution imaging.

CLINICAL RELEVANCE/APPLICATION
The high-quality delineation of anatomical details and non-enhanced vasculature may lead to more accurate diagnosis of pelvic parenchymatous and vasculature disease using 7T MRI.

SST07-02 • Spectrum of Pelvic Venous Congestion in Pudendal Neuralgia in Female Patients

Olga M Kalinkin MD (Presenter) ; Rohit Khanna MD ;  Diana Atashroo MD ; Andrea Chen MD ; Michael Hibner MD, PhD

PURPOSE
Pelvic congestion is a clinical condition with poorly understood etiology. Dilated vessels accompanying the pudendal nerve in anatomically narrowed spaces may cause extrinsic mass effect on the nerve. This study evaluates the presence of pelvic venous congestion in the patients with pudendal neuralgia.

METHOD AND MATERIALS
A retrospective analysis of the dedicated contrast enhanced pelvic MRI examination performed for 146 female patients with pudendal neuralgia clinically assessed by pelvic surgeons specialized in treatment of pudendal neuralgia. Diameter and localization of dilated venous vessels along the course of pudendal nerve in the interligamentous space, Alcock’s canal, at the inferior rectal branch, perineal branch, dorsal clitoral branch, caliber of vessels of the parauterine or paravaginal (in case of hysterectomy) venous plexus were assessed. Correlation of type of pelvic venous congestion with clinical symptom laterality was performed.

RESULTS
Among 146 female patients, 81 patients (55%), aged from 26 to 79 years, were found to have dilated venous pelvic vessels. Supralevator pelvic venous congestion is identified as dilatation of parauterine or paravaginal venous plexus without or with focally dilated vessels along the course of pudendal nerve in 34 and 28 patients respectively. Infralevator pelvic venous congestion as isolated dilated vessels in Alcock’s canal or interligamentous space and focally dilated small branches of pudendal nerves was seen in 13 patients and 6 patients respectively. 57 patients (90%) with supralevator pelvic venous congestion have bilateral site of pain or bilaterality of physical examination findings. In 7 from 19 patients the presence of isolated dilated veins along the pudendal nerve in Alcock’s canal or interligamentous space (infralevator unilateral pelvic congestion) are not associated with laterality of pain or symptoms.

CONCLUSION
Spectrum of pelvic venous congestion in the female patients with pudendal neuralgia is ranging from diffuse supralevator parauterine (paravaginal) venous plexus dilatation to isolated infralevator focal venous dilatation of pudendal veins in Alcock’s canal or interligamentous spaces or small venous varices along the branches of pudendal veins.

CLINICAL RELEVANCE/APPLICATION
Differentiation of supralevator versus infralevator pelvic venous congestion may guide the pelvic surgeon to select an appropriate treatment with gonadal vein ligation versus focal venosclerotherapy.

SST07-03 • Urinary Bladder Neck Dysfunction in Male Patients: Evaluation with MRI and with Voiding MR-Cystourethrography

Mark E Ladd MD (Presenter) ; Raj M Paspulati MD ;  Julia R Fielding, MD

PURPOSE
Urinary bladder neck dysfunction is a condition that can be clinically challenging to diagnose. MRI and voiding cystourethrography provide complementary information for the evaluation of bladder neck dysfunction. This study aims to compare the diagnostic accuracy of these imaging modalities in the assessment of bladder neck dysfunction.

METHOD AND MATERIALS
A prospective analysis of MRI and voiding cystourethrography in patients with clinical symptoms suggestive of bladder neck dysfunction. Imaging was performed using a 3 Tesla MRI system, with T2-weighted imaging and dynamic contrast-enhanced sequences. Voiding cystourethrography was performed using a contrast agent.

RESULTS
The diagnostic accuracy of MRI and voiding cystourethrography was evaluated using a blinded review by independent radiologists. MRI was found to be more sensitive in detecting bladder neck pathology, while voiding cystourethrography was more specific in identifying mechanical bladder neck obstruction.

CONCLUSION
MRI and voiding cystourethrography provide valuable information in the evaluation of bladder neck dysfunction. MRI is more sensitive, whereas voiding cystourethrography is more specific. Combining both modalities can improve diagnostic accuracy.

CLINICAL RELEVANCE/APPLICATION
The combination of MRI and voiding cystourethrography can aid in the accurate diagnosis and management of bladder neck dysfunction, leading to improved patient outcomes.

SST07-04 • Spectrum of Pelvic Venous Congestion in Pudendal Neuralgia in Female Patients: Evaluation with MRI and with Voiding MR-Cystourethrography

Mark E Ladd MD (Presenter) ; Raj M Paspulati MD ;  Julia R Fielding, MD

PURPOSE
Pelvic congestion is a clinical condition with poorly understood etiology. Dilated vessels accompanying the pudendal nerve in anatomically narrowed spaces may cause extrinsic mass effect on the nerve. This study evaluates the presence of pelvic venous congestion in the patients with pudendal neuralgia.

METHOD AND MATERIALS
A retrospective analysis of the dedicated contrast enhanced pelvic MRI examination performed for 146 female patients with pudendal neuralgia clinically assessed by pelvic surgeons specialized in treatment of pudendal neuralgia. Diameter and localization of dilated venous vessels along the course of pudendal nerve in the interligamentous space, Alcock’s canal, at the inferior rectal branch, perineal branch, dorsal clitoral branch, caliber of vessels of the parauterine or paravaginal (in case of hysterectomy) venous plexus were assessed. Correlation of type of pelvic venous congestion with clinical symptom laterality was performed.

RESULTS
Among 146 female patients, 81 patients (55%), aged from 26 to 79 years, were found to have dilated venous pelvic vessels. Supralevator pelvic venous congestion is identified as dilatation of parauterine or paravaginal venous plexus without or with focally dilated vessels along the course of pudendal nerve in 34 and 28 patients respectively. Infralevator pelvic venous congestion as isolated dilated vessels in Alcock’s canal or interligamentous space and focally dilated small branches of pudendal nerves was seen in 13 patients and 6 patients respectively. 57 patients (90%) with supralevator pelvic venous congestion have bilateral site of pain or bilaterality of physical examination findings. In 7 from 19 patients the presence of isolated dilated veins along the pudendal nerve in Alcock’s canal or interligamentous space (infralevator unilateral pelvic congestion) are not associated with laterality of pain or symptoms.

CONCLUSION
Spectrum of pelvic venous congestion in the female patients with pudendal neuralgia is ranging from diffuse supralevator parauterine (paravaginal) venous plexus dilatation to isolated infralevator focal venous dilatation of pudendal veins in Alcock’s canal or interligamentous spaces or small venous varices along the branches of pudendal veins.

CLINICAL RELEVANCE/APPLICATION
Differentiation of supralevator versus infralevator pelvic venous congestion may guide the pelvic surgeon to select an appropriate treatment with gonadal vein ligation versus focal venosclerotherapy.

SST07-05 • Spectrum of Pelvic Venous Congestion in Pudendal Neuralgia in Female Patients: Evaluation with MRI and with Voiding MR-Cystourethrography

Mark E Ladd MD (Presenter) ; Raj M Paspulati MD ;  Julia R Fielding, MD

PURPOSE
Pelvic congestion is a clinical condition with poorly understood etiology. Dilated vessels accompanying the pudendal nerve in anatomically narrowed spaces may cause extrinsic mass effect on the nerve. This study evaluates the presence of pelvic venous congestion in the patients with pudendal neuralgia.

METHOD AND MATERIALS
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RESULTS
Among 146 female patients, 81 patients (55%), aged from 26 to 79 years, were found to have dilated venous pelvic vessels. Supralevator pelvic venous congestion is identified as dilatation of parauterine or paravaginal venous plexus without or with focally dilated vessels along the course of pudendal nerve in 34 and 28 patients respectively. Infralevator pelvic venous congestion as isolated dilated vessels in Alcock’s canal or interligamentous space and focally dilated small branches of pudendal nerves was seen in 13 patients and 6 patients respectively. 57 patients (90%) with supralevator pelvic venous congestion have bilateral site of pain or bilaterality of physical examination findings. In 7 from 19 patients the presence of isolated dilated veins along the pudendal nerve in Alcock’s canal or interligamentous space (infralevator unilateral pelvic congestion) are not associated with laterality of pain or symptoms.

CONCLUSION
Spectrum of pelvic venous congestion in the female patients with pudendal neuralgia is ranging from diffuse supralevator parauterine (paravaginal) venous plexus dilatation to isolated infralevator focal venous dilatation of pudendal veins in Alcock’s canal or interligamentous spaces or small venous varices along the branches of pudendal veins.

CLINICAL RELEVANCE/APPLICATION
Differentiation of supralevator versus infralevator pelvic venous congestion may guide the pelvic surgeon to select an appropriate treatment with gonadal vein ligation versus focal venosclerotherapy.
To study the feasibility and value of contrast enhanced ultrasound (ECUS) in acute pelvic pain in women and children.

PURPOSE

Kastler Sandrine Chapuy

PURPOSE

Baronio Javier Vallejos

CONCLUSION

Ulrike I Attenberger MD (Presenter) *; John N Morelli MD; Alexander Herold; Peter Kienle MD, PhD; Werner Kleine; Axel Hacker; Christopher Baumann; Julia Heinzelbecker; Stefan O Schoenberg MD, PhD *; Henrik J Michaely MD *

RESULTS

RESULTS

CONCLUSION

CLINICAL RELEVANCE/APPLICATION

MRI with voiding MR-cystourethrography could be performed in male patients with bladder outlet obstruction in order to visualize the anatomical aspect of the bladder neck. These anatomical information are useful to determine the causes of voiding obstruction, to diagnose urinary bladder dysfunction and to establish the best therapeutic approach.

MRI with voiding MR-cystourethrography could be performed to diagnose urinary bladder neck dysfunction and can substitute conventional retrograde and voiding cystourethrography.

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MRI with voiding MR-cystourethrography could be performed to diagnose urinary bladder neck dysfunction and can substitute conventional retrograde and voiding cystourethrography.
METHOD AND MATERIALS
Seventeen adnexal torsion were included in this retrospective study (16 patients from 21 days to 58 years, including 3 pregnant women) after local ethics committee approval between 2008 and 2012. ECUS imaging findings were compared to regular non enhanced US and to either pathological findings in case of surgery and to follow up imaging in the remaining cases.

RESULTS
Thirteen adnexal torsion were confirmed, 9 of which occurred on a pathological ovary. ECUS sensitivity and positive predictive value were 84.6%. We report two cases of false negative and two cases of false positive. Ovary Vascularization assessment was possible in all 13 cases as opposed to 30.8% in Doppler mode, showing hypovascularization of ovary in ECUS in 58.8% against 15.4% in Doppler mode . In the three cases of ECUS performed pregnant women, imaging findings showed no transplacental passage. No adverse events were noted in all cases.

CONCLUSION
Our study showed that ECUS allowed accurate diagnosis of adnexal torsion in 84.6% of cases. ECUS is a feasible, safe and useful tool in the assessment of acute pelvic pain in women and children.

CLINICAL RELEVANCE/APPLICATION
Contrast enhanced US is a useful tool in the early diagnosis of adnexal and provides crucial information on ovary perfusion which may help conservative surgical management

SST07-07 • Comparison of the Pelvic Floor before Pregnancy and 6 Weeks after Delivery: An MRI Study
W. Thomas Gregory MD ; Terri E Reichner MD ; Amanda Holland BS ; Amy S Thurmond MD (Presenter) *

PURPOSE
Pelvic organ prolapse is linked to parity, and for millennia has resulted in stress urinary incontinence and other symptoms which affect large numbers of women and limit their ability to work and socialize. We used MRI to evaluate changes in the pelvic floor before and after a first pregnancy. We compared these changes between those undergoing cesarean delivery and those having a vaginal delivery.

METHOD AND MATERIALS
This is a subgroup from an ongoing prospective cohort study of nulliparous women planning pregnancy. Participants have a standardized evaluation before pregnancy (Visit 1), 6 weeks after delivery (Visit 2), and then 6 months after delivery (Visit 3). At all three visits the participant has an interview with questionnaire, clinical pelvic exam, transperineal and endoanal 3D ultrasound, electromyography (EMG) of the pelvic floor and anal sphincter muscles, and pelvic MRI using a 3 Tesla magnet. This report focuses on MRI findings of the women who have completed Visits 1 and 2.

RESULTS
In 42 women, there was no significant change in bony measurements before and after pregnancy and delivery. There were however significant differences in the soft tissue measurements, including statistically significant inferior position of the bladder neck 6 weeks after delivery in all women, which was related to descent of the puborectalis muscle. This was more pronounced following vaginal delivery (31 women) compared to cesarean delivery (15 women). This was particularly evident during the dynamic maneuvers of kegel and valsavla. Interestingly, the pre-pregnancy values of bladder neck descent were larger in the women who ended up needing cesarean delivery.

CONCLUSION
Our data supports observations that after a first pregnancy women who had a vaginal delivery are 5 to 6 times more likely to have measurable pelvic prolapse then women who had cesarean delivery. Universal cesarean delivery to avoid future pelvic prolapse would not however be safe or cost effective. The comparison of pelvic structures in the same woman before and after delivery has not been done before, and may help us predict the women in whom the benefits of cesarean delivery for maintaining pelvic support, outweigh the risks.

CLINICAL RELEVANCE/APPLICATION
This is the first large study to image the pelvic floor anatomy in women before and after their first delivery of a child.

SST07-08 • Endometriosis: Is there a Way to Differentiate between Silent Fibrotic Adhesions and DIE with MRI?
Lucia Manganaro MD ; Valeria Vinci MD (Presenter) ; Silvia Bernardo MD ; Paolo Sollazzo ; Maria Eleonora Sergi MD ; Matteo Saldari ; Carlo Catalano MD

PURPOSE
Feasibility of contrast enhanced (CE) MRI with rectal filling to differentiate between recto-sigmoid DIE and silent fibrotic adhesions, and to assess the severity of infiltration.

METHOD AND MATERIALS
From October 2011 and April 2013 We enrolled 18 women coming with either ultrasound or clinical suspect of posterior endometriosis. We performed a pelvic MRI examination on 1.5T system, with intravenous administration of gadobenate dimeglumine (Gd-BOPTA) and rectal filling with ultrasonographic gel. We evaluated the presence of recto-sigmoid involvements and its nature by taking in consideration the different CE behaviour. All patients underwent to laparoscopy within 1 month from MRI.

RESULTS
MRI diagnosed posterior cul-de-sac obliteration in 15/18 patients. 5/15 cases MRI reported fibrotic strand between uterus and rectum. In other 6/15 cases, MRI detected wide nodules (mean diameter 18mm) on the Rectal surface, involving at full depth the muscularis mucosa, these nodules were easily visible thanks to the difference of CE between the lesion and the normal enhancing surrounding muscolaris mucosa. In all cases overlying mucosa was intact. In 4/15 cases MRI detected smaller implants on the rectal wall, (mean diameter 8 mm); 3/4 appeared to involve partially the rectal wall, thus were suggestive for DIE; on the contrary 1/3 showed to be clearly remarkable from rectal wall in CE phase, therefore we suggested to be a pseudo-nodular adhesion.MRI findings were compared to laparoscopy, which demonstrated that the small implants suggestive for pseudo-nodular adhesion was indeed a implants of DIE (False negative). 1 case of small implants reported as DIE on MRI revealed to be fibrotic adhesion (False positive). We achieved a 92% sensitivity and a 75% specificity.

CONCLUSION
This study shows that CE MRI and rectal filling are suitable for the diagnosis of recto-sigmoid endometriosis and mainly in differentiating between fibrotic adhesions and DIE. Moreover, CE MRI may allow to detect the severity of infiltration trough rectal wall. All these information are important to guide the surgeon towards a resection or shaving of the nodules of DIE, or for the lysis of the adhesions.

CLINICAL RELEVANCE/APPLICATION
CE MRI associated to rectal filling proved to be suitable to differentiate between adhesions and DIE ;differentiate between these two type of manifestation is crucial for the surgical planning.

SST07-09 • Diffusion Weighted Imaging in the Evaluation of Hormonal Cyclic Changes in Abdominal Wall Endometriomas
Berhan Genc ; Mecit Kantarci (Presenter) ; Aynur Solak ; Neslin Sahin MD ; Mine Genc ; Hayrul Ogul ; Oya Sivrikoc ; Berhan Pirimoglu MD

PURPOSE
To investigate the utility of diffusion weighted (DW) Magnetic Resonance (MR) imaging in the diagnosis of abdominal wall endometrioma (AWE) and to compare ADC values of AWE with uterine endometrium, during different two phases of menstrual cycle.

Page 46 of 212
RESULTS
The ADC values of the endometrium were different in the two phases of the menstrual cycle (menstrual phase: 0.924±0.256; luteal phase: 1.171±0.135). Similarly the ADC values of AWEs were different in these phases (menstrual phase: 0.924±0.171, luteal phase: 1.171±0.135). Both ADC measurements (AWE and uterine endometrium) were significantly lower in the menstrual phase than during the luteal phase and statistical significant difference was observed between menstrual and luteal phase (p < 0.05). There was no significant difference in ADC values between endometrial layer and AWE, in the same phase (p=0.216 for menstrual phase, p=0.104 for luteal phase, paired sample t-test).

CONCLUSION
This study demonstrated that the DWI features of AWEs were significantly similar to the uterine endometrial tissue in all patients and they show similar cyclic changes on ADC measurements. These preliminary results suggest that ADC values of lesion close to the uterine endometrium may be used to differentiate AWE from the other pathologic conditions of abdominal wall.

CLINICAL RELEVANCE/APPLICATION
DWI particularly ADC measurements together with uterine endometrial lining, provide useful information for diagnosis of AWE.
SST08-03 • A Method for Segmenting Multi-focal Radiotracer Uptake in PET Images to Quantify Tuberculosis in Rabbits

Brent Foster (Presenter) ; Ulas Bagci PhD, MSc; Ziyou Xu PhD ; Awaiss Mansoor PhD ; Bappaditya Dey ; Brian Luna ; William Bishai ; Sanjay K Jain MD ; Daniel J Mollura MD

PURPOSE
To develop a novel segmentation method that can identify and quantify diffuse and multi-focal uptake regions using small animal model PET images that have a diagnosis of a pulmonary infection.

METHOD AND MATERIALS
Our segmentation approach is based on affinity propagation (AP) clustering and uses a novel distance metric and a probability density function that is estimated from a smoothed histogram. An overview of the proposed method is as follows: (i) the PET image histogram was estimated and smoothed by using a diffusion based kernel density estimation, (ii) a novel similarity function was constructed to determine how similar the histogram data points are to each other, based on two constraints: probability based and intensity based constraints, with the assumption that points that are more similar are more likely to belong to the same classification, and (iii) the AP clustering was applied to the similarities between the data points in order to find optimal thresholding levels that can separate the significant uptake regions into several tissue labels. Our proposed method was tested using an infectious disease small animal model that consisted of imaging ten rabbits at weeks 0,5,10,15,20,30, and 38 with FDG-PET® and all rabbits were infected with an aerosolized Mycobacterium Tuberculosis. Two experts segmented the images to define the ground truth for comparison.

RESULTS
The Dice Similarity Coefficient (DSC) and the sensitivity and specificity were calculated between the segmentation regions that were found by the proposed method and then compared to expert delineations. An average DSC of 0.96±0.82% with a sensitivity of 97.87±7.09% and a specificity of 83.70±15.32% were achieved. The Pearson correlation coefficient between the delineation performances of the two expert observers was R2=0.85 (p<0.05).

CONCLUSION
Current PET segmentation techniques focus on focal uptake regions and are not well suited for multi-focal uptake regions, commonly found in infectious lung diseases. Our proposed segmentation method quantified the multi-focal uptake regions with high accuracy and within seconds and it outperformed the state-of-the-art methods.

CLINICAL RELEVANCE/APPLICATION
This method can be used to segment diffuse and multi-focal FDG uptake normally seen in PET images from patients with infectious diseases like TB.

SST08-04 • Evaluation of a Novel Software for Fully Automated Detection of Osteoporosis in Abdominal MDCT Scans Performed for Other Clinical Indications, as an Aid to the Radiologist

Einat Blumfield MD (Presenter) * ; Jay S Leb MD ; Anthony Blumfield MSc *

CONCLUSION
The use of Radnostics software may increase early detection of OP in patients who have abdominal MDCT scans for other clinical indications.

Background
Osteoporosis (OP) is a common condition that increases the risk of fractures without significant trauma. Early detection and therapy may diminish fracture risk. While Screening with bone densitometry is considered the gold standard for diagnosing OP, the compliance for this test is low. OP may be detected in CT scans; however, it is under-reported by radiologists. An automated method for detection of OP may improve the rate of early diagnosis. Novel software, for automated spine segmentation and OP detection was developed by Radnostics® (Scarsdale, NY). The software performs phantomless measurement of bone mineral density (BMD) in vertebral bodies and presents the radiologist with an image (figure) on PACS that includes average BMD and density values and a sagittal image of the spine. The process is fully automated and takes <5 minutes per scan. The purpose of this study is to evaluate the efficacy of the software as an aid to the radiologist.

Evaluation
In this retrospective, IRB exempt study, 198 consecutive subjects (182F, 16M, age 34-89, mean-65.5+/−9 y) who had DXA and CT scans within a period of 6 months were included.

Discussion
The use of the software resulted in a 275% increase in the rate of reporting osteopenia in abdominal CT scans with only 3 additional FP scans. The Radnostics software is efficient as an aid to the radiologist. It provides the radiologist with an image that contains data needed for evaluation of bone mineralization and does not require any manual intervention.

SST08-05 • Semi-automatic Quantitative Measurement of Breast Background Parenchymal Enhancement and Breast Cancer Risk

Ya Wang (Presenter) ; Malcolm Pike ; Valencia King MD ; Janice S Sung MD ; Elizabeth A Morris MD ; Eve Burstein ; Erin E Onstad ; Jonine L Bernstein ; Jennifer Brooks PhD ; Joseph O Deasy PhD

PURPOSE
Breast fibroglandular tissue (FGT) amount, as measured by mammographic density or breast MRI, is an established breast cancer risk factor. Our recent study found that background parenchymal enhancement (BPE) on MRI of an unaffected breast is also strongly associated with breast cancer risk. To significantly reduce the intra- and inter-reader variability inherent in visual FGT and BPE classification, we developed a semi-automatic quantitative method and tested it on the MRIs in the aforementioned study.

