

2013 RSNA (Filtered Schedule)

**Sunday, December 01, 2013**

- 10:45-12:15 PM • **SSA05** • Room: N228 • Emergency Radiology (Imaging Chest Emergencies)  
10:45-12:15 PM • **SSA23** • Room: E350 • Vascular/Interventional (Embolotherapy/Guidance Technology)  
10:45-12:15 PM • **SSA24** • Room: E352 • Vascular/Interventional (Portal Interventions/TIPS)  
12:30-01:00 PM • **LL-VIS-SUA** • Room: Lakeside Learning Center • Vascular/Interventional - Sunday Posters and Exhibits (12:30pm - 1:00pm)  
01:00-01:30 PM • **LL-VIS-SUB** • Room: Lakeside Learning Center • Vascular/Interventional - Sunday Posters and Exhibits (1:00pm - 1:30pm)  
02:00-03:30 PM • **RC110** • Room: E450B • Renal Ultrasound and Doppler (An Interactive Session)  
02:00-03:30 PM • **RC112** • Room: S105AB • Thoracic Aorta: Key Concepts (An Interactive Session)

**Monday, December 02, 2013**

- 08:30-10:00 AM • **RC212** • Room: S504AB • Imaging and Endografts  
08:30-10:00 AM • **RC224** • Room: E353B • Mentored Case Approach to Pediatric Cardiovascular Disease 1: Vascular Disease (An Interactive Session)  
08:30-12:00 PM • **VSIR21** • Room: E352 • Interventional Radiology Series: Peripheral and Visceral Occlusive Disease  
10:30-12:15 PM • **MSMC22** • Room: S406A • Cardiac CT Mentored Case Review: Part II (In Conjunction with the North American Society for Cardiac Imaging) ...  
10:30-12:00 PM • **SSC16** • Room: E351 • Vascular/Interventional (Chemoembolization)  
12:15-12:45 PM • **LL-VIS-MOA** • Room: Lakeside Learning Center • Vascular/Interventional - Monday Posters and Exhibits (12:15pm - 12:45pm)  
12:45-01:15 PM • **LL-VIS-MOB** • Room: Lakeside Learning Center • Vascular/Interventional - Monday Posters and Exhibits (12:45pm - 1:15pm)  
01:30-03:05 PM • **MSMC23** • Room: S406A • Cardiac CT Mentored Case Review: Part III (In Conjunction with the North American Society for Cardiac Imaging) ...  
03:30-06:00 PM • **MSMC24** • Room: S406A • Cardiac CT Mentored Case Review: Part IV (In Conjunction with the North American Society for Cardiac Imaging) ...

**Tuesday, December 03, 2013**

- 08:30-10:00 AM • **RC312** • Room: E350 • Acute Abdominal Vascular Diseases  
08:30-10:00 AM • **RC350** • Room: E260 • Cardiac CT Angiography (A Practical Guide) (How-to Workshop)  
08:30-10:00 AM • **RC352** • Room: E264 • Doppler US: Visceral, Extremity and Carotid Applications (Hands-on Workshop)  
08:30-12:00 PM • **VSIR31** • Room: E351 • Interventional Radiology Series: Venous Disease  
08:30-12:00 PM • **VSPD31** • Room: S102AB • Pediatric Radiology Series: Chest/Cardiovascular Imaging I  
12:15-12:45 PM • **LL-VIS-TUA** • Room: Lakeside Learning Center • Vascular/Interventional - Tuesday Posters and Exhibits (12:15pm - 12:45pm)  
12:45-01:15 PM • **LL-VIS-TUB** • Room: Lakeside Learning Center • Vascular/Interventional - Tuesday Posters and Exhibits (12:45pm - 1:15pm)  
03:00-04:00 PM • **SSJ26** • Room: E352 • Vascular/Interventional (Aortic Imaging and Intervention)  
03:00-04:00 PM • **SSJ27** • Room: N230 • Vascular/Interventional (CTA: Dose and Contrast Reduction)  
04:30-06:00 PM • **RC410** • Room: E353B • Vascular Doppler (An Interactive Session)  
04:30-06:00 PM • **RC412** • Room: S502AB • Advanced Vascular Imaging Techniques and Applications

**Wednesday, December 04, 2013**

- 08:30-10:00 AM • **RC512** • Room: E353B • Non-Atherosclerotic Vascular Diseases (An Interactive Session)  
08:30-10:00 AM • **RC516** • Room: S104A • Women and Cardiovascular Disease (In Conjunction with the American Association for Women Radiologists)  
08:30-12:00 PM • **VSCA41** • Room: S502AB • Cardiac Radiology Series: Transcatheter Aortic Valve Replacement (TAVR)  
08:30-12:00 PM • **VSIR41** • Room: E352 • Interventional Radiology Series: Embolotherapy  
10:30-12:00 PM • **SSK23** • Room: E353A • Vascular/Interventional (Venous Access/Women's Intervention)  
12:15-12:45 PM • **LL-VIS-WEA** • Room: Lakeside Learning Center • Vascular/Interventional - Wednesday Posters and Exhibits (12:15pm - 12:45pm)  
12:45-01:15 PM • **LL-VIS-WEB** • Room: Lakeside Learning Center • Vascular/Interventional - Wednesday Posters and Exhibits (12:45pm - 1:15pm)  
03:00-04:00 PM • **SSM24** • Room: E450B • Vascular/Interventional (Vascular Ultrasound)

**Thursday, December 05, 2013**

- 08:30-10:00 AM • **RC610** • Room: S103CD • Abdominal Vasculature: Ultrasound and Doppler  
08:30-10:00 AM • **RC613** • Room: S102AB • Vascular Lesions in Children: Diagnostic Dilemmas and Treatment Options  
08:30-10:00 AM • **RC651** • Room: E261 • Emergency Body MRI: Vascular Emergencies, Abdominal Emergencies and the Pregnant Patient (How-to Workshop)  
08:30-12:00 PM • **VSPA51** • Room: S502AB • Vascular Imaging Series: CT Angiography-New Techniques and Their Application  
10:30-12:00 PM • **SSQ15** • Room: N229 • Neuroradiology (Cerebrovascular Imaging)  
10:30-12:00 PM • **SSQ21** • Room: N227 • Vascular/Interventional (Radioembolization)  
12:15-12:45 PM • **LL-VIS-THA** • Room: Lakeside Learning Center • Vascular/Interventional - Thursday Posters and Exhibits (12:15pm - 12:45pm)  
12:45-01:15 PM • **LL-VIS-THB** • Room: Lakeside Learning Center • Vascular/Interventional - Thursday Posters and Exhibits (12:45pm - 1:15pm)  
04:30-06:00 PM • **RC712** • Room: S404CD • Peripheral Artery Disease (PAD)

**Friday, December 06, 2013**

- 08:30-12:00 PM • **VSPA61** • Room: E352 • Vascular Imaging Series: MR Angiography-Principles and Technique Optimization  
10:30-12:00 PM • **SST12** • Room: S505AB • ISP: Nuclear Medicine (Cardiovascular Imaging)  
10:30-12:00 PM • **SST16** • Room: E350 • Vascular/Interventional (MR Guidance/Topics of Interest)

**Anatomy and Hemodynamics of Ectopic (Gastric and non-Gastric) Varices: Endoscopic and Vascular Classifications**

**LL-VIE1272**

Wael E Saad, MBBCh \*  
Abdullah Al-Osaimi, MD  
Stephen Caldwell, MD

PURPOSE/AIM

There are numerous classifications of ectopic varices including newly published classification that collectively take endoscopic and vascular classifications into account. Moreover, the detailed cross-sectional radiographic and surgical anatomy of varices and shunts have not been

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described. The purpose of the review is to display (illustrations) and discuss every published anatomical (including endoscopic) and hemodynamic classification of ectopic varices as well as describe the detailed anatomy and hemodynamics.

#### CONTENT ORGANIZATION

Discussing all ectopic variceal locations: Gastric, Duodenal, Mesenteric, stomal, uterine, vesciral (urinary bladder). Discussing and illustrating all classifications: Sarin, Hirota, Kiyosue (inflow/outflow), Watanabe, Fukuda-Hirota, and others recently published. Detailed cross-sectional anatomy and hemodynamics of ectopic varices including hemodynamic classifications.

#### SUMMARY

It is important to place all the anatomy, hemodynamics and all the classifications in a review to reduce the confusion and to discuss the overlaps as well as correlate between gastroenterology (endoscopic classifications) and vascular (radiologic and surgical) classifications.

### Yttrium 90 Radiotherapy: Usefulness of Tc99 MAA Scan beyond Lung Shunt Calculation

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#### LL-VIE1273

**George Zlotchenko** , MD

**Anuj Malhotra** , MD

**Mark A Westcott** , MD \*

**Stephen Scharf** , MD \*

#### PURPOSE/AIM

Tc99 MAA studies are essential prior to delivery of yttrium 90 microspheres primarily to estimate lung shunt fraction which may effect dosimetry calculations. Traditionally planar imaging has been used due to short imaging times. Tc99 MAA SPECT CT studies can also be performed and may yield information that necessitates a change in the radioembolization treatment protocol.

#### CONTENT ORGANIZATION

◆ Overview of Tc99 MAA preparation, intraarterial delivery, and mechanism of lung shunt

◆ Identify pitfalls and possible sources of error during Tc99 MAA imaging

◆ Compare planar and SPECT CT imaging

◆ Demonstrate various extrahepatic activity and importance for radioembolization

◆ Show different intrahepatic activity patterns and importance for radioembolization

#### SUMMARY

Tc99 MAA studies are primarily used to determine lung shunt. Combining Tc99 MAA scan with SPECT CT imaging allows us to ascertain more information prior to the delivery of Yttrium 90 microspheres.

### Fluoro CT- guided RF Ablation and Percutaneous Cementoplasty Plus Fixation for Palliative Treatment for Painful Metastatic Bone Lesions

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#### LL-VIE1274

**Julio Vargas** , MD

**Juan P Martinez** , MD

**Jorge E Navia** , MD

#### PURPOSE/AIM

To determine the indications and describe the technique of CT-guided RF ablation and percutaneous cementoplasty plus fixation as a palliative treatment for painful metastatic bone lesions refractory to conservative medical treatment

#### CONTENT ORGANIZATION

A. Anatomy

B. Pathophysiology

C. Review of Indications, Contraindications

D. Description of technique

E. Follow-up Management

F. Outcomes (include complications)

#### SUMMARY

Metastatic bone lesions are common in patients with cancer; up to 85% of patients with breast, prostate, and lung cancer have evidence of bone metastases at the time of death. These are a cause of significant cancer-related pain, affecting quality of life, performance status, and mood. Analgesics are the cornerstone treatment for patients with painful bone metastases; although, to achieve adequate pain control, higher doses are frequently required and can lead to significant side effects. External beam radiation therapy is the current standard of care, however, many patients do not achieve optimal relief. Image-guided RF ablation techniques and percutaneous cementoplasty of bone metastases have proved effective for palliative treatment in patients with painful bone metastases who have failed to achieve benefit from conventional therapies, and pain reduction that is achieved with this is durable over many months.

### Imaging Spectrum Post Radiofrequency Ablation (RFA) of 200 Renal Tumors: Pearls and Pitfalls

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#### LL-VIE1275

**Rohith Puthan Veettil** , MBBS, MRCS

**Tze M Wah** , MBChB, FRCR

**Paul S Walker** , MBBS

**Naeem Jagirdar** , MBBS, MRCP

**Jon Cartledge** , MD

**Peter J Selby** , MD, DSc

**Jonathan T Smith** , MBChB, FRCR

**Adrian D Joyce** , MD

**Henry C Irving** , MBBS

#### PURPOSE/AIM

This pictorial illustration aims to present our imaging experience in the assessment of 200 renal tumors post RFA at a tertiary university institution from 2004 to 2013.

#### CONTENT ORGANIZATION

We present a pictorial review of image guided renal RFA over an 8-year period. The contents include describing current techniques used to assess renal tumors following RFA and to illustrate the normal expected findings and sequential imaging interval changes longitudinally on both CT and or MRI and to describe the classic imaging signs associated with the interval change. To highlight the pearls and pitfalls of imaging findings on both CT and MRI and to demonstrate the use of contrast enhanced ultrasound in problem solving cases. This review also present unusual findings post renal RFA e.g. chyluria, latent infection in the zone of ablation with fistula formation to the pleural and inflammatory between zone of ablation and adjacent structure e.g. colon, as well as, to illustrate our complications e.g. acute tubular necrosis, calyceal cutaneous fistula and retroperitoneal abscess from a complicated ureteric stricture post RFA.

#### SUMMARY

It is important to recognise various salient features post image guided renal RFA on imaging and early recognition of residual/recurrent disease as well as complications would allow timely clinical management.

### The Proteomics of Ablation: Methodology for Understanding Systemic Biological Responses to Tumor Ablation

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**LL-VIE1276**

**Lucas D Breen** , BS  
**Madeleine L Cook**  
**Damian E Dupuy** , MD \*  
**Lulu Cao** , PhD  
**Lila M Camara** , RT  
**Maja Pucic** , PhD  
**Dennis Pantazatos**  
**Gordon Lauc** , PhD  
**Djuro Josic** , PhD

## PURPOSE/AIM

To show proteomic translational research of tumor ablation patients' plasma with the use of chromatographic protein separation and mass spectrometry quantification and identification techniques in order to understand the body's biological responses to tumor ablation.

## CONTENT ORGANIZATION

This exhibit will illustrate the scientific steps that have been taken to perform in-depth proteomic analysis on the plasma of cancer patients before and for six months following thermal ablation. Identification and quantification of low-abundance proteins by mass spectrometry with significant changes in spectral intensity during patient trials will be illustrated in conjunction with functional analysis. Confirmation of method reproducibility is shown by SDS PAGE. Additionally chromatographically isolated IgG from patient plasma identified glycosylation patterns which were analyzed by glycan cleavage followed by HPLC.

## SUMMARY

Image-guided tumor ablation is becoming more widely utilized for solid tumors. The systemic effects of local tumor treatment may enhance or hinder local tumor responses based on tumor and host biology. Proteomic analysis of tumor biomarkers, inflammatory mediators and immunological stimuli may add further insight to the growing evidence for modulation of both adaptive and innate immunity in response to tumor treatment.

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**Practice Makes Perfect: The Utility of Ultrasound Phantoms for Biopsy and Vascular Access Practice with Review of Available Options**


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**Adam DeFoe** , MD  
**Louis Morel** , MD  
**Adam Stibbe** , MD

## PURPOSE/AIM

1. Recognize the need and utility of ultrasound phantoms for biopsy and vascular access among trainees 2. Review the available options for commercially available and homemade ultrasound phantoms 3. Review the strengths and weaknesses of various phantoms for ultrasound guided procedures

## CONTENT ORGANIZATION

Utility of ultrasound phantoms for biopsy and vascular access practice

- Resident survey from our institution, before and after phantom practice, demonstrating improved confidence
- Results from others' similar work in the published literature demonstrating improved confidence and skill

Options for ultrasound phantoms with evaluation of their respective strengths and weaknesses

- Commercially available phantoms
- Homemade phantoms, including gelatin and animal tissue

## SUMMARY

Ultrasound guided procedures require practice to gain proficiency. Both skill and confidence can be gained with practice on phantoms, rather than on live patients, as we and others have shown. There are many commercial and homemade phantom options, each with inherent strengths and weaknesses.

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**Practice Makes Perfect: The Utility of Ultrasound Phantoms for Biopsy and Vascular Access Practice with Review of Available Options**


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## Portal Hypertension: A Review of Porto-systemic Collateral Pathways and Endovascular Interventions

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### LL-VIE1278

**Amish D Patel**, MD  
**Victor O Lopez**, MD  
**Anil K Pillai**, MD  
**Sanjeeva P Kalva**, MD \*  
**Steven L Hsu**, MD  
**Clayton K Trimmer**, DO

#### PURPOSE/AIM

To describe and illustrate the pathophysiology of portal hypertension, anatomy of porto-systemic collateral pathways, endovascular treatment options and the specific role of each endovascular procedure in the management of complications of portal hypertension.

#### CONTENT ORGANIZATION

We describe and illustrate the following:

1. Pathophysiology and clinical manifestations of portal hypertension.
2. Anatomy of various porto-systemic collateral pathways on CT, MR and angiography.
3. Role of various endovascular procedures, using case examples, for the management of both conventional and ectopic varices in portal hypertension.
4. Brief literature review of success and complications of the interventional procedures.

#### SUMMARY

We will educate the viewers about collateral venous anatomy and its importance in guiding the appropriate interventional therapy.

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## Virtual Navigation Systems in CT-guided Interventional Procedures in Liver and Kidney

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### LL-VIE1279

**Arash Anvari**, MD  
**Priyanush Kandakatla**, MD  
**Anthony E Samir**, MD  
**Ronald S Arellano**, MD  
**Raul N Uppot**, MD

#### PURPOSE/AIM

In this educational we review the role of the developing and evolving technology of virtual navigation systems in CT guided biopsies and tumor ablations in liver and kidney.

#### CONTENT ORGANIZATION

1. History and background of virtual navigation system
2. Definition of important concepts in this technology like trajectory guidance, needle tracking, body GPS, image fusion, virtuality, augmented virtuality, augmented reality, reality.
3. Limitation of current CT-guided or Ultrasound-guided for liver and kidney interventions.
4. Describe different techniques of CT-scan virtual navigation system:
  - a. Electromagnetic tracking methods
  - b. Optical tracking methods
  - c. Hybrid tracking methods
5. Role of each technique in CT-guided interventions for focal liver and kidney lesions.
6. Discuss about potential advantages and limitations of these methods like: impact of them on dose radiation, accuracy of their performance, cost benefit and their clinical effectiveness.
7. Compare CT-scan virtual navigation system with CT-fluoroscopy and C-arm cone beam CT (CBCT).

#### SUMMARY

This exhibition will emphasize on the clinical indications, advantages and limitations of various virtual navigation systems for CT-guided intervention of focal liver and kidney lesions.

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## Endovascular Therapy for an Occluded SVC: A Review of SVC Syndrome with a Pictorial Exhibit of Noninvasive Imaging, Interventional Modalities, and Respective Outcomes

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### LL-VIE1280

**Brandon M Shearer**, DO  
**Erin Horsley**, DO  
**Brian A Bianco**, DO, MBA  
**Alexander E Trebelev**, MD

#### PURPOSE/AIM

The goal is to provide a review of superior vena cava (SVC) syndrome and a greater understanding of endovascular management of SVC syndrome.

#### CONTENT ORGANIZATION

A review of the pathophysiology, clinical manifestations, differential diagnosis, imaging findings, and treatment modalities with a particular emphasis on endovascular management of SVC syndrome will be conducted. A pictorial case based review utilizing multiple imaging modalities of selected retrospectively identified patients with SVC syndrome who underwent endovascular therapy will be presented.

#### SUMMARY

Treatment of SVC syndrome relates to the cause, which may include thrombolytics, anticoagulants, radiation, chemotherapy, surgical, and endovascular interventions. Endovascular treatment is a minimally invasive therapy consisting of thrombolysis, angioplasty, and stent placement resulting in a 75-100% rate of symptom relief with minimal complications.

**LL-VIE1281**

**Matthew Suberlak** , MD  
**John Yoon** , MD  
**Abhishek Kumar** , MD  
**Sohail G Contractor** , MD, MBBS

**PURPOSE/AIM**

- Review complications of chronic IVC filters including inferior vena cava thrombus and renal failure
- Describe treatment options for IVC thrombosis including endovenous technique
- Review periprocedural and postprocedural management for patients treated with catheter guided thrombolysis
- Describe technique and potential complications of mechanical thrombectomy

**CONTENT ORGANIZATION**

1) Introduction 2) Clinical Findings 3) Imaging findings 4) Treatment options 5) Endovenous technique 6) Postop management and complications

**SUMMARY**

IVC thrombosis is a major complications with a chronic IVC filter(> 6 month duration). Catheter guided thrombolysis can provide definitive treatment for caval thrombosis. For those patients with renal failure, direct catheter guided thrombolysis of the renal vein will often immediately improve renal function. Followup endovenous mechanical thrombectomy is an effective treatment to clear the thrombus. Postprocedural care requires admission to the ICU with close observation of pertinent labwork including fibrinogen levels. Complications include recurrent thrombosis and bleeding.

**Imaging and Endovascular Treatment of Chronic Iliofemoral Venous Obstruction**[Back to Top](#)**LL-VIE1282**

**Julia Galuzina**  
**Adriaan Moelker** , MD

**PURPOSE/AIM****CONTENT ORGANIZATION**

1. Description of post-thrombotic syndrome regarding symptoms and pathophysiology
2. Imaging techniques for assessing location, severity and treatment options with emphasis on venography
3. Discussion of endovascular recanalization and stenting techniques
4. Treatment outcome in term of patency rates and re-do's
5. Complications during and after recanalization and stenting
6. Discussion on post-intervention anti-coagulation regimen protocols

**SUMMARY**

Venography remains the gold standard for assessing chronic iliofemoral venous obstruction. Recanalization with balloon angioplasty and stenting provides a safe option for treatment of iliofemoral obstruction with good clinical outcome and low morbidity.

**Deep Vein Thrombosis: Aging the Killer**[Back to Top](#)**LL-VIE1283**

**Hosam N Attaya** , MD  
**Sergio A Segrera**  
**H. B Harvey** , MD, JD  
**Richard L Hesketh**  
**Zubin Irani** , MD  
**Rahmi Oklu** , MD, PhD

**PURPOSE/AIM**

This educational exhibit will focus on the critical role age of a deep vein thrombus (DVT) plays in the therapeutic decisions of clinical management. We will review the mechanisms of clot organization in humans and in animal models with their associated imaging findings and the challenges they present to interventional radiologists.

**CONTENT ORGANIZATION****SUMMARY**

DVT is associated with major morbidity and mortality. Nearly 60% of DVT patients develop post-thrombotic syndrome while on 3-6 months of anticoagulation medication. During this time period, the clot organizes and becomes resistant to endogenous thrombolytic therapy. We will review the histopathological changes associated with aging of both human and animal clot and present novel imaging modalities that may potentially guide thrombolytic therapy.

**The Thyroid Nodule Conundrum: To Biopsy or to Not Biopsy?**[Back to Top](#)**LL-VIE1284**

**Amar M Amin** , MD  
**Pratish A Shah** , MD  
**Eric Chen** , MD  
**Amardeep S Johar** , MD  
**Mary Connell** , MD  
**Dan G Gridley** , MD  
**Michael C Switzer** , MD

**PURPOSE/AIM**

The purpose of this exhibit is: 1. To review the anatomy of the thyroid gland on sonography. 2. To explain which nodules should be biopsied and which ones can be left alone or followed up.

**CONTENT ORGANIZATION**

1. Anatomy of the thyroid gland and surrounding structures within the neck. 2. Standard sonographic protocol in evaluating the thyroid gland. 3. Review various types of nodules including sonographic characteristics which make nodules more suspicious for malignancy. 4. Discuss technique in performing fine needle aspiration of the thyroid nodule and review which parts of a thyroid nodule should be biopsied in order to provide the pathologist with adequate tissue sample.

