**Monday, December 02, 2013**
08:30-10:00 AM • RC221 • Room: S404AB • Medical Physics 2.0: Mammography
03:00-04:00 PM • SSE02 • Room: E450A • Breast Imaging (Digital Breast Tomosynthesis Lesions)

**Tuesday, December 03, 2013**
08:30-12:00 PM • VSBR31 • Arie Crown Theater • Breast Series: Emerging Technologies in Breast Imaging
03:00-04:00 PM • SSJ01 • Arie Crown Theater • Breast Imaging (Screening and Density)
03:00-04:00 PM • SSJ02 • Room: E450A • ISP: Breast Imaging (Computed Tomography)

**Wednesday, December 04, 2013**
10:30-12:00 PM • SSK01 • Arie Crown Theater • Breast Imaging (Digital Breast Tomosynthesis Screening Outcomes)
03:00-04:00 PM • SSM02 • Room: E451A • Breast Imaging (Multimodality Breast Imaging)

**Thursday, December 05, 2013**
10:30-12:00 PM • ICII51 • Room: S501ABC • Breast Imaging: Interoperability Challenges and Solutions
10:30-12:00 PM • SSQ02 • Room: E450A • Breast Imaging (CAD/Quantitative Imaging)
04:30-06:00 PM • RC715 • Room: E451B • Digital Breast Tomosynthesis

**Friday, December 06, 2013**
10:30-12:00 PM • SST01 • Room: E450B • Breast Imaging (Issues in Screening)

## Medical Physics 2.0: Mammography

**Monday, 08:30 AM - 10:00 AM • S404AB**

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**RC221** • *AMA PRA Category 1 Credit* ™:1.5 • ARRT Category A+ Credit:1.5
**Co-Director**
**Ehsan Samei** , PhD *
**Co-Director**
**Douglas E Pfeiffer** , MS *

### RC221A • Mammography Perspective

**Douglas E Pfeiffer** MS (Presenter) *

LEARNING OBJECTIVES
1) Understand the history and development of mammographic imaging equipment. 2) Understand the impact of equipment development on testing protocols. 3) Understand the impact of equipment development on regulation.

ABSTRACT
Mammographic imaging has undergone tremendous change since its inception. Rapid development from screen-film imaging to nearly universal acceptance of digital imaging has required a shift in testing methodology. This talk will briefly introduce the developments that have taken place and discuss the impact that this development has had on testing and regulation.

### RC221B • Mammography 1.0

**Melissa C Martin** MS (Presenter)

LEARNING OBJECTIVES
1) Current requirements for Quality Control for Hologic Digital Mammography Units. 2) Current requirements for Quality Control for General Electric Digital Mammography Units. 3) Current requirements for Quality Control for Fuji Computed Radiography for Mammography Units. 4) Current requirements for Quality Control for Printers used with Digital Mammography Units. 5) Current requirements for Quality Control for Monitors used with Digital Mammography Units.

### RC221C • Mammography 2.0

**Eric A Berns** PhD (Presenter)

LEARNING OBJECTIVES
1) To provide an overview of how the Medical Physicist can prepare for the future of clinical mammography physics. 2) To provide a landscape of mammography imaging technologies. 3) To describe methods of image quality metrics, dose reduction, and quality control in relation to mammography technologies. 4) To describe the future roles of the Medical Physicist in clinical mammography physics.

## Breast Imaging (Digital Breast Tomosynthesis Lesions)

**Monday, 03:00 PM - 04:00 PM • E450A**

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**SSE02** • *AMA PRA Category 1 Credit* ™:1 • ARRT Category A+ Credit:1
**Moderator**
**Liane E Philpotts** , MD *
**Moderator**
**Per Skaane** , MD, PhD *

### SSE02-01 • Digital Breast Tomosynthesis (DBT) and Breast Magnetic Resonance Imaging (MRI): Additional Roles as Compared to Conventional Digital Mammography (DM) in Assessment of Breast Disease

**Dalia S El Mesidy** MBBCh, MSc (Presenter) ; **Rasha M Kamal** MD ; **Sahar Mansour** MD ; **Ahmed H Khalil** MSc, MD

PURPOSE

To assess the additional role of DBT and MRI in comparison to conventional DM in the characterization of different breast lesions and to evaluate their impact on diagnosis and consequent management.

METHOD AND MATERIALS
55 patients, having 60 breast lesions were referred from the Surgery clinic to the Radiology Department to be assessed by DM, DBT and MRI. An informed written consent to participate in the study was obtained from all patients. Breast US was performed for all cases.Mammography images were acquired using the 'combo mode', a feature that acquires both a DM and a DBT scan in the same compression. MRI was performed using a 1 T system. Each lesion was assigned a blinded BIRADS score for each modality (DM, DBT and MRI) individually by different readers blinded to each other results. BIRADS scores of 1-3 were considered benign, and BIRADS scores of 4 and 5, were considered malignant. The resultant BIRADS scores for each modality were correlated with reports of pathology specimens.

RESULTS
The sensitivity for DM was 87% and those of DBTand MRI were equivalent to 93.75%. The specificity for DM was 50%,that for DBT was 84.1% and that of MRI was 86.36%.The PPV of DM was 38.89%,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 Martincich** MD * ; **Enrica Caramia** ; **Pier Paolo Campanino** ; **Andrea Luparia** ; **Laura Bergamasco** ; **Paolo Fonio** ; **Giovanni Gandini** MD

PURPOSE
To compare the diagnostic performance of DM with that of DM combined with DBT for the detection of ILC.

METHOD AND MATERIALS
We conducted a retrospective multi-reader blinded study, including 6 radiologists with experience of breast imaging ranging between 15 and 4 years and DBT experience ranging between 4 years and no experience (inexperienced readers underwent a DBT training session prior to the study). The radiologists interpreted 56 examinations of women (mean age 59.4 years, range 40-78) with 68 newly diagnosed ILCs, proved at definitive histology (tumours mean size 30.1 mm; range 5-95). All women, who signed an informed consent, underwent mammographic bilateral two standard views in Combo mode: DM and DBT images were acquired within a single compression for each projection. The readers, blinded to histology, were asked to primarily detect lesions in 2D images alone, reporting in previously predisposed modules breast density, mammographic signs with BI-RADS category, localization and size of lesions; then, they were asked to detect lesions by viewing DBT images in conjunction with 2D images, reporting the same parameters. Two experienced radiologists, non-participants in the study, compared the results of each reader to pathology. A statistical analysis was performed to evaluate performances and inter-observer agreement.

RESULTS
All 6 readers had a significantly higher sensitivity for detection of ILC by using DM combined with DBT (ranging between 84-91%) than DM alone (77-80%) (p=0.0002). There was no significant difference (p=0.29) in specificity values (DM alone 56.6-92.3%, DM combined with DBT 69.2-92.3%). The diagnostic accuracy was higher considering DM combined with DBT (ranging between 80.3-91.4%) than DM alone (69.2-85.5%) (p=0.0029). Considering breast density, for the readers the relative risk to miss a ILC in dense breasts (30/56) by using DM alone compared to DM with DBT was 2.0 (1.3-3.3) (p=0.0007) (i.e. a 100% increase in the probability of missing the cancer). In the no dense breasts (26/56), there were no significant differences (p=0.34).

CONCLUSION
The addition of DBT significantly increased sensitivity and diagnostic accuracy of DM in detecting ILCs, especially in dense breasts.

CLINICAL RELEVANCE/APPLICATION
The use of Digital Breast Tomosynthesis in addition to Digital Mammography (DM) improve diagnostic performances of DM and could be helpful in detecting Invasive Lobular Carcinomas.

**SSE02-03 ● Comparison of Lesion Detection and Characterization in Invasive Cancers Using Breast Tomosynthesis versus Conventional Mammography**

**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 on 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.

**SSE02-04 ● 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%,4/30). 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 and 2D mammography.

CLINICAL RELEVANCE/APPLICATION
As tomosynthesis becomes more widely utilized, it is pertinent to understand its relative benefit in different groups of patients.

**SSE02-05 ● Role of Digital Breast Tomosynthesis (DBT) Combined with Digital Mammography (DM) in Second-look (SL) for the Evaluation of Additional Lesions Detected on Preoperative Breast Magnetic Resonance Imaging (MRI): Preliminary Experience**

**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. Suspicious 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.
Considering the MRI morphological features of the 32 lesions depicted by SL DM+DBT, 15/32 (46.9%) were non mass-like, 9/32 (28.1%) mass-like and 8/32 (25%) foci. At SL DM+DBT, lesions were 13/32 (40.6%) small masses, 8/32 (25.0%) asymmetric densities with microcalcifications and 11/32 (34.4%) architectural distortions. Of these lesions, 24/32 were subsequently detected on re-targeted US and biopsied under US guidance if suspicious (8/24, 33.3% were cancer). 8/32 lesions were detected only by SL DM+DBT and biopsied under stereotactic guidance if suspicious (2/8, 25% were cancer). Of the 18/50 additional lesions not identified by SL DM+DBT, 2/18 were MR4 (underwent MRI-guided biopsy, resulting atypical ductal hyperplasia) and 16/18 MR3 (all cases sent to follow-up, resulting disease-free).