METHOD AND MATERIALS
Contrast-enhanced breast MRI sequences were obtained for 39 breast cancer cases and 78 for control group. Our segmentation algorithm was applied to the central slice images, providing an automatic classification of voxels into FGT and non-FGT. An enhancement image within the breast area was obtained by subtracting the baseline from the post-injection image. We defined a subtraction voxel with a signal intensity of 10 or greater as positive and the percentage of positive subtraction voxels within the FGT area (BPE-W) was calculated. The set of BPE-W was divided into quartiles. The lowest two and highest two quartiles were combined. We tested the association between the percentage of positive voxels and breast cancer risk using BPE-W as a continuous and a categorical variable, adjusted for menopausal status. We used different statistical tests to find the optimal thresholding levels that can separate the significant uptake regions into several tissue labels. Our proposed method was tested using an infectious disease small animal model that consisted of imaging ten rabbits at weeks 0,5,10,15,20,30, and 38 with FDG-PET® and all rabbits were infected with an aerosolized Mycobacterium Tuberculosis. Two experts segmented the images to define the ground truth for comparison.

RESULTS
The Dice Similarity Coefficient (DSC) and the sensitivity and specificity were calculated between the segmentation regions that were found by the proposed method and then compared to expert delineations. An average DSC of 0.96±0.82% with a sensitivity of 97.87±7.09% and a specificity of 83.70±15.32% were achieved. The Pearson correlation coefficient between the delineation performances of the two expert observers was R2=0.85 (p<0.05).

CONCLUSION
Current PET segmentation techniques focus on focal uptake regions and are not well suited for multi-focal uptake regions, commonly found in infectious lung diseases. Our proposed segmentation method quantified the multi-focal uptake regions with high accuracy and within seconds and it outperformed the state-of-the-art methods.

CLINICAL RELEVANCE/APPLICATION
This method can be used to segment diffuse and multi-focal FDG uptake normally seen in PET images from patients with infectious diseases like TB.
CONCLUSION
We developed a nearly real-time method to estimate the volumes of both RV and LV with minimum user input. The method was tested on short-axis MR images of 35 subjects and was demonstrated as a promising tool that enables semi-automated functional assessment for RV as well as LV simultaneously.

Background
Estimation of the two cardiac ventricles' volumes is of significant clinical importance for the purpose of cardiac functional assessment. Although very powerful semi-automated solutions have been employed for the left ventricle (LV), the estimation task is still performed manually or visually for the right ventricle (RV) in routine clinical use. We have developed a semi-automated method to efficiently estimate the volumes of RV as well as LV simultaneously with neither manual nor auto contouring.

Evaluation
Following IRB approval, 35 patients (22 men, 13 women, avg 52±17 yrs) underwent cardiac cine MR images using 1.5T GE scanner with FIESTA image sequence. A subject sequence consists of 20 frames of 3D images in short-axis view. For each subject, only two landmarks were placed at the attachment spots of the right ventricular wall to the left ventricular septal wall in the first frame on each slice. Then our method simultaneously estimated the volumes of both RV and LV, and computed their ejection fractions. The results on the 35 subjects were compared with gold standard created by a human expert manually contouring the biventricular endocardia.

Discussion
A comprehensive validation on 35 subjects demonstrates that the estimated volumes of RV and LV are highly correlated to gold standard with correlation coefficients 0.9470 and 0.9812. Furthermore, the agreement of both the RV/LV ejection fraction and gold standard are also as high as 0.8635 (RV) and 0.9676 (LV). Overall, the performance is lower on RV than on LV, which is expected due to the complex motion and geometry of RV. The whole bi-ventricular volume estimation process takes on average 1.26 seconds per subject and can be further optimized.

SST08-07 • Enhancement of CADx Accuracy by Using Multiple Slices from Various Views in 3D Liver Ultrasound

Ye-Hoon Kim (Presenter) ; Moon Ho Park ; Junghoe Kim ; Baek Hwan Cho ; Yeong Kyeong Seong PhD ; Kyoung-Gu Woo ; Min Woo Lee

CONCLUSION
3D US liver CADx using multiple slices in the vicinity of the lesion center and combination of their various views can enhance the diagnostic accuracy for liver cancer.

Background
The objective of this study is to enhance the performance of 3D US Computer-Aided Diagnosis (CADx) for liver cancer. The proposed 3D US liver CADx uses multiple slices and various views from 3D volume for diagnosis of benign and malignant tumors. Our CADx system segments the lesion and extracts the features and then classifies lesions as benign for cyst and hemangioma and as malignants for hepatocellular carcinoma.

Evaluation
2D (1024x768) and 3D (512x510x256) US images of liver lesions were acquired for this research from 44 patients (22 benign and 22 malignant cases) respectively by using 2D and 3D US probes. The accuracy of our CADx was 1) 80.8% by only a 2D slice containing a lesion; 2) 81.9%, 78.8%, 74.4% by using a center slice of the lesion with three orthogonal views, respectively; 3) 81.8% by combining three orthogonal views of the lesion (total 3 slices); 4) 85.5%, 79.0%, 75.5% by using seven slices of the lesion for three orthogonal views, respectively; and 5) 84.0% by combining seven slices of the lesion with their three orthogonal views (total 21 slices). The seven slices include a center slice which bisects a lesion and additional slices in the vicinity of the lesion center in 3D volume. 2D lesion contour for ground truth was obtained by a radiologist and 3D lesion volume was obtained semi-automatically. Majority voting was used to classify lesions from the multiple slices and views. The 10-fold cross-validation and averaged accuracy of 100 iterations were used for performance evaluation.

Discussion
The combination of three orthogonal views only at the center of the lesion was less effective to improve the 3D CADx accuracy. However because our 3D US liver CADx can use additional information of the 3D volume, the combination of multiple slices and their different views outperformed the case of combining multiple views only at the center of the lesion (p

SST08-08 • SyN and ART: Quantitative Evaluation of Two Leading Open-source Image Registration Software Tools for Automatic Segmentation and Measurement of the Corpus Callosum on MR Images of Multiple Sclerosis Patients

Paxton Smith MEng (Presenter) ; David K Li MD * ; Anthony Traboulsee MD * ; Roger Tam PhD

PURPOSE
The emergence of robust neuroimage analysis software enables automatic volumetry of brain structures commonly associated with neurodegenerative disease such as multiple sclerosis (MS). However, the application of such software is not standardized, and it is unclear how much variability can be expected from the choice of tools. In our study, we demonstrate the use of two open-source, state-of-the-art image registration tools, namely SyN (Symmetric Normalization) and ART (Automatic Registration Toolbox), in the automatic measurement of the corpus callosum area (CCA) in the mid-sagittal plane (MSP). Our goal was to find whether significant differences in volumetry exist between the tools when applied to our task, to the extent that tool selection could impact the outcome of clinical studies.

METHOD AND MATERIALS
We randomly selected 100 3-D, T1-weighted axially acquired MR images of patient brains from a recent MS clinical trial. Image format was 256 x 256 x 180 with 0.976 mm x 0.976 mm x 1 mm voxel size and the AC-PC line manually centered in the volume during acquisition. Extra-cranial regions were deleted from the images using BET, and the CCA was manually segmented in the MSP using ITKSNAP to provide ground truth. Patient brains were affinely registered to the MNI152 reference using FLIRT followed by non-linear transformations with SyN v1.9 and ART v2.0. The JHU CC label for the MNI152 atlas was then propagated to patient space using the corresponding inverse transformations.

RESULTS
The overlap between the automatic and manual segmentations was measured with the Dice coefficient (SyN = 0.764, ART = 0.769). The Wilcoxon test (p = 0.475) showed no significant difference between SyN and ART. The correlation of CCAs between automatic and manual segmentations was measured with Spearman's rank coefficient (SyN ? = 0.813 p = 0.9410 -24 vs. ART ? = 0.807 p = 1.60e10 -7), showing that the SyN and manual segmentations were more strongly correlated.

CONCLUSION
SyN and ART perform very similarly for common metrics in ours and past studies; however, there is sufficient difference in the volumetric
correlation to ground truth that they cannot be considered equivalent.

CLINICAL RELEVANCE/APPLICATION
Leading image registration tools, SyN and ART, perform similarly for most common metrics, but to compare results between clinical studies, standardization of the image analysis pipeline is critical.

SST09-09 • Fully Automated Segmentation of Multiple Organs in Contrast-enhanced Abdominal CT: Preliminary Study
Jing Liu (Presenter) ; Qiang Li PhD *

PURPOSE
Organ delineation in CT is a key component to computer-aided detection, radiotherapy planning, and pre-surgical planning. We developed a generic algorithm for fast and robust segmentation of multiple abdominal organs from contrast-enhanced CT scans.

METHOD AND MATERIALS
The fully automatic algorithm segments organs using a set of atlases, i.e., pre-learned abdominal organ shapes and inter-organ spatial relationship models. The algorithm consists of five major steps. First, a test image was filtered with an edge-preserving non-local-mean filter. Second, the centroid of an organ of interest (OOI) on the test image was identified by context-driven Generalized Hough Transform (cGHT) using organ atlases. Third, a probability map indicating the likelihood of being the OOI was assigned to image pixels according to the localized centroid and atlas of the OOI. Fourth, the initial organ segmentation was achieved by graph-cut method for maximizing the likelihood for the label assignment with a smoothness penalty. Finally, initial organ segmentation was refined by a fast adaptive erosion-dilation (AdaED) method. In this preliminary study, the algorithm was used for segmenting liver, spleen, left and right kidneys from 10 test CT scans. Livers, spleens and both kidneys on test images were manually segmented by two radiologists prior to the application of automatic algorithm and were used as reference standard. The segmentation algorithm was evaluated by Jaccard overlap scores between automatic segmentation and reference standard. The algorithm will be applied to the segmentation of more organs in more CT scans in the upcoming months.

RESULTS
The cGHT correctly localized all organs of interest on 10 test images. The Jaccard scores for segmentation of liver, spleen, left and right kidneys were 89.3±2.5%, 86.6±5.0%, 90.0±3.1% and 90.6±3.0%, respectively.

CONCLUSION
The use of cGHT, likelihood-based graph-cut and AdaED achieved, respectively, very efficient organ localization, initial segmentation and segmentation refinement in abdominal CT scans. The preliminary results showed that the automatic organ segmentation method is robust and accurate. We thank Drs. F. Li and C. Zhang for manual organ delineation.

CLINICAL RELEVANCE/APPLICATION
An automated segmentation algorithm greatly improves efficiency/consistency for organ contouring, and facilitates computer-aided detection, radiotherapy and pre-surgical planning in clinical practice.

SST09-01 • Vascular Communications between Donor and Recipient Tissues One Year after Successful Full Face Transplantation
Canako K Kumamaru MD, PhD (Presenter) ; Geoffrey C Sisk ; Michael L Steigner MD * ; Elizabeth George MBBS ; Bohdan Pomahac MD ; Frank J Rybicki MD, PhD * ; Kurt Schultz RT * ; Dimitris Mitsouras PhD ; David S Enterline MD * ; Ericka M Bueno PhD

PURPOSE
To noninvasively study vascular changes that have implications on graft survival and rejection, future surgical planning, and our understanding of the underlying biology changes after full face transplantation.

METHOD AND MATERIALS
Three full face transplant patients (single anastomosis bilaterally of artery and vein) for whom clinical findings were previously reported (NEJM 2012; 366:715-22) were, for the first time, evaluated for vascular reorganization 1 year after successful transplantation using a previously described 320 x 0.5 mm detector row dynamic CT angiography protocol (AJNR 2012, Aug 9, PMID 22878008).

RESULTS
Consistent, extensive vascular re-organization was observed among the recipients. Diverted external carotid artery (ECA) or facial artery angsisomes were found to be perfused from newly opened, elaborate collateral circulation. Using the metric of arterial blood flow (BF) at the temporal region expressed as the percentage of the BF at the internal carotid artery, allograft tissue was slightly less perfused when the facial artery was the only donor artery when compared to an ECA-ECA anastomosis (4.4±0.4% vs 5.7±0.7%). However, allograft BF was higher than the recipient normal neck soft tissue. Blood flow to the recipient's tongue was maintained, despite the fact that the temporal region expressed as the percentage of the BF at the internal carotid artery, allograft tissue was slightly less perfused when the facial artery was the only donor artery when compared to an ECA-ECA anastomosis (4.4±0.4% vs 5.7±0.7%). However, allograft BF was higher than the recipient normal neck soft tissue. Blood flow to the recipient's tongue was maintained, despite the fact that the recipient lingual arteries were not always preserved. On the side where the lingual artery was ligated, blood flow was redistributed from a contralateral artery. Venous drainage was adequate for all patients, including patients for whom the recipient internal jugular vein was Anastomosed in end-to-end fashion on one side.

CONCLUSION
Despite extensive surface contact between the donor and the recipient, disruption of recipient's blood supply depends on extensive collateralization rather than new vessel ingrowth from the donor tissues. These findings guide both surgical planning and the assessment of potential complications for larger scale face transplant studies.

CLINICAL RELEVANCE/APPLICATION
A single anastomosis bilaterally of artery and vein is adequate for full face transplantation, evidenced by substantial arterial flow demonstrated on dynamic CT angiography.

SST09-02 • Value of Dynamic Volume Imaging with 320-detector Row CT in the Pre-transplantation Evaluation of Head and Facial Skin Flap: Initial Experience
Kaiyuan Xu (Presenter) ; Xuelin Zhang ; Xing Chen *

PURPOSE
To investigate the value of dynamic volume perfusion CT scanning in the pre-transplantation evaluation of blood supply of head and facial flaps with 320-Detector row computed tomography (CT).

METHOD AND MATERIALS
Whole-head dynamic volume perfusion CT scan was performed in 576 patients with a 320-Detector row CT system. All the patients...
enrolled had normal internal carotid arteries but due to other reasons referred to CT perfusion examination. Volume perfusion data were generated and then analyzed with the body perfusion software. BF (Blood Flow) value of each separate skin flap within the scan region was measured. The numbers of flap arteries and veins that can be found in dynamic CTA images are summarized.

RESULTS
We succeeded to measure BF value of each skin flaps in the head or face for all the patients. BF value of the forehead flap, the eyelid flap, the nasal dorsum flap, the buccal flap, the parietal flap, occipital flap, cervial flap was (127 ± 7.7)ml/min, (268.0 ± 31.1)ml/min, (229.0 ± 50.9)ml/min, (67.8 ± 9.5)ml/min, (140.3 ± 5.5)ml/min, (163.8 ± 15.5)ml/min, (123.5 ± 12.5)ml/min, respectively. There are significant difference between the flaps in different region, among which BF value of the buccal flap was the lowest. Arteries and vein of flaps was observed through different phases. Display rate of arteries and vein that can be found on dynamic CTA image was 100% for all flaps.

CONCLUSION
Whole-head dynamic volume CT perfusion using 320-detector row MDCT is able to offer effective reference for assessing blood supply and vessel anatomy of different skin flaps for the patient who is going to undergo skin flap autotransplantation. Fusion of perfusion map and CT anatomical images were helpful to the analysis and orientation of flaps.

CLINICAL RELEVANCE/APPLICATION
Whole-head perfusion can be used as a method of preoperative assessment of the skin flap perfusion and avoid operation complications effectively, which has the potential to improve diagnostic utility.

SST09-03 • MRI Displays Affection of the Deep Temporal Artery and the Temporal Muscle in Patients with Giant Cell Arteritis

Simon Veldhnoen MD (Presenter); Thorsten Klink MD; Julia Geiger MD; Peter Vaith; Cornelia Glaser; Thomas Ness; Dirk Duwendag; Marcus Both MD; Thorsten A Bley MD

PURPOSE
Giant cell arteritis (GCA) is a vasculitis of large and medium-sized arteries. Dedicated MRI protocols have been developed to detect vasculitic changes of the superficial cranial arteries noninvasively. This study assesses the involvement of the deep temporal artery and the temporal muscle in MRI of patients with active GCA.

METHOD AND MATERIALS
99 patients who received MRI and subsequent temporal artery biopsy (TAB) were included. TAB was positive in 61 and negative in 38 patients. TAB negative patients served as reference group. Contrast enhanced T1-weighted spin-echo images were acquired utilizing 1.5T and 3T MRI scanners at three academic medical centres. Mural contrast enhancement and wall thickening of the deep temporal artery and contrast enhancement of the temporal muscle were defined as their inflammatory involvement and assessed by two radiologists with experience in vasculitis imaging. Correlation analyses between individual MRI results and jaw claudication were performed to test for a concordance of clinical symptoms and MRI findings.

RESULTS
Patients with active GCA showed inflammatory affection of the deep temporal artery in 34.4% (n=21) and 49.2% (n=30). Bilateral involvement was found in 80% (n=19) and 90.5% (n=24). Temporal muscle involvement was observed in 19.7% (n=12) and 21.3% (n=13), respectively, and occurred bilaterally in all cases. Relative risk for jaw claudication was increased to 2.1 [1.5; 3.1] for GCA patients. Its presence correlated with inflammatory MRI findings in the deep temporal artery (r=0.38; p<0.01) as well as in the temporal muscle (r=0.31; p<0.01).

CONCLUSION
MRI is able to assess vasculitic changes in the deep temporal artery and in the temporal muscle. Both structures were affected simultaneously in a remarkable number of GCA patients. A substantial correlation of clinical symptoms and MRI results was observed.

CLINICAL RELEVANCE/APPLICATION
MRI is able to display the involvement of the deep temporal artery and the temporal muscle in patients with active GCA.

SST09-04 • Evaluation of Head and Neck Arteriovenous Malformations with 4D Contrast-enhanced MR Angiography at 3T

Yasuhiro Iryo (Presenter); Toshinori Hirai MD; Mika Kitajima MD; Yoshinori Shigematsu; Minako Azuma; Yasuyuki Yamashita MD *

PURPOSE
Four-dimensional contrast-enhanced MR angiography (4D CE-MRA) at 3T may replace digital subtraction angiography (DSA) for certain diagnostic purposes in patients with arteriovenous malformations (AVMs) in the head and neck region. The purpose of this study was to compare the agreement between DSA and 4D CE-MRA findings for the evaluation of head and neck AVMs.

METHOD AND MATERIALS
Six patients with facial AVMs (4 men, 2 women; aged 15 - 83 years, mean 39.2 years) underwent 4D CE-MRA at 3T and DSA. The AVMs were located tongue, lip, scalp, orbit, nose and cheek in one each. 4D CE-MRA combined randomly segmented central k-space ordering, phase encoding in the axial direction and six direction navigator echo technique. A set of 3D CE-MRA images were acquired every 1.9 sec at an acquired spatial resolution of 0.9×0.9×1.5 mm; the matrix was 256×256. Two independent observers reviewed 4D CE-MRA images with regard to the nidus size, main arterial feeders and venous drainage. The venous drainage was recorded as being extracranial, intracranial, or extra- and intracranial veins. Interobserver and intermodality agreement was assessed by ? statistics.

RESULTS
On 4D CE-MRA, the interobserver agreement was excellent for main arterial feeders (? = 1.0) and good for the nidus size and venous drainage (? = 0.63 and 0.67, respectively). Intermodality agreement was excellent for main arterial feeders and venous drainage (? = 0.92 and 1.0, respectively) and good for the nidus size (? = 0.63).

CONCLUSION
The agreement between 4D CE-MRA and DSA findings was good to excellent with respect to the nidus size, main arterial feeders and venous drainage in head and neck AVMs.

CLINICAL RELEVANCE/APPLICATION
4D CE-MRA is a reliable tool for assessing head and neck AVMs, although it is not able to replace DSA for the detailed evaluation.

SST09-05 • Visualization of the Intraparotid Facial Nerve with 3T MRI

Hiroyuki Fuji MD (Presenter); Akifumi Fujita MD; Yukio Kimura MD; Edward K Sung MD; Osamu Sakai MD, PhD *; Hideharu Sugimoto MD

PURPOSE
It is important to know the spatial relationship of the intraparotid facial nerve to a parotid tumor since the location of the tumor influences the duration and difficulty of the surgery. Recently, several study have proposed MRI techniques to visualize the intraparotid facial nerve by 3-dimensional reversed fast imaging with steady-state precession with diffusion weighted imaging (3D-PSIF-DWI) and three-dimensional double-echo steady-state with water excitation (3D-DESSWE). The purpose of this study is to evaluate the visualization of the intraparotid facial nerve with both sequences using 3T MRI, and compare the utility of this application in clinical practice.

METHOD AND MATERIALS
We evaluated 72 parotid glands of 36 consecutive patients during routine clinical MR examination. We performed both 3D-PSIF-DWI and 3D-DESSWE sequences using our 3T MR scanner (MAGNETOM Skyra, Siemens). Two observers initially assessed the images...
independently, but later resolved inconsistencies by collaborative review and consensus agreement. The certainty of identifying the intraparotid facial nerve was evaluated and divided into four categories; (1) Excellent: branch of the facial nerve identified; (2) Good: distal facial nerve trunk identified; (3) Fair: proximal facial nerve trunk identified; and (4) Poor: intraparotid facial nerve not identified.

RESULTS
Both 3D-PSIF-DWI and 3D-DESSWE were successfully obtained in all 36 patients (72 parotid glands). The intraparotid facial nerve was identified in 62 parotid glands (86.1%; Excellent:17, Good:25, Fair:20) with 3D-PSIF-DWI sequence and in 71 parotid glands (98.6%; Excellent:40, Good:15, Fair:16) with 3D-DESSWE sequence.

CONCLUSION
Using 3T MRI, both 3D-PSIF-DWI and 3D-DESSWE sequences can adequately demonstrate the course of the intraparotid facial nerve. 3D-DESSWE demonstrated better than 3D-PSIF-DWI in visualization intraparotid facial nerve.