**SUMMARY**

The goal of this presentation is to: 1. Provide a review for the radiologist in recommending which nodules should be closely followed up, which ones can be stated to be benign and which nodules require further evaluation by fine needle aspiration. 2. Discuss and illustrate technique in performing fine needle aspiration on a thyroid nodule.

**The Thyroid Nodule Conundrum: To Biopsy or to Not Biopsy?**[Back to Top](#)

## LL-VIE1284

**Amar M Amin** , MD  
**Pratish A Shah** , MD  
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## The Thyroid Nodule Conundrum: To Biopsy or to Not Biopsy?

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## LL-VIE1284

**Amar M Amin** , MD  
**Pratish A Shah** , MD  
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## Sharp Recanalization Techniques for Central Venous Occlusions: A Pictorial Essay

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## LL-VIE1285

**Samir Kulkarni** , MD  
**Yi Ju Chuang** , MD  
**Anil K Pillai** , MD  
**Steven L Hsu** , MD

### PURPOSE/AIM

1. To emphasize the important of maintaining central venous access in dialysis patients  
2. To review the current techniques of sharp recanalization in the setting of central venous occlusion.

### CONTENT ORGANIZATION

A. Dialysis access and options for initiation  
B. Common mechanisms for central venous occlusions in hemodialysis (HD) patients  
C. Importance of maintaining central venous access in HD patients  
D. Review of 4 different methods for sharp recanalization with procedural steps, illustrative images depicting the anatomy with recanalization techniques, and actual case images  
a. Sharp needle recanalization  
b. Snare-assisted recanalization  
c. Balloon-assisted recanalization  
d. Rotation device (Tru-Path) assisted recanalization.

### SUMMARY

1. Central venous occlusion is not uncommon in patients with end stage renal disease (ESRD) on HD  
2. Loss of central venous access has a significant impact on quality of life and mortality for patients with ESRD on HD  
3. There are techniques to attempt to overcome central venous occlusion and maintain access for HD, which we will review with illustrations and cases.

## Three Dimensional Printing: A Highly Customizable Technology for the Rapid Fabrication of Personalized Tailored Devices

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## LL-VIE1290

**Rahul A Sheth** , MD  
**David S Kong** , PhD  
**Zubin Irani** , MD  
**Rahmi Oklu** , MD, PhD

### PURPOSE/AIM

Rapid prototyping methods, also known as 3D printing, are a recent technological advancement with tremendous potential for advancing personalized medical device design. 3D printing represents an additive construction method: material is added layer by layer, so that complex structures can be created without a pre-existing mold. As a result, the incremental cost of creating a new design is minimal, thereby greatly expanding the design possibilities, which in many ways are limited only by the creativity of the designer. We will summarize the methods for 3D printing, their current and potential roles in medical device design, and emphasize their particular relevance to Interventional Radiology.

### CONTENT ORGANIZATION

1. Methods for 3D printing: selective polymerization and sintering 2. Potential applications of 3D printing in medicine 3. Relevance of 3D printing to Interventional Radiology: Custom fabrication of devices tailored to patients on an individual basis

## SUMMARY

3D printing is a burgeoning fabrication technology that allows for highly customizable device design. With the ability to interpret volumetric data from cross-sectional imaging and subsequently implant devices tailored to match the imaged anatomy, Interventional Radiologists are uniquely poised to serve in the vanguard of 3D printing.

## Climbing the Learning Curve: Lessons Learned with Balloon-occluded Retrograde Transvenous Obliteration (BRTO) of Gastric Varices

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### LL-VIE1291

**Steven Steer**, MD  
**Shain S Wallis**, DO  
**Rajesh Patel**, MD

#### PURPOSE/AIM

BRTO is an effective treatment for gastric varices. Utilization of the procedure is increasing as techniques evolve. Our purpose is to facilitate an exchange of ideas aimed at improving outcomes and minimizing complications. We will discuss technical considerations involving approach (transjugular vs. transfemoral), estimation of variceal diameter, appropriate sizing of the occlusion balloon, and duration of balloon inflation. We will describe our use of a dual-sheath technique consisting of a balloon occlusion system and a sclerosant injection system and we will discuss its advantages over the traditional single coaxial system.

#### CONTENT ORGANIZATION

1. Review of the principles and technique of BRTO. 2. Discuss the relevant anatomical considerations of gastric varices and the classifications of gastroduodenal shunts. 3. Discuss the indications for BRTO. 4. Describe the step-by-step interventional technique. 5. Illustrate modifications to the technique in a pictorial review.

#### SUMMARY

BRTO is an effective and increasingly utilized treatment for gastric varices. An understanding of indications and anatomical considerations is essential to appropriate patient selection and procedural planning. As techniques evolve, an exchange of ideas is needed to facilitate improvements to the procedure, optimize outcomes and minimize complications.

## Liquid Casting Agents for Embolic Therapies-Agent Options and Selection

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### LL-VIE1295

**Gordon M Butler**, MD  
**Yi Ju Chuang**, MD  
**Ikponmwosa Iyamu**, MD  
**Jed A Hummel**, MD  
**Sadia Choudhery**, MD  
**Anil K Pillai**, MD

#### PURPOSE/AIM

To discuss liquid casting agents available and how they work.  
To present criteria for agent and patient selection.  
To discuss techniques employed when working with liquid casting agents.  
To discuss common complications.

#### CONTENT ORGANIZATION

Current agents and how they work. Criteria for case and patient selection. Common complications.  
Technique and technical pearls. Clinical scenarios with imaging findings.

#### SUMMARY

Liquid casting agents are relatively new options for embolic therapy. There are two types of such agents, adhesive and nonadhesive. With a wide range of embolic agents to choose from, standardizing the approach to agent selection simplifies the process. Determining the best embolic agent for a case depends of factors including: how large is the vessel to be embolized, should the embolized tissue remain viable after embolization, and length of time the vessel should remain occluded. Liquid casting agents are ideal for case when tissue death is desired and vessel size is small. These agents have been applied with various pathologies and may offer some unique benefits in certain scenarios. Liquid casting agents require unique preparation techniques. Complications associated with liquid casting agents are similar to those seen with conventional embolic agents including post embolization syndrome; although there are some unique pitfalls.

## Particle Embolization: Past, Present, Future

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### LL-VIE1296

**Rahul A Sheth**, MD  
**Patrick D Sutphin**, MD, PhD  
**Zubin Irani**, MD  
**David S Kong**, PhD  
**Rahmi Oklu**, MD, PhD

#### PURPOSE/AIM

Particles for endovascular embolization have evolved from materials such as lead pellets, muscle, fat, autologous blood clot and gelfoam to particles comprised of complex polymers with varying biochemical properties which can be modified to carry therapeutic payloads. We will summarize the current methods in the synthesis of particles and present the merits of the latest technologies such as 3D printing and microfluidic technology that have tremendous potential for advancing personalized particle design.

#### CONTENT ORGANIZATION

1. Methods for current particle synthesis, design, applications and limitations. 2. Application of 3D printing and microfluidic technology in the synthesis of particles for embolization. 3. Potential use of pH, heat and energy activated biodegradable particles in tumor ablation. We will review current polymers available for human use that may be adapted for embolization.

#### SUMMARY

Point-of-care 3D printing and microfluidic technology using activatable polymers represents rapid fabrication technologies that may be adapted to synthesize highly customizable particles for endovascular embolization.

## Ablative Therapies in the Treatment of Renovascular Hypertension

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### LL-VIE1297

**Aaron B Paul**, MD  
**Alexander Golberg**  
**Richard L Hesketh**  
**Avinash R Kambadakone**, MD, FRCR  
**Rahmi Oklu**, MD, PhD

#### PURPOSE/AIM

Hypertension remains one of the greatest public health threats facing the United States today involving 1 in 3 American adults. Percutaneous renal artery denervation using the application of radiofrequency ablation (RFA) energy has been shown to be safe, effective

and durable in reducing systolic blood pressure in patients with resistant hypertension. In this exhibit, we will review the pathogenesis of renal artery denervation, compare current and emerging technologies such as irreversible electroporation (IRE) technology and propose celiac axis alcohol ablation as a viable alternative as a treatment for renovascular hypertension.

#### CONTENT ORGANIZATION

1. Review the Pathogenesis of Renovascular Hypertension 2. Explore the Biological Basis of Renal Artery Denervation in the Treatment of Renovascular Hypertension. Compare and contrast RFA and IRE 3. Celiac axis alcohol ablation as a potential alternative to renovascular hypertension. We will provide a pictorial review of the relevant neuroanatomy and their interconnections with the celiac axis.

#### SUMMARY

This educational exhibit will provide a comprehensive review of the biological basis and effectiveness of current and emerging ablative strategies in clinical practice. We will also provide a detailed pictorial review of the relevant neuroanatomy that play a role in renovascular hypertension.

## Review of Perforator Flap Imaging with High Resolution MRA

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### LL-VIE1298

**Alexander C Kagen**, MD \*  
**Rydhwana Hossain**, MD  
**Erez Dayan**, MD  
**Soumya Maddula**, BA  
**William Samson**, MD  
**Joseph Dayan**, MD  
**Mark Smith**

#### PURPOSE/AIM

1. Educate the reader regarding various autologous-based tissue flap reconstructions, an increasingly common surgical technique, particularly in head and neck and breast surgeries.
2. Discuss the general MRI protocol for imaging donor flaps and to highlight the differences related to each specific flap.
3. Review the associated imaging findings, reporting of pertinent vascular anatomy, and common pitfalls for each donor flap that are relevant to the surgeon.

#### CONTENT ORGANIZATION

Types of Flaps:

- DIEP (deep inferior epigastric perforator)
- GAP (gluteal artery perforator)
- TDAP (thoracodorsal artery perforator)
- TUG (transverse upper gracilis)
- Fibular Flap
- ALT (anterolateral thigh)

MRI Technique and Findings:

- General and Specific Perforator Flap Protocols
- DIEP
- GAP
- TDAP
- TUG
- Fibular Flap
- ALT

Reporting:

- Variant vascular anatomy
- Incidentals and relevant prior surgical anatomy
- Artifacts and other pitfalls

#### SUMMARY

Major teaching points of this exhibit:

1. Review of different types of donor flaps used in breast and head and neck surgeries.
2. Acquisition of high-resolution MRA images to identify relevant perforator vessels.
3. Understanding of how variant vascular anatomy, remote surgical history and common artifacts affect accurate interpretation.

## Review of Perforator Flap Imaging with High Resolution MRA

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### LL-VIE1298

**Alexander C Kagen**, MD \*  
**Rydhwana Hossain**, MD  
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## Review of Perforator Flap Imaging with High Resolution MRA

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**Alexander C Kagen**, MD \*  
**Rydhwana Hossain**, MD  
**Erez Dayan**, MD  
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3. Understanding of how variant vascular anatomy, remote surgical history and common artifacts affect accurate interpretation.

## An Update on Devices Currently Available to Treat Chronic Total Occlusions in the Peripheral Vasculature

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### LL-VIE1299

**Stephen P Reis**, MD \*  
**Anil K Pillai**, MD  
**Brian Cox**, MD  
**Matthew E Anderson**, MD  
**Sanjeeva P Kalva**, MD \*

PURPOSE/AIM

- ◆ To illustrate the mechanism of action of currently available intra luminal and extra luminal CTO devices.
- ◆ To illustrate the TASC 11 classification in the management of occlusive peripheral vascular disease.
- ◆ To present a brief review of literature pertaining to the success and complication of the currently available CTO devices.

CONTENT ORGANIZATION

A pictorial review of the currently available chronic total occlusion (CTO) crossing devices illustrating mechanism of action and highlighting the benefits and drawbacks of each device will be presented. We also discuss the current TASC classification and the use of CTO crossing devices within and outside the confines of the classification. A short table with a brief literature review of published data regarding the success and complication rates for each of these devices will be presented. The following devices will be profiled: 1) Crosser (Bard)  
 2) Tru-Path (Boston Scientific)

- 3) Front Runner (Cordis)
- 4) SafeCross (Spectranectics)
- 5) Excimer Laser angioplasty (Spectranectics)
- 6) Pioneer (Medtronic)
- 7) Outback (Cordis)
- 8) Viance (Covidien)
- 9) Enteer (Covidien)

#### SUMMARY

The above exhibit, with illustrations will educate the viewers about the currently available Chronic Total Occlusion devices; their specific indications with respect to the TASC classification and currently published data.

## The Role of IR in Thyrotoxic Crisis

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### LL-VIE1300

**Rustain L Morgan** , MD, MS  
**Aaron Kovaleski** , MD  
**Kyle Werth**  
**Philip L Johnson** , MD

#### PURPOSE/AIM

The purpose of this exhibit is to provide a clinical and pictorial review of thyrotoxic crisis (thyroid storm). We will review published data on thyroid arterial embolization as treatment of thyrotoxic crisis, and present of our own case of thyrotoxic crisis refractory to medical and surgical management that underwent thyroid arterial embolization.

#### CONTENT ORGANIZATION

We will review thyroid anatomy and clinical presentation and outcomes of thyrotoxic crisis, with a specific focus on multitude of etiologies. Given the mortality rate of 20-30%, which can rise up to 75% with delayed treatment, medical management is crucial. While thyroidectomy is often necessary, critically ill patients are often poor surgical candidates. Utilizing a limited number of published case reports, we will discuss thyroid arterial embolization as a treatment option for unstable patients and review our own case of a clinically unstable patient in thyrotoxic crisis who underwent thyroid embolization.

#### SUMMARY

Patients in thyroid storm are often unstable, which combined with poor overall prognosis, often makes them poor surgical candidates. Limited literature and our own experience suggests some patients may benefit from thyroid arterial embolization, implying interventional radiologists may play an key role in the treatment of thyroid storm.

## Recognition and Management of Aortic Intussusception: Review of Literature and Case Examples

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### LL-VIE1301

**Anika L Mirick** , MD  
**Narasimham L Dasika** , MD  
**Michael Deeb** , MD  
**Himanshu J Patel** , MD \*  
**David M Williams** , MD

#### PURPOSE/AIM

The purpose of our educational exhibit is to present the imaging features of an uncommon complication of aortic dissection and to focus on the importance of its recognition during endovascular surgical treatment of aortic dissection.

#### CONTENT ORGANIZATION

1. Overview of aortic intussusception
  - \* Epidemiology
  - \* Pathophysiology
  - \* Imaging features and recognition using CT and TEE, as demonstrated by cases
2. Case presentation
  - \* Case summary
  - \* Recognition and real-time diagnosis of aortic intussusception using IVUS
  - \* Management strategy
3. Future directions and summary

#### SUMMARY

Circumferential tears of the intimal flap are uncommon. The free floating intima can fold and collapse, resulting in antegrade or retrograde intussusception. It is important to recognize the presence of an inverted and invaginated intimal flap during endovascular and surgical repair of aortic dissections associated with malperfusion. Furthermore, an incomplete tear may progress into a complete tear during endovascular instrumentation of a collapsed true lumen. Dynamic intravascular ultrasound (IVUS) allows precise diagnosis of intimal intussusception during endovascular treatment. This abnormality can also be recognized on CTA or MRA, however, the finding may be overlooked unless three-dimensional reformats are performed.

## The ABC of Percutaneous Management of Pseudoaneurysms

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### LL-VIE1304

**Virgilio Benito Santamaria** , MD  
**Jairo A Molina Zuluaga** , DSc  
**Ruben Guerrero Vara** , MD

#### PURPOSE/AIM

To describe the role of minimally invasive techniques for the management of pseudoaneurysms and to illustrate the spectrum of these procedures. To review the different available materials (such as coils, stent grafts or liquid embolic agents) and when to use each of them. To outline the advantages, limitations and best indications for percutaneous treatment of pseudoaneurysms.

#### CONTENT ORGANIZATION

- A. Introduction
- B. When to treat a pseudoaneurysm?
- C. How to treat a pseudoaneurysm?
  1. Pretreatment assessment of a pseudoaneurysm
  2. Therapeutic options for pseudoaneurysm management

-Minimally invasive procedures: indications, techniques, materials, management and complications -Surgery: indications D. Conclusions

#### SUMMARY

The minimally invasive techniques due to their low morbidity and mortality, have increased their role in the last years for the management of pseudoaneurysms. Therefore, a proper knowledge of available endovascular materials and techniques is essential. This exhibit will review:

- a. the spectrum of minimally invasive techniques
- b. the percutaneous management of pseudoaneurysms
- c. the advantages, limitations and best indications for percutaneous treatment of pseudoaneurysms

**LL-VIE1305**

**Jakub Wiskirchen** , MD  
**Tobias Kubis**  
**Udo Bresch**  
**Benjamin Wiesinger** , MD  
**Claus D Claussen** , MD

**PURPOSE/AIM**

The aim of this exhibit is - to give an overview about embolization materials and techniques - to present common and rare causes of abdominal hemorrhage and successful ways of endovascular treatment

**CONTENT ORGANIZATION**

Multiple causes for abdominal hemorrhage like trauma, rupture of visceral artery aneurysms as well as iatrogenic causes exist. Continuous bleeding may result in patient's destabilization and cardiovascular breakdown. As conservative treatment often does not suffice, the bleeding cause itself has to be treated. With new and sophisticated materials, endovascular techniques became the therapy of choice in most of those cases. With microcatheters, glues, particles and especially coils and hydrocoils the interventional radiologist can safely treat causes like traumatic liver hemorrhage, postoperative bleeding as well as bleeding from visceral artery aneurysms. In this presentation a variety of bleeding causes and their endovascular treatment will be presented (e.g. liver laceration, kidney bleeding due to puncture, tumor bleeding, bleeding from ruptured aneurysms from the GDA, the celiac trunk, the splenic artery as well as from pseudo aneurysms due to partial kidney resection).

**SUMMARY**

Endovascular treatment of acute and subacute abdominal hemorrhage is safe and beneficial for the patient and should be the first choice treatment if applicable.

**The Vascular Distribution of Fibromuscular Dysplasia: A Pictorial Essay****LL-VIE1306**

**Aparna Baheti**  
**Nicholas J Hendricks** , MD  
**Alan H Matsumoto** , MD \*

**PURPOSE/AIM**

To provide examples of fibromuscular dysplasia in less-commonly described vascular beds and to showcase other vascular lesions that can be seen in patients with FMD.

**CONTENT ORGANIZATION**

Fibromuscular dysplasia (FMD) is a non-inflammatory disease of medium sized arteries, most commonly seen in the renal arteries. With the creation of the National FMD Registry, it has become apparent that this disease is frequently present in non-renal vascular beds. In that cohort, the prevalence of FMD in carotid arteries (56%) approaches the prevalence of renal artery FMD (65%). This exhibit demonstrates the imaging and clinical manifestations of FMD in extra-renal vascular beds and its possible association with intracranial and aortic aneurysms. Case examples include: 1) Renal, carotid and intracranial FMD. 2) Bilateral renal FMD with abdominal aortic aneurysm. 3) Renal and iliac FMD with thoracic aortic aneurysm. 4) Renal FMD with an aortic dissection. 5) Mesenteric FMD. 6) Coronary FMD. 7) Vertebral FMD. 8) Renal intimal FMD.

**SUMMARY**

As awareness of FMD increases, we will see extra-renal FMD more often. This will increase the possible utility of screening for carotid disease and ankle-brachial indices in patients with known renal FMD. The clinical implications of these findings will remain prominent in the discussion of FMD-related complications in the future.

**Interventional Radiology Management of Pediatric Vascular Malformations****LL-VIE1307**

**Joel Woodley-Cook** , MSc, MBBS  
**Martin E Simons** , MD  
**Philip R John** , MBBCh, FRCR  
**Joao G Amaral** , MD

**PURPOSE/AIM**

To provide an overview of the role of interventional radiology (IR) in the management of pediatric vascular malformations (VM).

**CONTENT ORGANIZATION**

- Discuss the classification of VM, which has historically been separated into two groups: hemangiomas and vascular malformations, based on their natural history, cellular turnover, and histology. The more modern classification of VM into low-, intermediate-, and high-flow malformations will be discussed.
- Outline imaging used to characterize and determine the anatomic extent of VM, including Doppler ultrasound, contrast-enhanced CT/MRI, and conventional angiography.
- Discuss syndromes associated with VM with examples of clinical and radiologic images.
- Discuss treatment principles and options of VM with an emphasis on current IR treatment methods, which include sclerotherapy, coil embolization, and/or particle embolization. A discussion of prognosis and a comparative analysis of medical, surgical, and IR treatment will be included.
- Discuss the importance of a multidisciplinary approach to VM, which involves pediatric radiology, surgery, hematology/oncology, dermatology, otolaryngology, orthopedic surgery, and occupational/physical therapy.
- Key learning points.

**SUMMARY**

IR plays an integral role in the management of VM, which requires a multidisciplinary approach.

**AtlaVasc: An Interactive Online Vascular Atlas and Interventional Radiology Review****LL-VIE1308**

**Donald J Perry** , MD  
**Gabriel C Fine** , MD  
**Michael L Richardson** , MD  
**Matthew J Kogut** , MD

**PURPOSE/AIM**

A thorough understanding of complex vascular anatomy in various imaging modalities is critical for radiologists, interventional radiologists, and other specialties. However, interactive vascular atlases are currently limited and there are few advanced online resources with an emphasis on interventions. Our aim is to review the upper and lower extremity vascular anatomy, anatomic variants, and related interventions with correlation between multiple modalities including CT, DSA, MRA, and 3D reformats.

#### CONTENT ORGANIZATION

The online vascular anatomy atlas will enable visitors to review anatomy by interactive scrolling through the upper extremity vasculature in 3 planes with labeled static images that highlight pertinent anatomy. Additionally, the user will be able to review relevant pathology, clinical applications and interventions at various regions of the upper and lower extremities. Self-quiz questions will be available for additional review.

#### SUMMARY

The Atlavasc website will be an ideal resource for reviewing vascular anatomy, pathology, and interventional procedures within the upper and lower extremities. The user will be able to scroll through vasculature in 3 planes with labeled static images that highlight pertinent anatomy with available self quizzes, links to interventional updates, links to resources and opportunities for case submission.

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### **Intratumoral Vascular Shunting: Conduit for Circulating Tumor Cells and Their Role in Metastasis**

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#### **LL-VIE1309**

**Amy R Deipolyi** , MD, PhD  
**Rahmi Oklu** , MD, PhD

#### PURPOSE/AIM

Metastasis is the leading cause of cancer-related deaths; understanding the factors that enable or prevent metastasis is essential in diagnosing and treating cancer. Circulating tumor cells (CTCs) initiate metastases, but must gain access to distant sites in the body.

#### CONTENT ORGANIZATION

1. Describe current knowledge of the mechanisms underlying tumoral angiogenesis. 2. Describe the pathogenesis of intratumoral vascular shunting including prevalence in various tumor types. 3. Illustrate vascular shunting in a variety of tumors including primary and metastatic liver cancers with case images from ultrasound, angiography, and nuclear medicine studies. 4. Illustrate how intratumoral vascular shunts can provide conduits for CTCs to access distant sites of metastasis.

#### SUMMARY

Intratumoral vascular shunting is likely an important etiologic factor in cancer metastasis; their prevalence with respect to cancer staging is unknown. Angiogenic processes result in significant intratumoral vascular shunts that could provide conduits for CTCs to gain access to distant sites for tumor metastasis. Such shunts can be evaluated with imaging, and the extent of intratumoral shunting may be a robust marker of tumor aggressiveness and likelihood of progression.