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. Particular attention was given to BI-RADS 3 and the reasons including asymmetries, calcifications, masses or architectural distortion were evaluated and compared between the two groups.

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, 563 patients were categorized as BI-RADS 3(27.6%), 1315 patients as BI-RADS 1 or 2(64.6%), 153 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
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
Tomosynthesis use in diagnostic mammography can reduce the number of patients categorized as BI-RADS 3 requiring follow up.

## Breast Series: Emerging Technologies in Breast Imaging

**Tuesday, 08:30 AM - 12:00 PM • Arie Crown Theater**

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**VSBR31** • *AMA PRA Category 1 Credit* ™:3.25 • ARRT Category A+ Credit:4
**Moderator**
**Michael A Cohen** , MD
**Moderator**
**John M Lewin** , MD *

LEARNING OBJECTIVES
ABSTRACT

### VSBR31-01 • Contrast Mammography

**John M Lewin** MD (Presenter) *

LEARNING OBJECTIVES
1) This course will review the use of contrast enhancement in mammography- prior results with temporal evaluation and current results using dual energy technology. 2) Results of trials comparing contrast enhancement with standard breast imaging such as routine mammography, ultrasound and MRI will be discussed.

ABSTRACT
Contrast-enhanced digital mammography, now a clinically available product, continues to be a fruitful area of both basic and clinical research. This session will provide an overview of the physics of CEDM, its history, recent research results, current status and potential clinical applications.

### VSBR31-02 • Contrast-enhanced Spectral Mammography vs. Mammography and MRI - Clinical Performance in a Multi-reader Evaluation

**Eva M Fallenberg** MD (Presenter) * ; **Felix Diekmann** MD * ; **Corinne Balleyguier** MD ; **Diane M Renz** MD ; **Ritse M Mann** MD, PhD * ; **Florian Engelken** MD, MBBCh ; **Alexander Poellinger** MD ; **Heba A Amer** ; **Clarisse Dromain** MD

PURPOSE
To compare contrast-enhanced digital mammography (CESM) to mammography (MG) and MRI on diagnostic accuracy of histologically proven breast lesions.

METHOD AND MATERIALS
The study was approved by Health Authorities and Ethics Committee. 90 consenting patients diagnosed with breast cancer were imaged with MG, CESM and MRI and underwent surgery. CESM was performed as a bi-lateral mammography starting 2 minutes after injection of 1.5ml/kg of an iodinated contrast agent (300 mg/ml) with a flow of 3ml/s. CESM images alone and MG images were interpreted by two blinded independent radiologists with an interval of minimum 4 weeks for memory wash-out. MRI was analyzed by another set of two independent readers. Per lesion sensitivity and specificity were evaluated across readers. BI-RADS 4 was defined as threshold for true positives. Gold standard was post-surgical histology.

RESULTS
105 malignant and 10 benign histologically proven lesions were assessed in this dataset.
Average sensitivity were 84.1% (reader1) and 67% (reader 2) for MG, 90.2% and 88.8% for CESM and 91.1% and 90% for MRI, respectively.
Specificity was 100% (reader 1) and 80% (reader 2) for MG, 81.8% and 90% for CESM and 71.4% and 50% for MRI.

CONCLUSION
CESM and MRI showed similar sensitivity for index cancer and multiple foci, both superior to MG. MG and CESM outperformed MRI in specificity.

CLINICAL RELEVANCE/APPLICATION
CESM is a reliable imaging technique, which may replace MRI in cases with contraindications and may replace MG due to superior diagnostic accuracy in symptomatic patients.

### VSBR31-03 • Contrast-enhanced Spectral Digital Mammogram versus Contrast-enhanced MR Mammography in the Assessment of Breast Carcinoma: Initial Clinical Experience

**Maha Helal** MD (Presenter) ; **Rasha M Kamal** MD ; **Radwa Essam** MBBS ; **Iman Godda** MD ; **Sahar Mansour** MD ; **Nelly Alieldin** MD ; **El-Shaimaa M Sharaf** MBBCh

PURPOSE
evaluate the diagnostic performance of contrast-enhanced spectral digital mammography versus dynamic contrast-enhanced magnetic resonance imaging in the detection and staging of breast cancer.

METHOD AND MATERIALS
In this institutional ethics approved prospective study, we compared the performance of contrast based digital mammography with magnetic resonance imaging on 70 female patients. Standard digital mammogram was done in the mediolateral oblique and craniocaudal projections followed by low (22–33 kVp) and high (44–49 kVp) energy exposures in the same projections. Sequentional post contrast magnetic resonance imaging was set in the axial orientation and post processed using maximum intensity projection and multiplanar reconstruction images. Both examinations performed by IV injection of non- ionic contrast agent. Outcomes of the surgical specimen or ultrasound guided core biopsy were the gold standard of reference in all cases.

RESULTS
The study included 33 pathologically proved benign (47 %) and 37 (53%) malignant breast lesions. The areas of contrast uptake had been correlated with abnormalities seen on the conventional mammography. Both contrast enhanced digital mammography and magnetic

resonance imaging were individually assessed in the same group of cases. Multicentric and multifocal carcinomas were detected by contrast mammograms in 29.7% (n=11) of diagnosed malignant cases, when only unifocal carcinoma was reported on conventional mammograms. In the contest of malignancy both modalities stood on the same land. Enhancement detection of some benign lesions (n=5) was limited in digital mammography. Statistical analysis yielded a sensitivity, specificity and accuracy of 93.7%, 66.6% and 80.6% compared to 93.7 %, 86.6% and 90.3% for contrast enhanced mammograms and magnetic resonance imaging respectively

CONCLUSION
Contrast-enhanced digital mammogram is non-inferior to breast MRI in the contest of detection and characterization of breast malignancy.

CLINICAL RELEVANCE/APPLICATION
Contrast-enhanced mammography is an advanced application of digital mammography that had to be compared with breast MRI as it is more applicable and cost effective.

**VSBR31-04 ● Contrast-enhanced Breast Tomosynthesis versus Dynamic Contrast-enhanced Breast MRI in the Diagnosis of Suspicious Breast Lesions on Mammogram**

**Chen-Pin Chou** MD (Presenter) * ; **Chia-Ling Chiang** ; **Tsung-Lung Yang** MD

PURPOSE
To compare the diagnostic performance of contrast-enhanced breast tomosynthesis (CEBT) and dynamic contrast-enhanced breast MRI (DCE-MRI) for breast lesions detected on digital mammogram.

METHOD AND MATERIALS
The study was approved by institutional review board. Written informed consent was obtained from all patients. A total of 102 consecutive women suspected of having breast lesions on digital mammogram between March 2012 and December 2012 underwent both CEBT and DCE-MRI. For the dual-energy CEBT, a modified Selenia Dimensions (Hologic, Inc.) machine was used. Simultaneously 2D mammogram and 3D tomosynthesis were taken after injection with 1.5 mL iodine contrast agent per kilogram of body weight of and imaged between 2 and 6 minutes after injection. Contrast-enhanced images were taken in the suspicious breast (pre-contrast MLO view, post-contrast CC and MLO view) and contralateral breast (post-contrast MLO view). The lesion classifications on CEBT were finally determined based on findings on 2D mammogram, 3D tomosynthesis and post-contrast subtraction 2D and 3D images. Women were also evaluated at 1.5T (GE) or 3T MRI (Siemens) with dedicated breast coil. CEBT and DCE-MRI were interpreted by different radiologists.

RESULTS
Total 90 histological findings were available in 76 women (mean age 50.7 years, range 35-66 years). About 89% women did not have clinical symptoms. Ten women had two breast lesions in unilateral breasts. Four women had bilateral breast lesions. Of the 90 lesions, 67% had microcalcification on mammogram. The pathology revealed 46 benign lesions and 44 breast malignancies (21 carcinoma in situ, and 23 invasive breast cancers). The sensitivity/ specificity for CEBT and DCE-MRI were 97%/63% and 91%/63%, respectively.

CONCLUSION
Both CEBT and DCE-MRI showed similar diagnostic efficacy for women with suspicious breast lesions on mammogram, but CEBT was faster and easily accomplished diagnostic tool than breast DCE-MRI.

CLINICAL RELEVANCE/APPLICATION
CEBT may be an alternative tool for women who have suspicious breast lesions and cannot tolerate breast DCE-MRI.

**VSBR31-05 ● Benign Enhancement on Contrast Enhanced Dual Energy Digital Mammography**

**Maxine S Jochelson** MD (Presenter) ; **D. David Dershaw** MD ; **Janice S Sung** MD ; **Mary Hughes** MD ; **Elizabeth A Morris** MD

PURPOSE
To describe the incidence, appearance and etiologies of non-malignant enhancing lesions depicted on contrast enhanced dual energy digital mammography (CEDM).

METHOD AND MATERIALS
In a retrospective HIPAA compliant IRB approved study, images and clinical histories of 100 consecutive women who underwent CEDM for either breast cancer staging or high risk screening were reviewed. The incidence of benign, focally enhancing lesions or diffuse parenchymal enhancement on CEDM, diagnosed by either biopsy, correlation with the clinical history or recent MRI findings, was determined.