CLINICAL RELEVANCE/APPLICATION
Knowledge about the course of the intraparotid facial nerve in relation to a parotid tumor is important for preoperative planning, and can optimize the surgical approach to prevent facial nerve damage.

SSTO9-06 • High Resolution Diffusion-weighted MR Imaging in the Head and Neck: A New Approach
Thorsten Klink MD (Presenter) ; Daniel Chong ; Dechen W Tshering-Vogel ; Nedelina Slavova ; Berthold Kiefer PhD * ; Harriet C Thoeny MD

PURPOSE
To evaluate whether diffusion-weighted MR images acquired with readout-segmented echo planar imaging (RESOLVE) are superior to single-shot echo planar imaging (ssEPI) in the head and neck region.

METHOD AND MATERIALS
After ethics committee approval and written informed consent, 10 volunteers were prospectively included in our MRI study of the head and neck region. The 3T MR study protocol included axial T2w-TSE, ssEPI, and RESOLVE acquisitions. Image analysis was performed by two independent observers. DWI was qualitatively evaluated by visual assessment using a 10-point score, and quantitatively by measuring SNR and ADC values of various predefined structures. Image distortion was assessed qualitatively and quantitatively by measuring the diameter of anatomical structures on RESOLVE and ssEPI images in comparison to T2w images. The RESOLVE sequence was additionally tested in four patients. Differences were considered statistically significant, when p=0.05 applying the non-parametric Mann-Whitney-U test.

RESULTS
Quality of RESOLVE images was significantly higher in comparison to ssEPI (Quality scores, RESOLVE 7.51 ±0.18 and ssEPI 4.50 ±0.32; p=0.007). RESOLVE produced superior image quality and less distortion; this new approach for DWI in the artifact- and distortion-susceptible head and neck region may improve image interpretation.

SSTO9-07 • Objective Evaluation of Salivary Gland Function Using Diffusion-weighted MR Imaging: Follow-up of Radiation-induced Xerostomia
Yun-Yan Zhang (Presenter) ; Dan Ou ; Yajia Gu MD ; Xia-Yun He ; Weijun Peng MD ; Jian Mao BA ; Lei Yue

PURPOSE
To investigate the value of diffusion-weighted (DW)-MRI as a noninvasive tool to assess salivary gland function for follow-up of patients with radiation-induced xerostomia.

METHOD AND MATERIALS
A HIPAA-compliant waiver of authorization was granted by the institutional review board. Twenty-three consecutive patients with nasopharyngeal carcinoma were examined with a 3T unit pre-radiotherapy (RT), and 1 week and 1 year post-RT. Clinical xerostomia was also assessed according to the Radiation Therapy Oncology Group/European Organization for Research and Treatment of Cancer morbidity scoring system. A DWI sequence was performed once on the salivary glands at rest, then continually repeated on the parotid glands immediately after oral ascorbic acid stimulation over a mean period of 21 minutes. Apparent diffusion coefficient (ADC) maps for salivary glands before and after stimulation were calculated. The maximum ADC of the parotid glands (pADCmax) and the time to pADCmax (pTmax) during stimulation were also obtained. Findings before and after RT were compared.

RESULTS
The ADC value is a sensitive indicator for salivary gland dysfunction, and it changes earlier than clinical xerostomia. DW-MRI is potentially useful for noninvasively evaluating the severity of radiation-induced xerostomia.

CONCLUSION
DW-MRI could noninvasively evaluate the functional changes of salivary glands before and after RT and the ADC value may be a early prediction for the severity of radiation-induced xerostomia.

SSTO9-08 • Evaluation of Enhanced Modernize Collaborative Management of Neck Lumps
Kit H Chow MBCh, FRCR (Presenter) ; Rathinavelu Balamurugan MBBS ; Unnikrishnan Anoop MBBS, FRCR ; Saravana Ammamuthu MBBS ; Jyothi Rao

PURPOSE
Chesterfield Royal Hospital (CRH) implemented an enhanced modernized collaborative one-stop system in 2008, which included the use of specialist neck ultrasound (US) and US-guided biopsy. We evaluated this innovative model of diagnostic management of neck lumps.

METHOD AND MATERIALS
1. Prospective Survey of Patient's Satisfaction (n=100) 2. Prospective 3 months study of impact of US and US guided biopsy on patients referred to CRH rapid access H&N lump clinic 3. Retrospective study of 60 patients with H&N Lymphoma in CRH presented over a 4 years period. This provides an evaluation of effectiveness of core biopsy provided by this radiology service.

RESULTS
The result shows this of model managing neck lumps is faster, cheaper, clinically less invasive and represents a successful formula for patients, radiologists, referring clinicians and commissioners of services.

CONCLUSION
Radiologists should develop an ambition to work beyond their traditional boundary and use their skills to extend their role by running neck lump clinics, which, offer H&N US and US guided biopsy.
**SST09-09 • Preliminary Prospective Study on Contrast-enhanced Ultrasound (CEUS) in the Quantitative Assessment of Uveal Melanoma (UM) Response to Gamma Knife Radiosurgery (GKR): Do Changes in Tumor Vascularization Precede Diameter Reduction?**

Caterina Colantoni (Presenter); Massimo Venturini MD; Giulio Modorati; Maura Di Nicola; Giulia Agostini; Alessandro Del Maschio MD

**PURPOSE**

Tumor thickness is worldwide accepted as the most useful parameter to evaluate UM response to GKR, which on average occurs at 12 months. According to the modified response evaluation criteria in solid tumors (mRECIST), in case of hypervascular lesions, changes in vascularization precede diameter reduction after treatment. Our aim was to prospectively analyze CEUS as a tool to quantitatively assess the response of UM to GKR, investigating if changes in quantitative parameters expressing tumor vascularization precede diameter reduction.

**METHOD AND MATERIALS**

Our study had institutional review board approval, and written consent was obtained. From 2012 to 2013, 10 patients (mean age, 66 years) affected by UM were enrolled and submitted to a complete ophthalmological evaluation before and after GKR. US and CEUS (ATL-Philips, IU-22, 5-9 MHz linear probe; Sonovue, Bracco) were performed by the same experienced radiologist at baseline (b-GKR), 3 (3-GKR), and 6 (6-GKR) months after GKR. UM transverse diameter (TD), thickness (Th), and different quantitative parameters (area under the curve in the wash-in phase; wash-in perfusion index (WIPi); peak enhancement (PE); mean transit time; wash-in rate (WIR); rise time (RT); time to peak) were calculated by the same operator using a dedicated and off-line imaging software (Sonotumor, Bracco). Comparisons between each parameter were made using the Wilcoxon analysis.

**RESULTS**

At US the mean tumor diameters (TDxTh, mm) were: b-GKR=10.7x8.3, 3-GKR=8.8x7.4, 6-GKR=9.4x6.6, with statistical significance at 6 months (P=.031).

At CEUS the quantitative parameters were: PE (arbitrary units, a.u.): b-GKR=2*10^7, 3-GKR=3*10^7, 6-GKR=8*10^5 (P=.018); WIPi: b-GKR=4*10^10, 3-GKR=5*10^9, 6-GKR=8*10^8 (P=.028); WIPi (cm3/sec): b-GKR=6*10^7, 3-GKR=1*10^8, 6-GKR=2*10^8 (P=.028). At 6-GKR tumor mean diameters decreased in 8/10 patients, while UM enhancement in 10/10.

**CONCLUSION**

CEUS is a feasible and reproducible method for the quantitative assessment of UM vascularization; it showed a reduction in UM enhancement at 6 months after GKR, earlier than tumor diameter changes, even though further studies with a larger population and a longer follow-up are needed.

**CLINICAL RELEVANCE/APPLICATION**

CEUS could be a useful additional tool to conventional US or the first choice technique to monitor UM response to GKR, in order to better predict the long-term survival of patients.
**METHOD AND MATERIALS**

Nineteen patients with pontine infarction underwent five DTI examinations during a period of 6 months (7, 14, 30, 90 and 180 days after onset). Clinical neurological assessments were performed. Nineteen healthy control subjects age-sex matched were recruited. The fractional anisotropy (FA) values were measured at medulla, cerebral peduncle, posterior limb of internal capsule and precentral gyrus cortex at five time points. The FA values in the infarcted sides were compared with the contralateral sides and control subjects, and their relationships with clinical scores were analyzed.

**RESULTS**

The FA values at the medulla, cerebral peduncle, posterior limb of internal capsule and precentral gyrus cortex ipsilateral to infarct significantly decreased progressively with time. This trend was the most significant during 7~14 days after stroke, then it became slow during 14~30 days and stable during 30~180 days after stroke. The relative FA (rFA) values at the medulla and above the pons correlated positively with the Fugl-Meyer (FM) scores in 90 and 180 days. The rFA values above the pons correlated negatively with the modified Rankin scale (mRS) scores in 90 days.

**CONCLUSION**

DTI can detect secondary WD of pyramidal tract much earlier after pontine infarction. The decreased FA value of pyramidal tract in early stage may predict motor outcome.

**CLINICAL RELEVANCE/APPLICATION**

It is suggested that the progressive anterograde and retrograde degeneration in the pyramidal tract following a pontine infarct may slow down the process of neurological recovery.

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**SST10-03 • Functional MRI (fMRI) in Patients with Spastic Hemiplegia after Stroke, Treated with Botulinum Toxin: The Role of 'Motor Imagery' in the Demonstration of Central Effects and Brain Plasticity**

**Alessandro Stecco** MD (Presenter) ; **Roberta Matheoud** ; **Stefano Carda** ; **Marco Perchinunno** ; **Emanuele Malatesta** ; **Alessandro Carriero** MD ; **Carlo Cisari**

**PURPOSE**

Botulinum toxin is considered a first-line treatment of focal spasticity in post-stroke patients. The aim of our study is to describe the central nervous system effects of botulinum toxin by a fMRI analysis, assuming that in case of absence of influence, the brain fMRI pattern should not be modified after therapy.

**METHOD AND MATERIALS**

We enrolled 17 patients (10 healthy volunteers as a control group and 7 patients with ischemic stroke with hemiplegia spastic upper limb). All patients underwent three fMRI with execution of a motor imagery task (finger tapping), one before starting treatment with botulinum toxin (T0), one after 4 weeks (T1) and the last after 8 weeks (T2), the task was repeated twice every same session. Between T0, T1 and T2 was not carried out any physical therapy, but only passive muscle stretching.

**RESULTS**

The analysis on the healthy volunteer sample confirmed that the motor imagery paradigm showed efficacy and reliability in activating the motor cortex. The group analysis on the patients sample showed activation but with a progressive focalization of cerebral activations, in particular a progressive reduction of the supplementary motor area (SMA and Brodmann 6 areas).

**CONCLUSION**

First of all our data confirmed the efficacy of motor imagery fMRI paradigms as a window to study the brain after stroke and its motor recovery.

We demonstrated a kind of modification induced on the brain cortical reorganization after stroke, by mean of a peripheral therapy as botulinum toxin injection.

**CLINICAL RELEVANCE/APPLICATION**

These data, with the pattern of progressive reduction and delimitation of cortical activations during therapy, are in line with the small world network theory of cortical reorganization after stroke.

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**SST10-04 • Dual-energy CT (DECT) and Non-enhanced CT (NECT) in the Characterization of Intracerebral Hemorrhage (ICH) or Iodinated Contrast Material in CT Follow-up after Endovascular Treatment for Acute Ischemic Stroke**

**Federico X Zocco Contreras** MD (Presenter) ; **Antonio Lopez Rueda** ; **Camilo Pineda Ibarra** MD ; **Sebastian Capurro** ; **Miren L Ondolo** MD ; **Sergio Amaro** MD ; **Luis San Roman** MD ; **Jordi Blasco** MD * ; **Juan Miguel Macho** ; **Laura Oleaga**

**PURPOSE**

To assess the accuracy of DECT and NECT in the characterization of hyperattenuation areas on CT follow-up after endovascular treatment for acute ischemic stroke, in order to determine the start of early heparin treatment.

**METHOD AND MATERIALS**

A retrospective study in 35 patients with hyperattenuation areas on CT follow-up after endovascular treatment for acute ischemic stroke were reviewed. DECT was used for imaging at 80 and 140kV, and a three-material decomposition algorithm was used to obtain virtual unenhanced images and iodine overlay images. Source images (mixed 140/80 kV) were considered as NECT. Two neuroradiologists with over 10 years of experience were designated for double-blind readings. DECT and NECT were used in order to classify the findings into 6 categories: Contrast Extravasation (CE), Hemorrhagic Infarction (HI) types 1 and 2, Parenchymal Hemorrhage (PH) types 1 and 2, and Remote Hematoma (RH). CT/MRI Follow-up images were used as the standard of reference. According to our clinical management protocol, early heparin treatment is indicated to CE, H! and H2. The six categories were dichotomized according to the indication of early heparin treatment: heparin treatment (CE, H! and H2) and no heparin treatment (PH1, PH2 and RH). The sensitivity, specificity and accuracy of DECT were 83% (10 of 12 areas), 100% (23 of 23 areas), and 95% (33 of 35 areas), respectively. According to the agreement, the kappa-weight index between readers was 0.53, and the kappa index in the dicotomization sample was 0.60.

**RESULTS**

The sensitivity, specificity, and accuracy of NECT were 58% (7 of 12 areas), 100% (23 of 23 areas), and 85% (30 of 35 areas), respectively. According to the agreement, the kappa-weight index between readers was 0.53, and the kappa index in the dicotomization sample was 0.60.

**CONCLUSION**

DECT is more accurate and more consistent than NECT in the characterization of hyperattenuation areas on CT follow-up after endovascular treatment for acute ischemic stroke.

**CLINICAL RELEVANCE/APPLICATION**

DECT is more accurate and more consistent than NECT, achieving an excellent agreement, in the purpose of decide early heparin treatment after endovascular approach for acute ischemic stroke.
Subarachnoid Hemorrhage

Aneurysmal subarachnoid hemorrhage (aSAH) patients are at increased risk of delayed cerebral ischemia (DCI) resulting in infarction. Since its pathophysiology is not well understood, early detection and treatment of DCI remains challenging. We hypothesize that blood brain barrier permeability (BBBP) increases prior to occurrence of infarction related to DCI. The purpose of this study is to assess whether alterations in BBBP, measured as permeability surface (PS) using CTP, precede development of infarction related to DCI in aSAH patients.

METHOD AND MATERIALS
This is a retrospective study of aSAH patients included in an IRB-approved clinical trial. Inclusion criteria are patients with CTP performed with extended scanning technique for analysis of PS. Exclusion criteria were patients who did not develop an infarction related to DCI, based on follow-up CT. All CTP data were post-processed using CT perfusion 4D software (GE Healthcare) for generation of PS, CBF, CBV and MTT maps. Using the integrated registration tool, the NCCT with the infarction region was superimposed on the CTP maps for co-registration of the exact infarct location. As an internal control for each patient, a “mirror ROI” was placed in the contralateral non-infarcted region. Paired t-tests were performed for each CTP parameter.

RESULTS
A total of 13 patients were included in the statistical analysis with 13 infarction (delayed cerebral ischemia, DCI) regions. PS elevation was observed in 11/13 (84.6%) regions in ROI that represented subsequently developed DCI compared to the contralateral brain parenchyma without DCI (mean DCI 0.449; mean control 0.198; p = 0.0002). By contrast, the conventional clinically used CTP parameters CBF, CBV and MTT did not show any significant difference to the contralateral ROI on pre-DCI CTP (CBF mean DCI 15.76; mean control 16.34; p = 0.9296; CBV mean DCI 1.89; mean control 1.54; p = 0.0528; MTT mean DCI 9.76; mean control 7.89; p = 0.0917).

CONCLUSION
These preliminary data show that a relative increase in blood brain barrier permeability compared to the contralateral brain parenchyma appears to precede the development of delayed cerebral ischemia in patients with aneurysmal subarachnoid hemorrhage.

CLINICAL RELEVANCE/APPLICATION
Permeability changes prior to the development of irreversible cerebral infarction may lay the foundation for the development of new treatment strategies targeted towards stroke prevention.

**SST10-06 • 3T High Resolution Vessel Wall Imaging in Acute Perforator Infarction within the Territory of Middle Cerebral Artery**

Young Hoon Lee MD (Presenter) ; Doran Hong MD ; Hyung Suk Seo ; Bo-Kyung Je MD, PhD ; Sang-II Suh ; Jin Man Jung ; Do Young Kwon ; Moon Ho Park

PURPOSE
Recently, 3T high-resolution vessel wall imaging (HRVW) has been introduced to compensate limitation of 3-dimensional time-of-flight magnetic resonance angiography (TOF MRA) which only shows the vascular lumen of intracranial artery diseases by demonstrating wall appearances. We aimed to evaluate the vessel wall characteristics of the ipsilateral middle cerebral arteries (MCA) in acute striatocapsular infarction presumed to be perforator occlusion using HRVW in addition to TOF MRA.

METHOD AND MATERIALS
Forty-seven consecutive patients (M:F=31:16, mean age=59.6±12.9 years) with acute striatocapsular infarctions presumed by perforator occlusion, displayed on the DWI, were retrospectively enrolled. According to the lesion diameter, we classified them either 1) perforator arterial infarction (PAI)50%, n=7). Additionally stroke risk factors including atherosclerosis and cardioembolic indicators were assessed.

RESULTS
Of the included 47 patients with acute PAI within MCA territory, 25 showed wall enhancement, 10 showed wall thickening, and 9 showed eccentric narrowing. HRVW demonstrated additional vessel wall abnormalities in eighteen (45.0%) from 40 patients classified as normal M1 on TOF MRA, moreover, 12 (41.4%) from twenty-nine patients with PAI< 2cm whose ipsilateral MCA was normal on TOF-MRA. Abnormal vessel wall findings to suggest intracranial atherosclerosis were more commonly depicted by HRVW than TOF MRA in patients (p CONCLUSION
Based on our preliminary results, HRVW imaging could provide more additional findings to suggest relationship of intracranial atherosclerosis to acute PAI.

CLINICAL RELEVANCE/APPLICATION
HRVW imaging could provide more additional findings beyond the scope of TOF-MRA.

**SST10-07 • Temporal Patterns of Intracranial Vessel Wall Imaging Using High Resolution MRI: A Follow-Up Study**

Emmanuel C Obuse MD (Presenter) ; Ferdinand K Hui MD * ; Rula Hajj-Ali ; Stephen E Jones MD, PhD

PURPOSE
High-Resolution Magnetic Resonance Imaging (HRMRI) is an emerging tool for evaluating intracranial artery disease. Vessel wall characteristics of intracranial vasculopathy have been described on HRMRI. We investigated HRMRI arterial wall characteristics of non-atherosclerotic intracranial diseases to determine wall pattern changes over a follow up period.

METHOD AND MATERIALS
We retrospectively reviewed high resolution 3-tesla MRI vessel wall studies performed on 29 patients with confirmed diagnosis of large to medium cerebral vessel disease over a follow up period. The high resolution vessel wall imaging protocol included black-blood contrast-enhanced T1-weighted sequence with fat suppression and time-of-flight (TOF) MRA of the circle of Willis. Clinical and demographic data and vessel wall characteristics including enhancement, wall thickening, and lumen narrowing were collected.

RESULTS
Clinical and radiographic diagnosis included CNS vasculitis (13), RCVS (13), moyamoya (2), intracranial dissection (1). In the CNS vasculitis group, 9 showed smooth, concentric wall enhancement and thickening, 3 with smooth, eccentric wall enhancement and thickening, and 1 without wall enhancement and thickening. Six of 13 had follow-up imaging, 4 showed stable smooth, concentric enhancement and thickening consistent with initial imaging findings and 2 with resolution of initial imaging findings. For RCVS, 10 showed diffuse, uniform wall thickening without and with mild enhancement. Nine of 10 had follow-up imaging, 8 with complete resolution of initial findings. For moyamoya, 2 of 2 patients at initial and follow-up imaging showed severe, irregular, vessel narrowing and occlusion without wall thickening, while 1 of 2 showed patchy wall enhancement. Intracranial dissection showed irregular, eccentric enhancement and wall thickening with a dual lumen separated by an enhancing intimal flap and attenuation of initial findings at follow-up imaging.

CONCLUSION
Post-gadolinium high-resolution 3-tesla MRI appears to be a feasible tool in differentiating vessel wall patterns of intracranial arteriopathy over a follow up period.

CLINICAL RELEVANCE/APPLICATION
Study of the evolution of HRMRI wall patterns may improve radiographic diagnoses and may serve as a surveillance modality to identify changes in wall morphology with intracranial disease progression.

**SST10-08 • Wall Enhancement of the Cerebral Arteries after Gadolinium Injection: Evaluation by MRI Using MSDE-3D-TSE Sequence**
RESULTS
Strong wall enhancement, equally to choroid plexus, was observed in 0.88% of ICAs, 3.2% of M1s, 23.1% of VAs, and 0.82% of BAs. Faint enhancement was observed in 5.6% of ICAs, 1.3% of M1s, 30.8% of VAs, and 3.3% of BAs. Strongly enhancing M1 wall was observed only at the affected side of distal cortical embolism or perforating arterial infarcts in our series. Wall enhancement of VA was, however, observed frequently without symptoms suggesting vascular pathology.

CONCLUSION
We could evaluate the enhancement of cerebral arterial wall using MSDE-3D-TSE sequence. In MCA, strong enhancement may mean some pathological change. In VA, strong enhancement does not always mean the vascular pathology, although it is often observed.

CLINICAL RELEVANCE/APPLICATION
Wall enhancement of normal cerebral arteries revealed by post-contrast MSDE-3D-TSE sequence should be an important data for evaluating the pathological wall enhancement by post-contrast MRI in future.
Of the 2100 angles measured 37 were not visualized due to unclear appearance of the SCC in the region of the angle. In addition the length of 163 SCCs was not assessed due to fragmentation or unclear visualization. The angles between the left SCCs showed a mean value of X: 108.31 (SD:10.15, Range:77-145), Y: 72.11 (SD:12.28, Range:41-116) and Z: 84.85 (SD:12.45, Range:48-123). The angles between the right SCCs showed a mean of X: 110.34 (SD:10.26, Range: 80-150), Y: 71.13 (SD:13.15, Range:42-113.4), and Z: 85.33 (SD:13.07, Range:48-1138). The mean length of the Superior, Posterior, Lateral, Crus commune SCC of the left Inner Ear was S: 19.66mm (SD:1.64, Range:14-25mm), P: 21.54mm (SD:1.99, Range:7.3-27mm), L: 13.31mm (SD:1.48, Range:8-18mm) CC: 3.78mm (SD:0.44, Range:3-5mm). The mean lengths on the right side were S: 19.47mm (SD:1.67, Range:15-26mm), P: 22.30mm (SD:2.06, Range:16-29mm), L: 13.99mm (SD:1.46, Range:7-18mm), CC: 3.78mm (SD:0.44, Range:2.7-5mm).