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### **Ghrelin Busters: A Novel Approach to Weight Loss Treatment**

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#### **LL-VIE1310**

**Elizabeth J Hamilton**  
**Andrew J Gunn** , MD  
**Richard L Hesketh**  
**Rahmi Oklu** , MD, PhD

#### PURPOSE/AIM

Nearly 36% of American adults are obese. The health complications associated with obesity, including type 2 diabetes, cardiovascular disease, and various cancers, are debilitating and expensive to treat: the United States currently spends \$190 billion on treatments related to obesity. The current surgical and lifestyle interventions targeting obesity have so far failed to control the epidemic. A less invasive and more effective treatment is needed to reverse the obesity trend. The purpose of this exhibit is to explore the molecular relationship between the orexigenic hormone ghrelin and obesity and to demonstrate a potential role for interventional radiology in ghrelin suppression as a novel approach to weight loss therapy.

#### CONTENT ORGANIZATION

1. Historical review of ghrelin and its role in weight loss 2. Current understanding of the mode of action of ghrelin 3. Potential of ghrelin suppression for obesity control in interventional radiology

#### SUMMARY

New treatments are needed to control the obesity epidemic. This exhibit will review current understandings of the physiological relationship between ghrelin and weight gain, and will explore interventions in animal models and the potential for human applications.

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### **Pathogenesis of Mycotic Aneurysms**

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#### **LL-VIE1311**

**Junsung Rho** , BSc  
**Bailin Alexander** , BA  
**Richard L Hesketh**  
**Anand M Prabhakar** , MD  
**Zubin Irani** , MD  
**Rahmi Oklu** , MD, PhD

#### PURPOSE/AIM

To explore the relationship between infection, inflammation and arterial wall breakdown to better understand the pathogenesis of mycotic aneurysms. We will review imaging traits, microbiology findings including blood culture at the time of imaging, surgical findings and correlate with pathology results.

#### CONTENT ORGANIZATION

1. Define mycotic aneurysm and provide potential mechanisms of bacterial seeding of arterial wall 2. Review the interaction between microorganisms, arterial endothelial cells and leukocytes, with a specific focus on the balance of matrix metalloprotease activation and regulation. 3. Provide a pictorial review of mycotic aneurysms on CT or MRI and correlate with pathology findings (histology and gross images) 4. Review the treatment algorithm of mycotic aneurysms and the difficulties they present

#### SUMMARY

Mycotic aneurysms are often a diagnostic challenge by cross sectional imaging. We will provide a pictorial review of varying stages of mycotic aneurysm and associate with typical blood culture results, clinical presentation and pathology findings. Mycotic aneurysms are associated with high morbidity and mortality; thus, early diagnosis is essential for best outcome. Molecular mechanisms of tissue degradation resulting from arterial wall infection will be further explored.

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### **Imaging of Venous Malformations: State of Art**

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#### **LL-VIE2921**

**Ahmed Abdel Razek** , MD  
**Ehab Saad**

#### PURPOSE/AIM

1) To review basic background and classification of venous malformations

- 2) To review characteristic imaging findings of venous malformations
- 3) To illustrate imaging findings suggestive of associated syndrome
- 4) To discuss methods of treatment of venous malformations

**CONTENT ORGANIZATION**

- 1-Update classifications of venous malformations
- 2-Pathogenesis, pathology, clinical presentation and biomarkers of venous malformations
- 3-Plain radiography, ultrasound and CT imaging findings
- 4-MR imaging findings of venous malformations
- 5-Venography and MR venography of subtypes of venous malformation
- 6-Imaging-based classifications and treatment implications based on venous malformation morphology
- 7-Imaging of syndrome associated with venous malformations
- 8-Interventional and imaging guided sclerotherapy of venous malformations
- 9-Post treatment imaging of venous malformations
- 10-Conclusion and further directions

**SUMMARY**

The major teaching points of this exhibit are:

- 1-To be familiar radiologist with imaging appearance of venous malformations
- 2-To be familiar with syndromes associated with venous malformations.
- 3- Imaging-based classifications help to select appropriate line of treatment
- 4- To be familiar radiologist with interventional and imaging guided sclerotherapy of venous malformations

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**Interventional Oncology of the Thorax Beyond the Parenchyma: Management of Chest Wall and Pleural Disease**

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**LL-VIE2922**

**Quazi Al-Tariq** , MD  
**Robert D Suh** , MD  
**Fereidoun G Abtin** , MD

**PURPOSE/AIM**

To provide an evidence based review of techniques and treatment options for patients with primary and secondary neoplasms of the thorax involving the chest wall and pleural space, including a how to approach and use of adjunctive techniques.

**CONTENT ORGANIZATION**

General review with study data to support the use of techniques and procedures to be discussed. A how to approach with mention of pitfalls and adjunctive techniques using actual cases will be used. The section on chest wall disease will focus on the treatment of painful, osseous metastases. The section on pleural disease will focus primarily on the management of malignant pleural effusions.

**SUMMARY**

In addition to treating primary and secondary neoplasms of the lung, many patients will present with higher stages of disease with involvement of the chest wall and pleural space. The interventionalist must be familiar with the techniques best suited for these clinical scenarios. This presentation will focus exclusively on chest wall and pleural space disease. By offering case based examples of their use, overviews on how they should be performed, and adjunctive techniques, this presentation should better prepare one for undertaking the care of these patients.

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**Angiographic Patterns of TIPS Dysfunction and Interventional Approaches to Shunt Revision**

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**LL-VIE2923**

**Ahmad Parvinian** , BS  
**Benedictta O Omene** , MD  
**James T Bui** , MD  
**Martha-Gracia Knuttinen** , MD, PhD  
**Jeet Minocha** , MD  
**Ron C Gaba** , MD

**PURPOSE/AIM**

1. To illustrate different angiographic patterns of transjugular intrahepatic portosystemic shunt (TIPS) dysfunction. 2. To review technical and pathophysiological bases underlying different types of TIPS dysfunction. 3. To demonstrate simple and complex interventional techniques for TIPS revision, as well as angiographic indicators of successful therapy.

**CONTENT ORGANIZATION**

1. Case-based review of TIPS dysfunction, including thrombotic occlusion, intimal hyperplastic stenosis, portal and hepatic venous stenosis, abnormal angulation, occult pressure gradient elevation, tumor ingrowth, and insufficient or excessive shunting. 2. Overview of proper TIPS creation with emphasis on technical pitfalls and TIPS induced alterations in liver vascular physiology. 3. Case-based demonstration of approaches to shunt revision, including balloon angioplasty, stent relining, shunt extension, percutaneous recanalization, stiff guide wire and metal cannula supported access, parallel TIPS insertion, and shunt reduction or occlusion, with imaging hallmarks of treatment response.

**SUMMARY**

1. Recognize different angiographic patterns of TIPS dysfunction. 2. Understand technical errors and pathophysiological mechanisms underlying TIPS dysfunction. 3. Be familiar with basic and advanced techniques for TIPS revision, as well as indicators of procedure success.

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**Transjugular Intrahepatic Portosystemic Shunt Creation in Patients with Portal Vein Cavernoma: The Importance of a Recognizable Portal Vein Remnant**

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**LL-VIE2924**

**Roberto Miraglia** , MD  
**Luigi Maruzzelli** , MD  
**Kelvin Cortis** , MD, MRCS, FRCR  
**Angelo Luca** , MD

**PURPOSE/AIM**

The aim of this exhibit is to evaluate the technical considerations and results of transjugular intrahepatic portosystemic shunt (TIPS) creation in patients with portal vein cavernoma and a recognizable portal vein remnant.

**CONTENT ORGANIZATION**

The technical considerations of TIPS creation in non-cirrhotic patients with portal vein cavernoma and complications of portal hypertension will be presented in representative cases. Special attention will be paid to imaging evaluation before TIPS, real-time sonographic guidance for puncture of the portal vein remnant using the Colapinto needle, technique for recanalization of the portal vein remnant, type and diameter of the stent, together with the results achievable as evaluated by follow-up imaging.

**SUMMARY**

TIPS creation in patients with portal cavernoma and a recognizable portal vein remnant is technically challenging. However, it remains a feasible and clinically effective procedure in such patients for the treatment of the complications of portal hypertension.

**LL-VIE2925**

**Alok B Bhatt** , MD  
**Mittul Gulati** , MD  
**Harshawn Malhi** , MD  
**Katherine J Too** , MD  
**Vinay A Duddalwar** , MD, FRCR

**PURPOSE/AIM**

1. Review the incidence of tumor tract seeding after percutaneous intervention. 2. Provide an atlas of tumor seeding resulting from different interventions. 3. Review techniques to minimize risk of tumor seeding.

**CONTENT ORGANIZATION**

1. Incidence of tumor seeding after various percutaneous interventions
2. Cases, including CT and/or MRI examples of tumor seeding after:
  - A. Percutaneous biopsy of pancreatic adenocarcinoma, hepatocellular carcinoma, cholangiocarcinoma, and renal cell carcinoma
  - B. Percutaneous drainage including suprapubic bladder diversion, biliary drainage, and abdominal abscess drainage
  - C. Ablation, including cryo and radiofrequency
3. Techniques to minimize risk of tumor seeding, including
  - A. Co-axial technique
  - B. Needle selection (size, side versus end cutting)
  - C. Marking tract (methylene blue)
  - D. Tract ablation

**SUMMARY**

Incidence of tumor seeding after percutaneous procedures is widely variable, and may be underestimated due to a reliance on self-reporting and lack of large studies. This presentation will review both the appearance of percutaneously seeded tumor resulting from a variety of interventions, as well as best practice techniques to minimize the risk of seeding.

**Navigating the Murky Waters of Coding for Interventional Radiology Procedures; A Practical Approach for the Novice!****LL-VIE2926**

**Nikhil B Amesur** , MD \*  
**Amanda M Wiant** , MD  
**Robert W Wilson** \*  
**Marlon Johnson** , RN

**PURPOSE/AIM**

Many trainees and seasoned veterans have a hard time understanding the basic concepts of procedure coding in Interventional radiology (IR), as well as the revenue cycle for procedures. We would like to offer a simple overview in this complex coding process and how to follow the money.

**CONTENT ORGANIZATION**

We will describe IR procedures as organized in the CPT Manual which is the source of codes and their descriptions. Ultimately, physicians are held responsible for what is coded and inaccurate coding can lead to reduced reimbursement and severe penalties. Proper coding can also maximize reimbursement. Payment categories

- Inpatient ♦ Payment to hospital based on diagnosis
- Outpatient - Professional component; Technical component (staff, equipment and supplies)
- Physician Services - Evaluation and Management

**IR coding**

- Brief History ♦ excellent component coding system created for IR
- Future ♦ dumbing down coding may lead to reduction of payments

**Basics of Component coding**

- Order of catheter placement
- Elements of therapeutic procedures

**Coding of Specific Exams**

- Vascular - some arterial and venous examples
- Non-Vascular ♦ examples of biopsies, drainage, biliary and urinary procedures

**SUMMARY**

The authors hope to provide the audience with a broad overview of the principles used in coding of various IR procedures.

**When Good Filters Go Bad: CT Findings of IVC Filter Complications****LL-VIE2927**

**Brett Sadowski** , BS  
**Daniel R Swerdlow** , MD

**PURPOSE/AIM**

The purpose of this exhibit is: 1. To briefly review the indications for IVC filter placement and to review the complications that can occur. 2. To discuss the CT appearance of various complications and their potential for clinical manifestations in patients 3. To discuss the role of the radiologist in the continued management of all patients undergoing imaging studies who have previously placed IVC filters

**CONTENT ORGANIZATION**

1. Indications for IVC filter placement . 2. Incidence of filter complication. 3. Review of imaging findings including filter migration, suprafilter thrombus, fracture and limb penetration of adjacent structures 4. Multiplanar and 3Dreformatted images of damaged filters highlighted 5. Conclusions regarding radiologist's role in evaluation on followup studies.

**SUMMARY**

The major teaching points of this exhibit are: 1. Discuss the role of the radiologist in the continued management of all patients undergoing imaging studies who have previously placed IVC filters as malpositioned filters are often encountered on CT scans obtained for unrelated indications 2. List the common complications of using inferior vena cava filters and describe the potential clinical manifestations of each 3. Recognize and describe the appearance of IVC filter complications on both abdominal and chest computed tomographic imaging

**Emerging Noncontrast MRA Techniques for the Body Imager****LL-VIE2928**

**Anup S Shetty** , MD  
**Jeffrey C Maxwell** , MD

**Kathryn J Fowler** , MD \*  
**Motoyo Yano** , MD, PhD  
**Nael E Saad** , MBBCh \*  
**Constantine A Raptis** , MD  
**Vamsi R Narra** , MD,FRCR \*

#### PURPOSE/AIM

1. Review the MR physics principles underpinning noncontrast MRA techniques 2. Discuss technical considerations, potential benefits and pitfalls of these techniques 3. Review cases applying these techniques to imaging of the aorta, renal arteries, portal vein and peripheral arteries

#### CONTENT ORGANIZATION

Introduction Rationale for noncontrast MRA (renal insufficiency, risk of nephrogenic systemic fibrosis, contrast allergy) MR physics principles of bright blood, black blood, time-of-flight, phase-contrast, fresh blood and quiescent interval steady state imaging Technical considerations, advantages and disadvantages of both vendor-agnostic and vendor-specific noncontrast MRA using the above techniques Sample cases of these techniques imaging the aorta, renal arteries, portal vein, and peripheral arteries Future directions in noncontrast MRA

#### SUMMARY

While MR angiography offers the advantages of absence of ionizing radiation and nephrotoxicity over CT or catheter-based angiography, patients with severe renal insufficiency pose a challenge regardless of modality. Noncontrast MRA provides the body imager with another tool for evaluating the arterial and venous vasculature in these patients. This exhibit aims to characterize and provide examples of emerging noncontrast MRA techniques in body imaging applications.

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### Emerging Noncontrast MRA Techniques for the Body Imager

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### MRI-guided Focal Cryoablation of Prostate Cancer Recurrence: How We Do It

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#### LL-VIE2929

**Christiaan G Overduin** , MSc  
**Joyce G Bomers** , MSc  
**Derya Yakar** , MD  
**Michiel Sedelaar** , MD, PhD  
**Emile Van Lin** , MD  
**Sjoerd Jenniskens** , MD  
**Jurgen J Futterer** , MD, PhD

#### PURPOSE/AIM

To describe our approach to magnetic resonance imaging (MRI)-guided focal cryoablation of prostate cancer (PCa) recurrence. To describe our initial experience with this treatment in patients with PCa recurrence after radiotherapy.

#### CONTENT ORGANIZATION

In this educational exhibit, we describe step-by-step how we perform transperineal MRI-guided focal cryoablation of histologically proven PCa recurrence after radiotherapy. Also, technical details on procedure setup and equipment will be provided. Finally, we present case examples to illustrate our initial experience with this treatment.

#### SUMMARY

We present a feasible and safe approach to perform transperineal MRI-guided focal cryoablation in patients with recurrent PCa after radiotherapy, with promising initial results.

### All Bleeding Stops Eventually: Case Studies and Evidence Based Review of Atypical Causes of Gastrointestinal Hemorrhage; What the Gastroenterologist and the Diagnostic and Interventional Radiologist Need to Know

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#### LL-VIE2930

**Alexander Z Copelan**, MD  
**Purushottam K Dixit**, MD  
**Monzer A Chehab**, MD  
**Matthias J Kirsch**, MD  
**Jeremy D Handel**, MD

#### PURPOSE/AIM

Gastrointestinal hemorrhage is a potentially life threatening condition. The majority are due to more common etiologies and managed with institutional protocols, however, less common etiologies exist in which specific management may be less well defined. Here, we present multiple atypical causes in order to make those involved in the management of these patients more cognizant of these atypical etiologies.

#### CONTENT ORGANIZATION

Approximately 90% of cases of gastrointestinal hemorrhage are due to typical etiologies and managed with institutional protocols[1-4]. Due to the importance of timely and unique management, however, it is crucial for the clinician, radiologist, interventionalist, and surgeon to be cognizant of atypical causes of GI bleeds. This is an exhibit of multiple atypical cases of GI hemorrhage, spanning a range of pathologic entities, from hemosuccus pancreaticus to stomal varices, in which clinical presentation, diagnosis, management, and a review of the literature are presented.

#### SUMMARY

Massive bleeding from the gastrointestinal tract has the propensity to be life threatening. While the endoscopist, interventional radiologist, or surgeon may be well versed in typical causes, there exist atypical causes in which management may be less well defined. Multiple case studies of these atypical etiologies are presented in order to raise awareness.

### Perioperative Internal Iliac Artery Balloon Occlusion in the Setting of Placenta Accreta and Its Variants: What the Interventional Radiologist Needs to Know

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#### LL-VIE2931

**Benjamin D Karlberg**, MD  
**Gordon K McLean**, MD  
**Matthew S Hartman**, MD  
**Sheri Macrino**, MD

#### PURPOSE/AIM

- To review normal and pathologic placentation
- To provide an overview of the diagnosis and clinical significance of placenta accreta and its variants
- To describe prophylactic internal iliac artery balloon occlusion and its role in achieving hemostasis following cesarean section in the setting of placenta accreta

#### CONTENT ORGANIZATION

This presentation will cover the following sections:

- Overview of normal and pathologic placental attachment to the uterine wall
- Diagnosis and clinical significance of placenta accreta and its variants
- Outline of internal iliac artery balloon occlusion and its role in peri-operative hemostasis during cesarean section in the setting of placenta accreta and its variants
- Summary

#### SUMMARY

- Placenta accreta and its variants can lead to significant morbidity and mortality as a result of postpartum uterine hemorrhage.
- Prophylactic internal iliac artery balloon occlusion in the setting of cesarean section functions as an adjunctive therapy to reduce intraoperative blood loss and achieve post-partum hemostasis in patients with placenta accreta and its variants.
- There is an ongoing need for large scale prospective, randomized studies to more adequately evaluate the efficacy of internal iliac artery balloon occlusion in the setting of placenta accreta and its variants.

### Bleeding after Paracentesis: Managing Complications of Paracentesis with Attention to Critical Vascular Anatomy

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#### LL-VIE2932

**Daniel H Macarthur**, MD  
**Salar Hakham**, DO  
**Kevin P Daly**, MD  
**David W Allen**, MD

#### PURPOSE/AIM

To discuss the clinical indications and contraindications for paracentesis and how to safely perform the procedure with attention to critical vascular anatomy. Cases complicated by injury to the major anterior abdominal wall arteries will be included, focusing on the interventional radiology management. Special consideration will be given to the endovascular management of injury to the inferior epigastric artery and intercostal artery.

#### CONTENT ORGANIZATION

1. Discuss the clinical indications and contraindications for paracentesis. 2. How to safely perform a paracentesis to minimize risk of injury to the anterior abdominal wall arteries. 3. Discuss the interventional radiology management of paracentesis complicated by vascular injury to the major anterior abdominal wall arteries. 4. Focus on the endovascular management of injury to the inferior epigastric artery and intercostal arteries.

#### SUMMARY

By viewing this exhibit, the reader will: 1. Understand the clinical indications and contraindications for paracentesis. 2. Learn how to safely perform a paracentesis. 3. Understand the interventional radiology management of paracentesis complicated by vascular injury to the major anterior abdominal wall arteries.

### Review of Endovascular Intervention in Acute Deep Vein Thrombosis



**LL-VIE2933**

**Jaskirat S Virk** , MD  
**Robert A Lookstein** , MD \*  
**Aaron M Fischman** , MD \*  
**Edward Kim** , MD \*  
**Francis S Nowakowski** , MD  
**Rahul S Patel** , MD \*

**PURPOSE/AIM**

1. To review the pathophysiology of deep vein thrombosis (DVT) and its acute and chronic complications, including the post-thrombotic syndrome (PTS) 2. To review the indications of thrombolysis and the various techniques to achieve thrombus removal, including the risks and benefits of each technique 3. To discuss future directions and clinical applications

**CONTENT ORGANIZATION**

1. Pathophysiology of DVT and its acute and chronic complications 2. Discussion of the indications, contraindications, and complications of the various techniques used in acute DVT treatment, including systemic thrombolysis, catheter-directed thrombolysis, open surgical thrombectomy, percutaneous mechanical thrombectomy, venous angioplasty/stenting, and pharmacomechanical thrombolysis (PMT). This will include images depicting these various techniques being employed. 3. Future directions and summary

**SUMMARY**

1. DVT is very common and its acute and chronic complications cause significant morbidity and mortality 2. Anticoagulation alone does not directly lyse clot and various endovascular techniques have been developed to achieve immediate clot lysis 3. Several of these techniques yield high efficacy with low associated risk 4. Ongoing studies will help to further define the clinical utility of these techniques

**Controversial Issues in the Embolization of Pelvic Fractures in Haemodynamically Unstable Patients**[Back to Top](#)**LL-VIE2934**

**Marta Cufi Quintana**  
**Anna Alguersuari** , MD  
**Eva Criado**  
**Jose Ramon Fortuno Andres**  
**Carlos Serrano Burgos**  
**J. Carlos Tortajada Bustelo**  
**Cristina Maria Spinu** , MD  
**Marta Sola** , MD

**PURPOSE/AIM**

To outline the optimal strategy for emergency procedures in unstable patients with pelvic fractures. To describe the techniques, limitations and complications of pelvic embolization (PE). To analyze how the injury type, patient's basal condition, and PE technique can affect the outcome. To evaluate the PE results for the management of patients with multiple trauma.

**CONTENT ORGANIZATION**

PE plays a key role in the management of unstable patients with PF. Proximal embolization of both internal iliac arteries is the standard technique. PE complications are uncommon. One of the most feared complication is gluteal necrosis, because its high morbidity and mortality. The type of fracture, embolization technique, patient hemodynamic status, and injury severity might contribute to gluteal necrosis. We describe the angiographic findings after selective and nonselective PE of both internal iliac arteries. We review the collateral pathways established between contralateral iliac, liliolumbar and deep femoral arteries to prevent ischemic complications.

**SUMMARY**

PE is an effective technique to control arterial bleeding in patients with pelvic fractures. Complications are uncommon. Ischemic events are more likely in nonselective bilateral embolization but the severity of the injury and the patient's hemodynamic condition are other underlying causes.

**Visceral Artery Arcades: What the Radiologist Needs to Know**[Back to Top](#)**LL-VIE2935**

**Umberto Rossi** , MD  
**Paolo Rigamonti** , MD  
**M'hamed Dahmane** , MD  
**Francesco Petrocelli** , MD  
**Maurizio Cariati** , MD

**PURPOSE/AIM**

The aim of this study was to review the embryology of the visceral arteries in order to understand the development of the visceral artery anastomoses and all potential collateral circulation in the case of stenosis/obstruction of one or several visceral arteries.