RESULTS
CEDM was performed for staging of known cancer in 67/100 (67%) and for high risk screening in 33/100 (33%). 95/100 (95%) of patients had a breast MRI within 30 days of CEDM. Focal enhancement, subsequently determined to be the result of a benign process , was detected in 11/100 (11%) of women: 8/67 (12%) of women with cancer and 3/33 (9%) of screening patients. 5 patients demonstrated rim enhancing lesions: 3 corresponded to cysts on MRI (2 simple and 1 inflammed) and 2 to seromas at the site of recent intervention. 1 corresponded to a skin lesion on MRI. 5 other areas of focal enhancement underwent biopsy yielding radial scar, fibroadenoma, adenosis, PASH, and periductal inflammation. Diffuse background parenchymal enhancement was present in 26/100 (26%), all of whom had a similar pattern on MRI.

CONCLUSION
Focal non-malignant enhancement occurred in 11% of studies. Etiologies included cysts, seromas, a radial scar and a fibroadenoma among others. Half of them required tissue sampling to exclude malignancy. Appreciating the imaging appearance of these benign lesions may potentially prevent unnecessary biopsies in the future.

CLINICAL RELEVANCE/APPLICATION
Both focal and diffuse non malignant enhancement can be seen on CEDM. Recognition of the appearance of these findings may improve the specificity of this exam and limit unnecessary biopsies.

**VSBR31-06 ● Tomosynthesis**

**Mark A Helvie** MD (Presenter) *

LEARNING OBJECTIVES
1) To understand the basic principles used in obtaining digital breast tomosynthesis (DBT) images. 2) To understand experimental and clinical trial data which form the basis for DBT clinical application. 3) To understand the potential benefits and areas of weakness of DBT compared to conventional mammography. 4) To understand the potential clinical applications of DBT and current regulatory status of DBT. 5) To understand future issues related to DBT.

ABSTRACT
DBT clinical trial data is emerging which will form the basis of clinical use. Because DBT has the potential to significantly change the practice of breast imaging, careful review of the results of these trials and implications for clinical practice is essential for informed decision regarding DBT.

**VSBR31-07 ● Implementation of Synthesized 2D Plus Tomosynthesis Images in Breast Cancer Screening: Comparison of Performance Levels with Full Field Digital Mammography Plus Tomosynthesis in a Population-based Screening Program**

**Per Skaane** MD, PhD (Presenter) * ; **Randi Gullien** RT * ; **Ellen B Eben** MD * ; **Ingvild N Jebsen** * ; **Unni Haakenaasen** MD * ;

**Ulrika Ekseth** MD * ; **Mona Krager** MD *

PURPOSE
To compare diagnostic performance of combined FFDM plus digital breast tomosynthesis (DBT) with synthesized 2D (C-view) plus DBT in breast cancer screening.

METHOD AND MATERIALS
Eight radiologists prospectively interpreted independently 12,271 screening examinations including FFDM plus DBT and C-View plus DBT. Both reading modes included standard CC and MLO views of each breast. A 5-point rating scale for probability of cancer was used in the image interpretation. All cases with a positive score (defined as 2 or higher) were discussed at an arbitration meeting before decision for final recall. The reconstructed images (C-Views) do not require additional radiation exposure. Using analyses for binary data accounting for correlated interpretations and adjusted for reader-specific volume and performance levels and two-sided significance levels of 0.05, we compared performance levels when using C-view plus DBT with respect to positive scores, recall rates, and cancer detection rates with the corresponding FFDM plus DBT interpretations.

RESULTS
Interpretation of 12,271 independently interpreted examinations under the two modes resulted in 656 (656/12,271=5.3%) and 651 (651/12,271=5.3%) positive scores for the FFDM plus DBT and the C-view plus DBT, respectively. Following arbitration meeting, the recall rates were 297/12,271= 2.4% and 270/12,271=2.2%, respectively. The cancer detection rate was 100/12,271=0.81% and 100/12,271=0.81%, for FFDM plus DBT and C-view plus DBT, respectively. There was no significant difference in the cancer detection between the two modes (McNemar test, p=0.85).

CONCLUSION
Synthetically reconstructed 2D images applied in combination with DBT showed comparable results regarding positive predictive values and cancer detection rates with FFDM plus DBT.

CLINICAL RELEVANCE/APPLICATION
The use of synthetically reconstructed 2D images (C-View) in combination with tomosynthesis resulted in comparable performance to actual exposure generated 2D plus tomosynthesis.

**VSBR31-08 ● Diagnostic Accuracy of Combination Synthetic Mammograms with Tomosynthesis vs. Combination FFDM with Tomosynthesis**

**Margarita L Zuley** MD (Presenter) ; **Andriy I Bandos** PhD ; **Jules H Sumkin** DO * ; **Victor J Catullo** MD ; **Amy H Lu** MD ; **Denise Chough** MD ; **Marie A Ganott** MD ; **Grace Y Rathfon** MD ; **Luisa P Wallace** MD

PURPOSE
To assess the diagnostic performance of combination synthetic mammograms and tomosynthesis (synthetic 2D+Tomo) to combination FFDM and tomosynthesis (FFDM+Tomo)

METHOD AND MATERIALS
IRB approval was obtained. 123 cases deemed challenging by 2 non-participating independent reviewers were chosen from our research database to create a stress test, including 36 biopsy verified cancers, 35 biopsy proven benign lesions and 52 recalled screening exams proven to be normal on recall and 1 year follow up. 5 academic womens imagers performed a retrospective fully crossed and balanced multi case multi reader study where each study was reviewed twice, once with the synthetic mammogram and then tomosynthesis and once with the standard mammogram and then tomosynthesis. Probability of malignancy (POM) on a 100 point scale and BI-RADS scores were recorded for the 2D study and then again with tomosynthesis for each mode. Data analysis was performed using random-reader analysis (DBM MRMC, v.2.33) based on the nonparametric area under the ROC curve (AUC).

RESULTS
The reader-averaged AUC for the FFDM+Tomo and synthetic 2D+Tomo modalities were 0.898 and 0.871 correspondingly (p=0.15). Four readers performed somewhat poorer albeit not significantly (p>0.05) with synthetic 2D+Tomo. The average difference of 0.027 was not statistically significant with 95% confidence interval from -0.013 to 0.067.

CONCLUSION
Synthetic 2D mammograms with tomosynthesis allowed similar interpretive performance to standard FFDM in combination with tomosynthesis and, therefore, may be an acceptable alternative for screening.

CLINICAL RELEVANCE/APPLICATION
Lowering radiation dose during tomosynthesis based screening is possible with synthesized 2D images.

**VSBR31-09 ● Features of Additional Breast Cancers Detected by Digital Breast Tomosynthesis after Normal Digital Mammography**

**Paula Martinez Miravete** ; **Jon Etxano** MD (Presenter) ; **Pedro Slon** MD ; **Paula B Garcia** MD ; **Maite Millor** MEd ; **Luis Pina** MD, PhD

PURPOSE
To evaluate the radiological presentation and histology of breast cancers detected by digital mammography (DM) and additional cancers detected by complemmentary Digital Breast Tomosynthesis (DBT).

METHOD AND MATERIALS
From December 2010 to Septembre 2012, we prospectively recruited 9300 consecutive patients with ACR density patterns II, III and IV in a enriched population that underwent both DM and DBT (COMBO mode).165 patients with cancer were detected using the COMBO mode. Out of these 165 breast tumors, 105 were detected by DM and 71 by additional DBT. We retrospectively evaluated the features of the radiological presentation and histology of breast cancers detected by DM and breast cancers detected by DBT. For the statistical analysis we performed a Pearson's Chi Square test with the SPSS 15.0 software.

RESULTS
Significant differences were found regarding the radiological presentation of both groups (p0.05) were found in the rate of Invasive Ductal Cancers (DM= 35/105; 33%, DBT=25/61; 41%) and Invasive Lobular Carcinoma (DM= 14/105; 13.3%, DBT=13/61; 21.3%).

CONCLUSION
The additional breast cancers detected by DBT show different radiological presentation and histology than breast cancers detected with DM, being more common architectural distortions and tubular breast cancers.

CLINICAL RELEVANCE/APPLICATION
DBT is an emerging imaging technique capable to detect additional cancers not seen in conventional DM. The radiological presentation and histology of these additional cancers are different.

**VSBR31-10 ● Addition of Tomosynthesis to Conventional Digital Mammograms: Effect on Image Interpretation Time of Screening Examinations**

**Pragya A Dang** MD (Presenter) ; **Phoebe E Freer** MD ; **Kathryn L Humphrey** MD ; **Elkan F Halpern** PhD * ; **Elizabeth A Rafferty** MD *

PURPOSE

To determine the impact of the implementation of a screening tomosynthesis program on real-world clinical performance by quantifying the differences in interpretation times of conventional screening mammography to combined tomosynthesis-mammography screening for multiple participating radiologists with a wide range of experience in a large academic center.