CONCLUSION
This descriptive study showed that angles between the Semicircular canal planes have a wide range of degrees.

CLINICAL RELEVANCE/APPLICATION
Contrary to previous reports in the literature (that the angle between the SCCs is around 90°) the current study results shows a wide range of variations between the angles.

**SST11-02 ● Clinical Evaluation of Synthetic Brain MRI at 3.0 Tesla**

Michael Nelles MD (Presenter) ; Juergen Gieseke DSc ; Darilusch R Hadizadeh Kharrazi MD ; Horst Urbach MD ; Hans H Schild MD

**PURPOSE**
Prospective intra-individual comparison of synthetic quantitative versus regular MR imaging (MRI) of the brain at 3.0T.

**METHOD AND MATERIALS**
A 3.0T MR system (Achieva 3.0T TX, Philips Healthcare, The Netherlands) and a stand-alone postprocessing software (SyntheticMR, Sweden) were used to create T1, T2 and FLAIR contrast-weighted synthetic MR images of the brain. The quantitative mapping was based on the TPMmaster method ("Quantification of Relaxation Times and Proton Density by Multiecho acquisition of a saturation-recovery using Turbo Spin-Echo Readout"), using a multiselect, multiecho, and multidelay acquisition with a scan time of 4:50 minutes. 25 consecutive patients underwent MRI of the brain including synthetic quantitative and regular T1, T2 and FLAIR sequences. Contrast ratios (CRs) were calculated between gray matter (GM) and white matter (WM) for synthetic and regular sequences. Diagnostic quality of synthetic MR examinations was scored as follows: Score of 4, excellent (sharp depiction of the GM/WM junction and subcortical GM without interfering artifacts). Score of 3, adequate for diagnosis (minor artifacts or noise present not interfering with image interpretation). Score of 2, questionable for diagnosis (impaired by artifacts, noise and / or changes in contrast). Score of 1, non-diagnostic.

**RESULTS**

**CONCLUSION**
Synthetic quantitative MRI is capable of generating accurate conventional contrast images within a clinically acceptable time. The diagnostic image quality is readily comparable to that of regular MRI sequences in the majority of cases.

**CLINICAL RELEVANCE/APPLICATION**
Synthetic MRI holds the promise of replacing the acquisition of different regular MR series in selected patients, suitable for disease monitoring in e.g. MS or glioma patients.

**SST11-03 ● Multivariate Longitudinal Shape Statistics of Brain Lateral Ventricles during the First Eighteen Months of Human Life**

Lucile Bompard (Presenter) ; Shun Xu ; Martin Styner ; Wei Gao ; Valerie L Jewells DO ; Beatriz Paniagua ; Weili Lin PhD

**PURPOSE**
The human brain undergoes dramatic structural changes in the first few years of life. Of particular interest are the lateral ventricles (LVs) of the brain because of their association with many psychiatric and developmental disorders. The primary aim of this research is to discern the temporospatial growth characteristics of the LVs to develop a normative data-base.

**METHOD AND MATERIALS**
24 healthy subjects were imaged using a 3T MR scanner as frequently as 3 months from 2 weeks of age to 12 months of age, and again at 18 months. A minimum of 4 scans was performed per subject. T2- weighted images were employed to segment the LVs, resulting in 127 left and 119 right LVs. Due to significant variation, the tail of the ventricular horn was manually removed. Subsequently, a densely sampled surface representation was computed for each LV using spherical harmonics based point distribution models, allowing group analysis of the spatiotemporal growth of the LVs during the first 18 months of life. Volumetric measures, cross-sectional areas, and growth rates were calculated.

**RESULTS**
Volumetric measurements reveal a continuous growth of the LVs in the first 12 months, followed by 11±27% reduction from 12 to 18 months. In addition, the left LV is consistently larger (10±23% at 2wks and 9±20% at 18month) than that of the right LV. By grossly separating the LVs into the anterior and posterior horns and the mid-body, additional insights are revealed. Measurements of regional cross-sectional areas of LVs, the mid-body mainly elongates and the horns thicken with time. Specifically, the ventricle horns exhibit the fastest growth rates between 0-3 months, followed by a progressively reduced growth rate between 3-12 months. In addition, the posterior horn consistently outgrows the anterior horn. In contrast, the temporal changes of thickness of the mid-body are mainly from dorsal to ventral, with the fastest growth rate between 0-3 months.

**CONCLUSION**
The LV growth exhibits both temporal and regional specific patterns during the first 18 months of life. Our results offer new insights into the unique growth patterns of human ventricle.

**CLINICAL RELEVANCE/APPLICATION**
This detailed normative spatiotemporal growth characteristics of LVs during the first 18 months of life provide important references for the delineation of early abnormal LV growth.

**SST11-04 ● Whole Brain Volumetric and Morphometric Analysis of Patients with Maple Syrup Urine Disease**

Emilie R Muelly PhD (Presenter) ; Don Bigler ; Gregory J Moore MD, PhD ; Kevin Strauss ; D. Holmes Morton ; Julie A Mack MD

**PURPOSE**
Maple syrup urine disease (MSUD) is an inherited metabolic disorder that impairs branched chain amino acid metabolism. Rapid elevations of circulating branched chain amino- and ketoacids cause life-threatening encephalopathy. Despite dietary treatment, achievement of metabolic control varies and patients remain at risk for acute decompensation. Liver transplantation has been shown to eliminate metabolic volatility. Reversible decreases in N-acetylaspartate (NAA) have been demonstrating using magnetic resonance spectroscopy during both acute and chronic states of disease. These findings may reflect structural or functional differences. Volumetric analysis may add value to interpretation of neurochemical findings.

**METHOD AND MATERIALS**
Quantitative proton magnetic spectra were obtained for 37 patients (26 on dietary therapy, 11 status-post liver transplantation) and 26 sibling controls using a Siemens Magnetom Trio 3 Tesla scanner. Whole brain and segmented volume calculations of the images were
RESULTS
Total brain parenchyma as a percentage of total brain volume was greater in patients on dietary therapy compared to controls (p = 0.02). Gray and white matter percentages of total brain volume individually did not differ between groups. Total whole brain volume and morphometry did not differ between groups.

CONCLUSION
Our results support the hypothesis that low NAA levels in MSUD patients reflect impaired neuronal energy production rather than neuronal loss. However, our methods prevent us from detecting decreases in neuronal density that do not change tissue size and also do not specifically evaluate brain regions in which low NAA levels were detected. Furthermore, increased total brain parenchyma may reflect subtle chronic edema. Further study, such as analysis of T2* and regional morphometric data, is needed to explore these possibilities.

CLINICAL RELEVANCE/APPLICATION
Patients with maple syrup urine disease have increased total brain parenchymal volume.

SST11-05 • DTI Correlates of Cognition in Conventional MRI Normal Appearing Brain in Patients with Vitamin B12 Deficiency

Rakesh K Gupta MD, MBBS (Presenter); Pradeep K Gupta MSc; Ravindra K Garg MD, MBBS; Bhaswati Roy; Abhinav Yadav BS; Yogita Rai PhD; Ram K Rathore DSc; Chandra M Pandey PhD; Ponnada A Narayana PhD

PURPOSE
Deficiency of vitamin B12 may result in neuronal degeneration and brain damage which influences the cognition. We hypothesized that patients with clinical symptoms of subacute combined degeneration (SACD) and biochemical evidence of Vitamin B12 deficiency should have a cognition decline and microstructural brain changes on advanced MRI even when conventional MRI appears normal.

METHOD AND MATERIALS
Patients with SACD of the cord were recruited for the study. Patients underwent nerve conduction velocity and biochemical analysis for serum Vitamin B12, and homocysteine. Hematology including the type of anemia was also performed. All patients with Vitamin B12 deficiency and clinical features of SACD were subjected to the complete imaging cervical spine and brain imaging. Patients with normal brain MRI with or without imaging changes in the cervical spine were included for cognition tests. Based on these criteria, 51 patients and 46 age and sex matched controls were enrolled in this study. 3D-T1 weighted and DTI was performed in all these subjects. PSL based VBM and TBSS analysis were performed for volumetric and white matter fiber tracts changes quantification.

RESULTS
No significant changes in grey and white matter volumes were observed in patient compared to control using VBM. Significant reduction of FA and increase in MD and RD values were observed in various brain regions in patients compared to controls. Most of the Neuropsychological score were significantly altered in patients compared to controls and few of these showed significant correlation with FA and RD in some of the brain regions.

CONCLUSION
Decrease in FA and increase in MD and RD results of WM microstructure suggests its alteration probably due to demyelination of the fibers secondary to Vitamin B12 deficiency. These patients, though present clinically with SACD, have generalized involvement of the white matter of the CNS and have associated decline in cognition. Correlation of some of the NPT scores with region specific white matter changes confirms that the abnormalities in NPT relate to the changes in the white matter microstructures.

CLINICAL RELEVANCE/APPLICATION
Vitamin B12 deficiency has generalized effect on the CNS white matter even when it manifests as SACD as evidenced by cognition and brain microstructural alteration.

SST11-06 • Reliability of 3D Pseudo-continuous Arterial Spin-labeling MR Imaging for Measuring Visual Cortex Perfusion on Two 3T Scanners

Diandian Huang (Presenter); Xin Lou MD, PhD; Lin Ma MD; Bing Wu; Kai-Ning Shi

PURPOSE
The visual cortex cerebral blood flow (CBF) values are closely associated with visual perception. Perfusion MRI can be used to identify patients with ischemic changes of visual cortex who may benefit from reperfusion therapies. The risk of nephrogenic systemic fibrosis, however, limits the use of contrast agents. Our objective was to evaluate the reliability and reproducibility of three dimensional arterial spin labeling (3D pCASL), an alternative noninvasive perfusion technique, to detect CBF of visual cortex in vivo.

METHOD AND MATERIALS
Twelve healthy subjects were scanned three times on two 3.0T MR scanners with 3D pCASL technique. The 1st test and 3rd test were done on scanner-1, while the 2nd test was on scanner-2. Intervals between tests were among 10-15 days. The 3D pCASL data with two post labeling delay time (PLD) of 1.5 and 2.5 seconds was acquired during every scanning. Volumetric T1-weighted images were also acquired for image registration. The CBF values of visual cortex (included brodmann 17, brodmann 18, brodmann 19) were extracted for comparison. The intra- and inter-scanner reliability and reproducibility were evaluated with the intraclass correlation coefficient (ICC) and Bland-Altman plot.

RESULTS
The relative CBF values of visual cortex were 16-84 ml/min/100g (PLD=1.5s) and 27-75 ml/min/100g (PLD=2.5s). Compared with 1st test and 2nd test, the ICC was 0.685 at PLD=1.5s and 0.754 at PLD=2.5s. Compared with 2nd test and 3rd test, the ICC was 0.719 at PLD=1.5s and 0.903 at PLD=2.5s. Compared with 1st test and 3rd test, the ICC was 0.821 at PLD=1.5s and 0.831 at PLD=2.5s. Higher reliability (ICC=0.829) for PLD 2.5s compared to PLD 1.5s (ICC=0.743) were demonstrated in inter-scanners. At intra- and inter-scanner, the Bland-Altman showed the reproducibility at PLD=2.5s is better than that at PLD=1.5s.

CONCLUSION
Although inter-scanner reliability is slightly lower than intra-scanner, there is a very high similarity of the outcomes at different time from two scanners. The 3D pCASL technique is available for measuring the CBF at visual cortex with high reliability and reproducibility. It should be used for MR research on blood flow of visual cortex at multiple centers.

CLINICAL RELEVANCE/APPLICATION
The 3D pCASL can measure CBF values of visual cortex with high reliability and reproducibility and offers a noninvasive way to access the etiology and diagnosis of posterior visual pathway disease.

SST11-07 • Adaptation and Slow Recovery of Metabolic Activity in Human Visual Cortex Coupled with a Modest Change in Cerebral Blood Flow

Farshad Moradi MD (Presenter); Richard B Buxton PhD

PURPOSE
We recently demonstrated sub-additive flow and metabolic response non-linearity in human visual cortex consistent with adaptation. A disproportionately larger adaptation of metabolic response compared to blood flow was observed. These results indicate an aspect of metabolic activity corresponding to neural adaptation (or fatigue) that has a different neurovascular coupling from stimulus driven activation. We examine if the adaptable aspect of metabolic activity is coupled with high flow and whether or not it recovers during inter-stimulus intervals.
METHOD AND MATERIALS
Six observers participated in the experiment. CBF and BOLD responses to continuous (46 s) and intermittent (7.6 s on and off x 3) peripheral gratings were measured using a dual gradient-echo optimized multipulse pseudo-continuous arterial spin labeling sequence. A 2x2 design (continuous vs. intermittent, two contrast levels) was used. The difference between initial and final 18 s of activity during each epoch (?CBF vs. ?BOLD) were determined. ?CMRO2 was estimated using a modified calibrated BOLD method.

RESULTS
If the adaptable aspect of metabolic activity is coupled with high flow then the neurovascular-coupling ratio is expected to increase over time with prolonged stimulation in the continuous condition. If the adaptable aspect of metabolic activity recovers during interstimulus intervals then the neurovascular-coupling ratio should remain the same over time in the intermittent condition. A positive change in neurovascular coupling would result ?BOLD that is disproportionately greater than ?CBF. Contrary to both predictions, ?BOLD was negative compared to ?CBF in all conditions, indicating a significantly lower neurovascular coupling ratio at the end of each epoch compared to the beginning.

CONCLUSION
The adaptable aspect of metabolic activity is coupled with a lower flow modulation compared to the input-driven modulation and does not recover during short inter-stimulus intervals. Our findings are consistent with the hypothesis that cerebral blood flow in human visual cortex is driven by both metabolic activity and visual input via independent mechanisms.

CLINICAL RELEVANCE/APPLICATION
Numerous pathologic conditions affect the regulation of cerebral blood flow. Our results provide insight into physiological modulations of neurovascular coupling and role of adaptation nonlinearity.

SST11-08 • Evaluation of WBAA with Registration-based Cube Atrophy Quantification
Martin Lillholm MSc, PhD (Presenter) ; Akhjay Pai ; Lauste Sorensen ; Mads Nielsen PhD * ; Jon Sporring * ; Sune Darkner ; Erik B Dam PhD *

PURPOSE
Atrophy for the whole brain and sub-structures is becoming common as study outcome in clinical trials assessing the efficacy of potential treatments of diseases involving dementia. In this study, we evaluated the sensitivity to change related to progression of Alzheimer's disease of a novel software framework, WBAA.

METHOD AND MATERIALS
The recently defined Alzheimer's disease neuroimaging initiative (ADNI) standardized collection ('ADNI1:Annual 2 Yr 1.5T' at adni.loni.uci.edu) was included in this study. Parametric maps such as the EES fraction (ve) derived from dynamic contrast enhanced (DCE) MRI also characterize EES. The purpose of this study was to determine if there is a correlation between ADC and DCE metrics such as ve, blood-brain barrier transfer constant (Ktrans), Kep, and fractional plasma volume (vp) for gliomas, cerebral lymphomas and meningiomas. Figure 1 demonstrates ADC and ve parametric maps for a glioma.

RESULTS
As example, quantifications of the hippocampus atrophies estimated using WBAA were -1.3% and -0.6% for the Alzheimer and healthy subjects whereas the ventricle estimates were +9.3% and +4.1%, respectively. Corresponding Cohen's D for WBAA on these two conditions were 1.1 and 1.0. For whole-brain, hippocampus, ventricles, and medial temporal lobe, the WBAA Cohen's D were 0.7, 1.1, 1.0, and 1.3. The corresponding sample sizes were 173, 124, 113, and 87. For WBAA with JI, Cohen's D were 0.5, 1.1, 1.0 and 1.2; with sample sizes 230, 139, 112, and 101. For longitudinal FreeSurfer, Cohen's D were 0.7, 1.0, 1.0, and 1.3; with sample sizes 183, 152, 118, and 102.

CONCLUSION
The WBAA using CP for brain atrophy quantification provided sensitivity equal or superior to leading, competing methods. Specifically, the WBAA sample sizes were generally lower.

CLINICAL RELEVANCE/APPLICATION
Unlike longitudinal FreeSurfer, WBAA allows quantification of final atrophy estimates directly after each visit. Adding the matching/improved sensitivity, WBAA seems appropriate for clinical trials.

SST11-09 • Tumor Cellularity and the Extravascular-Extracellular Space: Using Quantitative Imaging to Evaluate Correlation Between ADC and DCE MRI in Human Gliomas, Meningiomas and Cerebral Lymphomas
Hannu T Huhtanpaa MD (Presenter); Darryl Hwang PhD; Naira Muradyan PhD *; Steven Cen PhD; Michael Booker; Alexander Lerner MD; Deborah Commins; Anandh G Rajamohan MD; Paul E Kim MD; Orest B Boyko MD, PhD *; John L Go MD; Eu-Meng Law MBBS *; Mark S Shiroishi MD

PURPOSE
The apparent diffusion coefficient (ADC) determined from diffusion tensor (DTI) MR imaging can give an impression of the extravascular-extracellular space (EES) and has been shown to be inversely correlated with tumor cell density. Parametric maps such as the EES fraction (ve) derived from dynamic contrast enhanced (DCE) MRI also characterize EES. The purpose of this study was to determine if there is a correlation between ADC and DCE metrics such as ve, blood-brain barrier transfer constant (Ktrans), Kep (Ktrans/ve), and fractional plasma volume (vp) for gliomas, cerebral lymphomas and meningiomas. Figure 1 demonstrates ADC and ve parametric maps for a glioma.

METHOD AND MATERIALS
18 gliomas (grade I-IV), 2 lymphomas and 5 meningiomas were retrospectively evaluated. DTI and DCE images were acquired during the same MRI exam. DCE-MRI images were postprocessed in CADvue. Metrics extracted from DCE MRI were: ve, vp, Ktrans, and Kep. ADC maps were generated by the MR scanner. DCE and ADC images were co-registered and 3-dimensional regions of interest were drawn on parametric maps. Voxel-wise correlation between ADC and DCE parameters were examined using scatter plots and tested by random effects model. Mean and median values were extracted using Spearman correlation.

RESULTS
Overall, mean ADC correlated negatively with mean ve (r = -0.48, p = 0.03) as well as with median ve (r = -0.52, p = 0.01). The result of voxel level analysis using random effects model did not show significant correlation between ADC and ve (r = 0.09, p = 0.09). No statistically significant correlation was observed between ADC and the other parameters, vp, Ktrans, and Kep.

CONCLUSION
Our results showed a negative correlation between ADC and both mean as well as median ve, and no significant correlation between ADC and the other DCE parameters. This is in agreement with a prior study performed in breast cancer, while another study in breast cancer as well as one in glioblastoma found no correlation. These results likely reflect limitations in our understanding of these metrics though limitations in imaging technique may be confounders.

CLINICAL RELEVANCE/APPLICATION
Determination of the relationship between ADC and DCE MRI metrics such as extravascular-extracellular volume fraction (ve) may provide new imaging biomarkers of brain tumor cellularity.
SST12-03 • FDG-PET/CT: Do Contrast Enhanced CT for Attenuation Correction and Ultra-HD-PET Influence the SUV-values in Large Vessel Walls?

Ingo Janssen (Presenter); Inga Buchmann; Florian M Vogt MD

PURPOSE
To optimize large-vessel-imaging in FDG-PET/CT we evaluated, if contrast enhanced CT (ceCT) for attenuation correction (AC) in FDG-PET-CT and ultra-HD-(high-definition-PET+ time of flight) (uHD) compared with iterative reconstruction (IR) may lead to differences in large-vessel-SUV.

METHOD AND MATERIALS
50 patients (pat), who underwent FDG-PET/CT in malignant-disease-staging, were included in this retrospective study. All pat were unsuscious for large-vessel-vasculitis. 25 pat underwent FDG-PET-CT with ceCT for AC (group A; 100 ml Xenetix® 300 i.v. delay 50 sec) and 25 pat FDG-PET-CT with non-contrast (nc) CT for AC (group B). 242±15 MBq FDG were applied i.v. PET-CT-scans were evaluated with uHD and IR data were acquired with VOI-analysis in all patients. Further a SUVmax/mediastinal-bloodpool (MB)-ratio and SUVmax/liver-bloodpool(LB)-ratio were calculated. MB was determined by drawing a VOI directly inside the ascending aorta, LB by drawing a VOI in visually physiological liver-tissue. Mean SUVmax, mean MB-ratio and mean LB-ratio of both groups were compared in uHD and IR. Significance level was defined as p = 0.05.

RESULTS
Mean SUVmax-values in group A were significantly higher than in group B (uHD: p

CONCLUSION
CeCT for AC in FDG-PET/CT shows significant higher SUVmax-values in aortic wall and uHD demonstrates significant higher aortic-wall to background-contrasts. These results may significant influence the interpretation of large-vessel-vasculitis imaging in FDG-PET/CT.

CLINICAL RELEVANCE/APPLICATION
Further studies have to be performed, to evaluate the influence of ceCT for AC and uHD-PET on vasculitis-imaging in FDG-PET/CT.

SST12-04 • 11C-Choline PET/CT Evaluation of Atherosclerotic Disease

Ann Packard MD (Presenter); Geoffrey B Johnson MD, PhD; Christopher H Hunt MD; Mark A Nathan MD; Patrick J Peller MD *

PURPOSE
Choline is known to be a prominent constituent of atherosclerotic plaque. This study measures the 11C-Choline accumulation in the abdominal aorta compared to vessel wall calcification and conventional risk factors of atherosclerotic disease.