**CONTENT ORGANIZATION**

Arterial vascularization of the gastrointestinal tract is a three-level system composed of the celiac trunk, and both superior and inferior mesenteric arteries. The three vessels are joined together via arterial trunk anastomoses: the arcades. The celiac trunk and the superior mesenteric artery are joined together via the pancreaticoduodenal, the Kirk and the Buhler arcades. The mesenteric arteries are joined together by the Riolan and the Villemin arcades and by the marginal artery of Drummond.

**SUMMARY**

Vascular variants and arteriopathy are responsible for frequent stenosis/occlusion one or several digestive arterial trunks with subsequent development of collateral circulation. For such reasons, imaging and knowledge of digestive arterial anatomy is an absolute prerequisite for endovascular/surgical technique choice.

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## Correlation between MD-CT and DSA Before Percutaneous Embolization in Cystic Fibrosis Patients Affected by Massive Hemoptysis

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### LL-VIE2936

**Paolo Rigamonti** , MD  
**Umberto Rossi** , MD  
**Fabio Melchiorre** , MD  
**Maurizio Cariati** , MD  
**Gianpaolo Cornalba** , MD

#### PURPOSE/AIM

the purpose of our presentation is to evaluate the diagnostic role of Multi-Detector Computed Tomography (MD-CT) in depiction of bronchial systemic arteries in cystic fibrosis patients with massive hemoptysis before digital subtraction angiography (DSA) embolization.

#### CONTENT ORGANIZATION

MD-CT with MIP and VRT reconstruction allowed a detailed delineation of the origin, course, calibre, traceability of the affected bronchial arteries. This allowed organize the selective DSA of pathological bronchial arteries with a correct pre-operative planning with position of the field of view, inclinations of the flat-panel, vascular access, guide-wires, catheters and embolization materials.

#### SUMMARY

currently MD-CT represents the gold standard in the pre-intervention imaging of cystic fibrosis patients with massive hemoptysis. MD-CT permits to plan accurately the subsequent interventional procedure of endovascular embolization, reducing procedure time and the radiation dose given to the patient.

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## Isolated Limb Infusion: The Interventional Radiologist's Role in Treating Recurrent Limb Melanoma

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### LL-VIE2937

**Mark L Lessne**, MD  
**Matthew P Lungren**, MD  
**Brian P Holly**, MD  
**Charles Y Kim**, MD \*

#### PURPOSE/AIM

Introduce isolated limb infusion (ILI) as a minimally invasive therapy for recurrent limb melanoma. Review ILI procedural technique, as well as the literature regarding efficacy and toxicity of therapy. Define the place of ILI within the algorithm for treatment of limb melanoma and emphasize the radiologist's role as a primary member of the multidisciplinary melanoma team.

#### CONTENT ORGANIZATION

Step by step details of the procedure, along with a graphical depiction, will be provided. Angiographic images from ILI procedures in the upper and lower extremities will be exhibited. A detailed review of the relevant efficacy and toxicity data will be discussed, including ILI response rates and toxicity estimates from the literature as well as a comparison to those data from ILP surgeries. In addition, factors that influence efficacy and toxicity, such as chemotherapy dosing, intraprocedural vasodilation, and limb volume will be addressed.

#### SUMMARY

Isolated limb infusion is an underutilized interventional procedure that may offer comparable results to surgical isolated limb perfusion while improving the toxicity profile. Interventional radiologists have the opportunity to take an active role treating recurrent limb melanoma, but must first familiarize themselves with the procedure technique, efficacy, toxicities, and the factors that may influence success of therapy.

## Failing to Plan is Planning to Fail: Pre-procedural Planning in Percutaneous Ablations

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### LL-VIE2938

**Hilary A Brazeal**, MD  
**Kathryn J Fowler**, MD \*  
**Guillermo Gonzalez-Araiza**, MD  
**Matthew M Niemeyer**, MD  
**Christine O Menias**, MD  
**Nael E Saad**, MBBCh \*

#### PURPOSE/AIM

1. Outline indications for percutaneous ablation of solid organ tumors.
2. Review different ablation methods.
3. Discuss considerations for planning, how they differ by organ.
4. Discuss procedural risks and how to minimize.

#### CONTENT ORGANIZATION

1. Evidence based review of indications for ablation of solid organ tumors.

- Tumor type
- Co-morbidities
- Role of percutaneous ablation in oncologic management

2. Brief background on basic principles, technique (pearls/pitfalls), and indications for:

- Microwave ablation
- Radiofrequency ablation
- Cryoablation
- Irreversible electroporation
- Ethanol ablation

3. Pre-procedural planning:

- Imaging work-up
- Pertinent anatomy by organ and region
- Medical co-morbidities and their role in treatment algorithm
- Risk assessment based on pre-procedure labs and organ function

4. Complications of procedures and how to best minimize. 5. Long-term follow-up and management implications.

#### SUMMARY

Multiple methods of ablation are available to the radiologist. This exhibit reviews the biology and science behind each method, the algorithm for choosing the appropriate technique, and the essential imaging and clinical information necessary to minimize risk through effective pre-procedural planning.

## Endovascular Management of Anticoagulation-related Spontaneous Soft Tissue Hematoma: How "To Do" It

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### LL-VIE2939

**Anthony Dohan**, MD  
**Olivier Pellerin**, MD  
**Massimiliano Di Primio**, MD  
**Marc R Sapoval**, MD, PhD

#### PURPOSE/AIM

To describe the various locations of anticoagulation-related spontaneous soft tissue hematoma (SSTH) and the feeding arteries involved by this condition.

To illustrate the impact of computed tomography angiography (CTA) in the evaluation of the severity of SSTH and in planning arterial embolization.

To discuss the indications for arterial embolization of SSTH.

#### CONTENT ORGANIZATION

- A. Epidemiology and impact of anticoagulant therapy
- B. Anatomy and feeding arteries of mostly involved muscles
- C. Potential indications for arterial embolization
- D. Diagnostic Imaging with CTA and planning of arterial embolization
- E. Endovascular Management
- F. Outcomes

#### SUMMARY

The indications and challenges of embolization of SSTH are presented. This exhibit will review:

- a. the various techniques of embolization.
- b. the different anatomical supplies.
- c. the impact of CTA in diagnosis and planning of arterial embolization.

## Acute Non-variceal Gastrointestinal Bleeding: Imaging and Treatment

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### LL-VIE2940

**Paul E Smith**, MBBS  
**Geertje D Noe**, MD  
**Mark D Goodwin**, BMBCh  
**Dinesh G Ranatunga**, MBBS

#### PURPOSE/AIM

1. Provide an imaging atlas of the various causes of acute non-variceal gastrointestinal (GI) bleeding
2. Review how acute non-variceal GI bleeding presents
3. Discuss the work-up of bleeding patients, and the pros and cons of various modalities
4. Discuss the management options, focussing on endovascular therapy

#### CONTENT ORGANIZATION

- Introduction
- Pathophysiology
- Presentation
- Work-up Diagnostic
- Imaging Management (including evidence)
- Outcomes
- Conclusion

#### SUMMARY

Gastrointestinal (GI) bleeding is a common cause of morbidity and mortality. Its successful management involves a multiple disciplinary approach, in which imaging plays a key role through diagnosis and endovascular therapeutic options. The spectrum of disease is diverse due to the multiple pathologies that can cause bleeding and also multiple sites from which it can occur. Imaging and endovascular intervention both play a pivotal role in the management of these patients. In this exhibit, we review the pathology, presentation and the treatment options that exist for the management of acute non-variceal bleeding.

## Principles and Applications of Ultrasound Fusion with Other Cross-Sectional Imaging for the Purpose of Biopsy

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### LL-VIE2941

**Stephanie F Coquia**, MD  
**Katarzyna J Macura**, MD, PhD \*  
**Sheila Sheth**, MD \*  
**M. Robert Dejong** \*  
**Ulrike M Hamper**, MD, MBA

#### PURPOSE/AIM

To discuss practical applications of ultrasound fusion with other cross sectional imaging modalities (CT, MRI, and PET) when performing biopsies of lesions within the chest, abdomen, and pelvis.

#### CONTENT ORGANIZATION

1. Basic principles and requirements for fusing US to other modalities
2. Clinical applications of fusion in the biopsy of lesions in the chest, abdomen, and pelvis:
  - a. Locating lesion when not initially seen on screening ultrasound
  - b. Identification of a specific target lesion initially detected on other cross-sectional imaging modalities (suspicious prostate lesions on multiparametric MRI)
  - c. Confirmation of the absence of a target lesion visualized on other imaging modalities (resolution of lesion after treatment)
3. Case examples:
  - a. Pleural based lung lesions
  - b. Liver
  - c. Adenopathy-mesenteric, retroperitoneal, pelvic
  - d. Prostate
4. Advantages and limitations of the fusion technique
5. Description of our approach: how to incorporate CT and MR fusion into the biopsy practice

#### SUMMARY

After reviewing this exhibit, the reader should be able to:

1. Understand the basic principles of cross-sectional imaging-US fusion and what is necessary for its performance.
2. Determine which biopsies may benefit from this technique.

## Principles and Applications of Ultrasound Fusion with Other Cross-Sectional Imaging for the Purpose of Biopsy

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### LL-VIE2941

**Stephanie F Coquia**, MD  
**Katarzyna J Macura**, MD, PhD \*  
**Sheila Sheth**, MD \*  
**M. Robert Dejong** \*  
**Ulrike M Hamper**, MD, MBA

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## Image Guided Radiofrequency Ablation (RFA) of Liver Tumors: A Pictorial Review on Imaging Guidance Techniques and Post Treatment Radiology Findings

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### LL-VIE2942

**Constantinos Tingerides** , MBBS, FRCR  
**Rohit P Veettil**  
**Tze M Wah** , MBChB, FRCR  
**Jonathan T Smith** , MBChB, FRCR  
**Raj Prasad**  
**Peter Lodge**  
**Giles Toogood**  
**Rebecca Jones**  
**Ernest Hidalgo**  
**Henry C Irving** , MBBS

#### PURPOSE/AIM

Image guided RFA of primary/secondary liver tumors is now an established treatment technique as part of the management of liver tumors. We aim to present our experience in the treatment of 55 primary and secondary liver tumors using a variety of imaging guidance techniques to facilitate treatment and post treatment radiology findings from March 2009 to 2013.

#### CONTENT ORGANIZATION

This pictorial review presents our experience in using a variety of image guidance techniques to treat liver tumors in our institution. These include the fusion imaging navigation system to guide treatment, contrast enhanced ultrasound (US) guidance as well as using anatomical localisation techniques with CT guidance. To illustrate the normal expected findings and sequential changes longitudinally on both CT and or MRI and to describe the classic imaging signs associated with the interval change. In addition, to present our complications during this period e.g. pseudoaneurysm of the segmental vessel in the zone of ablation post RFA that was treated with embolization.

#### SUMMARY

To demonstrate a range of image guided techniques that are available to facilitate liver RFA especially in difficult liver tumors that are poorly visualized on conventional US and also to highlight sequential imaging appearances post treatment and the potential complications.

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## The Interventionalist's Guide to the BRTO Galaxy: How-to Guide and Overview of Variant Procedures

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### LL-VIE2943

**Jonathan K Park** , MD  
**Sung Ki Cho** , MD  
**Luyao Shen**  
**Stephen T Kee** , MD  
**Edward W Lee** , MD, PhD

#### PURPOSE/AIM

1. To review the anatomy and pathophysiology of portosystemic shunts resulting in gastric varices and hepatic encephalopathy
2. To guide the reader through the indications, diagnostic imaging, interventional methods, contraindications, and potential complications of balloon-occluded retrograde transvenous obliteration (BRTO)
3. To introduce variants of BRTO, including vascular plug-assisted retrograde transvenous obliteration (PARTO), and coil-assisted retrograde transvenous obliteration (CARTO)

#### CONTENT ORGANIZATION

- A. Pictorial review of anatomy, pathophysiology, and diagnostic imaging of portosystemic shunts
- B. Graphic and radiographic guide to BRTO technique, as well as review of various embolic agents
- C. Introduction to newer variants of BRTO, including PARTO and CARTO
- D. Visual overview of outcomes and complications

#### SUMMARY

The benefits and challenges of BRTO are presented.

- This exhibit will review:
- a. anatomy and pathophysiology behind portosystemic shunts in the development of gastric varices and hepatic encephalopathy
  - b. technique and inventory involved in BRTO
  - c. new variants of BRTO including PARTO and CARTO

## Articulated Percutaneous Plastic Biliary Stents. How to Do It

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### LL-VIE2944

**Jorge E Lopera** , MD \*  
**Ghazwan M Kroma** , MD  
**Andres Garza**  
**Rajeev Suri** , MD

#### PURPOSE/AIM

To review the technique, applications and complications of articulated plastic stents for the percutaneous treatment of benign and malignant biliary strictures.

#### CONTENT ORGANIZATION

1. History and current status of articulated plastic stents 2. Indications and potential complications of the technique 3. How to articulate plastic stents 4. How to remove and change articulated plastic stents

#### SUMMARY

The use of articulated plastic stents is not well known. The technique uses common materials and can be custom made for each patient's specific needs. This technique allows drainage of two or more biliary segments using a single percutaneous access and is an alternative for the percutaneous management of complex benign and malignant biliary strictures.

## Endovascular Techniques for Treatment of Uterine Disease: What Can IR Offer to Gynecologists Outside of the Fibroid Management?

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### LL-VIE2945

**Pedro V Staziaki**  
**Stephan Wicky** , MD  
**Gloria M Salazar** , MD

#### PURPOSE/AIM

To review the unusual uterine endovascular radiological interventions outside of the fibroid management spectrum, along with their indications, relevant anatomy, imaging findings, and technique.

#### CONTENT ORGANIZATION

1 Indications for endovascular treatments a. Emergency -Postpartum hemorrhage -Postsurgical bleeding b. Vascular lesions -Arteriovenous malformation -Arteriovenous fistulas c. Prophylactic -Abnormal placentation -Ectopic pregnancy -Preoperative management of malignancies 2 Anatomy and imaging findings 3 Endovascular techniques for interventions a. Uterine artery embolization b. Iliac artery balloon placement c. Embolization of arteriovenous malformation

#### SUMMARY

This review aims at demonstrating various endovascular interventions that could be safely performed in obstetric and gynecologic patients in the emergency and elective management of uterine diseases.

## Sonazoid-CEUS during Radiofrequency (RFA) for Small Hepatocellular Carcinoma (HCC)

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### LL-VIE2946

**Toshiya Shibata** , MD  
**Minoru Yabuta** , MD  
**Ken Shinozuka**  
**Toyomichi Shibata** , MD  
**Hiroyoshi Isoda** , MD  
**Kaori Togashi** , MD, PhD \*

#### PURPOSE/AIM

The specific feature of Sonazoid is that parenchymal imaging of the liver (Kupffer imaging) as well as early vascular imaging can be obtained. Kupffer imaging, lasting over 60 minutes, may be very useful for performing real-time US-guided RFA. Purpose of our exhibition is to demonstrate the effectiveness of Sonazoid-CEUS during RFA for small HCC.

#### CONTENT ORGANIZATION

Sonazoid-CEUS is superior to B-mode US in: (1) detection of small HCC nodules about 1.0cm in patients with severe liver cirrhosis. Kupffer imaging is especially useful for real-time US-guided RFA. (2) detection of local recurrence after RFA. Local recurrence is clearly depicted at early vascular imaging. Early vascular and Kupffer imaging should be carefully correlated before RFA for the local recurrence. (3) detection of an ablated area and a residual viable lesion. So, we can diagnose whether an additional ablation is needed or not.

Limitations of Sonazoid-CEUS: (1) Some deeply-located nodules are hardly depicted with Sonazoid-CEUS due to the attenuation. (2) Some well-differentiated HCCs are more clearly detected with B-mode US as a hyperechoic nodule.

#### SUMMARY

Sonazoid-CEUS is useful in RFA for small HCCs and it might be mandatory in some cases.

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Limitations of Sonazoid-CEUS: (1) Some deeply-located nodules are hardly depicted with Sonazoid-CEUS due to the attenuation. (2) Some well-differentiated HCCs are more clearly detected with B-mode US as a hyperechoic nodule.

#### SUMMARY

Sonazoid-CEUS is useful in RFA for small HCCs and it might be mandatory in some cases.

### Preoperative Portal Vein Embolization with Ethanol Injection: Indications, Technique, and Comparison with Alternative Embolic Agents

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#### LL-VIE2947

**Kevin Ching** , MD  
**Nikhil B Amesur** , MD \*  
**Philip D Orons** , DO  
**David A Geller** , MD  
**J. Wallis Marsh** , MD  
**Albert B Zajko** , MD

#### PURPOSE/AIM

Transhepatic portal vein embolization prior to major liver resection is beneficial for inducing both atrophy of the diseased lobe and compensatory hypertrophy of the future liver remnant. Because of its effectiveness in stimulating remnant hypertrophy and low cost in comparison to traditional embolic agents, portal vein embolization with ethanol should be considered prior to major hepatic resection.

#### CONTENT ORGANIZATION

1. Review normal and variant hepatic segmental, biliary, and vascular anatomy. 2. Preprocedural volumetric planning, surgical indications, and contraindications for portal vein embolization. 3. Accessing the portal system with ultrasound guidance including ipsilateral access to avoid potential vascular injury to the future liver remnant. 4. Pictorial guide illustrating transhepatic portal venous embolization with ethanol. 5. Review and discuss alternative embolic agents.

#### SUMMARY

Major teaching points include: 1. Transhepatic portal vein embolization with absolute ethanol is an effective procedure for inducing liver remnant hypertrophy prior to major hepatic resection. 2. Interventional radiologists must understand the implications of portal vein access and embolization on the future liver remnant. 3. Absolute ethanol should be considered as an effective alternative to traditional embolic agents.

### Vascular Conditions Occurring around the Knee - A Pictorial Review

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#### LL-VIE2948

**Daniel I Glazer** , MD  
**Peter S Liu** , MD

#### PURPOSE/AIM

1. Describe the common imaging techniques for non-invasive vascular imaging of the lower extremities, including vascular ultrasound, CT Angiography, and MR Angiography
2. Present cases of common and uncommon vascular pathology occurring around the knee using a multimodality approach
3. Describe pearls and pitfalls in interpretation for the practicing radiologist

#### CONTENT ORGANIZATION

##### **1. Background/Techniques 2. Arterial Disease and Variant Anatomy**

- a. Normal and variant anatomy and relevance to flap/perforator surgery
- b. Embolic occlusion
- c. Traumatic dissection
- d. Chronic peripheral arterial disease
- e. Popliteal artery entrapment syndrome
- f. Adventitial cystic disease
- g. Popliteal artery aneurysm

##### **3. Venous Disease**

- a. Deep venous thrombosis
- b. Arteriovenous fistula

##### **4. Conclusion**

#### SUMMARY

Over the past 2 decades, non-invasive vascular imaging has replaced catheter angiography as the primary diagnostic method for imaging the lower extremity arterial and venous systems. While traditional systemic/diffuse vascular disease processes can occur around the knee, there are additional unique pathologic entities that occur specifically in this anatomic location. Using case examples, the practicing radiologist will become familiar with typical and atypical causes of lower extremity vascular disease that occur primarily around the knee.

### Vascular Emergencies in Cancer Patients

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#### LL-VIE2949

**Justin G Smith** , MD  
**Kamran Ahrar** , MD  
**Tam T Huynh** , MD

**Michael J Wallace** , MD \*  
**Judy U Ahrar** , MD

PURPOSE/AIM

**The purpose of this exhibit is:** 1. To review vascular emergencies requiring interventional radiology treatment in the unique oncology population 2. To discuss the salient clinical and imaging findings 3. To demonstrate the management of these conditions

CONTENT ORGANIZATION

This exhibit will review the unique vascular emergencies that occur in cancer patients involving arterial hemorrhagic and ischemic injury, veno-occlusive disease, and variceal bleeding. **Clinical History Presenting Symptoms Imaging Findings Endovascular Management**

SUMMARY

**The major teaching points of this exhibit are:** 1. Awareness of the unique vascular emergencies that present in oncology patients. 2. Recognizing the pertinent clinical history, presentation, and imaging findings related to these entities. 3. Appropriate endovascular treatment of these conditions.

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**Comprehensive Contrast-enhanced Magnetic Resonance Venography with Gadofosveset Trisodium**

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**LL-VIE2950**

**Larry A Kramer** , MD  
**Alan M Cohen** , MD \*  
**Jerry Wolinsky** , MD \*  
**Jared H Heimbigner** , DO  
**Khader M Hasan** , PhD, MSc  
**Andrew Barreto** , MD  
**William K Carson** , MD  
**Staley A Brod** , MD \*  
**Ponnada A Narayana** , PhD

PURPOSE/AIM

Magnetic Resonance Venography (MRV) often utilizes non-contrast 2D time-of-flight (TOF) sequences due to sensitivity to slow flow, however, flow related artifacts due to turbulence, vortical flow and in-plane saturation effects can limit accuracy. Contrast-enhanced MRV with 3D Turbo Field-Echo (TFE) sequences minimizes these artifacts but may only be effective for a single acquisition. However, with the advent of the intravascular agent, gadofosveset trisodium, prolonged steady-state enhancement of venous system extends MRV acquisition to multiple sequences without significant signal decay. The goal of this exhibit is to present the technique of comprehensive MRV evaluation of the intracranial and extracranial venous system using gadofosveset trisodium with comparison with catheter venography and non-contrast 2D TOF.

CONTENT ORGANIZATION

A. 3D contrast-enhanced MRV acquisition technique B. Processing considerations C. Normal examples D. Non-contrast 2D TOF sequences versus contrast-enhanced MRV E. Catheter venography versus contrast-enhanced MRV

SUMMARY

Contrast-enhanced MRV with gadofosveset trisodium allows steady-state imaging of the venous system over a prolonged interval permitting acquisition of multiple anatomic compartments with minimization of flow related artifacts and in-plane saturation effects commonly present in 2D TOF technique.

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## Hepatobiliary Applications of Cone-Beam Computed Tomography: An Update

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### LL-VIE2951

**Jenny Wu**, MD

**Baljendra S Kapoor**, MBBS

**Dustin E Thompson**, MD

**Karunakaravel Karuppasamy**, MBBS, FRCR

**Abraham Levitin**, MD

**Mark J Sands**, MD

#### PURPOSE/AIM

To provide an update and review of Cone-Beam Computed Tomography (CBCT) and its applications in hepatobiliary interventions, including complex biliary reconstruction, unconventional transjugular intrahepatic portosystemic shunt (TIPS), ablation of the liver tumors and transcatheter management of hepatocellular carcinoma.

#### CONTENT ORGANIZATION

In this review, a variety of hepatobiliary procedures demonstrating the usefulness of CBCT in pre-treatment planning and intra-procedural guidance will be discussed. Complex hepatobiliary cases of biliary reconstruction, transjugular intrahepatic portosystemic shunt (TIPS), and ablation of hepatocellular carcinomas demonstrate how the enhanced spatial resolution of C-arm CBCT can add to localization, guidance, and treatment planning. Discussion will be supported by three-dimensional images generated from Cone beam CT along with fluoroscopic images generated during the procedures.

#### SUMMARY

This exhibit demonstrates how CBCT combined with real-time fluoroscopic guidance is valuable for planning interventions in areas with complex surrounding anatomy. Specifically, it will demonstrate how CBCT is useful for delineating the safest pathways to small, localized targets in hepatobiliary procedures, which in turn contributes to overall patient safety and increased procedural success rates.