METHOD AND MATERIALS
Ten board certified radiologists read digital mammography alone or combined tomosynthesis-mammography screening examinations in batch mode for one hour-long uninterrupted sessions, as a part of routine screening practice. Number of examinations read during each session was recorded for each reader. The experience level for each radiologist was also correlated to the average number of cases read during the hour. The BI-RADS density and BI-RADS assessment category for each examination were collected. Analysis of Variance (ANOVA) test (SAS) was used to determine differences in the number of studies interpreted per hour for different radiologists, different techniques, and different experience levels of radiologists.

RESULTS
A total of 3,665 examinations (1,502 combined tomosynthesis-mammography and 2,163 digital mammography) were interpreted by 10 radiologists, with at least 5 sessions per radiologist per modality. An average of 23.8±0.55 (14.4-40.4) and 34.0±0.55, (20.4-54.3) examinations per hour, were interpreted by combined tomosynthesis-mammography and digital mammography, respectively. The average interpretation time for a combined tomosynthesis-mammography examination was 2.8 (1.5-4.2) minutes and digital mammography was 1.9 (1.1-3.0) minutes. The time taken to read a combined tomosynthesis-mammography examination was on average 0.9 minutes longer (47% longer) compared to the digital mammography alone examination. With the increase in years of breast imaging experience, there was a decrease in the overall additional time required to read combined tomosynthesis-mammography examinations (p= 0.03, R2= 0.52).

CONCLUSION
Addition of tomosynthesis to mammography results in increased time to interpret screening examinations when compared to conventional digital mammography alone.

CLINICAL RELEVANCE/APPLICATION
Reliable estimation of differential interpretation time with tomosynthesis should prove useful in preparing for its impact on radiologists' workload and resource allocation.

**VSBR31-11 ● Diagnostic Performance of Digital Breast Tomosynthesis: Comparison with Breast Magnetic Resonance Imaging and Conventional Digital Mammography in Women with Known Breast Cancers**

**Won Hwa Kim** MD, MS ; **Jung Min Chang** MD (Presenter) ; **Ann Yi** MD ; **Woo Kyung Moon** ; **Su Hyun Lee** MD ; **Nariya Cho** MD ; **Hye Ryoung Koo** MD ; **Min Sun Bae** MD, PhD ; **Seung Ja Kim**

PURPOSE
To evaluate the diagnostic performance of digital breast tomosynthesis (DBT) compared with breast magnetic resonance (MR) imaging and conventional digital mammography (DM) in women with known breast cancers.

METHOD AND MATERIALS
This study was approved by the institutional review board and informed consent was obtained. Between March and October 2012, 176 consecutive patients with known breast cancer (mean age, 51.3 years; range, 22-78 years) underwent DM, DBT and MR imaging. All 176 index cancers and 12 additional cancer (6 ipsilateral and 6 contralateral) cancers were identified. Two radiologists independently interpreted the images from each examination without clinical information and evaluated probability of cancer (5-point scale) for all findings. Sensitivity, false-positive rates, and area under the alternative free-response receiver operating characteristic curve (AUC) were estimated with histopathology and follow-up data as a reference standard.

RESULTS
The mean invasive tumor size was 2.2cm. Sensitivity for index cancers was the highest in MR imaging followed by DBT and DM (all $P <$ .05; reader 1, 98%, 93%, and 85%; reader 2, 98%, 92%, and 85%). Sensitivity for additional cancer was the highest in MR imaging followed by DBT and DM (all $P <$ .05; reader 1, ipsilateral, 67%, 33%, and 0%; reader 2, ipsilateral, 83%, 50%, and 17%; reader 1, contralateral, 100%, 67%, and 50%, reader 2, contralateral, 100%, 83%, and 67%). False-positive rate was the highest in MR imaging followed by DBT and DM (reader 1, 18%, 9%, and 7%; reader 2, 13%, 8%, and 7%), and was significantly frequent in MR imaging than DBT in one reader ($P$ = .033). The AUC for MR imaging, DBT, and DM were 0.946, 0.920, and 0.832 for reader 1; and 0.945, 0.912, and 0.828 for reader 2. The AUCs for DBT and MR imaging were significantly higher than DM ($P <$ .05); AUCs were not significantly different between DBT and MR imaging (Reader 1, $P$ = .18; Reader 2, $P$ = .12).

CONCLUSION
DBT showed lower sensitivity than MR imaging in detection of index and additional breast cancers, but false positives were less frequent with DBT than MR imaging.

CLINICAL RELEVANCE/APPLICATION
With DBT, comparable diagnostic performance to MR imaging and higher performance than DM was achieved. For additional cancer detection, DBT had limited diagnostic performance compared to MR imaging.

**VSBR31-12 ● Comparison of Visibility and Diagnostic Accuracy of Cone Beam Computed Tomography, Tomosynthesis, MRI and Digital Mammography for Breast Masses**

**Margarita L Zuley** MD (Presenter) ; **Ben Guo** PhD ; **Marie A Ganott** MD ; **Andriy I Bandos** PhD ; **Victor J Catullo** MD ; **Amy H Lu** MD ; **Amy E Kelly** MD ; **Maria L Anello** DO ; **Gordon S Abrams** MD ; **Denise Chough** MD

PURPOSE
To compare lesion visibility and diagnostic accuracy of cone beam computed tomography (CBCT) and tomosynthesis (DBT) to MRI and digital mammography (FFDM)

METHOD AND MATERIALS
IRB approval was obtained. From 04/16/2009 to 06/21/2011,, 178 mass lesions in 151 consecutively consenting women underwent FFDM, DBT, CBCT and contrast enhanced MRI prior to percutaneous biopsy. 97 CBCTs were unenhanced (NC-CBCT) and 81 had contrast (CE-CBCT). DBTstudies were unenhanced. Histopathology established truth. A nonparticipating radiologist marked each lesion location. A retrospective fully crossed, balanced reader study was performed with 7 MQSA qualified academic breast radiologists who recorded lesion visibility in each mode and if visible provided a probability of malignancy (POM) score on a 100 point scale. For each mode, ROC curves were obtained by a vertical average of the reader specific curves. Statistical analyses accounting for correlation and random reader effects were performed using the MRMC analysis (DBM MRMC, v.3.0) for area under the ROC curve (AUC) and using the generalized linear mixed model (proc glimmix, SAS, v.9.3) for visibility.

RESULTS
100 benign and 78 malignant masses were included. Average size was 19.7 mm (median 14mm, range 4-100mm). Percentage of visible lesions differed (88% FFDM, 91% DBT, 82% CBCT [81% NC-CBCT sub-set, 84% CE-CBCT sub-set] and 93% MRI). For visualization, MRI was significantly better than CBCT (p
CONCLUSION
For masses MRI has the highest accuracy and visibility and was significantly better than CBCT but not DBT. CBCT accuracy and visibility improve with use of contrast but further improvements are necessary for use as an alternative to MRI, FFDM or DBT.

CLINICAL RELEVANCE/APPLICATION
Tomosynthesis may possibly be a viable alternative to MRI for breast mass evaluation.

**VSBR31-13 ● Elastography**

**A. Thomas Stavros** MD (Presenter) *

LEARNING OBJECTIVES
1) To understand the elastic properties of normal and pathologic breast tissues. 2) To get an overview of the different ultrasound methods and technologies. 3) To learn about the clinical results obtained with the different methods. 4) To understand the role of elastography within the imaging protocol.

ABSTRACT
Real-time elastography (RTE) of the breast may easily and quickly integrate conventional breast imaging. Excitation is applied to the tissue and sophisticated algorithms are used to estimate their elasticity. Different technologies use direct mechanical or radiation force excitation. Qualitative scores and/or quantitative values are usually derived from the estimate of the effect on the tissue and help to differentiate soft benign lesions from malignancies. These are usually stiffer due to the secretion of collagen and fibronectin, and the surrounding edema. Fluid lesions almost always show a typical three-layered pattern on strain elastography. They have typical patterns even with radiation force technologies (ARFI and shear wave). These last allow a true quantitative evaluation of the acoustic modulus and promise to be the gold standard for the future applications. Clinical reports show a high diagnostic accuracy: increased specificity for atypical carcinomas and a very high specificity in benign lesions, including BI-RADS category 3 lesions. With the best cutoff point between elasticity scores 3 and 4, the true negative predictive value is over 90%. Most mistakes are linked to the histopathology of the lesions. In invasive carcinomas RTE clearly shows the peripheral infiltration improving the volume measurement; 3D elastography and tomographic imaging may help in this respect. RTE scores and values are well reproducible. Indexes of intra-observer and inter-observer agreement are very good. Elastography scores have been introduced into the new BI-RADS edition. They upgrade BI-RADS 3 lesions and downgrade 4a lesions. In daily practice this results into earlier biopsies for cancers and reduced biopsies and longer follow-up intervals for benign lesions. Elastography is easy and quick; it must become part of the evaluation of all focal lesions. Still RTE score is only a complementary descriptor to BI-RADS and its interpretation requires some training.