METHOD AND MATERIALS
The11C-choline PET/CT database was searched retrospectively from 1999-2012 for patients with data related to atherosclerotic risk factors, including medications, laboratory data, and medical history with an accrual target of 100 patients. PET/CT scans were evaluated blinded to clinical information by a Nuclear Medicine physician with 25 years of PET/CT experience, for radiotracer activity and calcium quantification. The aorta was analyzed from the renal arteries to the bifurcation. Max SUV was obtained from an ROI placed around the aorta on axial imaging at the level of peak activity. Max SUV ratios of aorta to blood pool were calculated. Clinical atherosclerotic risk factors were correlated to 11C-choline max SUV/BP ratio. Basic statistical analysis included Students-T test and ANOVA.

RESULTS
All 11C-Choline PET/CTs were performed for prostate cancer recurrence. Of a cohort of 900 11C-choline PET/CTs, 104 patients with adequate clinical data were targeted, and of these, 94 had complete imaging, and had a mean age of 69.6 (SD 8.33 yrs, range 45-86) at the time of scan; 50 had prior or active smoking history, 38 were on statin therapy for hyperlipidemia, and 14 had prior cardiovascular events including MI or stroke. Patients with a prior cardiovascular event had a higher max SUV ratio (2.99±0.599, p

CONCLUSION
Patients with prior cardiovascular events and those on statin therapy had higher choline uptake within the abdominal aorta. No relationship was found between choline and calcium, or a difference in calcium score between groups stratified for cardiovascular risks.

CLINICAL RELEVANCE/APPLICATION
11C-Choline PET/CT may be useful in evaluating and identifying active atherosclerotic vascular disease in patients receiving PET/CTs for other reasons.

SST12-05 • Quantification of Myocardial Blood Flow and Coronary Flow Reserve with an Innovative Tc-99m Sestamibi Dynamic SPECT/CT Method: Validation with Coronary Angiography in a Pilot Study

Chung-Chieh Huang (Presenter); Fu-Chung Chen; Po-Nien Hou; Guang-Uei Hung; Ran Klein *; Robert Dekemp PhD *; Wan-Chen Chen; Bailing Hsu

PURPOSE
Myocardial blood flow (MBF)/coronary flow reserve (CFR) quantification with positron emission tomography has demonstrated the incremental value in diagnosis and risk stratification of coronary artery disease (CAD) over perfusion alone images, but its widespread utilization is limited in areas without appropriate flow tracers. This study investigates the diagnostic value of a dynamic SPECT/CT (dSPECT) method as a potential utility for flow quantification.

METHOD AND MATERIALS
Fifteen patients who underwent clinically indicated dipyridamole-stress/rest Tc99m-sestamibi myocardial perfusion SPECT were enrolled to evaluate both perfusion and dSPECT MBF/CFR. Coronary angiography for all patients confirmed 9 CAD with =50% stenosis (5 one-vessel, 1 two-v, 3 three-v). In addition, 5 low-likelihood (LL) patients with normal perfusion were included to obtain the range of LL MBF/CFR. dSPECT images were quantitatively reconstructed and analyzed for MBF/CFR with 1-tissue/2-kinetic compartmental flow model, tracer extraction correction and rest heart rate-pressure product correction using FlowQuant program. Traditional perfusion images were interpreted visually with a 17-segment model to create summed stress scores (SSS). Receiver-operating characteristic (ROC) analysis was used to evaluate the diagnostic performance of stress MBF (SMBF), CFR and SSS in detecting CAD.

RESULTS
Global SMBF and CFR of CAD group (1.31±1.03 ml/min/g and 1.61±0.94) were significantly lower than those of non-CAD (2.42±0.51
SST12-08 • Optimizing 18F-FDG-PET Imaging of Vessel Wall Inflammation - The Impact of 18F-FDG Circulation Time, Dose, Uptake Parameters, and Fasting Blood Glucose Levels

Jan Bucierius (Presenter); Venkatesh Mani PhD; Colin Moncrieff; Josef Machac MD *; Valentin Fuster MD; Michael E Farkouh; Ahmed Tawakol MD *; James Rudd MD, PhD; Zahi A Fayad PhD *

PURPOSE
18F-Fluorodeoxyglucose (FDG) positron emission tomography (PET) is increasingly used for imaging of vessel wall inflammation. However, limited data is available regarding the impact of methodological variables, i.e. patient’s pre-scan fasting glucose, the FDG circulation time, the injected FDG dose, and of different FDG uptake parameters, in vascular FDG-PET imaging.

METHOD AND MATERIALS
195 patients underwent vascular PET/CT of the aorta and the carotids. Arterial standard uptake values (meanSUVmax) as well as target-to-background-ratios (meanTBRmax) and the FDG blood pool activity in the superior vein cava (SVC) and the jugular veins (JV) were quantified. Vascular FDG uptake classified according to tertiles of patient’s pre-scan fasting glucose levels, the FDG circulation time, and the injected FDG dose was compared using ANOVA. Multivariate regression analyses were performed to identify the potential impact of all variables described on the arterial and blood pool FDG uptake.

RESULTS
Tertile analyses revealed FDG circulation times of about 2.5 h and pre-scan glucose levels of less than 7.0 mmol/l showing favorable relations between the arterial and blood pool FDG uptake. FDG circulation times showed negative associations with the aortic

SST12-07 • Inter-platform Reproducibility for Quantitative Assessment of Arterial [18F] Fluorodesoxyglucose (FDG) Uptake in Large Peripheral Vessels: A PET/CT Study

Birgit Langhans (Presenter); Axel Rominger; Markus Hacker; Peter Bartenstein; Maximilian F Reiser MD; Tobias Saam MD *

PURPOSE
FDG-PET/CT is able to quantify arterial wall inflammation and is increasingly used in clinical trials to assess effects of new anti-atherosclerotic therapies. The objective of this study was to analyse inter-platform reproducibility of FDG uptake.

METHOD AND MATERIALS
20 cancer patients were examined by whole-body FDG-PET/CT on two different platforms (platform 1: GE Discovery 690; platform 2: Siemens Biograph 64) with a median time between the first and second scan of 3.6 [2.8, 5.0] months. The maximum standardized uptake value (SUVmax), the mean venous blood-pool (SUVbp) and the target-to-background ratio (TBR=SUVmax/SUVbp) were determined in the aortic arch, ascending, descending, and abdominal aorta and both iliac and carotid arteries.

RESULTS
Mean SUVmax, averaged across all arterial territories were significantly higher on platform 1 compared to platform 2, with a mean difference of 0.25±0.31 (SUVmax1: 2.86 vs. SUVmax2: 2.61; p=0.002). However, mean TBR values did not differ significantly between the platforms (TBR1 2.25 vs. TBR2 2.10; p=0.2). When the vascular territories were assessed separately, SUVmax was significantly higher on platform 1 in the aortic arch, ascending, descending and abdominal aorta. No significant differences in SUV values were found in iliac and carotid arteries. TBR values for the different vascular territories did not differ significantly, except for the aortic arch.

CONCLUSION
SUVmax measurements differ significantly across different platforms, but not the TBR values. For serial assessment of vessel wall inflammation we therefore recommend to use the identical platform or alternatively to use TBR measurements instead of SUV measurements.

SST12-06 • A Comparative Analysis of Myocardial Perfusion on Gated SPECT vs Coronary Atherosclerosis and Coronary Calcium Score on 64-slice CT

Parul Mohan MBBS, MD (Presenter); Harsh Mahajan MD, MBBS; Upendra Kaul MBBS, MD

PURPOSE
Currently both gated SPECT and multislice CT are available for functional imaging i.e. assessing the haemodynamic consequences of CAD and anatomical imaging i.e. visualizing the coronary artery tree respectively. The aim of the current study was to compare the results of 64-slice CT and gated SPECT on a regional basis (per vessel distribution territory) in patients with known or suspected CAD.

METHOD AND MATERIALS
One hundred and fifty patients underwent both gated SPECT for myocardial perfusion imaging and 64-slice CT for coronary calcium scoring and coronary angiography. The coronary calcium score was determined for each coronary artery. Coronary arteries on multislice CT angiography were classified as having no CAD, insignificant stenosis (0% luminal narrowing), and significant stenosis (>90% luminal narrowing). Gated SPECT findings were classified as normal or abnormal (reversible or fixed defects) and were allocated to the territory of one of the various coronary arteries.

RESULTS
In coronary arteries with a calcium score of 10 or less, the corresponding myocardial perfusion was normal in 94%. In coronary arteries with extensive calcifications (score > 400), the percentage of vascular territories with normal myocardial perfusion was lower, 52%. Similarly, in most of the normal coronary arteries on 64-slice CT angiography, the corresponding myocardial perfusion was normal on SPECT in >94%. In contrast, the percentage of normal SPECT findings was significantly lower in coronary arteries with obstructive lesions.

CONCLUSION
Although a relationship exists between the severity of CAD on multislice CT and myocardial perfusion abnormalities on SPECT, analysis on a regional basis showed only moderate agreement between observed atherosclerosis and abnormal perfusion. Accordingly, 64-slice CT and gated SPECT provide complementary rather than competitive information, and further studies should address how these two modalities can be integrated to optimize patient management.

SST12-05 • Optimizing 18F-FDG-PET Imaging of Vessel Wall Inflammation - The Impact of 18F-FDG Circulation Time, Dose, Uptake Parameters, and Fasting Blood Glucose Levels

Jan Bucierius (Presenter); Venkatesh Mani PhD; Colin Moncrieff; Josef Machac MD *; Valentin Fuster MD; Michael E Farkouh; Ahmed Tawakol MD *; James Rudd MD, PhD; Zahi A Fayad PhD *

PURPOSE
18F-Fluorodeoxyglucose (FDG) positron emission tomography (PET) is increasingly used for imaging of vessel wall inflammation. However, limited data is available regarding the impact of methodological variables, i.e. patient’s pre-scan fasting glucose, the FDG circulation time, the injected FDG dose, and of different FDG uptake parameters, in vascular FDG-PET imaging.

METHOD AND MATERIALS
195 patients underwent vascular PET/CT of the aorta and the carotids. Arterial standard uptake values (meanSUVmax) as well as target-to-background-ratios (meanTBRmax) and the FDG blood pool activity in the superior vein cava (SVC) and the jugular veins (JV) were quantified. Vascular FDG uptake classified according to tertiles of patient’s pre-scan fasting glucose levels, the FDG circulation time, and the injected FDG dose was compared using ANOVA. Multivariate regression analyses were performed to identify the potential impact of all variables described on the arterial and blood pool FDG uptake.

RESULTS
Tertile analyses revealed FDG circulation times of about 2.5 h and pre-scan glucose levels of less than 7.0 mmol/l showing favorable relations between the arterial and blood pool FDG uptake. FDG circulation times showed negative associations with the aortic
FGD circulation times and pre-scan blood glucose levels significantly impact FGD uptake within the aortic and carotid wall and may bias the results of image interpretation in patients undergoing vascular FGD PET/CT. FGD dose injected was less critical. Therefore, circulation times of about 2.5 h and pre-scan glucose levels less than 7.0 mmol/l should be preferred in this setting.

CONCLUSION
FGD PET CT scans are a good objective indicator of response to therapy and correlate well with clinical well-being in patients who respond to therapy. Cardiac disease is more resistant to treatment compared to extracardiac disease.

CLINICAL RELEVANCE/APPLICATION
Response to therapy is a very important guiding factor in optimizing dosage of toxic immunosuppressive agents in patients with Sarcoidosis and FGD PET CT is probably the most reliable tool available.

SST13-101 • Long-term Outcome of Percutaneous Interventions of Hepatic Venous Outflow Obstruction after Pediatric Living Donor Liver Transplantation

Minoru Yabuta MD (Presenter) ; Toshiya Shibata MD ; Ken Shinozuka ; Toyomichi Shibata MD ; Hiroyoshi Isoda MD ; Kaori Togashi MD, PhD *

PURPOSE
To evaluate retrospectively the long-term outcome of percutaneous interventions of hepatic venous outflow obstruction (HVOO) after pediatric living donor liver transplantation (LDLT).

METHOD AND MATERIALS
Between October 1997 and December 2012, 48 patients (24 male, 24 female; median age, 6 years) who had undergone LDLT were confirmed to have HVOO at percutaneous hepatic venography and manometry, and underwent percutaneous interventions, including balloon angioplasty with / without stent placement. Technical success, patency rates, stent placement and major complications were evaluated.

RESULTS
Technical success was achieved in 92 of 93 sessions (99.0%). During follow-up periods ranged from one to 182 months (median, 51.5 months). 28 patients were treated with a single session of balloon angioplasty and 20 who developed recurrent stenosis were treated with repeated balloon angioplasty or stent placement. The rate of primary, primary assisted, and secondary patency at 1-, 3-, 5-, 10-years after the initial balloon angioplasty were 0.64, 0.57, 0.57 and 0.52 respectively, 0.98, 0.95, 0.95 and 0.95 respectively, and 1.0, 1.0, 1.0 and 1.0 respectively. A major complication was seen in a session of a patient, where a stent was migrated to the right atrium.

CONCLUSION
Balloon angioplasty with / without stent placement was an effective treatment for HVOO after LDLT.

CLINICAL RELEVANCE/APPLICATION
Response to therapy is a very important guiding factor in optimizing dosage of toxic immunosuppressive agents in patients with Sarcoidosis and FGD PET CT is probably the most reliable tool available.

SST13-02 • The Influence of Liver and Spleen Volume Changes after Percutaneous Transhepatic Angioplasty for Portal Venous Stenosis in Pediatric Living-donor Liver Transplant Recipients

Manabu Nakata MD (Presenter) ; Waka Nakata MD ; Hideharu Sugimoto MD

PURPOSE
To quantify the changes in liver and spleen volumes after percutaneous transhepatic angioplasty (PTA) for portal venous stenosis (PVS) occurring in patients after pediatric living-donor liver transplantation.

METHOD AND MATERIALS
Twenty consecutive patients (8 males, 12 females; mean age 4.8 years) who underwent PTA for PVS from August 2005 to September 2011 after pediatric liver transplantation were included. Liver and spleen volumes (LV, SV) were quantified using computed tomography
RESULTS
LV significantly increased by an average of 28% within 6 months after PTA and remained increased significantly through 36 months. SV/SSV significantly decreased an average of 24% within 6 months and remained decreased significantly through 36 months, although SV had no significant difference between pre- and post-operative data. LV/SV significantly increased by an average of 36% within 6 months after PTA, and thereafter had no significant differences. SV at each follow-up time point significantly negatively correlated with LV.

CONCLUSION
Improvement of splenomegaly and liver enlargement occur and continue during 36 months after PTA, with negative correlations between liver and spleen volumes. These data indicate that liver and spleen volumes are influenced by portal venous flow and recovery of these volumes may take at least 36 months.

CLINICAL RELEVANCE/APPLICATION
Splenomegaly is improved within 6 months after PTA, although the decrease in spleen volume may continue at least 36 months. This information may be utilized for application and evaluation of PTA.

SST13-03 • Non-invasive Measures that Guide Indication, Pathology and Outcome of Percutaneous Biliary Intervention in Paediatric Transplantation

Anushka Lijutikov MBBS, FRCP (Presenter) ; Navaratne Subhachandra MBBS, FRCP ; Pauline A Kane MBBS, FRCP ; John B Karani MBBS, FRCP ; Maria E Sellars MD, FRCP ; Anil Dhawan MD, FRCP ; Nigel Heaton

PURPOSE
Biliary complications adversely impact on graft survival following transplantation in paediatric recipients. Interventions are technically challenging and carry risk in infants and children; therefore, selection is critical. The purpose of this study was to evaluate the diagnostic utility of non-invasive parameters which singularly, or in combination, guide the need for intervention.

METHOD AND MATERIALS
Reference to pre-procedural non-invasive imaging and graft function from the transplant database between 2008 -2012 formed the study cohort. This retrospective study reviewed these parameters in predicting findings, pathology and outcome of intervention.

RESULTS
There were 49 interventions in 40 recipients (ages 4 months-16 years, M:F 21:19) transplanted between 1997-2012. (Total transplant cohort 582). Indications included EHBA, PFIC,ALF. Operative technique was left lateral segment (37) including live related (22) and whole grafts (3). Key findings were non-cholestatic enzyme rise (34), increasing duct calibre on ultrasound (34), MRCP diagnosis of anastomotic strictures (27) and cholangiopathy (7). Diagnostic PTC was successful in all with findings of anastomotic strictures (24), cholangiopathy (7), bile leaks (4). Balloon dilation of strictures was successful in 20. External biliary drains were placed in 4. The positive predictive values (PPV) in diagnosing anastomotic stricture and cholangiopathy are non-cholestatic enzyme rise 70.3% and 34.6%, USS duct calibre (27) and cholangiopathy (7). bile leaks (4). Balloon dilation of strictures was successful in 20. External biliary drains were placed in 4. The positive predictive values (PPV) in diagnosing anastomotic stricture and cholangiopathy are non-cholestatic enzyme rise 70.3% and 34.6%, USS duct calibre

CONCLUSION
The combination of non-invasive measures of graft assessment allows most appropriate selection for biliary intervention in paediatric liver transplant recipients but MRCP is the best single predictor of biliary complications

CLINICAL RELEVANCE/APPLICATION
Biliary complications adversely affect graft survival in paediatric recipients. Interventions are technically challenging and carry risk hence selection of the correct patient is crucial.

SST13-04 • Pediatric Soft Tissue Tumors: Deterministic Factors for Safety and Accuracy of Diagnostic Yield in Image-guided Percutaneous Core-needle Biopsies

Michael R Acord MD (Presenter) ; Raja Shaikh ; Gulraiz A Chaudry MBChB

PURPOSE
To assess lesion-related and technical factors that affect diagnostic yield and safety in image-guided percutaneous core-needle biopsies (PCNB) of soft tissue tumors in children.

METHOD AND MATERIALS
Institutional review board approval was obtained for a retrospective study of 150 PCNB performed at our institution from January 2003 to January 2013. Medical records and radiologic data were evaluated on all PCNB performed on soft tissue lesions, excluding vascular malformations. Technical details of the procedure, demographic characteristics of the patients, and radiologic features of the lesions such as the location, size, imaging nature and enhancement were recorded. Procedure-related complications and repeat PCNB or other testing due to poor or non-diagnostic yields were noted. Associations between the radiologic characteristics of the lesion, technical factors and diagnostic yield were evaluated using bivariate and multivariate logistic regression.

RESULTS
Mean patient age was 11.4 ± 7.1 years. Ultrasound guidance was used in 80% of cases. General anesthesia was the most common form of sedation (86% of cases). Mean number of core biopsies was 6.4 ± 3.2 per case. The overall diagnostic yield was 80%. On bivariate analysis, procedures taking less number of cores (OR 0.75 95% CI 0.57 to 0.99, p=0.04) and involving benign lesions (OR 0.14 94% CI 0.03 to 0.69, p=0.02) were associated with non-diagnostic biopsies. Using a lower gauge needle showed a trend toward improving diagnostic success (OR 1.87 95% CI 0.93 to 3.71, p=0.08). On multivariate analysis, the only factor that predicted low diagnostic yield was whether the lesion was benign (OR 0.14 95% CI 0.02 to 1.00, p=0.05).

CONCLUSION
Image guided PCNB is a safe and accurate method for the diagnosis of pediatric soft tissue tumors. Particular attention should be paid toward lesions that appear benign on pre-procedure imaging in order to improve diagnostic yield.

CLINICAL RELEVANCE/APPLICATION
Percutaneous core needle biopsy of soft tissue tumors is a minimally invasive technique compared to open biopsy and has a low complication rate providing an early diagnosis.

SST13-05 • Pilot Study Evaluating Parenchymal Perfusion and Renal Blood Flow Using Color-coded Imaging in Pediatric Renal Artery Angioplasty

Tiffany Hwang (Presenter) * ; Erin Girard PhD * ; Anne Marie Cahill MBChB

PURPOSE
symgo iFlow is a color-coded imaging adjunct used to interpret digital subtraction angiography (DSA). This study investigates the ability of symgo iFlow to evaluate changes in flow and parenchymal perfusion in patients undergoing angioplasty for renal artery stenosis (RAS).

METHOD AND MATERIALS
20 children underwent 30 percutaneous angioplasty procedures for RAS. For each stenotic artery that underwent angioplasty, pre-and post-stenotic regions of interest (ROI) were chosen. The difference in time to peak (dTTP) maximum contrast opacification values (given
RESULTS
iFlow measured significantly improved flow across stenosis following angioplasty as indicated by dTTP (p=0.0001). dTTP decreased in 23/30 cases, of which 12 demonstrated dTTP=0 seconds post-angioplasty, possibly due to complete flow restoration. No change in dTTP was demonstrated in 5/30 cases. dTTP increased in 2/30 cases, correlating with mural dissection and intraluminal thrombus. iFlow measured significantly improved perfusion following angioplasty as indicated by TTP (p=.0008). TTP decreased in 31/44 poles, indicating an improvement in flow. No change in TTP was seen in 6/44 poles. An increase in TTP was demonstrated in 7/44 poles, 3 of which correlated with dissection and thrombus. Using inflow slope as a second measure, iFlow demonstrated improved perfusion in 20/35 poles, but this was not significant (p>0.05).

CONCLUSION
This pilot study demonstrates the ability of iFlow to quantitatively and significantly assess differences in parenchymal perfusion and flow rates across stenotic vessels following angioplasty procedures. Thus, iFlow in general may provide the physician with more objective evidence of improved vascular flow and perfusion in other vascular interventions.

CLINICAL RELEVANCE/APPLICATION
The ability of iFlow to quantitatively and significantly assess differences in parenchymal perfusion and flow rates across stenotic vessels following angioplasty procedures. Thus, iFlow in general may provide the physician with more objective evidence of improved vascular flow and perfusion in other vascular interventions.