## Concomitant Computed Tomography Arteriography (CTA) and Computed Tomography Venography (CTV) in the Evaluation of Iliac Vein Compression Syndrome

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### LL-VIE2952

**Chee Hwee Lee**, MD

**Po-Yen Chang**, MD

**Wing Pong Chan**, MD

#### PURPOSE/AIM

Chronic limb edema due to iliac venous compression syndrome (IVCS) and other vascular anomalies are not uncommon in clinical practice. The goal of this exhibit is to describe a specific technique in demonstrating IVCS with the aid of digital subtraction angiography (DSA) and multidetector computed tomography (MDCT). We address the typical clinical presentation of IVCS, variant IVCS (right side IVCS, compression of ipsilateral iliac vein by corresponding iliac artery), Klippel-Trenaunay syndrome (KTS) and the vascular pathology as seen with this technique. The role of the computed tomography (CT) is determining the extent of the compression and confirmation of equivocal case. The management of the condition will also be discussed.

#### CONTENT ORGANIZATION

The step-by-step process of the DSA and CT protocol of this technique will be discussed. The classic and equivocal cases will be illustrated with state of the art imaging including three-dimensional (3D) displays.

#### SUMMARY

After reviewing this exhibit the user will have a better understanding of the technique and the role of concomitant CTA and CTV in detection, confirmation and management of the patient with a range of venous compression disease, including IVCS.

## Which Sphere, Why and Where Are We Headed? Review of Current Concepts and Future Directions in Radioembolization

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### LL-VIE2953

**Anthony C Brown**, MD

**Charles E Ray**, MD, PhD \*

**Matthew G Gipson**, MD

#### PURPOSE/AIM

To provide a comprehensive comparison of SIR-spheres and Thera-spheres as well as review of novel technologies and imaging in radioembolization.

#### CONTENT ORGANIZATION

- Liver arterial anatomy important to radioembolization
- Indications and contraindications for radioembolization
- Institutional method for radioembolization
- SIR-Spheres and Thera-spheres
- Characteristics, kinetics and mechanism of action -- Dosimetry -- Pre and post embolization imaging
  - Current imaging literature
- Dosimetry prediction with 99m Tc- MAA/ SPECT/CT -- Dosimetry modification with FGD-PET/CT -- Bremsstrahlung SPECT/CT
  - Alternative/novel radionuclides
- Holmium - 166 -- Rhenium - 188
  - Clinical Considerations
- Downstaging -- Combination therapy
  - Summary

## SUMMARY

An exciting and young field, further studies in radioembolization will drive innovation in radiation delivery using Y-90 as well as novel radionuclides and will continue to advance image guidance for therapeutic planning and monitoring.

## A Pictorial Review of Ancillary Techniques for Difficult Inferior Vena Cava Filter Retrievals

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### LL-VIE2954

**Elijah Burton**  
**Noah R Schwind**, MD  
**Jennifer Karp**  
**Robert K Ryu**, MD  
**Robert J Lewandowski**, MD \*

#### PURPOSE/AIM

Due to increased complications associated with potentially retrievable inferior vena cava filters (prIVCF), the FDA advocates retrieval as soon as mechanical prophylaxis is no longer indicated. However, suboptimal filter placement or fibrin overgrowth can result in failed retrieval. In these patients ancillary techniques can be used to increase retrieval rates. This exhibit will review the guidelines on currently available prIVCF and highlight ancillary techniques for difficult retrievals.

#### CONTENT ORGANIZATION

A review of the recent literature regarding prIVCF will be supplemented by radiologic images and descriptions of retrieval techniques. Emphasis will be placed on advanced retrieval techniques, including loop-snaring, excimer laser fibrinolysis, fibrin cap disruption, double access techniques, and endobronchial forceps retrieval.

#### SUMMARY

Difficult prIVCF retrievals are challenging for interventional radiologists, many of who may be falsely reassured by FDA approval for permanent implantation. However, significant complications have been reported and therefore retrieval attempts should be made. By reviewing the guidelines for prIVCF and advanced retrieval techniques, this exhibit will provide a better understanding of prIVCF and demonstrate techniques that will increase successful prIVCF retrievals.

## Pictorial Review of Liver Imaging-Reporting and Data System (LI-RADS) Category Lesions Correlated with Imaging Findings during Transarterial Chemoembolization (TACE)

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### LL-VIE2955

**David C Irwin**, MD  
**Sean D Raj**, MD  
**Katsuhiko Kobayashi**, MD  
**Daniel Anaya**, MD  
**Khözema Hussain**, MD  
**Mark A Sultenfuss**, MD

#### PURPOSE/AIM

To provide an imaging overview of the Liver Imaging-Reporting and Data System (LI-RADS), correlated with angiography and cone-beam CT during TACE.

#### CONTENT ORGANIZATION

The Liver Imaging Reporting and Data System (LI-RADS) was developed to standardize liver lesion interpretation and reporting in cirrhotic patients. The intention of LI-RADS is to improve communication with clinicians and facilitate management decisions, including TACE. The LI-RADS categorization uses objective CT and MR imaging criteria to classify the lesion from LI-RADS 1, definitely benign, to LI-RADS 5, definitely hepatocellular carcinoma (HCC). Imaging examples of LI-RADS category lesions which were referred for TACE through multidisciplinary HCC tumor board are correlated with the intra-procedural angiographic and cone-beam CT appearance of these lesions.

#### SUMMARY

Understanding the correlation between LI-RADS category and intra-procedural angiography and cone beam CT can facilitate TACE procedures.

## Imaging of Nonatherosclerotic Vasculitis

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### LL-VIE2956

**Sangam G Kanekar**, MD  
**Jennifer L Kissane**, MD

#### PURPOSE/AIM

1. To review the various imaging appearances of nonatherosclerotic vasculitis on MR, MRA and CTA.
2. To give the algorithmic approach for evaluation of nonatherosclerotic vasculitis.

#### CONTENT ORGANIZATION

Diagnosis of vasculitis is always challenging on cross sectional examination. Though MR is very sensitive in identifying the non-specific parenchymal changes, CTA and MRA lack resolution to diagnose the vessel changes. Imaging studies of 203 pts with nonatherosclerotic vasculitis were studied from our PACS. We classified them into: *a) primary vasculitis* (giant cell arteritis, primary angiitis of the CNS, Takayasu's disease, periarteritis nodosa, Kawasaki disease, Churg-Strauss syndrome, Wegener's granulomatosis) and *b) secondary vasculitis* (collagen vascular diseases SLE, Rheumatic disease Sjogren's), infection, sarcoidosis, illicit drugs, malignancy, radiation and other systemic conditions). *c) Non-inflammatory* (FMD, NF, Moya-Moya) *d) Immuno/hematological disorders* (SCD, PC Vera) *e) Genetic causes* (MELAS, CADASIL, Fabry's, Homocystenemia).

#### SUMMARY

This exhibit reviews various causes and imaging appearances of nonatherosclerotic vasculitis. We highlight the salient differentiating points and diagnostic pearls to various pathologies.

## Peer Review of Peripheral Vascular Ultrasound Studies: Analysis of Errors and Strategies for Improving Performance

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### LL-VIE2957

**Tonguc Pinar**, MD  
**Robert G Sheiman**, MD  
**Peggy Newman**  
**Bettina Siewert**, MD  
**Robert A Kane**, MD  
**Jonathan B Kruskal**, MD, PhD \*

#### PURPOSE/AIM

Peer review of radiologist performance is widely performed per regulatory requirements. When optimized, analysis of errors allows for improvement strategies to be introduced. Peripheral vascular ultrasound studies are technically challenging and fraught with potential interpretive pitfalls. Based on over 10 years' experience and 75,000 peer reviewed cases, this exhibit highlights the major categories of vascular ultrasound errors, their potential impact, and illustrates simple strategies for preventing their occurrence.

#### CONTENT ORGANIZATION

Classification of peer review errors of peripheral vascular US studies: - Perceptual misses and their contributing factors. - Interpretive errors, including false positive (tendon confused with thrombus), false negative (failure to recognize duplicated circulation, and misclassification errors (DVT vs. superficial thrombus). - Errors of information transfer, including input (faulty clinical information), and output (relaying results and acuity). - Technical acquisition errors. Strategies for preventing errors when interpreting peripheral vascular US studies.

#### SUMMARY

This exhibit will explain how to classify and approach errors detected through peer review, factors contributing to error occurrence and strategies for avoiding errors when performing and interpreting the peripheral vascular ultrasound examination.

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### Wires, Catheters and More: A Primer For Radiologists Entering IR

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#### LL-VIE2958

**Anjali A Shah** , MD  
**Benjamin G Northcutt** , MD  
**Yun R Sheu** , MD, MS  
**Lemore Carmi** , MD

#### PURPOSE/AIM

Radiologists beginning training in the field of IR often lack knowledge regarding basic IR equipment and nomenclature. A consolidated resource for this information is not widely available in textbooks or the literature. A pictorial guide showcasing the basic wires, catheters, and sheaths as well as their identifying features and nomenclature would allow radiology residents and new fellows to communicate better with staff, critically think about equipment utilization, and be more productive in the IR suite.

#### CONTENT ORGANIZATION

- 1) Image rich chart organizing wires and catheters into logical groups (glide vs non-glide, size, stiffness, typical uses)
- 2) Pictures showcasing the identifying characteristics of commonly used catheters, wires, sheaths and needles.
- 3) What fits in what: Explanation of how to convert between French, gauge, and wire thickness; allowing the user to easily determine what catheter(s) and/or wire(s) will fit in a specific catheter, needle, or sheath.
- 4) Practice cases where one can use knowledge gained to select an appropriate catheter/wire for a procedure, though we recognize there is inter-user variability.

#### SUMMARY

Information regarding the identification, nomenclature, and general uses of common IR catheters, wires, and sheaths is not widely available and would be high yield information for radiologists entering the field of IR.

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### Ultrasound Guided (US) Endovenous Laser Ablation (EVLA) of Lower Limb Varicose Veins: How to Do

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#### LL-VIE2959

**Francesca Nosenzo**  
**Giovanni Turtulici**  
**Mario Maturanza**

**Riccardo Sartoris**  
**Angelo Corazza**, MD  
**Enzo Silvestri**, MD

PURPOSE/AIM

1. Illustrate the EVLA procedure.
2. Show how to obtain a good US-visualization of veins in order to monitor the ablation procedure and to avoid possible complications.
3. Describe the post-operative management

CONTENT ORGANIZATION

EVLA is a minimally invasive procedure for the treatment of great and small saphenous venous insufficiency in which, after local anesthesia, a laser fiber is inserted through the skin into the vein under US guidance. The laser heats the vein walls, causing shrinking and vein collapse. This happens due to the radial energy emission at 1470nm, optimally absorbed by water molecules. US guidance is mandatory in order to introduce needle and laser fibers and to monitor vessel shrinking during the ablation procedure. We will provide a 'how to do' guide of the EVLA procedure highlighting the following steps:

- Pre-treatment US-evaluation of patient lower limb veins with detailed scan planes
- Sterile field setting and patient arrangement
- US-guided laser fiber insertion procedure
- Endovenous laser ablation
- Post-operative management and follow-up

SUMMARY

US-guided EVLA of lower limb varicose veins is an effective and safe treatment that allows a quick and painless shrink of veins. Such an a therapeutic option appear also to be faster and cheaper compared to the gold standard (surgical stripping).

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## Dual Energy CT in the Evaluation of Vascular Structures

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**LL-VIE2960**

**Patricia M Carrascosa**, MD \*  
**Carlos Capunay**, MD  
**Alejandro Deviggiano**, MD  
**Gaston Rodriguez Granillo**  
**Jorge M Carrascosa**, MD  
**Javier Vallejos**, MD

PURPOSE/AIM

1. To demonstrate the role of Dual Energy CT (DECT) in the evaluation of vascular territories.
2. To reduce intravascular contrast volume based on the possibility of analyzing monochromatic data at different keV.
3. To show the usefulness of material decomposition such as idone-calcium (to take away calcified plaques in the vascular structures).

CONTENT ORGANIZATION

1. Dual energy CTA scan using 80/140 keV with rapid switching for acquisition.
2. Iterative reconstruction technique to reduce radiation dose.
3. Reprocessing using monochromatic images with different keV levels as well as material decomposition (iodine-calcium) being able to measure the stenosis more precisely.
4. To show optimal enhancement at the best keV level to reprocess the image data.
5. To reduce beam hardening artifact as well as blooming artifact from the calcified plaques.

SUMMARY

1. Dula Energy CT is a new modality that allows evaluating vascular structures with significant reduction in e.v contrast volume.
2. The possibility of using monochromatic images at different keV contributes to more precise vascular stenosis quantification due to a reduction in blooming and beam hardening artifacts.

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## Making the Undoable Case Doable: Advanced Adjunctive Techniques in Percutaneous Ablation

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### LL-VIE2961

**Meghan G Lubner** , MD \*  
**Timothy J Ziemlewicz** , MD  
**Doug R Kitchin** , MD  
**J. Louis Hinshaw** , MD \*  
**Fred T Lee** , MD \*  
**Christopher L Brace** , PhD \*

**PURPOSE/AIM**

- Review advantages of percutaneous approach to ablation
- Discuss adjunctive techniques such as patient repositioning, probe retraction and leverage, blunt tipped needle leverage, hydrodissection, pyeloperfusion to facilitate a percutaneous approach using case examples
- Discuss advantages of using contrast doped fluid for hydrodissection and introduce the concept of polaxamer gels for hydrodissection.

**CONTENT ORGANIZATION**

- Comparison of percutaneous to laparoscopic or open ablation
- Criteria for percutaneous case selection
- Adjunctive techniques with case examples: Patient reposition, probe retraction or leverage, blunt tipped needle leverage, hydrodissection, ureteral stent placement and pyeloperfusion
- Advantages of using contrast in hydrodissection fluid with case examples
- Introduction of use of polaxamer gels for hydrodissection

**SUMMARY**

1. Percutaneous ablation has lower cost, fewer major complications, and shorter hospital stay than laparoscopic or open ablation.
2. Adjunctive techniques may allow for more aggressive patient selection for a percutaneous approach.
3. More advanced techniques such as blunt-tipped needle leverage and novel hydrodissection materials may make challenging cases safe for the percutaneous approach.

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## Biopsy Tips and Tricks

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### LL-VIE2962

**Declan G Sheppard** , MD

**PURPOSE/AIM**

To describe and illustrate some standard and not so standard biopsy techniques and to show how they can be used in routine practice.

**CONTENT ORGANIZATION**

- The exhibit will describe and illustrate the roles of:
1. Pre-planning
  2. Real time planning
  3. Artificially created windows for access
  4. Artificially created windows for biopsy
  5. Patient positioning for access
  6. Respiratory positioning for access
  7. Use of anatomical landmarks for guidance
  8. Chiba needle as a guide wire
  9. Co-axial techniques
  10. Curved needles
  11. IV contrast for real time guidance
  12. Oral contrast
  13. Viscus decompression or expansion for access
  14. Angled, curved and oblique approaches
  15. Transosseous access
  16. CT fluoroscopy
  17. Hemostasis valves
  18. Cutting channel positioning for the safe performance of biopsies.

**SUMMARY**

Following this exhibit the reviewer will hopefully have acquired a number of new biopsy techniques that they can use in everyday practice.

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## Intentional Pneumoperitoneum: Its Preoperative Role in the Patient with Peritoneal Adhesions

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### LL-VIE2963

**Suzanne L Palmer** , MD \*  
**Peter F Crookes** , MD

**PURPOSE/AIM**

- Understand the indications for intentional pneumoperitoneum creation
- Discuss the techniques for optimal placement of the peritoneal drain and instillation of peritoneal air via detailed instructional and imaging examples
- Learn how to modify the techniques in technically challenging cases
- Become familiar with the risks and complications
- Be able to discuss and promote this technique with surgeons

**CONTENT ORGANIZATION**

Present brief background on abdominal adhesions Utilizing the experience at our institution:

- Review appropriate patient selection
- Review risks and complications
- Describe procedure, including optimal catheter placement and infusion of air

- Provide examples of imaging during infusion of air
- Present surgical outcomes

#### SUMMARY

Adhesions are a surgeon's nemesis. For patients requiring abdominal surgical intervention, adhesions may add hours to and increase complexity of even the most basic surgical procedure. In the appropriately selected patient, creating an intentional pneumoperitoneum prior to planned abdominal surgery can be a useful tool. By understanding the potential usefulness of this procedure and having the ability to perform it correctly, the radiologist can offer their surgical colleagues a preoperative way to minimize the impact of adhesions.

### Non-surgical Treatment of Benign Thyroid Nodules: Management Strategies According to the Nodule Composition

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#### LL-VIE2964

**Eun Ju Ha**  
**Jung Hwan Baek**  
**Jeong Hyun Lee**, MD, PhD  
**Hun Cho**, MD

#### PURPOSE/AIM

Non-surgical treatment of benign thyroid nodules is classified into two types; chemical ablation (ex. ethanol ablation) and thermal ablation (ex. laser- and radiofrequency (RF) ablation). The purpose of this education exhibit is to comprehensively review the efficacies in these modalities and conduct the best treatment option regarding to nodule characteristics based on current evidences.

#### CONTENT ORGANIZATION

The current results of ethanol-, laser-, and RF ablation of benign thyroid nodules will be described based on efficacy and complications. The efficacy will be explained according to volume reduction rate, therapeutic success rate, number of the treatment session, and changes of the symptom/cosmetic score. Based on current evidences, we will propose a 3-step approach for non-surgical treatment according to the nodule composition: cystic ( 50% of the solid portion). We will introduce the concept of ♦step by step management♦ and ♦combination therapy♦ for the treatment of nodules with solid component, and present examples of practical cases.

#### SUMMARY

The best treatment modality of benign thyroid nodules should be established according to the proportion of solid component. Understanding of proper management strategies of benign thyroid nodules will be helpful for daily practice.

### Catheter-based Renal Sympathetic Denervation Using Radiofrequency Ablation in Resistant Hypertension Treatment

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#### LL-VIE2965

**Liliana Renza**, MD  
**Rocio Carreno-Gonzalez**, ARRT  
**Maria Santillana**, MD  
**Jose Manuel Rodriguez**  
**Ivan Artero**, MD  
**Jose Munoz**

#### PURPOSE/AIM

1. To review the resistant hypertension (RH) and the role of the renal sympathetic hyperactivity
2. To explain the background of sympathectomy treatment and the major studies
3. To understand the indications, contraindications, and complications of the Catheter-Based Renal Sympathetic Denervation (C-B RSD) procedure
4. To expose our experience with the procedure and the long term follow up

#### CONTENT ORGANIZATION

- Definition of RH
- Symplicity HTN-1 Trial (2009) and HTN-2 Trial (2010)
- Diagnostic Imaging pre-procedure (US, CT, MRI)
- Explain the procedure: an endovascular catheter-based approach to disrupt renal sympathetic nerves♦ using radiofrequency (RF) ablation applied via an electrode at the catheter tip
- Review of indications, contraindications and complications of the procedure
- Our experience: we have performed 6 procedures of C-B RSD by RF ablation since January 2012. Patient follow up have been from 3 to 12 months. Every patient had a blood pressure (BP) reduction at all time points postprocedure
- Summary

#### SUMMARY

- The C-B RSD using RF Ablation have shown be useful in the RH treatment with significant reductions in BP in the two-year follow-up
- Current trials address the effectiveness of RSD in mild forms of essential hypertension, and in other diseases in which the renal sympathetic outflow was activated

### Treat or Not to Treat? -Controversial Patient-related Issues in Radiofrequency Ablation for Hepatocellular Carcinoma

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#### LL-VIE2966

**Kenny Q Sam**, MD  
**Katsuhiko Kobayashi**, MD  
**Vivek G Sahani**, DO  
**Mark A Sultenfuss**, MD

#### PURPOSE/AIM

1. Identify patient-related issues that may arise when treating hepatocellular carcinoma (HCC) with radiofrequency ablation (RFA).
2. Review currently available evidence for safety in treating HCC patients with those issues and discuss a tailored approach to minimize complications from RFA.

#### CONTENT ORGANIZATION

1. General indications and contraindications to RFA for patients with HCC.
2. Controversial patient-related issues in RFA for HCC, evidence for safety in treating patients with those issues and a tailored approach.
  - a. Ascites
  - b. Advanced liver disease (Child-Pugh C)
  - c. Recurrent HCCs following hepatectomy
  - d. Status post TIPS (potential worsening of liver function and possible hepatic encephalopathy)
  - e. Chronic kidney disease (patients on regular hemodialysis)
  - f. HIV
  - g. Status post liver transplant

#### SUMMARY

There are few contraindications to RFA for patients with HCC, however, some patient-related issues such as limited liver functional reserve,

## Image-guided Interventions in the Spleen: Knocking out Myths and Prejudices

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### LL-VIE2967

**Guilherme L Martins** , MD  
**Eduardo P Anastacio**  
**Felipe D Barbosa** , MD  
**Eduardo Garcia**  
**Publio C Viana** , MD  
**Marcos R Menezes** , MD

#### PURPOSE/AIM

Percutaneous image-guided splenic procedures are seldom performed due to fear of complications, mainly hemorrhage. However, the complication rates are similar to those of other abdominal organs and they are an excellent option particularly in those patients with clinical comorbidities. The purpose of this exhibit is to provide the radiologist a guide to ensure the correct interventional techniques and their limitations for safe performance of image-guided percutaneous interventions in the spleen.

#### CONTENT ORGANIZATION

1. Review relevant anatomy to facilitate selection of appropriate techniques to access the spleen.
2. Describe the various types of percutaneous splenic interventions, including biopsy, catheter abscess drainage and radiofrequency ablation (RFA).
3. Illustrate these techniques with drawings, examples of our routine and challenging cases.
4. Show complications and outcomes.

#### SUMMARY

A widely held view of splenic interventions among physicians is that there is a high risk of morbidity, mainly because of the relatively infrequent performance of spleen interventions in comparison with those in other abdominal organs. The literature suggests much lower rates of complications and what we see is that splenic procedures can be safely used to provide a definitive diagnosis and, sometimes, therapeutically, as an effective alternative to surgery.

## Key Anatomy of Varicose Veins: Demonstration by Three-dimensional CT Venography

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### LL-VIE2968

**Rihyeon Kim** , MD  
**Jiyeon Lim**  
**Eun-Ah Park** , MD  
**Whal Lee** , MD, PhD  
**Jin Wook Chung** , MD \*

#### PURPOSE/AIM

Varicose veins are one of the most common diseases of the lower extremity venous system. It typically has simple pathophysiology, however, at times its underlying anatomical cause may be complicated. CT venography with three-dimensional reconstruction could be a useful method to evaluate the venous anatomy of the lower extremity when combined with Doppler ultrasonography. The aim of this exhibit is to review the key anatomies of varicose veins using CT venography, which is crucial for diagnosis and treatment.

#### CONTENT ORGANIZATION

#### SUMMARY

Varicose veins, at times, are accompanied by complicated anatomical variations. CT venography with three-dimensional reconstruction may enhance the understanding of these underlying anatomies leading to a more successful diagnosis and treatment. Reviewing the key anatomy of varicose veins as well as knowing its variations and their incidence will be beneficial to radiologists who perform imaging and treat varicose veins.