**VSBR31-14 ● BIRADS Classification for Real Time Ultrasound Elastography: More Comprehensive, Accurate and Action Oriented Results**

**Mukta D Mahajan** MBBS (Presenter) ; **Sonal Garg** MBBS ; **Mukund S Joshi** MD ; **Chander Lulla** MBBS

PURPOSE
1. To devise a BIRADS category of standardized breast reporting for Elastography of focal breat lesions based on the elastography score and distance ratio method of evaluating them. 2. To qualitatively assess the sensitivity, specificity, positive and negative predictive value of preset cutoffs of elastography score and distance ratio in assigning a BIRADS rating to them when compared with BIRADS grey scale ultrasound and histopathology. 3. To evaluate the efficacy of implementing this Elastography BIRADS scheme in the diagnostic pathway of evaluating breast lesions at our institution and thereby generate a protocol based guide to management. 4. To reduce the incidence of biopsies and diagnostic conundrums in assessing indeterminate focal breast lesions.

RESULTS
The data was analyzed using 2 cut offs for ES and 4 cut offs for DR to compute the most accurate scheme for BIRADS-EL categorisation.The sensitivity, specificity,PPV and NPV for BIRADS-EL was found to be 71.7%, 90.1%, 68%, 91.5%. This was found to be superior the existing methods of analysis. The area under the receiver operating characteristic (ROC) curve for BIRADS-US, ES, DR and BIRADS-EL was 0.888, 0.928, 0.938 and 0.956 respectively. After implementing BIRADS-EL as a part of diagnostic workflow and protocol, assessment of the number of biopsies that were successfully averted was analyzed. The data collected after its implementation was evaluated after 3 months, 6 months and 1 year and has shown consistent result as the study group.

CONCLUSION
The present study suggests that Elastographic BIRADS classification of focal breast lesions is mopre accurate than BIRADS grey scale ultrasound in differentiating benign and malignant lesions when both methods i.e. ES and DR are combined. This method of reporting can standardize elastography results and make them readily comparable with other modalities. Results obtained are action oriented and leave no ambiguity in inconclusive or indeterminate lesions thereby improving the quality of non-invasive diagnosis and reducing the incidence of ultrasound guided biopsies.

METHODS
We studied a total of 215 breast lesions in 112 women by B-mode ultrasonography and real time breast elastography. All the lesions were assigned an ultrasound BIRADS category based on their imaging appearance. An Elastography score (ES) of 1 to 5 and distance ratio (DR) of 1 was assigned to each lesion based on elastographic assessment. BIRADS US category 4 and 5 lesions, ES 4,5 and DR = 1 or >1 lesion were biopsied. BIRADS US 3, ES 3 and DR 0.8 to 1 lesions were either followed up every 6 months for a period of 2 years or biopsied. BIRADS US 2, ES 1,2 and DR

**VSBR31-15 ● Added Value of Shear-Wave Elastography in Evaluation of Breast Masses Detected on Screening Ultrasound**

**Su Hyun Lee** MD ; **Jung Min Chang** MD (Presenter) ; **Nariya Cho** MD ; **Hye Ryoung Koo** MD ; **Min Sun Bae** MD, PhD ; **Won Hwa Kim** MD, MS ; **Mirinae Seo** MD ; **Woo Kyung Moon**

PURPOSE
To prospectively validate the added value of shear-wave elastography (SWE) in evaluation of breast masses detected on screening ultrasound (US).

METHOD AND MATERIALS
This study was conducted with institutional review board approval, and written informed consent was obtained. From April to October 2012, B-mode US and SWE were performed for 207 breast masses detected on screening US (mean size, 1.0 cm) in 207 consecutive women (mean age, 45 years) prior to US-guided core biopsy. Ten radiologists performed the examinations and assessed the likelihood of malignancy and Breast Imaging Reporting and Data System (BI-RADS) category for breast masses using B-mode US alone and a combination of B-mode US and SWE, respectively. Radiologists were allowed to upgrade BI-RADS category 3 masses to 4a when the maximum elasticity color (Ecol) was red and to downgrade category 4a to 3 when Ecol was dark blue or light blue with a maximum elasticity value (Emax) = 65 kPa, a cutoff value determined in a prior study, to achieve the best diagnostic accuracy in differentiating benign lesions from malignant ones. The areas under the receiver operating characteristics curve (AUC), sensitivities, and specificities of the two datasets were compared.

RESULTS
Twelve of the 207 breast masses (5.8%) were malignant and consisted of nine invasive ductal carcinomas, two ductal carcinomas in situ, and one tubular carcinoma. The AUC of B-mode US increased from 0.700 to 0.879 when SWE was added (P =.002). Considering category 4a or higher as a positive result for malignancy, the sensitivities were not different between B-mode alone and combined B-mode and SWE (91.7% [11 of 12], both). However, the specificity increased from 17.4% (34 of 195) to 73.8% (144 of 195) when SWE was added (P
CONCLUSION
Combined use of SWE and B-mode US can increase both the accuracy and specificity in differentiating benign from malignant breast masses detected on screening US.

CLINICAL RELEVANCE/APPLICATION
SWE can be valuable in reducing the considerable false-positive rate of screening breast US examinations.

**VSBR31-16 ● Volume of Peri-tumoural Stromal Stiffness (VPSS) Surrounding Invasive Breast Cancer as Measured by 3D Shearwave Elastography (SWE): An Imaging Biomarker for Risk of Systemic Spread?**

**Andrew Evans** MRCP, FRCR (Presenter) ; **Patsy Whelehan** MSc * ; **Sarah J Vinnicombe** MRCP, FRCR ; **Kim Thomson** ; **Lee Jordan** ; **Caroline Mitchie** ; **Colin Purdie** ; **Alistair M Thompson**

PURPOSE
3D SWE allows the VPSS around breast cancers to be measured. Vascular invasion (VI) is most commonly detected at the tumour/stromal interface and is strongly associated with nodal involvement. We hypothesised that the likelihood of VI and nodal involvement may vary with the VPSS and that these relationships may be stronger than those seen between these risk factors for systemic spread and other ultrasound (US) parameters such as mean stiffness on 2D SWE, grey scale diameter and grey scale volume.

METHOD AND MATERIALS
2 and 3D grey scale US and SWE were carried out on a series of 62 consecutive breast cancers treated by immediate surgery. The VPSS and other US features were measured prior to surgery and then correlated with the presence of vascular invasion and nodal status at histologic examination. Statistical significance was ascertained using chi square and chi square test for trend.

RESULTS
VPSS has a strong relationship to VI status (p=0.003) with none of the 17 patients with 3 of VPSS having VI, 13 of 36(36%) with a VPSS between 0.5 and 3cm$^3$ having VI and 5 of 9(56%) with a VPSS >3cm$^3$ having VI. Grey scale diameter and grey scale volume had significant but weaker relationships with VI (p=0.02 and 0.03 respectively). A significant relationship was also found between VPSS and nodal status (p=0.04). Nodal positivity rates using the above VPSS cut offs were 12%, 33% and 44% respectively. None of the other US parameters had statistically significant associations with nodal status

CONCLUSION
VPSS has stronger associations with markers of systemic spread than other US parameters and may be helpful in patient selection for neoadjuvant chemotherapy.

CLINICAL RELEVANCE/APPLICATION
In women with breast cancer the volume of peritumoral stiffness seen on 3D shearwave elastography may help patient selelection for neoadjuvant chemotherapy

**VSBR31-17 • Shear-wave Elastography in Detection of Residual Breast Cancer after Neoadjuvant Chemotherapy**

**Su Hyun Lee** MD ; **Jung Min Chang** MD (Presenter) ; **Nariya Cho** MD ; **Hye Ryoung Koo** MD ; **Min Sun Bae** MD, PhD ; **Won Hwa Kim** MD, MS ; **Mirinae Seo** MD ; **Woo Kyung Moon**

PURPOSE
To evaluate the accuracy of shear-wave elastography (SWE) in detecting residual cancer after neoadjuvant chemotherapy (NAC).

METHOD AND MATERIALS
This retrospective study was approved by our institutional review board and the requirement for written informed consent was waived. From January 2012 to February 2013, 71 women with stage II-III invasive breast cancers who received NAC and were imaged with B-mode ultrasonography (US), SWE, and magnetic resonance imaging (MRI) before surgery were included. Clinical tumor response was assessed using image findings from B-mode US and MRI and classified into two groups (0: no residual tumor, 1: residual tumor). Quantitative elasticity values (maximum kPa) were acquired for primary lesions depicted on US. Pathological complete response (pCR) was defined as no residual invasive cancer cells. The quantitative SWE values were compared between the pCR and non-pCR group using independent samples t-test. The areas under the receiver operating characteristics curve (AUC), sensitivities, and specificities of B-mode US, MRI, and SWE for detecting residual tumor were compared, with histopathologic examination as the reference standard.

RESULTS
Of the 71 women, 15 (21.1%) achieved pCR. The mean size of residual invasive cancers was 2.1 cm (range 0.1-6.4 cm). The maximum SWE value was significantly higher in the non-pCR group (mean, 122.9 kPa) than in the pCR group (30.6 kPa) (P
CONCLUSION
SWE was accurate in the detection of residual cancer after NAC. When combined with B-mode US, the accuracy improved to a level similar to breast MRI.