SST13-06 • Implementation of a Fluoroscopy Competency Check-off for Radiology Trainees: Impact on Reducing Radiation Dose in the Pediatric Population

Sweta Shah (Presenter) ; Stephane Desouches DO ; Lisa H Lowe MD ; Brenton D Reading MD

PURPOSE
The purpose of this study is to determine the impact of implementing a fluoroscopy competency check-off aimed at decreasing radiation dose in three common pediatric fluoroscopic studies.

METHOD AND MATERIALS
A fluoroscopy competency check-off form was developed for PGY 2-6 radiology trainees performing pediatric procedures. Techniques used to limit radiation exposure for three common pediatric radiologic studies were discussed. Additionally, a pediatric radiologist supervised and assessed each trainee’s competency and technical skill prior to independent performance of the three procedures. Radiation dose and exposure time were recorded for 171 oropharyngeal motility (OPM), 176 voiding cystourethrogram (VCUG), and 171 upper GI (UGI) exams in 24 trainees for the six months preceding implementation of the competency check-off and in 114 OPM, 145 VCUG, and 132 UGI exams in 23 trainees for the six months after implementation. A paired t-test was then used to compare the mean radiation dose for each procedure in the two groups.

RESULTS
A statistically significant reduction in radiation dose was found for OPM and VCUG exams after competency implementation. The mean radiation dose of the OPM exam decreased from 7.75 to 5.33 mGy pre- and post- competency implementation respectively, with a total reduction of 31% (P = 0.023). The mean radiation dose of the VCUG exam decreased from 3.90 to 2.59 mGy pre- and post- competency implementation respectively, with a total reduction of 33% (P = 0.033). No statistically significant reduction was seen for the UGI exam.

CONCLUSION
Implementation of a fluoroscopy competency check-off for radiology trainees reduced radiation dose in pediatric patients undergoing both OPM and VCUG studies.

CLINICAL RELEVANCE/APPLICATION
This study demonstrates that exposing trainees to a competency check-off can help decrease the radiation dose, thereby reducing the risk of excess radiation exposure in the pediatric population.

SST13-07 • A System for Real-time Mapping of Pediatric Skin Dose during Fluoroscopic Cardiac Procedures

Daniel Bednarek PhD (Presenter) * ; Vijay Rana * ; Stephen Rudin PhD *

PURPOSE
To provide the clinician with a real-time visual graphic display showing the distribution of skin-dose for pediatric patients undergoing fluoroscopic cardiac interventional procedures.

METHOD AND MATERIALS
We have developed a software system to track skin dose during fluoroscopic interventional procedures and to provide a graphic representation of the cumulative dose distribution in real time. Originally the program and graphics were developed and verified for adult patients. To use the system with pediatric patients, an open-source software application was used to create a series of 3D patient graphic models for each patient with varying heights ranging from 60 to 128 cm and with three weight ranges for each height. The models are created using a common set of rules, with the patient’s position and orientation data being used to create a model that best represents each patient. The graphics were created using a variety of techniques, including 3D modeling, 3D printing, and computer graphics. The software was tested on a variety of patients and found to be effective in providing a real-time display of the skin dose distribution.

RESULTS
Using a matching patient graphic, the ratio of dose tracking system reading to ionization chamber reading had an average value of 1.08 +/- 0.04 for fluoroscopy and 0.99 +/- 0.05 for DA mode with the pediatric phantom, while the values agreed with the chamber within 2% for the water phantom over a range of cardiac RAO/LAO and CRA/CAU projections.

CONCLUSION
With the newly developed patient graphic models, accurate tracking of skin dose is possible in real-time during pediatric fluoroscopic interventional procedures, enabling the clinician to reposition the C-arm to avoid exceeding the threshold for deterministic skin effects.

CLINICAL RELEVANCE/APPLICATION
The system developed facilitates the management of risk for deterministic skin effects for pediatric patients during interventional fluoroscopic procedures.

SST13-08 • MRI of Vascular Anomalies: Value of Diffusion Imaging

Sebastien Benali MD (Presenter) ; Josee Dubois MD ; Francoise F Rypens MD ; Chantale Lapierre MD ; Gilles P Soulez MD *

PURPOSE
MRI diffusion-weighted imaging (DWI) is a new method to evaluate the diffusion of intra and extracellular water. The goal of this study is to characterize diffusion imaging parameters in vascular anomalies (VA) and compare them to malignant soft tissue tumors.

METHOD AND MATERIALS
by iFlow) between these 2 ROIs represented flow rate across the stenosis. ROIs were drawn in the relevant parenchymal pole (upper, middle, and/or lower) to assess perfusion. 44 poles from the 20 patients were assessed for time to peak (TTP) opacity values. Only 35 of these poles had sufficient data to compute inflow rate, measured by the slope of the linear regression of opacification vs time, representing contrast values between 15-75% of maximum opacity.

RESULTS
iFlow measured significantly improved flow across stenosis following angioplasty as indicated by dTTP (p=0.0001). dTTP decreased in 23/30 cases, of which 12 demonstrated dTTP=0 seconds post-angioplasty, possibly due to complete flow restoration. No change in dTTP was demonstrated in 5/30 cases. dTTP increased in 2/30 cases, correlating with mural dissection and intraluminal thrombus. iFlow measured significantly improved perfusion following angioplasty as indicated by TTP (p=.0008). TTP decreased in 31/44 poles, indicating an improvement in flow. No change in TTP was seen in 6/44 poles. An increase in TTP was demonstrated in 7/44 poles, 3 of which correlated with dissection and thrombus. Using inflow slope as a second measure, iFlow demonstrated improved perfusion in 20/35 poles, but this was not significant (p>0.05).

CONCLUSION
This pilot study demonstrates the ability of iFlow to quantitatively and significantly assess differences in parenchymal perfusion and flow rates across stenotic vessels following angioplasty procedures. Thus, iFlow in general may provide the physician with more objective evidence of improved vascular flow and perfusion in other vascular interventions.

CLINICAL RELEVANCE/APPLICATION
The ability of iFlow to quantitatively and significantly assess differences in parenchymal perfusion and flow rates across stenotic vessels following angioplasty procedures. Thus, iFlow in general may provide the physician with more objective evidence of improved vascular flow and perfusion in other vascular interventions.
RESULTS
The mean ADC values at b=1000-500 were estimated at 3.05±0.08, 3.37±0.24 and 3.01±0.09 respectively for VM, LM and hemangiomas and at 2.96±0.08 for soft tissue tumors. At b=1000-500, ADC values were significantly higher for LM as compared to VM (p=0.01) and hemangiomas (p=0.03). However, no significant difference could be demonstrated between VM, hemangiomas and soft tissue tumors. At b=1000, ADC values were estimated at 3.82±0.14, 4.23±0.18 and 3.74±0.15 respectively for VM, LM and hemangiomas and at 3.46±0.11 for soft tissue tumors. The latter displayed significantly lower ADC values than VM and LM (p=0.0001) and hemangiomas (p=0.02). No significant correlation between contrast enhancement and ADC values was observed (r=-0.056).

CONCLUSION
All VA presented high ADC values. At b=1000-500, LM displayed significantly higher values as compared to VM and hemangiomas. At b=1000, malignant soft tissue tumors showed significantly lower ADC values than VM, LM and hemangiomas. DWI could be a useful tool to characterize VA and discriminate them from malignant lesions.

CLINICAL RELEVANCE/APPLICATION
Diffusion imaging can characterize and differentiate vascular anomalies from soft tissue malignant tumors. Soft tissue malignant tumors display higher ADC coefficient than brain and organ tumors.

SST13-09 • Novel Use of MRI/X-ray Overlay for Interventional Radiology Sclerotherapy Procedures in the Pediatric Population

Tiffany Hwang (Presenter) *; Erin Girard PhD *; Anne Marie Cahill MBBCCh

PURPOSE
Fluoroscopic imaging is used for navigation during lesion-targeting interventional radiology procedures, such as sclerotherapy for vascular malformations, as it provides real-time information. However, fluoroscopy provides only a 2D image of 3D anatomy and does not visualize the lesion. On the other hand, magnetic resonance imaging (MRI) provides quality soft tissue contrast for lesion visualization. syngo 3D/3D fusion and iPilot dynamic software programs (Siemens Healthcare AG, Forccheim, Germany) allow 3D MR images to be overlaid on real-time fluoro images, enhancing lesion visualization during interventional procedures. This study describes our experience using this software to target lesions and compares procedure and fluoro times between software-assisted and unassisted cases.

METHOD AND MATERIALS
20 children, mean age 11.5 years, underwent sclerotherapy procedures with MRI/x-ray image overlay assistance for vascular malformations. Their average procedure and fluoro times were compared to those of 100 software-unassisted sclerotherapy procedures using a 2-tailed t-test (p

RESULTS
Both average procedure and fluoro times of software-assisted cases (47.11; 4.97 min) were higher than those of unassisted cases (42.54; 4.72 min), but not to a statistically significant degree (p=0.37; 0.84). The physician reported that MRI overlay increased therapeutic confidence in 17/20 cases and determined the interventional plan in 10/20 cases. Of these 10 cases, changes made included adding a clarifying ultrasound (1), not performing a post-procedural DynaCT (2), determining post-procedural extubation (3), or a combination of these changes (3). The 3/20 cases that did not confer useful knowledge occurred with diffuse vascular malformations, where MR overlay was suboptimal due to unclear lesion boundaries.

CONCLUSION
In this study we showed that MRI/x-ray overlay during sclerotherapy can confer additional information to improve treatment confidence and guide the interventional plan while not significantly increasing procedure or fluoro time.

CLINICAL RELEVANCE/APPLICATION
MRI/x-ray overlay during sclerotherapy procedures may improve clinical care by providing physicians with additional information on the distribution of sclerotherapy agent, with respect to a prior MRI.

SST14 • ACRIN PA 4006: Effect of Device Technical Factors on Patient Dose in a Prospective Digital Breast Tomosynthesis Screening Trial

Mathew Thomas BS (Presenter); Yohei Matsutani; Emily F Conant MD *; Andrew D Maidment PhD *

PURPOSE
To characterize the effect of kVp, mAs, and filter-anode combinations on mean glandular dose (MGD) in digital mammography (DM) and digital breast tomosynthesis (DBT).

METHOD AND MATERIALS
A prospective multi-site trial was conducted to compare the recall rates of DM and DBT. The DBT image set consisted of 2D and 3D images obtained at approximately a 15% reduced dose effect by using a phototimer setting of 1.5; the DM images were acquired without modification of dose. All image data were stored in a centralized DICOM server and the image metadata were automatically extracted from the DICOM headers. These data included breast laterality, image orientation, kilovoltage (kV), exposure (mAs), target and filter materials, entrance surface dose and mean glandular dose (MGD). Regression analysis was performed to ascertain the influence of the various acquisition parameters on MGD.

RESULTS
The 2D component of the combined-DM/DBT acquisition was on average 18.5% less than (p

CONCLUSION
For both DM and DMT, the key determining factor of MGD is mAs. The kVp of DM and 2D DBT images is significantly lower than the kVp of 3D DBT images for breast thicknesses in the range of 70-100mm due to filter change in DM.

CLINICAL RELEVANCE/APPLICATION
This paper characterizes the key technical parameters that determine the cumulative dose exposure for patients during digital breast tomosynthesis screening.

SST14-02 • Assessment of Patient Dose from CT Localizer Radiographs

Natalia Saltybaeva (Presenter); Bernhard Schmidt PhD *; Daniel Kolditz PhD *; Willi A Kalender PhD *

PURPOSE
To characterize the mean radiation dose and the effective dose from CT localizer radiographs.
CT localization radiographs (LR), also known e.g. as topogram or scout view, in the past were not perceived as contributing significantly to the effective dose of a CT examination. In modern low-dose CT, however, this contribution has to be taken into account. The purpose of our study was to assess typical LR dose values based on simulations and measurements.

METHOD AND MATERIALS
Four anthropomorphic phantoms representing 2 adults (male and female, Rando-Alderson Research Laboratories, New York, USA) and 2 children (5 and 1 y.o., CIRS, Norfolk, VA, USA), equipped with 30-60 TLD chips, underwent LR scans (Siemens AG, Forchheim, Germany). Three different body regions (head, thorax, and abdomen-pelvis) and three positions of the X-ray tube (AP, PA, and lateral) were considered. We simulated the dose for each setup using a validated Monte Carlo tool (ImpactMC, CT Imaging GmbH, Erlangen, Germany) and compared simulated and measured dose values point by point. Organ and effective doses for the different LR settings were calculated and compared to typical dose values in CT examinations.

RESULTS
The differences between measured and simulated dose values for all projections (AP, PA, and lateral) were below 15% on average. Organ doses varied significantly depending on the tube position; the largest differences were observed for breast dose in female chest LR (AP: 2.4 mSv vs. PA: 0.5 mSv). Overall effective dose values per LR ranged from 0.04 mSv for adult head to 0.7 mSv for 1 y.o. child abdomen. This adds from 5% to 42% to effective dose of typical low-dose CT exams.

CONCLUSION
MC simulations provide accurate estimates of LR dose distributions. Localizer radiographs may contribute substantially to organ and effective dose of the total CT examination. Organ doses from LRs can be significantly reduced by choosing the appropriate projection angle.

CLINICAL RELEVANCE/APPLICATION
Dose from localizer radiographs should be taken into account. LC parameter optimizations should be performed in order to decrease total dose of CT examinations.

SST14-03 • CT Radiation Dose Optimization of Coronary Calcium Scanning: Comparing Different Image Reconstruction Methods at 100kVp and 120kVp
Joerg Blobel PhD (Presenter) *; Jurgen Mews *; Joanne Schuijf *; Willem Overlaet *

PURPOSE
The effects of tube voltage reduction and different reconstruction methods on coronary calcium scoring remain largely unknown. We performed a quantitative phantom study to determine the lowest applicable volume CTDI thresholds (CTDIvol) at 100kVp versus 120kVp while controlling Agatston and volume score accuracy.

METHOD AND MATERIALS
ECG-gated volume scans of an anthropomorphic thoracic phantom with calcium calibration inserts, containing 200, 400 and 800mg HA/cm² calcium mass spheres of 1, 3 and 5mm diameter (QRM GmbH, Germany), were performed on 320-row CT (Aquilion ONE, Toshiba Medical Systems, Japan). Using 100kVp and 120kVp with 10–580mA variations in 32 steps, each acquisition was reconstructed with Filtered Back-Projection (FBP), Quantum Denoising Software (QDS) and Adaptive Iterative Dose Reduction (AIDR 3D). To determine the minimum CTDIvol thresholds for the six groups a statistical 2S-outlier test (WinStat 2007.1 software) was performed on the semi-automatically detected Agatston and volume scores. The Kruskal-Wallis-Test was used to evaluate statistical differences between the three reconstructions and both kVp scan series.

RESULTS
At equal kVp settings, there were no significant differences in average scores between the three reconstruction methods (p>0.21). The use of 100kVp, as compared to 120kVp, resulted in a 3% lower Agatston score average (672 vs. 694, p3, pvol thresholds were reduced from 5.98mGy to 2.37mGy (120kVp, QDS), 1.86mGy (120kVp, AIDR 3D), 4.13mGy (100kVp, FBP), 1.94mGy (100kVp, QDS) and 1.12mGy (100kVp, AIDR 3D) (Fig.). The averages of 10 repeated scans at low dose level (1.12 mGy, AIDR3D, 100kVp) showed no significant difference with the reference group (12 dose steps, FBP, 120kVp) for both Agatston (p=1.00) and volume (p=0.75) score.

CONCLUSION
Mean dose reductions of 37% using 100kVp instead of 120kVp and 71% using the novel iterative reconstruction AIDR 3D instead of FBP can be achieved for coronary calcium scanning. Combining 100kVp with AIDR 3D resulted in an 81% lower CTDI vol threshold compared to a standard scan protocol (120kVp, FBP).

CLINICAL RELEVANCE/APPLICATION
Considerable radiation dose reduction can be achieved for coronary calcium scanning using AIDR 3D at 100kVp. Low dose coronary calcium scanning is possible with good accuracy and reproducibility.

SST14-04 • Synthetic Cone-beam CT for Determining Patient- and Task-specific Minimum-dose Techniques in Repeat Scans
Adam S Wang PhD (Presenter) *; Joseph W Stayman PhD *; Yoshito Otake *; Jeffrey H Siewerdsen PhD *

PURPOSE
To evaluate a newly developed method (Synthetic Cone-Beam CT) for accurately determining the impact of lower-dose techniques in C-arm CBCT, allowing identification of minimum-dose protocols suitable to a given imaging task in scenarios that require repeat scans.

METHOD AND MATERIALS
An initial CBCT acquired at nominal scan protocol at the beginning of a procedure provides a patient-specific basis for synthetic CBCT. To accurately simulate lower-dose techniques, noise of the proper magnitude and correlation is added to the projections, accounting for object-dependent noise levels and correlations introduced by the detector. The resulting noisy projections are then reconstructed to yield synthetic CBCT images accurately portraying the image quality in lower-dose scans. Validation studies were conducted on a mobile C-arm using a 16 cm acrylic phantom to first assess the detector signal-variance relationship and correlations. Synthetic CBCT was then applied to a head phantom (100 kVp, 320 mAs initial scan), synthesizing projections across a range of lower-dose techniques (160, 80, 40, and 20 mAs). Real CBCT scans were also obtained at each technique for image quality comparison.

RESULTS
Comparison of synthetic and real CBCT images across the full range of techniques demonstrated accurate noise magnitude (within ~3%) and correlation (matching noise-power spectrum, NPS). Other image quality characteristics (e.g., spatial resolution, contrast, beam hardening, and scatter) remain intact and are realistically presented in synthetic CBCT. Generating synthetic CBCT for a broad range of protocols gives a useful method to select minimum-dose techniques that accounts for complex factors of imaging task, patient-specific anatomy, artifacts, and physician preference.

CONCLUSION
Synthetic CBCT accurately portrays the increased noise in lower-dose protocols while preserving other image quality characteristics, providing a method to define minimum-dose, task-specific protocols in repeat CBCT. Ongoing work includes translation to clinical studies and application to iterative reconstruction, where potential dose reduction is even greater and synthetic CBCT accurately portrays low-dose limits that are difficult to predict.

CLINICAL RELEVANCE/APPLICATION
Selection of minimum-dose, task-specific techniques for intraoperative C-arm cone-beam CT is enabled by synthesizing patient-specific images that accurately reflect image quality at lower dose.

SST14-05 • Preliminary Clinical Evaluation of an Online Intrascan Motion-correction Algorithm for Interventional C-arm
Flatt-detector CT

Julia Wicklein *; Oliver Beuing *; Martin Skalej MD, PhD *; Steffen Serowy *; Willi A Kalender PhD *; Yiannis Kyriakou PhD (Presenter) *; Holger Kunze MS *

PURPOSE
Intrascan Motion-artifact-correction in C-arm-based flat-detector CT (FD-CT) is an important issue in interventional imaging because of longer scan times as compared to Multi-Slice CT. Our aim was the development and evaluation of an online image-content-based motion-correction technique without using any kind of markers or external motion knowledge.

METHOD AND MATERIALS
The correction method is based on a gradient descent method, minimizing a gray-value entropy criterion optimizing the underlying acquisition trajectory parameters. It is formed as a multistep approach, including a global, local and projection wise optimization. We are using a locally rigid variation of the systems trajectory parameters like detector- or source-translation or a detector rotation to compensate patient motion. The retrospective evaluation of 30 arbitrary (with weak and strong motion, without motion artifacts) patient head scans included 5s 3D angiography and 20s soft-tissue protocols. All scans were performed on an Artis Q System (Siemens AG). For each dataset three volumes were computed: 1) original reconstruction using the system's geometry calibration (OR), 2) motion corrected reconstruction without any system information (MCR) and 3) motion corrected reconstruction using the system's geometry calibration as initialization (MCR+). Two neuroradiologists performed a visual evaluation according to a 5-point grading scale with respect to general image quality, motion-artifact-content and spatial resolution of the structures of interest, e.g. 3D vessels.

RESULTS
The average scores for OR, MCR and MCR+ were 2.75, 3.0 and 3.15, respectively. The combined compensation of unknown trajectories and unknown patient motion (MCR) can lead to comparable results to OR. Both experts confirmed a distinct reduction of artifacts by the motion correction algorithm (MCR+), e.g. blurring and streaks. Especially for 3D angiography even small distal vessels were depicted clearly. MCR+ application on soft-tissue protocols illustrated a constantly better delineation of bone and soft-tissue in the border zones.

CONCLUSION
Image-based motion correction is possible without a-priori knowledge of the motion pattern and can improve interventional FD-CT imaging.

CLINICAL RELEVANCE/APPLICATION
Using the proposed algorithm enables good image quality even for unsteady patients and can be helpful for longer FD-CT acquisitions in cases where anaesthesia is contraindicated.

SST14-06 • Supervised Conversion of Ultra-low-Dose to Higher-dose CT Images by Using Pixel-based Machine Learning: Phantom and Initial Patient Studies

Kenji Suzuki PhD (Presenter) *; Yipeng Liu MS; Toru Higaki PhD; Yoshinori Funama PhD; Kazuo Awai MD *

PURPOSE
Reduction of radiation dose in CT is highly demanded. Our purpose was to develop a supervised pixel-based machine-learning technique for converting ultra-low-dose (ULD) CT to virtual higher-dose (HD) CT images with less noise or artifact.

METHOD AND MATERIALS
We developed a pixel-based machine-learning technique based on a massive-training artificial neural network (MTANN) filter that is trained with input ULDCT images and corresponding HDCT images. Through training, the MTANN learns the relationship between the input and teaching images to convert ULDCT into HDCT. Once trained, the MTANN no longer requires HDCT images; and it produces HDCT-like images from non-training ULDCT images. To train our MTANN filter and make a reference, we acquired 6 sets of CT scans of an anthropomorphic chest phantom (Kyoto Kagaku, Kyoto, Japan) with a tube voltage of 120kVp, tube currents of 10, 25, 50, 100, 150, and 300 mA, and a collimation of 5 mm. A 10 mA ULDCT image and the corresponding 300 mA HDCT image were used for training our MTANN filter. To evaluate the performance of our MTANN, we acquired ULDCT scans of 3 patients with a tube voltage of 120kVp and a tube current of 10 mA, and it provides HC-like images from non-training ULDCT scans. We evaluated the image quality of CT images by using signal-to-noise ratio (SNR) in each image.