## CT Angiography Protocols with MDCT: A Guide to Reduce Radiation and Contrast Needs

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### LL-VIE2969

**Juan Arenas** , MBBS  
**Elena Garcia-Garrigos**  
**M Dolores Guirau-Rubio**  
**Javier De La Hoz**  
**Yanne Aviles**

#### PURPOSE/AIM

Discuss the modifiable technical factors related with imaging quality in MDCT angiography.  
Give a quick guide to reduce both radiation and contrast volumes in routine MDCT angiography.

#### CONTENT ORGANIZATION

- a) Technical factors involved in imaging quality of CT angiography.
- b) Steps to get a low radiation and low contrast study by considering: 1. Scanner type 2. What do you need the CT angiography for? first study, surgical planning, control, emergency? 3. Patient age and weight 4. Kilovoltage 5. Iodine concentration 6. Injection rate 7. Bolus tracking threshold level 8. Scan delay from threshold 9. Scan duration 10. Calculation of contrast and saline flush volumes.
- c) Examples of extra-low dose studies.

#### SUMMARY

Specially for young patients and for patients with risk factor for contrast induced nephropathy, MDCT technology gives the radiologist the opportunity to get vascular studies of good quality while maintaining acceptable radiation and iodinated contrast volumes, respectively. We give a step-by-step guide to reduce both radiation and contrast volumes in routine MDCT angiography, also applicable to other diagnostic studies.

## CT Angiography Protocols with MDCT: A Guide to Reduce Radiation and Contrast Needs

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### LL-VIE2969

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## Doppler Ultrasonography of Arteriovenous Fistula in Hemodialysis Patients ... Far More than Just a Pure Diagnosis Purpose

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### LL-VIE2970

**Jose R Fortuno** , MD  
**Anna Alguersuari** , MD  
**Eva Criado**  
**Joan Falco**  
**Carlos Serrano Burgos**  
**Juan Perendreu** , MD, PhD  
**Jordi Branera** , MD  
**Cristina Maria Spinu** , MD  
**Marta Cufi Quintana**

#### PURPOSE/AIM

The Doppler ultrasound (US) is an established technique in the diagnosis of access dysfunction in dialysis patients. The aim of this exhibit is to illustrate that hemodialysis access US can be used not only with a pure diagnosis purpose. An accurate arteriovenous fistula (AV) US examination have great therapeutic and prognostic implications and it is essential in the management of this patients.

#### CONTENT ORGANIZATION

Pictorial description of ultrasonographic findings and their angiography correlation to illustrate that an access US can be used to:  
1.-Monitoring the access. 2.-Diagnosis of dysfunction. 3.-Determination the best therapeutic option (surgical vs endoluminal treatment).  
4.-Determination of the optimal puncture site and access ( venous retrograde vs anterograde). 5.-Guidance for accessing immature fistulae.  
6.-Plannification the procedure (sheath, wire, catheter, angioplasty balloon and stent/stent graft). 7.-Guidance during the procedure alone or in combination with fluoroscopy. 8.- Assessment of outcome in the short and medium term with the evaluation of a morphologic and hemodynamic residual stenosis.

#### SUMMARY

Doppler US examination of dysfunctional AVF is useful not only in determining the cause of dysfunction, but it also plays a key role in the overall plannification, monitoring and outcome assessment of any intravascular intervention.

## Doppler Ultrasonography of Arteriovenous Fistula in Hemodialysis Patients ... Far More than Just a Pure Diagnosis Purpose

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### LL-VIE2970

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**Joan Falco**  
**Carlos Serrano Burgos**  
**Juan Perendreu** , MD, PhD  
**Jordi Branera** , MD  
**Cristina Maria Spinu** , MD  
**Marta Cufi Quintana**

**PURPOSE/AIM**

The Doppler ultrasound (US) is an established technique in the diagnosis of access dysfunction in dialysis patients. The aim of this exhibit is to illustrate that hemodialysis access US can be used not only with a pure diagnosis purpose. An accurate arteriovenous fistula (AV) US examination have great therapeutic and prognostic implications and it is essential in the management of this patients.

**CONTENT ORGANIZATION**

Pictorial description of ultrasonographic findings and their angiography correlation to illustrate that an access US can be used to:  
1.-Monitoring the access. 2.-Diagnosis of dysfunction. 3.-Determination the best therapeutic option (surgical vs endoluminal treatment). 4.-Determination of the optimal puncture site and access ( venous retrograde vs anterograde). 5.-Guidance for accessing immature fistulae. 6.-Plannification the procedure (sheath, wire, catheter, angioplasty balloon and stent/stent graft). 7.-Guidance during the procedure alone or in combination with fluoroscopy. 8.- Assessment of outcome in the short and medium term with the evaluation of a morphologic and hemodynamic residual stenosis.

**SUMMARY**

Doppler US examination of dysfunctional AVF is useful not only in determining the cause of dysfunction, but it also plays a key role in the overall plannification, monitoring and outcome assessment of any intravascular intervention.

**Don't Forget the Foregut! Anatomy, Variants and Pathologies of the Celiac Axis and its Branches****LL-VIE2971**

**Richard D White** , MBChB, FRCR  
**Carl M Sullivan** , MBBS  
**Syed Abdur Rahman Mustafa** , MBBS, MRCS  
**Jonathan Weir-McCall** , MBBCh, FRCR  
**Matthew J Budak** , MD, FRCR  
**Phey M Yeap** , MBChB  
**Ian A Zealley** , MD  
**Thiru A Sudarshan** , FRCR

**PURPOSE/AIM**

Illustrate normal celiac axis (CA) anatomy and variants on cross-sectional/angiographic imaging Depict pathologies affecting the CA and its branches on cross-sectional imaging and both non-invasive and invasive angiography Discuss interventional strategies for the management of CA pathologies and the challenges aberrant anatomy can impose

**CONTENT ORGANIZATION**

A retrospective review of 1170 cases and 1506 healthy volunteers imaged over a 5 year period (Mar 08-Feb 13) was performed, yielding 465 relevant cases. Of these, the best examples are provided of normal anatomy and variants and pathologies e.g. aneurysm, arteriovenous malformation, dissection, compression. Tips to differentiate between anatomical and pathological narrowing are provided. Relevant interventional management and pearls and pitfalls are discussed

**SUMMARY**

The CA is frequently visualized on imaging but often overlooked. This exhibit depicts the range of normality of anatomy and variants - essential to guide management (endovascular or otherwise). Common and esoteric pathologies are discussed along with tips and tricks relating to their endovascular management and means of differentiating between anatomical and pathological narrowing - which may obviate the need for unnecessary intervention and its significant associated complications

**Central Venous Intervention and Central Catheter Dysfunction in the Hemodialysis Patient: A Challenging Scenario for the Interventionalist****LL-VIE2972**

**Jose R Fortuno** , MD  
**Eva Criado**  
**Anna Alguersuari** , MD  
**Joan Falco**  
**Carlos Serrano Burgos**  
**Juan Perendreu** , MD, PhD  
**Jordi Branera** , MD  
**Marta Cufi Quintana**  
**Cristina Maria Spinu** , MD

**PURPOSE/AIM**

Central venous interventions in the hemodialysis patient remain a challenging issue for the interventionalist. Central venous interventions are often required in dialysis patients with dysfunctional temporary or tunneled catheter or with an arteriovenous (AV) fistula with a suspected central stenosis or occlusion. The management of these patients remains controversial. The purpose of the exhibit is to describe the wide spectrum of clinical scenarios the interventionalist will face and to detail the optimal diagnostic and therapeutic approach in each situation.

**CONTENT ORGANIZATION****CONTENT ORGANIZATION**

- Pathophysiology, diagnosis and therapeutic approach of central vein stenosis/occlusions in patients with AV fistula.
- Diagnosis and therapeutic implications for the interventionalist of central venous catheter dysfunction
- Analysis the spectrum of interventional techniques available for the mentioned clinical scenarios and review of the literature.

**SUMMARY**

Central venous interventions remain one of the more controversial topics in the hemodialysis patients care. Interventional radiology plays an important role in the management of these patients and the interventionalist should be familiar with the clinical issues and therapeutic approaches in the different clinical settings.

**Temporary Balloon Occlusion of the Common Iliac Artery in Management of Patients with Placenta Accreta****LL-VIE2973**

**Hiroshi Kondo** , MD

**Nobuyuki Kawai** , MD  
**Yukichi Tanahashi** , MD  
**Yoshifumi Noda** , MD  
**Satoshi Goshima** , MD, PhD  
**Masayuki Kanematsu** , MD

#### PURPOSE/AIM

The objectives are to (1) review the clinical indications, (2) radiologic findings with placenta accreta, (3) plan of occlusion balloon placement, and (4) efficacies of arterial occlusion to control the intraoperative hemorrhage volume.

#### CONTENT ORGANIZATION

- Typical US and MRI presentations of placenta accreta with various manifestations.
- Common clinical methods for blood loss reduction during cesarean operation.
- Clinical and MRI indications of arterial occlusion balloon placement and its efficacies.
- Discussion of problems and solutions associated balloon positioning.
- Suggestion of real time monitoring system during procedure.

#### SUMMARY

1. Since large amount of intraoperative blood loss was frequently seen in patients with placenta accreta, clinical and radiologic indications of arterial occlusion balloon placement should be established.
2. Understanding and recognizing methods for arterial balloon placement and its efficacies are crucial for the management of intraoperative hemorrhage volume in patients with placenta accreta.
3. Suggestion of real time monitoring system during procedure that could solve the balloon positioning problem.

## Percutaneous Ethanol Injection Revisited in the Era of Radiofrequency Ablation

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### LL-VIE2974

**Jung Hyeok Kwon** , MD, PhD  
**Mi Jeong Kim** , MD  
**Hyuk-Won Chang**

#### PURPOSE/AIM

PEI has been replaced by more effective thermal ablation techniques because of its high local recurrence rate. However, PEI remains useful in select settings, as PEI can be performed in any portion of the liver. The purpose of this exhibit is: 1. To review PEI in the past and at present 2. To discuss role of PEI in the era of RFA 3. To explain indication of PEI for treatment of HCC among various treatment modalities 4. To illustrate various PEI techniques

#### CONTENT ORGANIZATION

PEI in the past and at present Choice among various treatment modalities PEI techniques (multisession, high-dose, single session) Role of PEI in the era of RFA 1) HCC at risk or difficult to ablate by RFA (1) HCC close (

#### SUMMARY

The major teaching points of this exhibit are: 1. PEI is inferior to RFA in the therapeutic effectiveness and survival. 2. PEI is very useful in select situations. 3. PEI has valuable roles in the era of RFA .

## Development of a Novel Method for Manipulation of Angiographic Images Using a Motion Sensor in Operating Rooms

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### LL-VIE2975

**Toshihiro Ogura** , PhD  
**Yuki Ishida**  
**Norio Hayashi** , PhD  
**Yoshiaki Yasumoto**  
**Shoko Tsutsumi**  
**Kunio Doi**

#### PURPOSE/AIM

During angiographic examinations, interventional radiologists needs image processing operation such as paging, roaming, enlarging in order to assess vessels and sources of bleeding. Since radiologists always wore gloves to be kept clean, he or she could not operate the image processing on screen by hands. Therefore, we developed a novel image operation system using a motion sensor.

#### CONTENT ORGANIZATION

1. Usefulness of novel image operation system using a motion sensor for angiography in operating room.
2. System configuration for controlling images without manual contact on screen.
3. How to use this system.
4. Response time and recognition area of the radiologists' hand movement using this system.
5. Comparison of the required time such as paging and roaming with this system and conventional system.
6. Discuss the application of this system in the near future.

#### SUMMARY

With this system, radiologists can give instructions for image display and manipulation on the workstation only with movements in hands, which would be a new technology in operating rooms for angiography.

- a. The operation method of this system.
- b. Easy implementation in existing angiographic equipment.
- c. Advanced clinical application of this technique in the near future.

## Embolising Agents: What IR Trainee Needs to Know

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### LL-VIE2976

**Shivanand R Gamanagatti** , MBBS, MD  
**Rajeshkumar Gupta** , MBBS, DMRD  
**Atin Kumar** , MD

#### PURPOSE/AIM

1. To illustrate the various types of commonly used embolising agents
2. To discuss the when and what embolising agents to use through flow chart
3. To discuss the complications of inadvertent embolisation

#### CONTENT ORGANIZATION

1. History of embolization techniques and materials. 2. Description of the important aspects of commonly used agents 3. Types of embolisation techniques

- Proximal and distal mechanical
- Liquid agents
- Chemoembolisation

- Miscellaneous such as, flow directed, Stent-assisted and balloon-assisted, Direct fibrin adhesive injection, Covered stents, Direct thrombin injection and sandwich technique

4. Flow chart for embolization agent choice based on:

- What is the size of vessel, small or large?
- How long should the vessel stay occluded , permanent or temporary?
- Whether tissue death is desirable or not?
- What is the flow rate in the vessel, slow or high flow?

5. The complications of inadvertent embolisation; Causes and Prevention

#### SUMMARY

A uniform, systematic approach to each clinical situation, the operator can generally choose an appropriate embolising agent. Operator must ask himself the simple questions outlined in this exhibit, will help the interventional radiologist in deciding appropriate agent without encountering untoward complication or technical failure.

## Pancreatic Fistula: Imaging and Treatment

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### LL-VIE2977

**Yoshiaki Watanabe** , MD, PhD

**Takashi Omura** , MD

**Tetsuya Naito**

**Makoto Furuse**

#### PURPOSE/AIM

Pancreatic fistula remains a well-known and severe complication of acute pancreatitis, trauma and pancreatic surgery (especially pancreatoduodenectomy and distal pancreatectomy).

The aim of this presentation is to demonstrate the clinical feature, imaging feature and treatment including interventional (image-guided) procedure of pancreatic fistula.

#### CONTENT ORGANIZATION

**1. Clinical features of pancreatic fistula:** Incidence, patterns of fistula formation (disrupture of MPD, dehiscence of pancreatico-jejunal anastomosis and fistula formation of distal pancreatic stump).

**2. Imaging features and classification:** Typical CT and MRI images, ISGPF (International study group pancreatic fistula) grading.

#### 3. Treatment:

a) Conservative management (total parenteral nutrition, nasogastric suction and somatostatin)

b) Endoscopic treatment (ERPD)

c) Percutaneous treatment

i) Fistula and pancreatic duct drainage (CT-guided percutaneous puncture of MPD)

ii) Percutaneous pancreatic duct stenting

iii) Percutaneous anastomotic reconstruction (MPD to jejunum or stomach, fistula to jejunum)

iv) Percutaneous embolization of pancreatic duct by prolamine

d) Surgery (pancreatogastrostomy, completion pancreatectomy)

#### SUMMARY

Pancreatic fistulas resistant to conservative management could be treated successfully with minimally invasive interventional procedures.

## Applications of Contrast Enhanced Ultrasound for Radiofrequency Ablation of Hepatocellular Carcinoma

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### LL-VIE2978

**Atul Gera** , MD \*

**Ilya Lekht** , MD

**Bhushan Desai** , MD

**Alok B Bhatt** , MD

**Ajit Vyas** , MD

**Michael D Katz** , MD

**Ramon Ter-Oganesyan** , MD

**John R Daniels** , MD

**Edward G Grant** , MD \*

#### PURPOSE/AIM

1. To understand the technique and scientific basis of contrast enhanced ultrasound (CEUS). 2. To appreciate the uses of CEUS as an imaging modality to assess the efficacy of radiofrequency ablation (RFA) treatment of hepatocellular carcinoma (HCC) immediately after the RFA procedure and in follow up. 3. To learn the potential benefits of CEUS over traditional imaging modalities.

#### CONTENT ORGANIZATION

A. Background regarding current imaging modalities used in guiding therapy for HCC B. Literature review regarding the role of CEUS in the evaluation of HCC C. Limitations of conventional imaging modalities, such as CT and ultrasound, in guiding therapy for HCC during the RFA procedure D. Applications and advantages of CEUS for the immediate assessment of treatment response after RFA E. Technical factors regarding CEUS for RFA F. Ultrasound contrast agents G. Cases to demonstrate the utility of this technique

#### SUMMARY

1. CEUS permits assessment of the efficacy of RFA therapy for HCC, immediately after the procedure and during follow up. 2. CEUS constitutes an alternative to contrast enhanced multiphase CT for assessing HCC. Consequently, CEUS use could decrease patient exposure to ionizing radiation and iodinated contrast.

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### Applications of Contrast Enhanced Ultrasound to Delineate Percutaneous Drainage Catheters and Intra-abdominal Collections

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#### LL-VIE2979

**Anu Obaro** , MBBS  
**Venus Hedayati** , MBBS, MRCP  
**Mohammad Daneshi** , MBBS  
**Dean Y Huang** , MBBS, FRCR  
**Maria E Sellars** , MD, FRCR  
**Paul S Sidhu** , MRCP, FRCR \*

#### PURPOSE/AIM

To demonstrate the usefulness of ultrasound contrast agents administered via percutaneous drainage catheters or tubes (CEUS tubogram) to delineate intra-abdominal collections and to confirm tube patency and position.

To present the different applications of CEUS tubograms as a non-ionising modality which can be of benefit for follow-up in specific patient groups.

#### CONTENT ORGANIZATION

- The method of CEUS tubograms.
- The different clinical scenarios in which CEUS tubograms may be of benefit e.g. in suspected drain occlusion, to confirm drain position or to characterise solid organ abscess cavities.
- The use of CEUS tubograms in conjunction with intravenous CEUS agents to provide additional clinical information about abscess morphology (e.g. multiple loculations) and the superiority over B-mode ultrasound alone.
- The potential advantage of CEUS tubograms in cases that would classically utilise ionising radiation eg. to confirm of nephrostomy position.

#### SUMMARY

The administration of ultrasound contrast agents directly into percutaneous catheters is a novel technique which can assess drain position, patency and residual abscess cavity size. This provides a safe, real-time evaluation of the drainage catheter and is a valuable problem solving tool in cases that would have otherwise required ionising radiation.

### Applications of Contrast Enhanced Ultrasound to Delineate Percutaneous Drainage Catheters and Intra-abdominal Collections

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## Breaking the Bonds: Interventions Beyond Anticoagulation. A Comprehensive Review of Endovascular Techniques for the Management of Deep Venous Thrombosis

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### LL-VIE2980

**Salar Hakham**, DO  
**Daniel H Macarthur**, MD  
**Neil J Halin**, DO  
**David W Allen**, MD  
**Kevin P Daly**, MD

#### PURPOSE/AIM

1. Present a comprehensive, yet systematic approach in the treatment and management of acute and chronic DVT 2. Review the available endovascular techniques of DVT removal with illustrative examples 3. Review clinical scenarios where an endovascular treatment approach to DVT is appropriate over anticoagulation alone

#### CONTENT ORGANIZATION

Endovascular techniques have become increasingly important and effective tools in the management of extensive DVT to reduce acute symptoms and prevent long-term complications, namely post thrombotic syndrome. We will review the modern endovascular techniques and medical devices available for DVT treatment beyond anticoagulation including: 1. Catheter-directed thrombolysis, 2. Lytic assisted clot removal techniques, 3. Aspiration thrombectomy procedures, 4. Mechanical thrombectomy procedures, 5. Angioplasty/stenting techniques, with specific emphasis on which method of approach is most appropriate for a given clinical presentation. Where appropriate, pitfalls and potential complications will be discussed and further management options will be reviewed through illustrative examples.

#### SUMMARY

Our educational exhibit aims to provide the practicing interventional radiologist with a review of the available endovascular techniques for the effective management of acute and chronic DVT with an emphasis on clinical appropriateness.

## Pseudoaneurysms: Imaging, Interventions and Innovations

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### LL-VIE2981

**Niranjana Khandelwal**, MD  
**Manphool Singhal**, MD  
**Vivek Gupta**, MD  
**Anupam Lal**, MD  
**Naveen Kalra**, MBBS, MD  
**Ajay Kumar**, MD  
**Sameer Vyas**, MD  
**Mukesh K Yadav**, MBBS, MD  
**Ajay Gulati**, MD

#### PURPOSE/AIM

Evaluation of etiopathogenesis, imaging, principles for interventions and innovations in the management of pseudoaneurysms.

#### CONTENT ORGANIZATION

- ◆ Retrospective analysis of cases of pseudoaneurysms (n=144) irrespective of their sites managed with interventional techniques in last 5 years (2007-2012). The cases management by medical or surgical methods excluded.
- ◆ Location: cavernous ICA (n=3), cervical ICA (n=9), subclavian (n=4), costocervical trunk (n=1), Rasmussen's (n=9), visceral and renal (n=43), transplant kidney (n=3), uterine (n= 18) and peripheral (n=54).
- ◆ Etio-pathogenesis: trauma (n=91), infection (n=32), inflammatory (n=15) and tumor (n=6).
- ◆ The management techniques: coiling, stent graft placement, transcatheter and percutaneous injection of embolization agent or ultrasound guided compression.
- ◆ Newer techniques: percutaneous injection of acrylic glue in the aneurysmal sac (n=8).
- ◆ Technical success-100%; clinical success- 90%; repeat embolization in 14 cases.

#### SUMMARY

Pseudoaneurysms require timely recognition and therapy to prevent potential fatal complications. The interventional treatment depends upon the size, location, and status of distal circulation. Endovascular therapy is the modality of choice for management of pseudoaneurysms; however, in specific cases percutaneous techniques should also be considered as an alternative.

## Malperfusion Syndrome due to Aortic Dissection: Accurate Fluoroscopy-guided Balloon Fenestration

**LL-VIE2982**

**Franziska Wolfschmidt** , MD  
**Isabel A Platzer** , MD  
**Jan P Goltz** , MD  
**Werner Kenn** , MD, PhD  
**Thorsten A Bley** , MD  
**Ralph Kickuth** , MD

**PURPOSE/AIM**

To review indications and technical considerations of fluoroscopy-guided balloon fenestration using a conventional reentry catheter in aortic dissections.

**CONTENT ORGANIZATION**

1. Pathophysiology, classification and imaging findings 2. Interventional radiological therapeutic options in aortic dissections 3. Indications for balloon fenestration 4. Technique of accurate fluoroscopy-guided puncture in terms of an extendable coaxial needle for gaining target lumen reentry 5. Clinical outcome of patients with malperfusion syndrome from aortic dissection treated by fluoroscopy-guided puncture of the intimal flap.

**SUMMARY**

Interventional radiological techniques in aortic dissections include stent grafting of the false lumen entry, aortic true lumen stenting as well as percutaneous balloon fenestration of the intimal flap. In patients with malperfusion syndrome fluoroscopic-guided fenestration using a conventional reentry catheter is a safe and effective tool to improve perfusion of the true lumen and its branches.