CLINICAL RELEVANCE/APPLICATION
In predicting pCR after NAC, SWE can offer valuable information. Addition of SWE to conventional imaging can be useful for surgical planning in breast cancer patients.

## Breast Imaging (Screening and Density)

**Tuesday, 03:00 PM - 04:00 PM • Arie Crown Theater**

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DM BR

**SSJ01** • *AMA PRA Category 1 Credit* ™:1 • ARRT Category A+ Credit:1
**Moderator**
**Emily F Conant** , MD *
**Moderator**
**Martin J Yaffe** , PhD *

**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
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

PURPOSE
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 BC 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
CONCLUSION
Increased BD, BPE and possibly FGT are seen in women with breast cancer when compared with high risk women. 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.

**SSJ01-03 ● Younger Women with Breast Cancer Show Highest Risk from Increased Density Together with Abnormal Density Regression with Age**

**Nicholas M Perry** MD (Presenter) ; **Stephen W Duffy** ; **Sue E Milner** BSC ; **Kefah Mokbel** MD ; **Katja Pinker-Domenig** MD

PURPOSE
To assess whether the link between quantitatively measured breast density and associated cancer risk differs between younger and older women, and if so, could this relate to differing patterns of density regression with age in breast cancer patients compared to healthy controls.

METHOD AND MATERIALS
282 histopathologically verified breast cancer cases (age range 30-83) and 317 healthy controls matched by date of birth, age at examination and laterality of mammogram used for density determination were included in this IRB approved retrospective study. All breast cancer cases and healthy controls underwent FFDM with breast density measured separately on MLO and CC images using an automated volumetric breast density measurement system (Hologic, Quantra). For each cancer case, the contralateral mammogram was used. Breast density as percentage (%) of fibroglandular tissue was analysed by Quantra. After log transformation we performed polynomial regression to assess the age effect on breast density risk in cases and controls.

RESULTS
Breast cancer patients showed higher mammographic density than controls up to the age of 50. Healthy controls demonstrated a significant decline in log % density with age following a linear pattern resulting in the equation: [log(density) = 3.6926 -0.0126 x age ]. In breast cancer patients there was a significant departure from linearity, and a term in the square of age was required, as follows: [log(density) = 5.6531 -0.0822 x age +0.0006 x age2]. Both the coefficient for age and that for the square of age were highly significant (p
CONCLUSION
Conclusion The data suggest that automated volumetric breast density measurement is predictive of breast cancer risk in younger women from the age of 30 and that the risk of breast cancer may be related to an altered pattern of density regression with age

CLINICAL RELEVANCE/APPLICATION
Younger women are at highest risk of density-associated breast cancer and early estimation of density may be useful in offering enhanced screening to some.

**SSJ01-04 ● Correlation of Breast Cancer Incidence with Breast Density as Assessed by an Automated Assessment Tool in the TOMMY Trial**

**Fiona J Gilbert** MD (Presenter) ; **Oliver Morrish** ; **Richard Black** MS ; **Lorraine Tucker** ; **Paula Willsher** ; **Stephen W Duffy**

PURPOSE
To assess the relationship of breast density and breast cancer in a UK screening population.

METHOD AND MATERIALS
Women recalled to assessment following routine National Health Service breast screening and women attending family history screening were recruited into the UK tomosynthesis trial – TOMMY Trial (A comparison of TOMosynthesis with digital MammographY). Volumetric breast density (Vbd) was measured from the 2D full field digital mammography (FFDM) images of both breasts using an automated assessment tool (Quantra, Hologic Inc.). The relationship between breast density, age (in 10 year age bands) and cancer incidence was assessed. Pathology reports were used to confirm cancer cases.

RESULTS
Volumetric breast density (Vbd) of 5,713 women aged 34-85 was examined. Density ranged from 1% – 47% with mean Vbd of 11.21% across the cohort. The mean Vbd decreased with each increasing decade: 30-39: 21.42%; 40-49: 13.57%; 50-59: 11.09%; 60-69: 9.34%; 70-79: 8.87%; 80-89: 8.86%. The table shows the percentage of women with cancer in each age band/density category (cancers/total cases). Using logistic regression, for all age groups, there was a significant trend in increasing probability of cancer with increasing density, after adjusting for age (p=0.004). The age adjusted odds ratio for density 17-47 relative to 1-6 was 1.72 (95% CI 1.20-2.45). The trend did not differ significantly by age.
Analysis of data for the 40-49 FH screen cases and the 50-69 assessment cases show that there is a trend for cancer risk with increased breast density.

CONCLUSION
Breast density decreases with age as reported in the literature. Breast density is related to cancer incidence in the ages 40-69 year olds

using this automated breast density technique, consistent with the findings of other studies using different density measures. However the FH sample is small with few cancers and the assessment cohort may not be representative of population breast density. Further work needs to be undertaken in terms of establishing which Quantra values should be used to define breast density.

CLINICAL RELEVANCE/APPLICATION
This automated breast density tool analysing 2D digital mammograms demonstrates a relationship with cancer risk.

**SSJ01-05 • The Complementary Roles of Breast Density and Parenchymal Texture in Breast Cancer Risk Assessment: A Case-Control Study with Digital Mammography**

**Brad M Keller** PhD (Presenter) ; **Jinbo Chen** PhD ; **Yan Wang** MSc, PhD ; **Yuanjie Zheng** ; **James C Gee** PhD ; **Emily F Conant** MD * ; **Despina Kontos** PhD

PURPOSE
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, mediolateral 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 available 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** ; **Anna 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.
Optical techniques can provide functional and structural information on tissue in absolutely non-invasive way. We exploited time domain diffuse optical spectroscopy to assess both tissue composition in terms of key constituents and scattering parameters that are related to the microscopic structure of tissue and specifically to breast density.

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.
To develop a procedure for the identification of high-risk women, the mammographic density was dichotomized, comparing subjects in BI-RADS categories 1 to 3 to subjects in category 4, and applying regression logistic analysis to the optically derived parameters.

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 provides 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**

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DM CT BR

**SSJ02** • *AMA PRA Category 1 Credit* ™:1 • ARRT Category A+ Credit:1
**Moderator**
**John M Boone** , PhD *
**Moderator**
**Carl J D'Orsi** , MD *

**SSJ02-01 • 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 next few years. 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 BIRADS 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 BIRADS 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 (47%) of the malignant lesions were masses and 31 (53%) 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 p
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 BIRADS 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 BIRADS 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 µm 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 µm 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 1.5cm (range 0.3 to 4cm). Average lesion size on breast CT was 1.4cm (range 0 .3 to 4.5cm). 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 mammographically 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 BIRADS 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.

## Breast Imaging (Digital Breast Tomosynthesis Screening Outcomes)

**Wednesday, 10:30 AM - 12:00 PM ● Arie Crown Theater**

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DM BR

**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 tomosynthyesis 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
CONCLUSION
The addition of tomosynthesis to digital mammography in this screening population significantly reduced the recall rate without decreasing the biopsy positive predictive value or cancer detection rate.

CLINICAL RELEVANCE/APPLICATION
A 30% decrease in recall rate following the addition of tomosynthesis to mammography screening may result in decreased patient anxiety and healthcare costs.

**SSK01-02 ● Implementing Digital Breast Tomosynthesis (DBT) in a Screening Population: PPV1 as a Measure of Outcome**

**Emily F Conant** MD (Presenter) * ; **Fei Wan** ; **Mathew Thomas** BS ; **Marie Synnestvedt** ; **Susan P Weinstein** MD ; **Susan G Roth** MD ; **Despina Kontos** PhD ; **Anne Marie McCarthy** ; **Nandita Mitra**

PURPOSE
DBT has been reported to decrease both false positive recalls from screening and to improve cancer detection rates. The purpose of this study is to compare the impact of DBT on PPV1 in a prospective screening population.

METHOD AND MATERIALS
In October 2011, we began screening all of our patients with DBT and thus far, have imaged over 17,000 women. For the group and for each of six radiologists, all trained in DBT interpretation, the following metrics were compared for the 16 months of DBT screening and for the year prior of digital mammography (DM) screening: Total volume of cases read, recall volumes and rates, cancer detection rate and PPV1. PPV1 was defined as the proportion of positive screening mammograms (0, 4 or 5) from which cancer was diagnosed.

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.