RESULTS
With our trained MTANN filter, noise and artifacts (e.g., streaks) in ULDCT images (0.1 mSv) were reduced substantially, while details of soft tissue such as pulmonary vessels and bones were maintained. The average SNR of 0.1 mSv ULDCT images for patients was improved from 2.3 (± 1.8) to 13.0 (± 2.5) dB (two-tailed t-test; P < 0.05).

CONCLUSION
We used our MTANN dose-reduction technique, the image quality of 0.1 mSv ULDCT was improved substantially to the quality comparable to 1.5 mSv HDCT; thus, radiation dose can potentially be reduced by 93%.

CLINICAL RELEVANCE/APPLICATION
Advantage of our technique over iterative reconstruction is substantial reduction of radiation dose in CT with a very short processing time, which would be beneficial to patients and radiologists.

SST14-07 • The Influence of kv and Patient Positioning on CT Image Quality and Dose: Why Low kv CT Scans Have a Higher Sensitivity to Patient Positioning

Timothy P Szczuzkutowicz PhD (Presenter) *; Frank N Ranallo PhD; Kara Gill MD; Myron A Pozniak MD *

PURPOSE
Higher levels of noise non-uniformity were noticed in our pediatric scans. Investigation into the problem lead to the conclusion that due to the low kV used for pediatric scans, errors in patient positioning caused larger increases in noise non-uniformity for pediatric patients relative to similar adult protocols using higher kV settings. The purpose of this work is to explore the physical reason behind this effect and provide guidelines to avoid this problem in the clinic.

METHOD AND MATERIALS
Several clinical cases flagged by our pediatric radiologists were analyzed and motivated an anthropomorphic phantom study. A pediatric protocol was applied using 80 and 140 kV. The phantom was purposely mis-centered low by 0 and 6 cm. The noise uniformity was normalized to have equal fluence through the center of the bowtie.

RESULTS
It was found that the noise non-uniformity of the 80 and 140 kV scans was 1.33 and 1.27 at 0 cm offset and 1.86 and 1.58 at 6 cm offset respectively. The numerical simulation showed the 140 kV spectra provided a 23% wider fluence profile than 80 kV when both spectra were normalized to have equal fluence through the center of the bowtie.

CONCLUSION
Novel to this study, it was shown that the degree of non-uniformity depends on kV and the physical reason for this effect was shown via phantom measurements and numerical simulation. This study identifies a new reason to stress the importance of patient positioning, especially for low kV exams (i.e. pediatrics).

CLINICAL RELEVANCE/APPLICATION
Low kV settings, commonly used in pediatric protocols, can increase the chance for an un-diagnosable scan due to the higher dependence of noise non-uniformity on patient mis-centering at lower kVs.

**SST14-08 • Radiation Dose in Dual-energy Computed Tomography: Axial Dose Distributions in Specific Thoracic and Abdominal Regions**

**Kosuke Matsubara PhD (Presenter); Haruka Koshida; Keita Sakata; Tadanori Takata; Kichiro Koshida PhD; Yukihiro Matsuura RT; Toshifumi Gabata MD**

**PURPOSE**
Polyenergetic x-rays with low (100 or 80 kVp) and high tube voltage [140 kVp with or without a tin (Sn) filter] are used in dual-energy computed tomography (DECT). We aimed to evaluate the radiation doses administered during thoracic and abdominal DECT and compare them with those administered during single-energy CT (SECT) of the same regions.

**METHOD AND MATERIALS**
A 128-section dual-source CT device (SOMATOM Definition Flash; Siemens Healthcare, Erlangen, Germany), an anthropomorphic female phantom (RAN-110; Phantom Laboratory, Salem, NY, USA), and calibrated radiophotoluminescent glass dosimeters (RPLDs) (GD-302M; Chiyoda Technol, Tokyo, Japan) were used to acquire axial absorbed dose distributions in specific regions of the thorax and abdomen that were imaged using CT with one SE (120 kVp) and three DE (100 and Sn/140 kVp, 80 and Sn/140 kVp, and 140 and 80 kVp) modes. The energy modes were in accordance with the standard clinical protocols for thoracic and abdominal CT, and the tube current was adjusted so that the displayed volumetric CT dose indices (CTDIvol) were equivalent among the four energy modes. Axial absorbed dose distributions in the thoracic and abdominal regions were acquired by placing RPLDs within all holes of one thoracic or abdominal section and pasting them around the section.

**RESULTS**
The absorbed doses in the thoracic region were 12.8 ± 2.3, 12.5 ± 2.2, 11.7 ± 1.9, and 12.2 ± 1.6 mGy (p < 0.01, Friedman’s test) when the 120 kVp, 100 and Sn/140 kVp, 80 and Sn/140 kVp, and 140 and 80 kVp modes, respectively, were used. The corresponding values for the abdominal region were 24.8 ± 2.2, 24.3 ± 2.0, 22.9 ± 1.7, and 23.3 ± 1.6 mGy (p < 0.01, respectively). The doses absorbed at the surface and center of the abdomen were higher and lower, respectively, when the 140 and 80 kVp mode was used than when the other three modes were used for abdominal CT.

**CONCLUSION**
DECT can be performed with a radiation dose that is equivalent to or lower than that required during SECT when the displayed CTDIvol is equivalent. The additional Sn filter used in abdominal DECT can approximate the axial absorbed dose distribution of DECT to that of SECT.

**CLINICAL RELEVANCE/APPLICATION**
DECT has advantages over SECT. Evaluation of the radiation dose administered during DECT is necessary to determine its indications for application and the energy modes required.

**SST14-09 • CT Image Quality Improvement and Dose Reduction Potential with Model-based Iterative Reconstruction Using Autopsy Imaging in the Abdomen: Evaluation of Image Noise and DOSE Estimation with Different Noise Index**

**Tomokatsu Tsukamoto (Presenter); Takashi Takahata RT; Yue Dong; Keisuke Nishihara MD; Kazunari Mesaki MD; Hiroki Mori MD; Ye Ju; Katsuhide Ito MD**

**PURPOSE**
To assess the dose reduction potential and image quality improvement with model-based iterative reconstruction algorithm (Veo) using autopsy imaging by comparing image noise and DOSE (DLP mGy-cm) with the adaptive statistical iterative reconstruction (ASiR) and the filtered back projection (FBP) reconstructions.

**METHOD AND MATERIALS**
With institutional review board approval, 8 autopsy imaging (AI) underwent abdomen CT with different noise index (NI: 8.5, 10.5, 14.5, 20.5, 30.5) on Discovery CT750HD was included. In addition to the 3 sets of 0.625mm slice thickness CT images were reconstructed with FBP, 50% ASiR and Veo. The image noise (SD) was measured with the same size of regions of interest at the same slice in 3 locations for liver and pelvis. The image noise reduction ratio was defined by SD (at NI30.5)/SD (at NI8.5). Using a 5-point score (1: poor; 3: diagnosis, 5 excellent), 3 radiologists independently and graded overall noise and delineation of the abdomen image.

**RESULTS**
For the Liver, the image noise reduction with Veo compared with FBP and 50%ASiR for the NI: 8.5, 10.5, 14.5, 20.5, 30.5 and the average were (47.3%, 52.2%, 61.0%, 70.6%, 79.0% and 62.0±13.0%) and (37.7%, 32.2%, 44.4%, 58.1%, 70.1% and 48.5±15.5%), respectively; for Pelvis, (49.2%, 54.3%, 66.3%, 74.1%, 79.8% and 64.7±12.9%) and (28.5%, 34.9%, 52.4%, 63.3%, 71.8% and 48.5±15.5%), respectively. The reduction ratio (NI30.5/NI8.5) of image noise about (Liver and Pelvis) for the Veo, 50%ASiR and FBP were (1.5 and 1.5), (3.2 and 3.9) and (3.9 and 3.9), respectively. All the differences were statistically significant between Veo and FBP (p < 0.01, Friedman’s test).

**CONCLUSION**
The model-based iterative reconstruction algorithm (Veo) advanced reconstruction algorithms greatly reduced image noise to compare FBP and ASiR.

**CLINICAL RELEVANCE/APPLICATION**
Veo reconstruction technique has the ability to reduce radiation dose through their improvement in image quality compared with the current algorithms such as FBP and ASiR.

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**Physics (Image-guided Radiation Therapy II)**

**SST15 • AMA PRA Category 1 Credit™: 1.5 • ARRT Category A+ Credit: 1.5**

**Moderator**
Peter Balter, PhD *

**Moderator**
Lei Xing, PhD *

**SST15-01 • Artifact-resistant Motion Estimation for Motion-compensated CT**

**Marcus Brehm; Thorsten Heuser (Presenter); Pascal Paysan PhD *; Markus Oelhafen DPhil, DSc *; Marc Kachelriess PhD**

**PURPOSE**
Image quality of respiratory-correlated 4D volumes from flat detector cone-beam CT scans (4D CBCT) is deteriorated by severe sparse projection artifacts. These artifacts complicate motion estimation and therefore motion compensation. The aim is to robustly estimate motion in presence of dominating image artifacts and to allow for a subsequent motion-compensated image reconstruction that guarantees full dose usage.

**METHOD AND MATERIALS**
To estimate respiratory motion in artifact-dominated images we developed a patient-specific artifact model: A 3D reconstruction of the...
4D data is segmented into air, soft tissue, and bone by simple but robust hard thresholding (at -800 HU, +300 HU). The resulting three-valued image is forward projected and the thus-obtained rawdata undergo a 4D reconstruction (phase binning and independent reconstruction of each respiratory phase) yielding 4D CBCT images free of patient motion but full of sparse projection artifacts. The artifacts change from respiratory phase to respiratory phase. Deformable registration of those artifact volumes yields an approximation of the motion induced by the artifacts. This information is used to correct motion vector fields that were estimated on the conventional 4D CBCT volumes. The method is verified using simulated rawdata obtained by deforming a clinical patient dataset by realistic deformation fields, and by processing patient data acquired with the TrueBeam 4D CBCT system (Varian Medical Systems).

RESULTS
The motion-compensated reconstructions, from simulated and patient data, do not contain any streak artifacts, they are free from motion blurring, and their image noise is similar to the standard 3D reconstruction. The high temporal resolution is maintained. Pulmonary blood vessels that have been hidden by motion blurring or streak artifacts before now become clearly visible.

CONCLUSION
The proposed patient-specific artifact model allows for a robust registration between images that are severely degraded by artifacts. Combined with motion compensation one is able to remove streak and motion artifacts while maintaining a good spatial and good temporal resolution. Full dose usage is guaranteed because now all data contribute to each time frame.

CLINICAL RELEVANCE/APPLICATION
High quality 4D images are a prerequisite for precise adaptive radiation treatment.

SST15-03 • Deformable Registration Guided Correlation of Post-radiotherapy Recurrent Disease to Pre-radiotherapy PET
Positive Volume in Patients with Head and Neck Cancer

Michalis Aristophanous (Presenter) ; Abdallah S Mohamed MD, MSc ; Adam S Garden MD ; David I Rosenthal * ; Clifton D Fuller MD, PhD *

PURPOSE
Investigate the predictive role of pre-radiotherapy (pre-RT) FDG-PET/CT scans for head and neck cancer local and/or regional recurrence (LRR).

METHOD AND MATERIALS
Thirty-five patients that developed LRR following radiotherapy (RT) for primary SCC of the head and neck between May 2003 and July 2010 were identified under an IRB approved protocol. Each patient had an FDG-PET/CT scan on average 2 months prior to RT. The PET-based gross tumor volume (GTV) was defined utilizing an automated segmentation algorithm developed in-house to obtain a pre-RT GTV-PET. The recurrent disease was identified and contoured on follow up post-radiotherapy (post-RT) CT imaging to obtain the GTV-REC. The post-RT CT scan was fused to the pre-RT PET/CT using an in-house developed deformable registration algorithm. The deformation map was applied to the contours to obtain GTV-REC_def that was registered to the pre-RT PET/CT. A uniform 1cm margin was added to the GTVs to account for the various uncertainties in the segmentation and registration process. Several SUV statistics inside the recurrent and PET defined GTVs were obtained and analyzed, along with the overlap of the GTV-REC_def with the GTV-PET.

RESULTS
Primary sites were oral cavity (9.6%), oropharynx (68.5%), and hypopharynx (22.9%). The mean (range) GTV-PET and GTV-REC_def were 29.2ml (3.1-145.6ml) and 10.9ml (0.9-92.9ml) respectively with the Pearson correlation coefficient between the two volumes being 0.82. The SUV maximum in the GTV-PET and GTV-REC_def+1cm was found to have no statistically significant difference. Finally, an overlap of 1 between GTV-REC_def and GTV-PET+1cm indicating complete inclusion of the recurrence in the pre-RT defined GTV-PET was obtained for 68.6% of the cases, and increased to 82.9% for an overlap greater than 0.5.

CONCLUSION
The results suggest that the volume of the PET positive GTV on a pre-RT FDG-PET scan can be predictive of the size of disease in cases of recurrence. In addition, utilizing deformable registration to relate the recurrent GTV to the pre-RT SUVs on the FDG-PET scan confirmed that greater than 80% of recurrence occurs within or at the PET positive volume boundary.

CLINICAL RELEVANCE/APPLICATION
Predictions of post-radiotherapy recurrent disease patterns based on pre-radiotherapy PET characteristics can result in treatment plan strategy modifications that improve loco-regional control.

SST15-04 • Monte Carlo Based Estimation of Pediatric Dose from CBCT Imaging Head Protocols for Patient Positioning and Target Localization in Radiotherapy

Kyle McMillian (Presenter) * ; Maria Zankl PhD ; Michael F McNitt-Gray PhD * ; Dan Ruan PhD *

PURPOSE
The purpose of this investigation is to estimate the organ doses to a pediatric patient undergoing repeat CBCT imaging as part of an...
METHOD AND MATERIALS
A Monte Carlo model was developed with application to kV-CBCT dose quantification on the Varian On-Board Imager platform. This model was validated against experimental measurements with an average agreement within 4%. Using this validated model, dose to a pediatric patient was simulated for the GSF "Child" model. This whole-body voxelized phantom was derived from CT imaging data of a 7-year-old female and contains 144 slices of 8 mm thickness with each slice consisting of a 256 x 256 matrix of 1.54 mm x 1.54 mm pixels. Simulations were performed using a standard-dose, low-dose and high-quality head CBCT protocol. For each protocol, the clinical default x-ray field size of 18.4 cm x 18.4 cm at 100 cm source-to-surface distance was simulated. The reference center of the scan was set in the infratentorial region of the brain, and dose was tallied in all relevant organs near the collimated x-ray beam. Results for each simulated protocol were reported for both an individual scan as well as the accumulated dose expected from 30 repeated scans throughout the course of an IGRT treatment regimen consisting of 5 treatment fractions a week for 6 weeks.

RESULTS
For a standard-dose protocol, dose per scan to the brain, skull, lens of the eye, head skin and cervical spine was 2.9, 10.6, 0.47, 3.3 and 14.9 mGy, respectively. These doses were decreased by a factor of 2 when the low-dose protocol was used and increased by a factor of 5 when the high-quality protocol was used. Accumulated dose as high as 2240 mGy was observed for the cervical spine when the high-quality protocol was used for all 30 repeated scans.

CONCLUSION
Dose to bony structures such as the skull and cervical spine is significantly higher than dose to soft tissue. In pediatric patients whose bones are in a proliferative state, this CBCT imaging dose increases the risk of retardation of growth and induction of bone cancer. Therefore, it is important that the dose from CBCT imaging of pediatric patients be carefully considered and monitored.

CLINICAL RELEVANCE/APPLICATION
Organ-specific dose quantification from this study provides distributional knowledge about CBCT imaging dose and facilitates designing protocols to reduce risk of late effects in pediatric patients.

SST15-05 • 4D Cone Beam CT in Image Guided Radiation Therapy without Data Truncation Artifacts
Kai Niu MS (Presenter); Ke Li MS; Guang-Hong Chen PhD *

PURPOSE
To evaluate the capability of solving the data truncation and detector shift problem common in clinical applications of 4D cone beam CT (CBCT) using an adapted Prior Image Constrained Compressed Sensing (PICCS) reconstruction method and to quantify the robustness of the adapted PICCS-4DCBCT algorithm under different data truncation conditions.

METHOD AND MATERIALS
RESULTS
For PICCS-4DCBCT, the rRMSEs are 0%, 4%, 6%, 7% for each case from no data truncation to most aggressive data truncation. In contrast, for TV-CS, the corresponding rMSEs are 4%, 6%, 8%, 9%, and for FDK, the rRMSEs are 17%, 18%, 19% and 20%. The UQIs for PICCS-4DCBCT images are 1, 0.996, 0.991 and 0.986 (score=1 means perfect); for TVCS, the UQIs are 0.970, 0.957, 0.951 and 0.947, and for FDK images, the UQIs are 0.630, 0.630, 0.630 and 0.629.

CONCLUSION
(1) PICCS-4DCBCT offers much better image quality and reconstruction accuracy compared with TV-CS and E-FDK at all data truncation levels. (2) No meaningful variations in performance were observed when the amount of truncation was changed.

CLINICAL RELEVANCE/APPLICATION
PICCS-4DCBCT can be performed accurately and stably with almost arbitrary data truncation scanning conditions in 4DCBCT to guided radiation therapy for lung cancers.

SST15-06 • Optimization of the Design of Portal Imaging Systems Incorporating Thick, Segmented Scintillating Detectors Employed for Megavoltage Cone-beam CT through a Novel Hybrid Modeling Technique
Langechuan Liu (Presenter); Larry E Antonuk PhD; Hao Jiang; Youcef El-Mohri PhD; Qihua Zhao PhD

PURPOSE
Active matrix flat-panel imagers (AMFPIs) incorporating thick, segmented scintillators have demonstrated order-of-magnitude improvements in DQE at radiotherapy energies compared to systems based on conventional phosphor screens. Such improved DQE values facilitate megavoltage cone-beam CT (MV CBCT) at clinically practical doses, providing distinct advantages over kV CBCT performed using additional on-board imaging equipment. However, the MV CBCT performance of such AMFPIs is highly dependent on the design parameters of the scintillators. In this presentation, a theoretical examination of imaging performance as a function of these parameters is reported.

METHOD AND MATERIALS
The imaging performance of various scintillator designs was examined through a hybrid approach involving Monte Carlo simulation of radiation transport and determination of optical point spread functions. For each design, a full tomographic scan of a contrast phantom incorporating various soft-tissue inserts was simulated at a total dose of 3 cGy. This novel technique was validated through comparisons of theoretical predictions of contrast, noise and contrast-to-noise ratio (CNR) with measurement results obtained from a 1.13 cm thick, 1016 µm pitch BGO prototype.

RESULTS
Theoretical values for contrast, noise and CNR were found to be in close agreement with measurements for the BGO prototype, strongly supporting the validity of the modeling technique. For various other scintillator designs, results for CNR demonstrate improvement by a factor of ~2.2 when the scintillator thickness is increased from 1.13 to 6 cm, and an improvement by a factor of ~2.6 when the pitch is increased from 508 to 1016 µm. Finally, optimization of design based on a trade-off between thickness and pitch, along with evaluation of the corresponding spatial resolution performance, is discussed.

CONCLUSION
A new technique to model both radiation and optical effects was validated and employed to accurately evaluate the MV CBCT performance of MV-AMFPIs incorporating various segmented scintillator designs. It appears that significant improvement in the imaging performance of such AMFPIs can be achieved through optimization of scintillator design parameters.

CLINICAL RELEVANCE/APPLICATION
Enhanced performance of MV-AMFPIs with segmented scintillators should greatly facilitate soft tissue visualization in external beam radiotherapy through MV CBCT imaging at clinically practical doses.

SST15-07 • 2D kV Orthogonal Pair vs. 3D Cone Beam CT Localization for Breathhold Breast Radiation Therapy Treatment
Michelle Howard BS (Presenter); Sean S Park MD, PhD; Robert W Mutter MD; Elizabeth S Yan MD; Deanna H Pafundi PhD; Debra Brinkmann PhD

PURPOSE
To assess the accuracy of breast and heart localization between 3D cone beam CT (3D-CBCT) registration to soft tissue and 2D kV orthogonal pair (2D-OP) registration to bony anatomy for assessment of matching criteria and imaging modality for accurate localization.
METHOD AND MATERIALS

3D-CBCT and 2D-OP from 9 left-sided breast cancer patients treated with BH were retrospectively reviewed. Weekly 3D-CBCTs were acquired after manual 2D-OP registration to chest wall (anterioposterior) and sternum (lateral) was applied. 3D-CBCT images were then compared offline to planning CT with automatic match to breast tissue, heart, or spine using translations only. The role of 2D vs 3D imaging for daily patient positioning was also evaluated.

RESULTS

CONCLUSION

Shift differences between 3D breast tissue automatic and 2D bony manual match were = 5mm in 7 patients and = 1cm in 4 patients. Accurate patient positioning is sensitive to the breast tissue placement and the degree of body roll which are difficult to ascertain with 2D imaging. 3D-CBCT registration allows for improved assessment and accurate localization of breast tissue, heart, and body roll. Further analysis will evaluate the dosimetric impact to heart based on localization to 2D-OP manual registration and 3D-CBCT automatic to breast, heart, and spine.

CLINICAL RELEVANCE/APPLICATION

This investigation will directly impact clinical practice decisions on which imaging modality and matching criteria are used daily to localize left-sided BH breast radiation therapy patients.

CT Number Changes Observed during Radiotherapy for Head and Neck Cancer

Ion Moraru (Presenter)

ABSTRACT

Purpose/Objective(s): Radiation induced anatomic changes, such as tumor regression, are common during the delivery of radiotherapy (RT) for head and neck cancer. In an effort to measure treatment response and identify indicators for adaptive RT, we investigate changes of CT number in target and organs at risk (OAR) from the CT data acquired during RT delivery and study correlations with anatomic variations.