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**Balloon-occluded Retrograde Transvenous Obliteration for Large Gastric Varices: What We Need to Know**


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[Back to Top](#)**LL-VIE2983**

**Takuji Yamagami**  
**Rika Yoshimatsu**  
**Hiroshi Miura**  
**Masaki Ishikawa** , MD  
**Kei Yamada** , MD  
**Kazuo Awai** , MD \*  
**Kenji Kajiwara**

**PURPOSE/AIM**

The purpose of this exhibit is: 1. To review current strategies to treat gastric varices, 2. To explain the role of balloon-occluded retrograde transvenous obliteration (B-RTO) for treating gastric varices, 3. To highlight what needs to be done when sclerotic agents escape from the varices via collateral vessels developed despite gastro-renal shunt occlusion by balloon inflation.

**CONTENT ORGANIZATION**

1. Evaluation of gastric varices by gastric endoscopy, CT angiography, balloon-occluded retrograde venography, cone-beam CT, and portal venous pressure, 2. Collateral veins important at B-RTO, 3. Approach to collateral veins at embolization for sufficient obliteration of the gastric varices and a new concept for addressing collateral vessels, 4. Post-B-RTO follow-up, 5. Possible complications of B-RTO.

**SUMMARY**

The major teaching points of this exhibit are: 1. B-RTO effectively treats gastric varices. 2. Careful management of collateral veins is necessary for good therapeutic effects. 3. The availability of multiple interventional devices and techniques can improve treatment outcomes in patients with gastric varices subjected to B-RTO.

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**Burn, Freeze and Zap! The Expanding Role of the Interventional Radiologist in the Multimodality Treatment of Primary and Secondary Pulmonary Malignancy**


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[Back to Top](#)**LL-VIE2984**

**Rukshan Fernando** , MBBS, BSc  
**Kabir A Varghese** , MBBS, BSc  
**Narayanan Thulasidasan** , MBBS, MRCS  
**Simon P Padley** , MBBS  
**Nicos Fotiadis**  
**Benjamin J Robertson** , MRCP, FRCR

**PURPOSE/AIM**

To highlight the expanding role of the interventional radiology (IR) in the treatment of pulmonary malignancy. To review technologies and techniques, including established and novel thermal ablation technologies and the placement of fiducial markers to guide stereotactic radiotherapy, via percutaneous and transpulmonary artery routes.

**CONTENT ORGANIZATION**

IR has traditionally played a role early in the care pathway, performing image guided biopsy. With the advent of thermal ablation, IR now plays an expanding therapeutic role, of particular value in patients in whom cardiopulmonary impairment precludes surgery. We review the growing arsenal of ablation technologies, addressing the properties and technical nuances of each:

- Radiofrequency
- Microwave
- Cryo
- Laser
- Irreversible electroporation

IR is now also required to place fiducial markers to guide stereotactic radiotherapy. We discuss tips and techniques:

- Single and double marker placement
- Trans-pulmonary artery coil marker insertion

These techniques can be combined, allowing simultaneous ablation and fiducial placement with a single puncture, allowing dual modality therapy, or to guide radiotherapy in the advent of local recurrence.

**SUMMARY**

IR has an expanding role in the multimodality treatment of primary and secondary pulmonary malignancy.

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**Everything You Always Wanted to Know About Loco-regional Treatment of Hepatocellular Carcinoma**


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[Back to Top](#)**LL-VIE2985**

**Carmen Garcia Alba** , MD  
**Julien Cazejust** , MD  
**Bertrand Bessoud** , MD  
**Yves M Menu** , MD

**PURPOSE/AIM**

To review the different loco-regional therapeutic options for hepatocellular carcinoma (HCC) when surgery and transplantation are not feasible. To understand the importance of the evaluation of tumor size, number of lesions and their location for an optimal treatment choice. To comprehend the pros and cons of each treatment as well as their potential Achilles heel.

#### CONTENT ORGANIZATION

An overview of the spectrum of interventional radiology treatments for HCC will be done. The how, where and why of each technique will be exposed. We will review several techniques, with their keypoints and their proven or promising results: - Two thermal ablative techniques: radiofrequency and microwave ablation. - Three embolization techniques: conventional chemoembolization, Drug Eluted Beads chemoembolization and Y90 Radioembolization.

#### SUMMARY

A deep and thorough knowledge of the different loco-regional treatments available for hepatocellular carcinoma: indications, contraindications, advantages and disadvantages; is crucial for the correct choice of treatment and best results, with an improvement on patient care and disease free survival.

### Strategy and Clinical Results of Uterine Leiomyoma Treated Uterine Fibroid Embolization (UFE) Experienced over 1000 Cases

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#### LL-VIE2986

**Kumiko Koyama** , MD  
**Hidefumi Fujisawa** , MD  
**Shinya Yagi** , MD  
**Takako Fukushima** , MD  
**Tamio Kushihashi** , MD  
**Yasunori Taki**  
**Takahisa Kojima**

#### PURPOSE/AIM

1. To know indications of UFE correlating with clinical aspects
2. To understand patient selection, technique and results of UFE
3. To learn access of UFE for expecting mothers
4. To know results and complications of UFE
5. To understand effectiveness of MRI pre and post UFE
6. To know follicle stimulating hormone data pre and post UFE

#### CONTENT ORGANIZATION

- 1) Introduction
- 2) Strategy including patient selection and technique of UFE
- 3) Technique and access of UFE for expecting mothers
- 4) Pre and post UFE MR imaging of uterine leiomyoma
- 5) Results including hormonal data and complications of UFE
- 6) Case presentations
- 7) Summary

#### SUMMARY

Over the past 20 years, UFE has been an effective minimally invasive treatment for symptomatic patients. UFE for uterine leiomyomas has both monetary and non-monetary effects. We will show non-monetary effects of UFE particularly focusing on strategy of UFE for expecting mothers. Pre and post MRI imagings are also effective for evaluation of UFE.

### Interventional Techniques and Tips for Transarterial Chemoembolization (TACE) in Hepatocellular Carcinoma (HCC): Update 2013

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#### LL-VIE2987

**Seiji Kamei** , MD  
**Matthias Rief** , MD  
**Syuji Ikeda**  
**Akira Kitagawa**  
**Makiyo Hagihara**  
**Yuichiro Izumi**  
**Eisuke Katsuda**  
**Toyohiro Ota**  
**Tsuneo Ishiguchi** , MD

#### PURPOSE/AIM

Transarterial treatment of HCCs can be a major challenge depending on the site, size and vasculature of the lesions. The purpose of this educational exhibit is to present the anatomy of hepatic arteries, the diagnostic workup, and the options for immediate control of treatment. The focus will be on interventional techniques, including superselective TACE.

#### CONTENT ORGANIZATION

1. Anatomy of the hepatic arteries including the anterior and caudate segment and extrahepatic collaterals
2. Imaging recommended prior to TACE
3. Technical tips for TACE
  - a) Selection of guiding catheters and microcatheters according to the arterial anatomy
  - b) Superselective TACE
  - c) Balloon-occluded TACE
  - d) Role of C-Arm CT for lesion detection, guidance of the intervention (3D) and monitoring of the treatment success
  - e) Pitfalls and technical obstacles

#### SUMMARY

1. Prior knowledge of the patients hepatic artery anatomy and identification of the feeding vessel using pretreatment CT can improve the outcome of the intervention.
2. C-Arm CT bears advantages over conventional angiography in detecting and localizing the lesion. Further, treatment success can instantly be monitored.
3. Superselective approaches depend on the site of the lesion and the vascular prerequisite of the feeding artery.
4. For large lesions, balloon-occluded TACE can improve treatment success.

### Interventional Radiology and the Multimodality Treatment of Hepatic Malignancy-A New Horizon?

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#### LL-VIE2988

**Narayanan Thulasidasan** , MBBS, MRCS  
**Dariush Douraghi-Zadeh** , BSc, BMBS  
**Nasir Khan** , MBBS  
**James McCall** , FRCR  
**Benjamin J Robertson** , MRCP, FRCR

#### PURPOSE/AIM

To explore the expanding role of interventional radiology (IR) in the multimodality therapy of hepatic malignancy. To review the growing body of evidence for combining two or more treatment modalities and ask whether this represents a new horizon for interventional

oncology?

## CONTENT ORGANIZATION

We review the multiple treatment modalities available to treat hepatic malignancy including:

- Surgery
- Percutaneous ablation: radiofrequency, microwave and irreversible electroporation
- Transarterial therapy: bland embolization, chemoembolization and Yttrium-90 radioembolization
- External beam and stereotactic radiotherapy

We review the reported data for multiple modality therapy. We discuss the theoretical synergistic tumouricidal effects of combinations such as thermal ablation following sensitization with chemoembolization or chemoembolization and stereotactic radiotherapy. We discuss the logistical challenges of multimodality therapy and ask if there is evidence to support a multimodality approach to treatment.

## SUMMARY

There is a growing tendency towards the multimodality treatment of patients with hepatic malignancy, supported by theoretical advantages and expanding data. IR has plays a crucial role in this pathway, offering ablation, transarterial therapies, and guiding stereotactic radiotherapy.

## Percutaneous Fiducial Marker Implantation for Image Guided Radiotherapy: What Interventional Radiologists Need to Know

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### LL-VIE2989

**Yusuke Sakuhara** , MD  
**Norio Katoh** , MD  
**Daisuke Abo** , MD  
**Takeshi Soyama**  
**Bunya Takahashi**  
**Hiroki Shirato** , MD, PhD

## PURPOSE/AIM

1. To understand the basis of image guided radiotherapy (IGRT) and real-time tumor-tracking radiotherapy (RTRT) that is the modified technique of IGRT.
2. To learn the technique of gold fiducial marker implantation for IGRT/RTRT.

## CONTENT ORGANIZATION

1. The basis of image guided radiotherapy (IGRT) about which interventional radiologists need to know: history, theory, indications, and advantages.
2. The real-time tumor-tracking radiotherapy (RTRT) system which is the technique to solve organ motion in IGRT and to increase the accuracy of treatment of tumors in motion.
3. The interventional technique of percutaneous implantation of a gold fiducial marker for IGRT/RTRT: preparations, devices, implantation procedure and technical tips, and possible complications.

## SUMMARY

Improving knowledge of IGRT/RTRT will help interventional radiologists to provide radiation oncologists with the safe and accurate technique of fiducial marker implantation for advanced radiotherapy.

## Role of Interventional Radiology in the Management of Post Partum Hemorrhage

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### LL-VIE2990

**Audrey Fohlen** \*  
**Vincent Le Pennec** , MD \*  
**Olivier Limot** , MD  
**Penelop Labauge**  
**Arnaud Fauconnier**  
**Jean-Pierre J Pelage** , MD, PhD \*

## PURPOSE/AIM

1- Review the different causes of primary and secondary post partum hemorrhage 2- Be familiar with the relevant vascular anatomy of the female genital tract 3- Review the different techniques and devices used to treat intractable post partum hemorrhage 4- Understand the specific issues associated with abnormal placentation

## CONTENT ORGANIZATION

Epidemiology and causes: Post partum hemorrhage remains a leading cause of maternal mortality and morbidity even in developed countries. Primary post partum hemorrhage occurring within 24 hours following delivery is mainly related to uterine atony. Delayed post partum hemorrhage occurring within 42 days after delivery is mainly related to vascular abnormalities such as pseudoaneurysms and arteriovenous fistulae. Interventional radiology techniques : Review of embolization techniques and materials. Abnormal placentation: How to diagnose placenta accreta and percreta. Review specific techniques used in this setting such as prophylactic placement of balloons in the iliac arteries and arterial embolization with the placenta left in place.

## SUMMARY

Arterial embolization and prophylactic use of intra arterial balloons play a major role in the management of life-threatening post partum hemorrhage. Pluridisciplinary management of patients should be carried out in specialized centers.

## Hemoptysis: Workup and Endovascular Management

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### LL-VIE2991

**Antoine Khalil** , MD  
**Samuel Haddad**  
**Mikhael Benjoar**  
**Antoine Parrot** , MD  
**Marc Tassart** , MD  
**Marie F Carette** , MD

## PURPOSE/AIM

We report our experience gained in the management of hemoptysis of more than 1000 patients. We focus on the role of MDCTA for the initial workup of patients with hemoptysis, and on our endovascular approach of hemoptysis. The choice of the occlusions devices (coils, vascular plugg, stent graft) and material of embolisation in patients with hemoptysis.

## CONTENT ORGANIZATION

A-examinations to practice before the endovascular treatment B-How do I make a good MDCTA C- Contribution of MDCTA: a) localization, b) mechanisms of hemoptysis, and c) network of systemic arteries supplying the bleeding site D-Radiological anatomy of the bronchial and non-bronchial systemic arteries E- Role of bronchoscopy F- Etiologies of hemoptysis G- Choice of catheters, the role of guiding catheter for pulmonary artery occlusion H- Choice of embolization materials and medical devices I- Results of endovascular treatment of hemoptysis J- Management of the failure and recurrences

## SUMMARY



Hemoptysis could be a life threatening condition. The endovascular is admitted as a first line treatment. Recently, the MDCTA has improved the management of these patients by several approaches. The impact of MDCTA is effective for the localisation, the aetiology, and the demonstration of the systemic arteries' network. The major impact of the MDCTA was the diagnosis of the pulmonary artery involvement in the hemoptysis. For the localisation of the bleeding site, MDCTA and Bronchoscopy are complementary. The endovascular treatment of hemoptysis stays a challenge for the interventional radiologist. Currently, the use of microcatheter and the large choice of embolisations devices (particles, coils, liquid, vascular plugg, and stent graft), the field of treatment has not any contra-indication. The mechanisms and the management of recurrences are variable and depend of the time of occurrence after the embolisation's session.

## Approach for the Diagnosis and Endovascular Management of the Lower Limb Varicosities, How, Why and When?

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### LL-VIE2992

**Ahmed A Bessar** , MBCh, MSc  
**Ayman Salem**

#### PURPOSE/AIM

We discuss here the different techniques for endovascular management of lower extremity dilated varicosities with the focus on the major and essential role of the interventional radiologist in the procedure from diagnosis to the management and follow up.

#### CONTENT ORGANIZATION

A series of more than two hundred cases underwent radiofrequency ablation of great saphenous vein combined with foam injection of associated incompetent perforators by means of ultrasound guidance. Here we explain the whole technique and sequence of its events, radiofrequency is performed for the whole great saphenous vein in cases where there is grade II incompetent saphenofemoral junction, with aid of a spinal or epidural anaesthesia. Foam injection was done selectively in the perforators displayed more than 3 mm diameters in ultrasound in standing position with retrograde flow on valsalva.

#### SUMMARY

The authors had noticed that the whole technique can be done efficiently by a physician who is able to do ultrasound guided interventions and gained experience in vascular ultrasound, but the decision making was a dilemma needs much more experience in the fields of vascular surgery, angiology, vascular radiology and cosmology, so multidisciplinary approach is mandatory for every case in order to gain better results

## Informed Consent in Interventional Radiology: A Multimedia Education Tool for Radiology Residents

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### LL-VIE2993

**John P Gonzales** , MD  
**Michael Chung** , MD  
**James E Silberzweig** , MD

#### PURPOSE/AIM

The purpose of the exhibit is:

1. To illustrate the basic principles of informed consent, as they pertain to the interventional radiology setting.
2. To demonstrate how an educational tool, utilizing voice recording and video in a slideshow format, can teach radiology residents how to best acquire informed consent prior to interventional procedures.
3. To discuss our institutions success in utilizing this multimedia tool.

#### CONTENT ORGANIZATION

Principles of informed consent

Informed consent in the interventional radiology setting

Multimedia educational tool for radiology residents utilizing video and voice recording in slideshow format

◆ Pretest

◆ Nuts-and-bolts of obtaining informed consent

◆ Clinical scenarios in interventional radiology

◆ Post-test

Our experience utilizing the multimedia tool

◆ Resident pre- and post-test data

◆ Subjective feedback from radiology residents and attending physicians

#### SUMMARY

The major teaching points of the exhibit are:

1. How informed consent is obtained should be handled on a case-by-case basis.
2. Radiology residents can learn how best to obtain informed consent by utilizing a multimedia educational tool, which leads to improved resident competence and confidence when discussing procedures with patients.

## Rational Use of Fresh Frozen Plasma (FFP) in Interventional Radiology Practice

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### LL-VIE2994

**Sandeep T Laroia** , MD  
**Archana T Laroia** , MD

#### PURPOSE/AIM

Recent audits of clinical use of FFP have revealed that 45-47% of FFP transfusions are inappropriate. Most commonly the driving factor for the use of FFP is abnormal laboratory coagulation defects, in the setting of liver dysfunction. A complete understanding of the coagulation tests and the clinical implications are a must for limiting the inappropriate use of FFP

#### CONTENT ORGANIZATION

A detailed, well-illustrated description of the coagulation cascade and the central role of liver hemostasis will be discussed. Various coagulation tests including the traditionally used International Standardized Ratio (INR) and more clinically relevant Thromboelastography (TEG) will be discussed. Clinical interpretation of TEG will be discussed. Potential adverse effects of FFP, including transfusion related acute lung injury (TRALI) will be explained.

#### SUMMARY

An evidence based plan for the rational use of FFP in interventional practice will be proposed to limit the inappropriate use of FFP. This will also be of relevance to health administrators for adequate resource utilization.

## Overcoming Poor Popliteal Vein Inflow during Catheter Directed Thrombolysis for Lower Extremity Deep Vein Thrombosis

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### LL-VIE2995

**Akhilesh K Sista** , MD  
**Ronald S Winokur** , MD  
**Bradley B Pua** , MD \*  
**David W Trost** , MD  
**David C Madoff** , MD

#### PURPOSE/AIM

A deep vein thrombus that includes the popliteal vein presents a significant challenge to the interventionalist. While this occurs frequently, relatively little has been published on this subject, even though establishing inflow from the popliteal vein is essential to procedural success. Here, we review the various techniques that can be used to remove thrombus from an occluded popliteal vein to maximize inflow into the proximal lower extremity deep veins.

#### CONTENT ORGANIZATION

I. Anatomic review of the femoropopliteal segment and the popliteal vein trifurcation II. Diagnosing the degree of popliteal involvement on ultrasound III. Access options and their relative strengths and drawbacks - popliteal vein - calf vein - posterior tibial vein - greater saphenous vein III. Techniques to remove thrombus once access is achieved - pharmacomechanical thrombolysis (Trellis or AngioJet) - Balloon maceration - tPA pulse infusion via occlusion balloon - infusion catheter placement IV. Imaging follow-up V. Special considerations: chronic components, isolated popliteal vein thrombosis

#### SUMMARY

Several techniques can be used to establish flow in a thrombosed popliteal vein to allow inflow into the more proximal deep venous system. After viewing this exhibit, the practitioner will know at least 4 different approaches to clear thrombus from the popliteal vein.

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### Irreversible Electroporation - Expanding Interventional Therapy to Locally Advanced Pancreatic Adenocarcinoma

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#### LL-VIE2996

**Saravanan K Krishnamoorthy** , MD

**John Chabot** , MD

**Joshua L Weintraub** , MD \*

#### PURPOSE/AIM

Pancreatic adenocarcinoma is the fourth leading cause of death in the US. Unfortunately, as much as 40% of patients present with locally advanced disease that may preclude surgery. Irreversible electroporation (IRE) employs short, high voltage pulses into tissues to permanently induce permeability through cell membranes. This exhibit will highlight the multidisciplinary team involved in IRE of the pancreas, including preoperative imaging, standardized reporting, IRE technique, and existing data of IRE for pancreatic adenocarcinoma.

#### CONTENT ORGANIZATION

1. Examples of locally advanced pancreatic adenocarcinoma on MRI and FDG-PET. 2. Depiction of the IRE technique. 3. Published data. 4.

Future steps.

#### SUMMARY

IRE of the pancreas offers the potential for a safe effective therapy for locally advanced pancreatic adenocarcinoma. This exhibit will review a method for high quality MRI of the pancreas, a template for standardized reporting, the IRE technique, and existing data on IRE. Armed with this knowledge, the Radiologist will understand how to be part of the multidisciplinary Pancreas Team.

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### Percutaneous Irreversible Electroporation: Do We Really Need Another Ablation Technique?

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#### LL-VIE2997

**Seyed Amin Astani** , MD, MBA

**Kevin McGill** , MD, MPH

**Scott E Schwartz** , MD

#### PURPOSE/AIM

1. To understand the mechanism of irreversible electroporation (IRE)
2. To learn the advantages and challenges specific to this technique.
3. To compare use of IRE with more traditional thermal ablation techniques.
4. To demonstrate the effectiveness of IRE in the appropriate clinical setting.

#### CONTENT ORGANIZATION

1. Mechanism of IRE
2. Patient selection
3. Procedure planning/Electrode placement/Imaging modality
4. Potential complications
5. Post-procedure surveillance
6. Conclusion

#### SUMMARY

Irreversible electroporation (IRE) is a contemporary modality of non-thermal percutaneous tumor ablation that is gaining increasing recognition as a tool for treating soft tissue tumors. Its novel mechanism of action, using high voltage currents to increase membrane permeability, has expanded the use of percutaneous ablation. With proper patient selection, and pre-procedure planning, IRE is a safe and potent option, with both unique advantages as well as potential challenges compared to traditional percutaneous thermal ablation.

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### Budd-Chiari Syndrome: Imaging Findings and Interventional Radiologic Procedures

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#### LL-VIE2998

**Shivanand R Gamanagatti** , MBBS, MD

**Subrat K Acharya** , MD

**Arun K Gupta** , MBBS, MD

**Shalimar** , MBBS, MD

**Saurav Kedia** , MBBS, MD

#### PURPOSE/AIM

1. To discuss etiologies and pathogenesis of syndrome
2. To illustrate various imaging findings in this syndrome
3. To discuss the role and techniques of interventional radiologic procedures.

#### CONTENT ORGANIZATION

Budd Chiari syndrome (BCS) is a collection of clinical disorders with the common aspect of hepatic venous outflow obstruction. Imaging as well as radiological interventional procedures plays important role in the management of these patients (In establishing diagnosis, in relieving the obstruction and follow up of these patients. Etiopathogenesis of syndrome Imaging findings on Colour Doppler, MDCT, MRI and Venography Technique of Interventional procedures performed for treatment of syndrome

- Balloon angioplasty/Stenting
- Thrombolysis
- Transjugular Intrahepatic Portosystemic Shunt

Procedure related complications Post procedure care and anticoagulation Follow up of patients treated by interventional procedures

#### SUMMARY

BCS group of patients have venous outflow obstruction leading to raised sinusoidal pressure, hepatic fibrosis and portal hypertension. Imaging plays important role in diagnosis, treatment planning and follow up after radiological intervention. Interventional procedures such as angioplasty/stenting, helps in relieving the congestion by providing a satisfactory bypass.