**SSK01-03 ● Recall Rates on Baseline Screening Mammography: Initial Experience Using Digital Breast Tomosynthesis (DBT)**

**Anabel M Scaranelo** MD, PhD (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, Milwalkee, Wis). 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
853 women, (90% screening and 10% diagnostic baseline mammography); n=451 site withDBT; n=402 site with2D. Of 451 women, 37% declined tomosynthesis, where 245 had screeningDBT. The mean age was 44.33 (ranged 26-71) in the group withDBT and 43.51 (ranged 26-79) with2D screening (n=364). The DBT group recall rate was 13.1% compared to 18.7% for 2D (p=0.066) with a trend to statistical significance. Recall rates stratified by lesion type demonstrated significantly lower recall rates for asymmetries (21.9% vs. 60.3%, p=0.0001) but not for calcifications (18.8% vs. 8.8%, p=0.198) when comparing DBT to 2D. There was no significant difference in distribution of breast densities between the two cohorts (p=0.459). Lower recalls in DBT for non-dense breasts showed statistical trend (p=0.0672): fatty breasts (5.5% vs. 23.5%, p=0.1774), scattered densities (12.5% vs. 20.13%, p=0.1568), heterogeneously dense (14.2% vs. 20.2%, p=0.2080), and extremely dense (15% vs. 5%, p=0.3216), (DBT vs 2D, respectively). There was no significant difference in the mean age of patients with or without recall (p=0.591). Lower recall rates using DBT: for women older than 50 years (13.5% vs. 19.6%, p=0.4646) and aged 26-49 years (12.9% vs. 18.4%, p=0.1305) (DBT vs. 2D respectively

CONCLUSION
A lower recall rate was found in the group of women undergoing DBT and the benefit using this technology for asymmetries was demonstrated

CLINICAL RELEVANCE/APPLICATION
Baseline DBT significantly reduces recall rates for asymmetries. Not receiving recall for additional views reduces women anxiety, less radiation when considered all additional views associated.

**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 Jahr** * ; **Ulrika Ekseth** MD *

PURPOSE
Interpretation time using tomosynthesis (DBT) for breast cancer screening is longer than that required for FFDM. We assess trends in time to interpretation of tomosynthesis screening examinations during prospective batch readings as a function of radiologists' experience reading tomosynthesis.

METHOD AND MATERIALS
As an integral part of an ongoing prospective clinical trial we record time to interpretation of each case. Seven radiologists interpreted

over 2000 examinations each. We computed the time to interpretation of these examinations as a function of their experience. We compared their interpretation time during the first and the last 200 cases and compared these times with the average time to interpretation of FFDM read similarly in a batch mode during the trial.

RESULTS
The average time to interpretation was 42.3 seconds for FFDM (over all cases). For the seven readers analyzed (reading between 2035 and 5532 tomosynthesis exams), average interpretation times for FFDM plus tomosynthesis were 84.5 +/- 24.5 seconds and 59.7 +/- 8.7 second during the first and last 200 cases, respectively (p
CONCLUSION
Interpretation time of tomosynthesis examinations is longer than that of FFDM. However it decreases with experience trending toward approximately 60 seconds after reading 2000 examinations.

CLINICAL RELEVANCE/APPLICATION
Interpretation time with DBT decreases with experience approaching about 60 sec per exam after interpretation of 2000 examinations. DBT interpretation time is acceptable for high-volume screening.

**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 patients 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﷯MLO; DBT﷯MLO+CC), and low-dose ACRIN-Complete (DM﷯MLO+CC; DBT﷯MLO+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
CONCLUSION
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, nodule﯒s 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 FDDM

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 open surgical biopsy. The purpose of the study was to analyse the number of mammographic findings later confirmed as radial scars on excisional biopsy in mammography screening comparing full-field digital mammography (FFDM) and combined FFDM plus digital breast tomosynthesis (DBT).

METHOD AND MATERIALS
From Nov 22, 2010 to Dec 31, 2012 (one screening round), a total of 34,742 women attended an organized population-based screening program, of which 25,547 (73.5%) underwent FFDM plus DBT. All exams (bilateral CC and MLO views) were prospectively interpreted by 4 independent readers using a 5-point rating scale for probability of cancer. The trial had 4 arms: Arm A FFDM only; Arm B FFDM plus

CAD; Arm C FFDM plus DBT; and Arm D synthetic 2D plus DBT. Women with distortion suspected by at least one of the 4 independent readers were discussed at arbitration meeting before decision to recall for assessment or not. Diagnostic work-up included additional mammographic views, ultrasound, MRI as problem-solver, and needle biopsy or diagnostic surgical biopsy, if indicated. Open surgical biopsy was carried out in women with highly suspicious distortion when malignancy was not confirmed at needle biopsy.

RESULTS
A total of 31 radial scars were diagnosed at open surgery. One case having only FFDM (no DBT) was excluded in the comparison. Thus, at total of 30/25,547 (0.12%) of screened women with radial scar (a false positive mammographic finding) underwent surgical biopsies. In the 4 reading arms, the number of positive scores in these 30 women were: Arm A=7 (23%), Arm B=10 (33%), Arm C=25 (83%), and Arm D=23 (77%).

CONCLUSION
Radial scars (complex sclerosing lesions) are much better demonstrated on tomosynthesis than on FFDM and consequently these lesions will be more commonly found using DBT. Breast lesions presenting as highly suspicious distortions need open surgical biopsy if needle biopsy does not confirm malignancy. The problem is, however, minor and diagnostic surgical biopsy was only necessary in 0.12% of women in this study.

CLINICAL RELEVANCE/APPLICATION
The benefits of tomosynthesis in breast cancer screening including higher cancer detection rates outweigh the adverse effect of false positive mammographic findings caused by radial scars.

**SSK01-08 • Imaging and Histopathology Findings of Breast Lesions Detected by Tomosynthesis**

**Laurie L Fajardo** MD, MBA (Presenter) * ; **Limin Yang** MD, PhD ; **Jeong Mi Park** MD

PURPOSE
To assess imaging characteristics, histopathology results, cancer detection rate and biopsy PPV3 for lesions detected only by digital breast tomosynthesis (DBT) when used in combination with 2D digital mammography (DM) in a general population-screening group.

METHOD AND MATERIALS
Beginning September 2012, we offered DBT in additioin to conventional DM to all women presenting for screening. To compare characteristics of lesions detected by DM with those detected additionally by DBT, we prospectively gathered information from biopsy recommendations for each, including: age, BI-RADS breast density rating, final BI-RADS assessment, lesion type and size, type of biopsy performed and histopathology outcomes. For all cancers diagnosed, the pathologic size, grade and lymph node status were ascertained.

RESULTS
For 4350 women undergoing screening from 9/2012 through 3/2013, 50 biopsy recommendations were made, including 15 biopsies in 2610 women choosing to undergo DBT as part of their screening exam. Lesions recommended for biopsy by DM included: 19 calcifications of which 2 were invasive cancer, 5 DCIS and 12 benign; 14 masses of which 6 were invasive cancer and 8 were benign; and 2 focal asymmetries - both benign. Characteristics of DBT detected lesions recommended for biopsy included: 6 masses of which 5 were invasive cancers and 1 benign; and 8 architectural distortions of which 6 were invasive cancers and 4 were benign. All DBT detected lesions were visible by and biopsied using ultrasound guidance. The biopsy PPVs for 2D digital mammography and DBT were 0.37 and 0.73, respectively. Pathologically, cancers detected only by DBT comprised 7 invasive ductal carcinomas, 3 invasive lobular carcinomas and 1 mixed ductal-invasive carcinoma. A majority of DBT detected cancers were small (pathologic size: 5 = 10mm, 4 = 11-20mm, and 2 = 20mm); low or intermediate pathologic stage (6 = Elston-Ellis grade 1; 4 = grade 2; 1 = grade 3); and lymph node negative (9/11).

CONCLUSION
Fifteen additional cancers (30% increase) were detected and PPVs improved by DBT when combined with DM in our screening population. Our early experience with suspicious lesions seen only by DBT indicates the majority are clinically significant and curable.

CLINICAL RELEVANCE/APPLICATION
The addition of DBT to DM for screening improves cancer detection rate and biopsy PPV3 by detecting, additional small, early stage breast cancers beyond those detected by conventional DM.

**SSK01-09 • 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
The number of 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 (3/4/13-3/9/13).

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.

CLINICAL RELEVANCE/APPLICATION
Tomosynthesis expedites patient diagnostic workup and results in better patient throughput and resource utilization.

## Breast Imaging (Multimodality Breast Imaging)

**Wednesday, 03:00 PM - 04:00 PM • E451A**

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US MR DM BR

**SSM02** • *AMA PRA Category 1 Credit* ™:1 • ARRT Category A+ Credit:1
**Moderator**

**Sughra Raza** , MD
**Moderator**
**Priscilla J Slanetz** , MD, MPH *

**SSM02-01 ● Triple-negative Breast Cancers: Multimodality Imaging Features of Tumors with and without Androgen Receptor Expression**

**Min Sun Bae** MD, PhD (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 breast imaging experience, respectively) reviewed the mammogram, US, and MRI without knowledge of the clinicopathological findings based on the ACR BIRADS 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 = .009), 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.

**SSM02-02 ● 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, 87% (55/63) 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 an 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
CONCLUSION
When a suspicious breast MRI lesion has an ultrasound 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.

**SSM02-03 ● Breast Cancer Invisible to Ultrasound: What Does the Ultrasound Show? Characteristics of MR Discovered Breast Cancers Not Recognized on Second-look Ultrasound Examination**

**Phillip B Shaffer** MD (Presenter)

PURPOSE
Investigate the US appearance of regions with postive 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 adenoid cystic carcinoma of 1.0 cm. On US examination by dedicated breast sonographers and experienced radiologists the pattern seen was judged to be not 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 (3 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.