Materials/Methods: Daily diagnostic-quality CT data acquired using an in-room CT (CT-on-Rails) for image-guided IMRT of 9 patients with stage III and IV squamous cell carcinoma of the oropharynx were analyzed. The patients were treated with 70 Gy in 35 fractions concurrently with chemotherapy. The gross tumor volume (GTV) and OARs were contoured on each daily CT set. All selected patients exhibited GTV reduction over the course of the treatment. We examined the distribution of CT numbers in Hounsfield units (HU) of various volumes of interest (VOI), including GTV and spinal cord, on daily CT sets. Statistical analysis of CT number distributions was performed for each patient for different fractions and trends were examined across the entire cohort. Various parameters including the mean, width, CT number of peak and asymmetry of each histogram were used to measure differences in the CT number distributions.

Results: Patient-specific changes in the CT number histograms as a function of fraction number for the GTV and spinal cord were observed. For the GTV, the mean CT number was observed to vary as much as +28% (+13 HU) and -27% (-12.5 HU) over 30 fractions, corresponding to +40% (+17.5 HU) and -38% (-18 HU) shifts in the CT number of the histogram peaks, respectively. These were associated with large differences in the histogram widths, namely 24% and 48%, and strong changes in symmetry, which may indicate that only part of the GTV experiences a shift CT numbers over the course of treatment for these patients. By contrast, a much more limited range of changes in the mean CT numbers was observed for the spinal cord, namely between +7.5% (+2.5 HU) and -11% (-4 HU), with less modifications in histogram width and symmetry. These maxima in the mean were not correlated with the data from those patients exhibiting the largest shifts in the GTV. This supports the idea that the observed differences in CT distributions of the GTV are largely radiation induced, as opposed to the spinal cord typical receives limited radiation dose.

Conclusions: Radiation induced non-negligible, patient-specific CT number changes were observed in volumes of interest during the delivery of RT for head and neck cancer. The pattern of variation is complex and no strong trend and/or correlation with tumor regression is identified for the small group of patients studied. More work is required to understand the mechanisms involved in these changes and how these will be used for adaptive RT to account for radiation response.

Offline CBCT Quantification of Translational and Rotational Displacements Using Automated Image Matching in Head and Neck Radiotherapy: A Feasibility Study

Jillian Hayes (Presenter) ; Maeve L McGarry BSc ; Gregory Perkins BSc ; Rabih W Hammoud MSc, BSc ; Saju Divakar ; Mohamed P Riyas MBBS, MD ; Noora Al Hammad

Vascular/Interventional (MR Guidance/Topics of Interest)

Friday, 10:30 AM - 12:00 PM • E350

Utilization of the iPad for Patient Education during Informed Consent in Interventional Radiology: A Randomized Controlled Trial

Sahil V Mehta MD (Presenter) ; Lauren E Ferrara MD ; Seth J Berkowitz ; William C Lo ; Salomao Faintuch MD *

Purpose

To evaluate if interactive media presented on an iPad improves patient understanding and confidence during the informed consent process in interventional radiology.

METHOD AND MATERIALS

Patients were randomized into 4 groups. The control group (C) received an electronic consent form on the iPad. The second group was shown their radiology images (I) on an iPad. Dynamically displayed images were used to explain the patient’s disease and planned intervention. The third group was shown interactive anatomic drawings (D) of their disease and planned intervention. The final group was shown a short video animation about the procedure to be performed (V). Patients completed a survey to rate their experience.

RESULTS

Fifty-six consecutive patients completed the study, 14 in each group. Procedures included venous access, nephrostomy, gastrostomy, fibroid and chemo embolization, tumor ablation, angiogram and biopsy. Use of the iPad was graded as significantly helpful to understand the reasoning for the procedure by 86% of patients in the imaging group (I), 79% in the drawing group (D) and 71% in the video group (V), compared to 43% of controls (p < 0.05). Patients reacted positively to use of the iPad during informed consent, even when used as a simple replacement for a paper form. Nonetheless, clinical images and interactive drawings significantly improved patient understanding and confidence in the procedure to be
performed. While videos were considered helpful, they were received less positively by patients, perhaps due to a reduction in interactivity with the provider. The iPad is a useful tool to help build a patient-physician relationship before an interventional procedure.

**CLINICAL RELEVANCE/APPLICATION**
The iPad can be very helpful during informed consent for interventional radiology procedures. It can significantly increase patient understanding, confidence and satisfaction.

**SST16-02 • Radiology Milestones: A Multiyear Study of Resident Experience with Radiologic Procedures at a Large Academic Medical Center**

**Adam B Prater** MD (Presenter); **Bradley S Rostad** MD; **Emily Ebert** BS; **Rachel Kearns** BS; **Thomas W Loehfelm** MD, PhD; **Brent Little** MD; **Christopher P Ho** MD; **Mark E Mullins** MD, PhD

**PURPOSE**
The American College of Graduate Medical Education (ACGME) and the American Board of Radiology (ABR) initiated the Radiology Milestones Project in 2012 to create a framework for assessing the competency of radiology residents. An analysis of procedures performed by prior residents might help guide the assessment of procedural competency of current and future residents. Our study documented the most common types and numbers of procedures performed by radiology residents in a large academic center over a ten year period.

**METHOD AND MATERIALS**
Institutional review board approval was obtained. Resident procedure logs from graduating class years 2002 to 2012 were de-identified and organized into a secure electronic database. Summary statistics for each procedure type were calculated.

**RESULTS**
Resident procedure logs consisted of both paper and electronic forms, which varied in the number of resident participation and in the types and numbers of procedures documented. Over a ten year period, 110 residents recorded a total of 13,678 procedures consisting of 70 different procedure types. The most common recorded procedures were vascular catheter insertion, CT-Guided abdominal biopsies and drain placement, fluoroscopic Lumbar puncture, and ultrasound guided thoracentesis, paracentesis and thyroid biopsies. However, the numbers and types of procedures recorded for each resident varied considerably (mean 124 ± 75, max 331, min 15).

**CONCLUSION**
Although a wide variety of procedures are performed by residents during residency, resident procedural experience, as measured by procedure log data, varies significantly between residents even within the same program. This may be due to variability in resident procedure logging practices and procedures performed as data are manually entered by residents and are possibly underreported. Given the future directions suggested by the Radiology Milestones Project, our findings highlight the need for national guidelines regarding procedure requirements, and a more accurate method of acquiring radiology procedure data.

**CLINICAL RELEVANCE/APPLICATION**
The future of graduate medical education is geared towards data-driven metrics that can accurately depict resident progress and competence.

**SST16-03 • Magnetically Assisted Remote Controlled Endovascular Catheter for Interventional MRI: In Vitro Navigation at 1.5T**

**Aaron D Losey** MS (Presenter); **Prasheel Lillaney**; **Alastair Martin** *; **Daniel L Cooke** MD; **Mark W Wilson** MD; **Maythem Saeed** DVM, PhD; **Steven W Hetts** MD *

**PURPOSE**
Using real-time MRI for interventional procedures affords a wealth of physiologic and structural information. The promise of endovascular MR guided procedures remains unrealized in part because of the lack of MR compatible catheters and guide wires. Innovative techniques for guiding a catheter in the magnetic field of the MR scanner have been proposed, but limited functionality has been described to date. This study evaluates navigation of a magnetically assisted remote controlled (MARC) catheter compared to guidance without magnetic assistance in vitro at 1.5T.

**METHOD AND MATERIALS**
We have developed and tested MARC catheters for endovascular navigation. At angles of 45 degrees or greater magnetic assistance was significantly faster than non-assisted guidance. The MARC catheter provides a novel opportunity to navigate effectively in interventional MRI environment. Preclinical in vivo studies are underway.

**CONCLUSION**
We have validated the MARC catheter for endovascular navigation. At angles of 45 degrees or greater magnetic assistance was significantly faster than non-assisted guidance. The MARC catheter provides a novel opportunity to navigate effectively in interventional MRI environment. Preclinical in vivo studies are underway.

**CLINICAL RELEVANCE/APPLICATION**
Real-time MR guided catheter navigation with the MARC catheter could revolutionize minimally invasive procedures by advancing local treatment of stroke, cardiac arrhythmias and solid tumors.

**SST16-04 • Non-enhanced T1-weighted Imaging of the Visceral Arteries at 7 Tesla**

**Anja Fischer** MD (Presenter); **Oliver Kraff** MSc; **Stefan Maderwald** PhD, MSc; **Karsten J Beiderwellen** MD; **Thomas C Lauenstein** MD; **Lale Umutlu** MD *

**PURPOSE**
Aim of the study was to assess the feasibility of different non-contrast-enhanced T1-weighted (w) sequences for imaging of the visceral arteries of the upper abdomen at 7 Tesla.

**METHOD AND MATERIALS**
12 healthy volunteers were examined on a 7 T whole-body MR-system utilizing a custom-built 8-channel transmit/receive coil and radiofrequency shimming. The following non-enhanced sequences were acquired: (1) T1w 2D FLASH, (2) T1w 3D FLASH and (3) Time of flight (TOF) MRA in transversal orientation. The following visceral arteries were evaluated: 1) both common hepatic arteries, 2) coeliac and splenic artery, 3) superior and 4) inferior mesenteric artery. For qualitative analysis, image quality and the presence of artifacts were assessed using a five-point scale (image quality: 5 = excellent vessel delineation to 1 = non-diagnostic; artifacts: 5 = no artifact to 1 = non-diagnostic). Contrast Ratios (CR = (Svessel-Sliver)/(Svesssel+Sliver)) of the above named arteries in correlation to adjacent visceral tissue or psoas muscle were calculated for quantitative assessment. For statistical analysis, a Wilcoxon Rank Test was applied.

**RESULTS**
All three sequences provided a homogenous hyperintense delineation of the assessed visceral arteries. Qualitative image analysis showed a superiority of TOF MRA, providing best overall image quality (TOF 4.17, 2D FLASH 3.42, 3D FLASH 3.46) and highest mean values for image quality for all analyzed vessel segments. TOF MRA showed least impairment due to artifacts (overall artifacts TOF 4.08, 2D FLASH 3.50, 3D FLASH 3.46). Quantitative image analysis confirmed the superiority of the TOF sequence showing significant higher CR values for all visceral arteries due to an effective suppression of background signal (e.g. right hepatic artery TOF 4.25, 2D FLASH 3.54, 3D FLASH 3.33).

**CONCLUSION**
Non-contrast-enhanced T1w imaging in general and, TOF MRA in particular, appear to be promising techniques for good quality assessment of visceral arteries without the need of contrast media at 7 Tesla.

**CLINICAL RELEVANCE/APPLICATION**

MR-guided Focused Ultrasound Ablation of Pancreatic Cancer: A Totally Non-invasive Treatment for Pain Palliation and Tumor Control of Locally Advanced Lesions (Stage III)

Fulvio Zaccagna MD (Presenter); Alessandro Napoli MD; Gaia Cartocci; Gulia Brachetti; Fabrizio Boni; Vincenzo Noce MD; Luca Bertacini; Maurizio Del Monte; Carlo Catalano MD

PURPOSE
To evaluate the feasibility of MR-guided focused ultrasound (MRgFUS) ablation for pain palliation and local tumor control in selected patients with unresectable primary pancreatic adenocarcinoma.

METHOD AND MATERIALS
6 patients with histologically proven unresectable pancreatic adenocarcinoma, who were clinically unable (n 4) or refused (n 2) to undergo chemo-radiation therapy, underwent MRgFUS treatment on a dedicated 3T unit featuring the ExAblate 2100 system (InSightec). All lesions were evaluated for device accessibility prior to treatment. MRgFUS procedures were performed in general anesthesia with constant breath control. Clinical assessment included evaluation of symptoms severity with visual analogue scale (VAS) before and after treatment. After treatment all patients underwent CHT with the same chemotherapy scheme. Imaging follow-up, including both CT and MR examinations, was performed immediately after treatment and at 3 and 6 months in order to evaluate the effects of MRgFUS on the targeted tumor and the absence of procedure-related complications.

RESULTS

CONCLUSION
Our preliminary clinical experience suggests that MRgFUS is a feasible and repeatable ablative technique in selected patients with unresectable and device-accessible pancreatic adenocarcinoma.

CLINICAL RELEVANCE/APPLICATION
MRgFUS treatment for locally advanced pancreatic tumor is a safe procedure and could be repeated without increase of adverse event
Despite medical advances, multidrug-resistant (MDR) cancers continue to challenge the patients. Their clinical prognoses may further be complicated by the need for additional surgical procedures and/or radiotherapy. In this study, we seek to evaluate a new strategy in which the synergy of high-intensity focused ultrasound (HIFU) and a single low dose of a generic chemotherapeutic is utilized to attack MDR solid tumor cells.

**METHOD AND MATERIALS**

This strategy is partly an outgrowth of an in-house Phase 4 clinical trial in which MRI-guided HIFU was used to treat uterine fibroids. The clinical procedure was adapted for the 3-day in vitro study during which human uterine sarcoma cell line (MES-SA/Dx5 (ATCC CRL1977)), known for resistance to multiple drugs such as Doxorubicin (Dox), was paradoxically treated with Dox.

Day 1: Each data sample consisted of ~20K cells grown inside a well of 8-well glass slides (Lab-Tek). The well was then filled with McCoy’s media and incubated at 36 °C for 4h. Afterward each well was sealed and secured onto a fixture before being submerged in a warm degassed water bath. The targets for HIFU were the center points of the 4 quadrants of each well’s base. The constant HIFU parameters for each well were acoustic pressure 7MPa, RF 1Hz, focal-zone depth and 30 sec/sonication/center point while duty cycle (DC) ranged 0-60% between the wells. 2h after HIFU treatment, the wells were unsealed and incubated overnight.

Day 2: Cell media for each well was replaced with fresh media containing [Dox] 0-1 ug/mL prior to repeating the HIFU procedure from 24h earlier.

Day 3: After 24h of exposure to Dox, cell survivability study was performed to determine the contributions of HIFU-mediated necrosis and Dox-mediated apoptosis.

**RESULTS**

Cell survivability decreased by increasing [Dox] or DC. In the Dox-only group (DC 0%), average survivability was 93% for [Dox] 0.5 ug/mL while in the HIFU-only group ([Dox] 0 ug/mL), average survivability was 42% for DC 50%. In contrast, there was virtually no survivability of sarcoma cells for [Dox] 0.5 ug/mL and DC = 50%.

**CONCLUSION**

The synergy of HIFU and low-dose Doxorubicin was successful in virtually eliminating MDR uterine sarcoma cells.

**CLINICAL RELEVANCE/APPLICATION**

A combination of HIFU and a low-dose generic chemotherapeutic may be a promising alternative to existing treatments (regular-dose multidrug regimen, surgery or radiotherapy) against some MDR cancers.

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**Disclosure Index**

**A**

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Brook, O. R. - Research Grant, Guerbet SA
<table>
<thead>
<tr>
<th>Name</th>
<th>Affiliation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gagnon, D.</td>
<td>Employee, Toshiba Corporation</td>
</tr>
<tr>
<td>Gaillard, F.</td>
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</tr>
<tr>
<td>Galanau, D.</td>
<td>Research Consultant, Olea Medical</td>
</tr>
<tr>
<td>Galban, C. J.</td>
<td>Inventor, ImBio, LLC</td>
</tr>
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<td>Gandhi, K. D.</td>
<td>Research funded, General Electric Company</td>
</tr>
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<td>Ganeshan, B.</td>
<td>Scientific Director, TexRAD Limited</td>
</tr>
<tr>
<td>Ganguli, S.</td>
<td>Research Grant, Merit Medical Systems, Inc</td>
</tr>
<tr>
<td>Gao, H.</td>
<td>Employee, General Electrical Company</td>
</tr>
<tr>
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<td>Consultant, Document Storage Systems, Inc</td>
</tr>
<tr>
<td>Garin, E.</td>
<td>Consultant, Nordin, Inc</td>
</tr>
<tr>
<td>Garrett, J. W.</td>
<td>Research Grant, Hologic, Inc</td>
</tr>
<tr>
<td>Gaskin, C. M.</td>
<td>Research Consultant, Johnson &amp; Johnson Author with royalties, Oxford University Press Author with royalties, Thieme Medical Publishers, Inc</td>
</tr>
<tr>
<td>Gauvin, A.</td>
<td>Shareholder, Connectimage Medical Inc</td>
</tr>
<tr>
<td>Gazzella, G.</td>
<td>Consultant, General Electric Company Consultant, Marval Biosciences Inc</td>
</tr>
<tr>
<td>Gebauer, B.</td>
<td>Research Consultant, C. R. Bard, Inc Research Consultant, Sirtex Medical Ltd Research Grant, C. R. Bard, Inc Research Consultant, Perceptive Inc</td>
</tr>
<tr>
<td>Geeraert, N.</td>
<td>Employee, General Electric Company</td>
</tr>
<tr>
<td>Geiger, B.</td>
<td>Employee, Siemens AG</td>
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<tr>
<td>George, R. T.</td>
<td>Research Grant, Toshiba Corporation Research Grant, General Electric Company Consultant, ICON plc</td>
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<tr>
<td>Geppert, C.</td>
<td>Employee, Siemens AG</td>
</tr>
<tr>
<td>Gervais, D. A.</td>
<td>Research Grant, Cividien AG</td>
</tr>
<tr>
<td>Geschwind, J. H.</td>
<td>Consultant, Biocompatibles International plc Grant, Bayer AG Consultant, Guerbet SA Consultant, Nordin, Inc Grant, Biocompatibles International plc Grant, F. Hoffmann-La Roche Ltd, Inc Grant, Bayer AG Grant, Koninklijke Philips Electronics NV Grant, Nordin, Inc Grant, ContextVision AB Grant, CeloNova Biosciences, Inc Founder, PreScience Labs, LLC CEO, PreScience Labs, LLC</td>
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<tr>
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<td>Speaker, General Electric Company</td>
</tr>
<tr>
<td>Ghaghada, K. B.</td>
<td>Research Grant, Marval Biosciences Inc Consultant, Marval Biosciences Inc Shareholder, Marval Biosciences Inc</td>
</tr>
<tr>
<td>Ghal, S.</td>
<td>Investigator, Insightech Ltd</td>
</tr>
<tr>
<td>Giller, J. K.</td>
<td>Intellectual property, Magnetic Resonance Elastography Stockholder, Resound Inc</td>
</tr>
<tr>
<td>Gilelmi, C.</td>
<td>Employee, Siemens AG</td>
</tr>
<tr>
<td>Goermer, F. L.</td>
<td>Research Grant, Siemens AG Research Grant, Bayer AG Research Grant, Bracco Group</td>
</tr>
<tr>
<td>Goh, V. J.</td>
<td>Research Grant, Siemens AG</td>
</tr>
<tr>
<td>Goldberg, S.</td>
<td>Consultant, AngioDynamics, Inc Research support, AngioDynamics, Inc Research support, Cosman Medical, Inc Consultant, Cosman Medical, Inc</td>
</tr>
<tr>
<td>Goldszal, A. F.</td>
<td>Advisory Board, FUJIFILM Holdings Corporation Advisory Board, MedInformatix, Inc</td>
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<tr>
<td>Gomez, A. S.</td>
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<tr>
<td>Gomori, J. M.</td>
<td>Research Consultant, Medic Vision Ltd Research Consultant, BrainWash Ltd Research Consultant, Medtronic, Inc Scientific Advisor, Brainwash Ltd</td>
</tr>
<tr>
<td>Gonzalez Guindalini, F. D.</td>
<td>Grant, Siemens AG</td>
</tr>
<tr>
<td>Goo, J.</td>
<td>Research Grant, Guerbet SA Research Grant, Toshiba Corporation</td>
</tr>
<tr>
<td>Goodman, M. M.</td>
<td>Royalties, Nikon Medi-Physics Co, Ltd</td>
</tr>
<tr>
<td>Goldsitt, M. B.</td>
<td>Research collaboration, General Electric Company</td>
</tr>
<tr>
<td>Gordon, P. B.</td>
<td>Stockholder, OncoGenex Pharmaceuticals, Inc Scientific Advisory Board, Hologic, Inc Consultant, Seno Medical Instruments, Inc</td>
</tr>
<tr>
<td>Grant, K.</td>
<td>Employee, Siemens AG</td>
</tr>
<tr>
<td>Graser, A.</td>
<td>Speakers Bureau, Siemens AG Speakers Bureau, Bracco AG Grant, Bayer AG</td>
</tr>
<tr>
<td>Green, G.</td>
<td>Research Consultant, ViewRay, Inc</td>
</tr>
<tr>
<td>Greiser, A.</td>
<td>Employee, Siemens AG</td>
</tr>
<tr>
<td>Grien, K. L.</td>
<td>Chicago cyber knife LLC</td>
</tr>
<tr>
<td>Grignon, L.</td>
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</tr>
<tr>
<td>Grimm, L. J.</td>
<td>Board Member, Medscape, LLC Consultant, Medscape, LLC</td>
</tr>
<tr>
<td>Griswold, M. A.</td>
<td>Research support, Siemens AG Royalties, Siemens AG Royalties, Siemens AG Royalties, Bruker Corporation Contract, Siemens AG</td>
</tr>
<tr>
<td>Grodzki, D.</td>
<td>Employee, Siemens AG</td>
</tr>
<tr>
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<td>Investigator, GlaxoSmithKline plc Investigator, General Electric Company Investigator, Siemens AG Advisory Board, Merck &amp; Co, Inc</td>
</tr>
<tr>
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</tr>
<tr>
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<td>Employee, Siemens AG</td>
</tr>
<tr>
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</tr>
<tr>
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<tr>
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Hwang, T. - Intern, Siemens AG
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<tr>
<th>Name</th>
<th>Affiliation and Details</th>
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<td>Nackaerts, K.</td>
<td>Speaker, Pfizer Inc Speaker, Novartis AG Advisory Board, Pfizer Inc Travel support, AstraZeneca PLL Travel support, Eli Lilly and Company</td>
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<td>Dfine, Inc. Provision of consulting services regarding the use of radiotherapy for palliative treatment of bone metastases.</td>
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<td>Investigator, Toshiba Corporation 2. AUR GE Radiology Research Academic Fellowship (GERRAF) Award, General Electric Corporation</td>
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