CLINICAL RELEVANCE/APPLICATION
Many breast cancers are unrecognizable on ultrasound. Even a totally normal ultrasound does not rule out breast malignancy.

**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 and diffusion 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. 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=7) and 2 (n=3), while no 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=0,008). The size agreement was 69(41-89)% for US, 54(27-79)% for DM, 70(38-92)% for DM+DBT, 87(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 was 54.5(25.9-81)% for US, DM and DM+DBT, 84.6(57.8-97.3)% for MRI. NR prediction at mid-treatment was 80(47-99)% for US, 80(33-98)% for DM, 82(47-99)% for DM+DBT, 86(47-99)% 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 Slon** 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 histologycal 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 tumors detected by US was 14 (+18.6%) and by DBT was 17 (+22.6%). Out of these additional tumors, 7 (9.3%) were only detected by US, 4 (5.3%) only detected by DBT and 10 ( 13.3 %) were detected by both. The remaining 9 tumors were diagnosed with second look US

after presurgical MRI. All of the additional tumors were invasive carcinomas. We did not find statistical differences between both techniques in Group I (US= 2 , DBT=2; p=1.00), Group II (US= 5 , DBT= 8; p=0.375) and Group III (US= 3, DBT= 2; p= 1.000). In Group IV (US=7, DBT=2; p=0,06) we found a trend to statistical significance, with 5 tumors detected on US and missed on DBT and no additional tumors diagnosed by DBT not detected by US.

CONCLUSION
Both US and DBT present similar results in the detection of additional breast cancers when they are predominantly surrounded by fat (more than 25%). However, we found that in tumors with less than 25% of peritumoral fat, US seems to be more sensitive than DBT.

CLINICAL RELEVANCE/APPLICATION
This study supports that US seems to be better than DBT in the detection of tumors with a low quantity of surrounding fat, i.e, in dense breast (ACR density pattern IV).

## Breast Imaging: Interoperability Challenges and Solutions

**Thursday, 10:30 AM - 12:00 PM • S501ABC**

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IN DM BR

**ICII51** • *AMA PRA Category 1 Credit* ™:1.5 • ARRT Category A+ Credit:1.5
**Judith A Wolfman** , MD *
**Julian Marshall** *
**Paul Morgan** *

LEARNING OBJECTIVES
1) Review the clinical problems once common in the interpretation of digital screening and diagnostic mammograms on vendor-independent and general purpose PACS workstations. 2) Understand the technical solutions provided in the IHE Mammography Image integration profile to those problems. 3) Explore the similar challenges now being faced in the secondary review of Stereotactic Mammography images sets acquired during breast biopsy, while clearly understanding the differences in interpretation requirements. 4) Learn how the new IHE Stereotactic Mammography Image integration profile provides a complete set of solutions to address those challenges. 5) Explore new interoperability challenges presented as Breast Tomosynthesis is adopted. 6) Understand the technical solutions currently available within the DICOM standard that address those challenges, if properly implemented in commercial equipment.
ABSTRACT
The purpose of this session is to review the once prevalent interoperability challenges in Full-Field Digital Mammography acquisition and display that were successfully addressed using the IHE Mammography Image integration profile, and to explore new challenges and solutions in the areas of Digital Stereotactic Mammography (used in breast biopsy) and Breast Tomosynthesis.

## Breast Imaging (CAD/Quantitative Imaging)

**Thursday, 10:30 AM - 12:00 PM • E450A**

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IN MR DM BQ BR

**SSQ02** • *AMA PRA Category 1 Credit* ™:1.5 • ARRT Category A+ Credit:1.5
**Moderator**
**Despina Kontos** , PhD
**Moderator**
**Jennifer A Harvey** , MD *
**Moderator**
**Christopher E Comstock** , MD

### 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
Oncotype 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 a 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, size, and texture features. Output from the system yielded the probability of malignancy from a Bayesian artificial neural network (BANN). Classification performance was evaluated with a leave-one-case-out method using ROC analysis with area under the ROC curve as the figure of merit.

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 on 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 Rodogiannis** ; **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 correlative 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.

CLINICAL RELEVANCE/APPLICATION
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 breasts MRI of histologically proven breast cancer from July 2011 to February 2013. We retrospectively reviewed the MRI CAD results, corresponding immune-histopathologic 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 marked 259 (79.2%) 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 yo (SD:9.9) in the undetected group and 22.8 mm (range: 3-120) and 51.4 yo (SD: 10.7) in the detected group. Detectability rates for IDCs, DCIS were 86.7% (208 of 240) and 44.6 % (25 of 56), respectively. The tumor type was a significant (p
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-76 percentage, and HER-2 negative influenced the breast MRI CAD detectability in breast cancer patients.

CLINICAL RELEVANCE/APPLICATION
DCIS, low nuclear grade, low Ki-67, and HER-2 negative can influence CAD detectability. So, radiologist should check immunohistologic profiles and original images when interpreting breast MRI CAD.

**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, extensive intraductal 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
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(+).

CLINICAL RELEVANCE/APPLICATION
Accurate tumor size measurement is critical to surgical plan for breast conservation.
Size assessment by breast MRI CAD is accurate but it can be overestimated in cases of DCIS, EIC, 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 Newstead** 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
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.

CLINICAL RELEVANCE/APPLICATION
Identification of the molecular subtypes of breast tumors is expected to allow for improved prognostic assessment and more effective cancer treatment plans.

**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.

METHOD AND MATERIALS
The CAD system was retrospectively tested on a set of 143 patients. Craniocaudal (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 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.

METHOD 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 unware of pathological findings. Tumor roundness was measured quantitatively by a software developed in-house and was calculated according to the following equation: roundness = 4? x A / P2 (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
Interobserver 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 (-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 (67.3 for triple-negative vs. 55.9 for HER2-enriched, 53.8 for luminal B, and 51.7 for luminal A; P < .0001).

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.

## Digital Breast Tomosynthesis

**Thursday, 04:30 PM - 06:00 PM • E451B**

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DM BR

**RC715** • *AMA PRA Category 1 Credit* ™:1.5 • ARRT Category A+ Credit:1.5

**RC715A • Clinical Implementation**

**Lawrence W Bassett** MD (Presenter)

LEARNING OBJECTIVES
1) Identify the key practical issues affecting the clinical implementation of digital tomosynthesis. 2) Understand the technical aspects of digital tomosynthesis that will impact clinical workflow and IT resources. 3) Integrate changes to current workstation read-out protocols to allow for efficient interpretation of digital tomosynthesis studies.

ABSTRACT
Author will discuss approaches of image acquisition in digital breast tomosynthesis (DBT). The basics of DBT image interpretation and potential challenges of clinical digital breast tomosynthesis will be reviewed.

**RC715B • Interpretation**

**Emily F Conant** MD (Presenter) *

LEARNING OBJECTIVES
1) Understand the basics of DBT image presentation and interpretation. 2) Review DBT applications in screening and diagnosis. 3) Identify potential challenges in clinical implementation of DBT.

**RC715C • Research Evidence**

**Etta D Pisano** MD (Presenter) *

LEARNING OBJECTIVES
1) Understand the published literature on the use of tomosynthesis for breast cancer screening. 2) Understand the proposed trial design for the Tomosynthesis Mammographic Imaging Screening Trial (TMIST) and what that trial adds to the available data on tomosynthesis.

## Breast Imaging (Issues in Screening)

**Friday, 10:30 AM - 12:00 PM • E450B**

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**SST01** • *AMA PRA Category 1 Credit* ™:1.5 • ARRT Category A+ Credit:1.5
**Moderator**
**Susan G Roth** , MD
**Moderator**
**Sarah M Friedewald** , MD *

**SST01-01 ● 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 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

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 recall rate of MRI was 9.5% and PPV was 59.2%. The sensitivity of MRI, mammography and ultrasound in detecting the second breast carcinoma was 90.3%, 48.4% and 77.4%, 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 Klautau 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 and once more with the addition of the pre-contrast T2 images. The scan time for the 3 T1-sequences was 4 mins; the scan time for the T2-sequence was 4 mins. The time to interpret the study and the confidence score was assessed for each study. Comparison was made to the original diagnostic interpretation.

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 (21.9%) as BIRADS 3, 30 (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
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, BIRADS 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 BIRADS 3 assessments with no evidence of cancer on follow up or BIRADS 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%) BIRADS 3 and 89/1498 (5.9%) BIRADS 4/5. Follow up data on BIRADS 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 BIRADS 4/5, with 5 (41.7%) cancers. Cancer rate for BIRADS 3 lesions was 6.3%; 3 of 5 upgraded cancers occurred in mutation carriers. Biopsy results for BIRADS 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 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 704 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

0.8cm (range, 0.4-1.4cm). 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 biopsied foci, ranging from 3% to 28%. This study attempts to evaluate the malignancy rate of suspicious foci identified on screening MRI and to determine if short-term follow-up can be safely performed in leiu 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 foci.

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**

**Joost 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[illegible] 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 MR 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.

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