**LL-VIE2999**

**Kevin McGill** , MD, MPH  
**Seyed Amin Astani** , MD, MBA  
**Scott E Schwartz** , MD

**PURPOSE/AIM**

1. To review the mechanisms of microwave and radiofrequency ablation
2. To review the indications/contraindications for heat-based percutaneous ablation
3. To demonstrate the advantages and disadvantages of each technique
4. To compare the costs of percutaneous radiofrequency and microwave tumor ablation

**CONTENT ORGANIZATION**

Microwave ablation

- ◆ Mechanism of action
- ◆ Indications/contraindications
- ◆ Techniques
- ◆ Advantages/disadvantages
- ◆ Complications
- ◆ Efficacy
- ◆ Cost
- Radiofrequency ablation:
  - ◆ Mechanism of action
  - ◆ Indications/contraindications
  - ◆ Techniques
  - ◆ Advantages/disadvantages
  - ◆ Complications
  - ◆ Efficacy
  - ◆ Cost

**SUMMARY**

Two commonly used heat-based modalities of tumor ablation, radiofrequency and microwave ablation, have specific differences in techniques that interventionalists can utilize to provide precision tumor directed therapy. Studies demonstrate that microwave ablation is able to achieve larger ablation volumes, uses shorter ablation cycles, and is less susceptible to the heat sink effect. Although radiofrequency ablation has been more extensively evaluated in the scientific literature, neither technique has been proven to provide superior outcomes or cost effectiveness.

**Renal Denervation in End Stage Renal Disease Patients with Challenging Anatomy: Technical Aspects, Pitfalls and Preliminary Results**

**LL-VIE4000**

**Valerio Da Ros**  
**Giovanni Simonetti** , MD  
**Alessio Spinelli** , MD  
**Daniele Morosetti** , MD  
**Roberto Gandini** , MD, PhD  
**Silvia D'Onofrio**

**PURPOSE/AIM**

We describe our preliminary experience of Percutaneous Renal Denervation (PRD) in End Stage Renal Disease Patients with Resistant Hypertension (RH-ESRD) and challenging anatomy, assessing procedural feasibility, safety and efficacy.

**CONTENT ORGANIZATION**

Four RH-ESRD patients (mean Hemodialysis time 2.3 years) assuming at least four antihypertensive medications underwent PRD. Renal arteries eligibility includes absence of prior renal artery interventions, vessel stenosis All patients were successfully treated without any intra/post-procedural complications, showing 24-h Ambulatory Blood Pressure (AMBP) reduction at 12 months follow-up.

**SUMMARY**

PRD seems a feasible approach for ESRD-RH Patients with encouraging short term preliminary results in term of procedural efficacy and safety

**A Practical Guide to the Not-So-Normal Uterine Fibroid Embolization**

**LL-VIE4001**

**Anne Gill** , MD  
**Pardeep K Mittal** , MD  
**Emilio E Lopez** , MD  
**Courtney A Coursey** , MD \*  
**Gail L Peters** , MD

**PURPOSE/AIM**

- To review characteristic appearance of uterine fibroids on CT and MRI
- To describe indications/contraindications for uterine fibroid embolization (UFE)
- To delineate typical procedure and post-procedure course for UFE
- To demonstrate unusual findings encountered during UFE evaluation, performance, and post procedure follow-up
- To teach interventional techniques and strategies used to manage difficult patient presentations and challenging anatomy during UFE

**CONTENT ORGANIZATION**

- Pre-procedural imaging protocols for uterine fibroids
- Pictorial review of typical UFE
- Demonstrate unusual findings encountered during UFE including: aberrant uterine arteries, ovarian fibroid supply, and fibromuscular dysplasia
- Show examples of imaging presentations that preclude UFE
- Provide recommendations on how to proceed when unexpected findings are encountered during the evaluation or treatment periods
- Review expected and unexpected post UFE MRI imaging findings

**SUMMARY**

Uterine fibroid embolization began in 1995 and has come to be accepted as a safe and effective alternative to the surgical management of fibroids. The vast prevalence of fibroids mandates that atypical findings will inevitably be encountered; therefore, it is critical to be aware of the commonest of these and have a plan on how to proceed.

**Revisiting Recommendations for Central Venous Catheter Tip Position and Identification on Chest Radiograph**

## LL-VIE4002

**Zoe A Miller** , MD  
**Bradley B Pua** , MD \*  
**Daisy Q Huang** , MD  
**Ronald S Winokur** , MD  
**Akhilesh K Sista** , MD  
**David C Madoff** , MD

### PURPOSE/AIM

1. Review the recommendations by authorities for central venous catheter tip position and its basis. 2. Review complications of leaving catheter tips in various upper extremity locations. 3. Review current literature surrounding accurate location of the cavoatrial junction on a chest radiograph and its implications.

### CONTENT ORGANIZATION

Controversy surrounds the best location for central venous catheter tip position stemming from balancing optimal function while limiting catheter complications. This exhibit explores the opinions put forth by organizations like the FDA, SIR, the National Kidney Foundation and various nursing societies with a review of literature supporting or refuting each recommendation. The second aim of this exhibit focuses on determination of the position of central venous catheter tips as determined on chest radiography. This exhibit reviews the current literature on how to determine the location of the cavoatrial junction which includes correlation with cross-sectional imaging.

### SUMMARY

Upon review of this exhibit, viewers will obtain an understanding of the basis of various organization recommendations on optimal catheter tip position for central catheters. Viewers will be able to identify the cavoatrial junction on chest radiograph as validated by studies which correlate its location with cross-sectional imaging.

## Liver-directed Therapies for Neuroendocrine Tumor Metastases: Techniques and Follow-up Guidelines

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## LL-VIE4003

**Jordan Castle** , MD  
**Tanakorn Songrug** , MD  
**Joshua D Dowell** , MD, PhD

### PURPOSE/AIM

### CONTENT ORGANIZATION

### SUMMARY

## Tips and Tricks for the Use of Ethylene Vinyl Alcohol Copolymer (Onyx) in Peripheral Vessels

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## LL-VIE4004

**Mohammad A Saeed Kilani** , MD  
**Jean Izaaryene** , MBBCh  
**Guillaume Louis** , MD  
**Jean-Yves Gaubert** , MD  
**Jean-Michel Bartoli** , MD  
**Vincent Vidal** , MD

### PURPOSE/AIM

Onyx is a liquid embolic agent composed of ethylene vinyl alcohol copolymer dissolved in dimethyl sulfoxide. It was approved for embolization of cerebral and dural arteriovenous malformations. The aim of this work is to emphasize precautions and measures to be considered before and during use of Onyx in peripheral vessels in order to avoid potential complications and toxicity that may result from its use.

### CONTENT ORGANIZATION

- I. Introduction: Chemical and physical characteristics of EVOH (Onyx)
- II. When to use Onyx in peripheral vessels
- III. Preparation for use of Onyx
- IV. Precautions to be taken during Onyx injection
- V. Examples of complications related to mishandling of Onyx

### SUMMARY

Onyx is a well-known liquid embolic agent in interventional neuroradiology procedures. Its unique physical and chemical properties may be of great help in many challenging situations in peripheral endovascular procedures. It is considered by some interventional radiologists as a complex embolic agent. Knowledge regarding handling precautions of this product is mandatory to prevent potential complications. This work aimed to summarize the features, indications and appropriate ways to deal with this promising embolic agent in non-neuroradiological applications.

## Radiological Interventions in Portal Hypertension

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## LL-VIE4005

**Shivanand R Gamanagatti** , MBBS, MD  
**Rajeshkumar Gupta** , MBBS, DMRD  
**Subrat K Acharya** , MD  
**Pramod Garg** , MBBS, MD  
**Arundeeep Arora**

### PURPOSE/AIM

1. To discuss the various interventions performed in patients with portal hypertension
2. To discuss the role of various imaging techniques that help in treatment planning and follow up after endovascular management.

### CONTENT ORGANIZATION

Interventions that reduce portal blood pressure:

- Transjugular intrahepatic portosystemic shunts (TIPS)
- Recanalization of hepatic venous outflow
- Recanalization of the occluded portal vein and its tributaries
- Embolization of arterioportal fistula
- Partial splenic embolization

Interventions to palliate symptoms related to portal hypertension (without altering the portal blood pressure):

- Percutaneous transhepatic variceal embolization
- Balloon retrograde obliteration of gastric varices (BRTO)

Imaging techniques: An imaging tour that helps in which procedure to use in a particular setting.

## SUMMARY

There are various interventional procedures that can be offered to patients with PHT. The choice of the procedure is based on the etiology of PHT, the symptoms, the clinical status, and the results of imaging studies. Most procedures now offer high success rates, good mid- and long-term results, and significantly less morbidity than the corresponding surgical procedures.

## How to Choose and Successfully Access an Arterial Puncture Site: Techniques and Tips

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### LL-VIE4006

**Elizabeth R Tang**, MD  
**Jordan V Lao**, MD  
**Ducksoo Kim**, MD

#### PURPOSE/AIM

Depending on the angiographic goal, the interventionalist may choose among a variety of potential arterial puncture sites. The purpose of this exhibit is to review the principles of selecting an appropriate arterial puncture site, to discuss the advantages and disadvantages of commonly accessed arterial puncture sites (e.g., common femoral, high brachial, radial, etc.), and to illustrate techniques and tips for successfully accessing these sites.

#### CONTENT ORGANIZATION

1. Overview of common arterial puncture sites 2. General principles to consider when selecting an appropriate site a. Vessel caliber b. Directionality of the vessel c. Other risks inherent to the access site/vessel 3. General techniques for obtaining arterial access a. Ultrasound-guided vs. by palpation b. Single vs. double wall technique 4. For each arterial puncture site: a. Anatomy/risks specific to the site b. Techniques specific to the site (e.g., patient positioning) c. Specific tips to consider for successfully accessing the site

#### SUMMARY

This exhibit will present principles and contributing factors to consider when selecting an appropriate arterial puncture site for angiography, as well as techniques and tips for successfully achieving arterial access at the common puncture sites.

## Inferior Vena Caval Mass Lesions: Radio-pathological Correlation

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### LL-VIE4007

**Karuna Agawane**  
**Monika S Bapat**, MBBS  
**Palak B Popat**, MBBS, MD  
**Jayashree R Jadhav**, MBBS, DMRD  
**Priya Hira**, MBBS, DMRD  
**Pradeep Vaideeswar**, MBBS, MD

#### PURPOSE/AIM

1. To describe the etiopathogenesis of inferior vena caval (IVC) involvement by intra- or extra-luminal masses, affecting the infrahepatic, retrohepatic and suprahepatic segments 2. To make an attempt to classify these lesions into neoplastic and non neoplastic lesions with characteristic computed tomographic (CT) features and pathological correlation

#### CONTENT ORGANIZATION

1. Etiopathogenesis of IVC mass lesions 2. Imaging findings on CT :

- Intraluminal hypodensity
- contrast enhancement
- expansion of the lumen
- long or short segment
- extent- longitudinal and horizontal
- neovascularity
- secondary effects 3. Radio-pathological correlation and classification

a. Neoplastic- Primary and secondary

b. Non neoplastic- bland thrombus- trauma, sepsis, coagulopathy, venous stasis, foreign bodies etc. 4. To differentiate from pseudolesions of IVC

#### SUMMARY

1. Characteristic CT imaging features and radio-pathological correlation to classify IVC masses into neoplastic and non- neoplastic pathologies 2. The broad spectrum imaging morphology of the IVC masses according to the etiology 3. CT is an optimum imaging technique, to diagnose IVC masses as well as to describe its extent longitudinally and circumferentially determining the surgical approach.

## Veins in Chains: A Review of Angiographic Findings in Budd-Chiari Syndrome and Its Role in Planning Endovascular Management

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### LL-VIE4008

**Ulhaas S Chakraborty**, MBBS  
**Yogesh S Thube**  
**Amit C Sahu**, MBBS  
**Bhavesh Popat**  
**Hemant Deshmukh**  
**Krantikumar R Rathod**, MBBS, MD

#### PURPOSE/AIM

1. To review the normal angiographic appearance of hepatic venous outflow.
2. To determine the level of occlusion of hepatic venous outflow and describe corresponding collateral pathways.
3. To describe role of conventional angiography in planning endovascular management.

#### CONTENT ORGANIZATION

1. Budd-Chiari syndrome is a devastating disease which involves obstruction of the hepatic venous drainage, at the level of the hepatic veins, or the inferior vena cava.
2. The level of occlusion determines collateralisation which impacts the clinical features. Angiography is the gold standard for demonstration of level of occlusion, and collateral pathways.
3. Angiography also helps plan the endovascular management of Budd-Chiari syndrome.

#### SUMMARY

Budd-Chiari syndrome involves abnormal occlusion of hepatic venous outflow secondary to a variety of causes leading to significant morbidity and mortality. It is classified depending on levels of obstruction and type of presentation. Conventional angiography is the gold standard in demonstration of level of obstruction and collaterals and helps plan endovascular management.

## An Image Rich Procedural Review of Balloon Occluded Retrograde Transvenous Obliteration (BRTO) of Gastric Varices

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### LL-VIE4009

**Debkumar Sarkar**, DO  
**Joshua S Chern**, DO  
**Anton Mahne**, MD

#### PURPOSE/AIM

To review the indications for performing balloon occluded retrograde transvenous obliteration (BRTO) of gastric varices and provide an image rich step by step by step review of the procedure with an emphasis on management of potential complications in the treatment of bleeding gastric varices.

#### CONTENT ORGANIZATION

A. Anatomy of portosystemic vasculature. B. Pathophysiology of bleeding esophageal and gastric varices. C. Rationale for BRTO as adjunct to TIPS or stand alone therapy for bleeding gastric varices. D. Clinical and Imaging findings. E. Step by step procedural review for performing BRTO. F. Review of catheters and embolization agents. G. Post procedural imaging results H. Complications and post treatment management.

#### SUMMARY

Balloon occluded retrograde transvenous obliteration is an effective therapy for managing bleeding gastric varices which have a higher mortality rate than esophageal varices. While TIPS is effective for bleeding esophageal varices by reducing portosystemic gradients, gastric varices remain at low portosystemic gradients and maintain high rates of rebleeding. BRTO can be performed in patients with poor liver function or hepatic encephalopathy. This exhibit provides a procedural review while including anatomic and technical considerations as well as techniques to prevent and treat complications.

### Endovascular Interventions in the Inframalleolar Arterial Vasculature: Pushing the Vistas in Critical Pedal Ischemia

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#### LL-VIE4010

**David Hu** , BS  
**Rajeev Suri** , MD  
**Jorge E Lopera** , MD \*  
**Ghazwan M Kroma** , MD  
**Andres E Garza-Berlanga** , MD

#### PURPOSE/AIM

1. Review imaging techniques (CTA, MRA, DSA) for the evaluation of the inframalleolar arterial vasculature 2. Highlight cross sectional imaging of inframalleolar vasculopathies ♦ diabetic vascular disease; vasculitidis; vascular malformations; embolic 3. Describe recanalization and occlusive vascular techniques and provide an evidence based review for the vascular management of inframalleolar vascular disease

#### CONTENT ORGANIZATION

1. Arterial anatomy of the pedal circulation 2. Imaging (CTA, MRA, DSA) evaluation of inframalleolar arterial vasculature 3. Imaging evaluation of inframalleolar vasculopathies ♦ diabetes; vasculitidis; vascular malformations; embolic occlusion 4. Recanalization techniques (laser, angioplasty, atherectomy, thrombolytics, vasodilators) for occlusive vasculopathies 5. Occlusive techniques (alcohol, NBCA, glue, coils) for high flow vasculopathies 6. Evidence based review of the endovascular management for inframalleolar vascular disease

#### SUMMARY

Pedal tissue follows an end organ physiology similar to that of myocardial tissue and should be managed with similar urgency. The aim of this exhibit is to highlight awareness of inframalleolar vascular imaging and interventions as being essential to improving amputation free survivals.

### Endovascular Management of Pulmonary Vascular Abnormalities

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#### LL-VIE4011

**Varun A Thakur**  
**Yogesh S Thube**  
**Kiran V Naiknaware**  
**Bhavesh Popat**  
**Hemant Deshmukh**  
**Krantikumar R Rathod** , MBBS, MD

#### PURPOSE/AIM

1. To review pulmonary vascular anatomy.  
2. To discuss the imaging features and endovascular management of pulmonary vascular abnormalities.

#### CONTENT ORGANIZATION

1) Knowledge of pulmonary vascular anatomy is essential to detect, locate and plan endovascular management of pulmonary vascular abnormalities.  
2) Brief description of various pulmonary vascular abnormalities.  
3) Diagnosis of various pulmonary vascular abnormalities on X-ray, CT scan, and DSA.  
4) Protocols and materials used in the endovascular management of pulmonary vascular abnormalities.

#### SUMMARY

Pulmonary vascular abnormalities like Pulmonary AVMs, Rasmussen Aneurysm, Pulmonary artery stenosis and Pulmonary AVFs are rare. However, when they occur, they maybe life threatening. Surgery has been the mainstay of treatment for a few of them since long. With the advent of Interventional Radiology, the management of these conditions has dramatically changed, thereby making it a safe, effective and organ sparing alternative with significant decrease in the morbidity and mortality.

### Three-Dimensional Ultrasound for Guiding Abdominal Interventions, Current Stage of Development and Limitations

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#### LL-VIE4012

**Hamid Reza Sadeghi Neshat** , MSc  
**Derek W Cool** , MD, PhD \*  
**Matthew Bastian-Jordan** , MBBS, BSc  
**Nirmal Kakani** , MD  
**Aaron Fenster** , PhD \*

#### PURPOSE/AIM

To outline available technologies, main advantages and limitations of three-dimensional ultrasound (3D US) imaging for guiding abdominal interventions, and to review current and potential applications of 3D US in practice.

#### CONTENT ORGANIZATION

Development of 3D US has been active for more than two decades. Currently, 3D and tracked 2D ultrasound imaging technology is available on newer US machines or through external tracking equipment. However, its use in guiding interventional procedures is not widespread. In this presentation, we review available technologies to construct and visualize 3D US images. Each technology will be presented along with its advantages and limitations focusing on abdominal interventions. We present examples from our experience indicating the role of 3D US imaging compared to other modalities in planning and guiding a number of routine clinical and investigational procedures including image-guided biopsies and percutaneous tumor ablation in liver and kidneys.

#### SUMMARY

Ultrasound remains the main real-time modality to guide abdominal interventions. 3D US imaging possible through different technologies is growing and shown to be increasingly important. Understanding available technologies as well as their advantages and disadvantages can help to select the most efficient tool in current and future applications.

**LL-VIE4012**

**Hamid Reza Sadeghi Neshat** , MSc  
**Derek W Cool** , MD, PhD \*  
**Matthew Bastian-Jordan** , MBBS, BSc  
**Nirmal Kakani** , MD  
**Aaron Fenster** , PhD \*

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Ultrasound remains the main real-time modality to guide abdominal interventions. 3D US imaging possible through different technologies is growing and shown to be increasingly important. Understanding available technologies as well as their advantages and disadvantages can help to select the most efficient tool in current and future applications.

**Three-Dimensional Ultrasound for Guiding Abdominal Interventions, Current Stage of Development and Limitations****LL-VIE4012**

**Hamid Reza Sadeghi Neshat** , MSc  
**Derek W Cool** , MD, PhD \*  
**Matthew Bastian-Jordan** , MBBS, BSc  
**Nirmal Kakani** , MD  
**Aaron Fenster** , PhD \*

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**SUMMARY**

Ultrasound remains the main real-time modality to guide abdominal interventions. 3D US imaging possible through different technologies is growing and shown to be increasingly important. Understanding available technologies as well as their advantages and disadvantages can help to select the most efficient tool in current and future applications.

**A Survey of the Devices Used for Pharmacomechanical Thrombolysis in the Setting of Acute Deep Venous Thrombosis****LL-VIE4013**

**Sirish Kishore** , MD  
**Akhilesh K Sista** , MD  
**Bradley B Pua** , MD \*  
**Zoe A Miller** , MD  
**Ronald S Winokur** , MD  
**David C Madoff** , MD

**PURPOSE/AIM**

Pharmacomechanical catheter directed thrombolysis (PCDT) is an effective treatment for deep venous thrombosis. With the advent of this technique, a variety of innovative devices for mechanical thrombectomy have been designed. This exhibit will explore their relative strengths and limitations, their imaging appearances, and the unique complications of each.

**CONTENT ORGANIZATION**

We will review the use of percutaneous mechanical thrombectomy devices in the treatment of venous thrombosis. Current devices may be categorized as rotational, rheolytic, or ultrasound-enhanced. We will review the indications, mechanism of action, imaging findings, and strengths, limitations, and caveats of the AngioJet, Trellis, Trerotola, Cleaner, and Endowave devices.

**SUMMARY**

Catheter directed thrombolysis with percutaneous mechanical thrombectomy is an effective treatment for acute venous thrombolysis. After reviewing this exhibit, the viewer will have a better understanding of the devices used in modern PCDT.

**To Retrieve, or Not to Retrieve: Improving Patient Care and Management Following Optional IVC Filter Placement****LL-VIE4014**

**Summit Shah** , MD  
**Kyle J Cooper** , MD  
**Gregory E Guy** , MD  
**Joshua D Dowell** , MD, PhD

**PURPOSE/AIM**

Increased utilization of optional inferior vena cava filters (IVCFs) for temporary indications and associated long-term adverse events has prompted strategies to improve IVCF retrieval rates. This exhibit aims to provide an updated summary on optional IVCFs and present novel strategies to optimize patient care and improve IVCF retrieval rates.

**CONTENT ORGANIZATION**

1. Review the current literature on optional IVCFs, including filter types, placement and retrieval indications, and potential long-term complications. 2. Review data on optional IVCF placement, retrieval rates and long-term care. 3. Present novel strategies to improve retrieval rates and patient management, including pre-procedural filter selection, patient and physician communication and education, discharge planning, and IVCF clinic implementation and structure. 4. Present data on the implementation and effects of these strategies on retrieval rates at our institution.

**SUMMARY**

1. Knowing the indications for optional IVCFs and potential long-term complications is essential for patient care. 2. Understanding patient

management strategies and steps toward their implementation post IVCF placement is important for improved outcomes. 3. Active radiologist participation in a patient's post-procedural management may positively impact IVCF retrieval rates and practice building.

## Emergency Radiology (Imaging Chest Emergencies)

Sunday, 10:45 AM - 12:15 PM • N228

ER CT VA CH

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SSA05 • AMA PRA Category 1 Credit™:1.5 • ARRT Category A+ Credit:1.5

Moderator

Sanjeev Bhalla, MD

Moderator

Michael N Patlas, MD

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

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

#### PURPOSE

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

#### METHOD AND MATERIALS

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

#### RESULTS

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

#### CONCLUSION

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

#### CLINICAL RELEVANCE/APPLICATION

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

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

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

#### PURPOSE

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

#### METHOD AND MATERIALS

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

#### RESULTS

Within the post-contrast group, the readers were diagnostically accurate for IMH 72.8% of the time, as opposed to the combined pre- and post-contrast group, where they were accurate 76.8%. (p-value .340). (95% CI -2.2?8.8.) Since the difference between the 2 groups was statistically insignificant and it can be asserted with 95% confidence that no greater than 8.8% of cases of IMH would be missed with post-contrast imaging alone, post-contrast imaging alone was statistically non-inferior to combined pre- and post-contrast imaging. .

#### CONCLUSION

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

#### CLINICAL RELEVANCE/APPLICATION

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

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

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

#### PURPOSE

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



#### METHOD AND MATERIALS

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

#### RESULTS

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

#### CONCLUSION

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

#### CLINICAL RELEVANCE/APPLICATION

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

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

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

#### PURPOSE

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

#### METHOD AND MATERIALS

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

#### RESULTS

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

#### CONCLUSION

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

#### CLINICAL RELEVANCE/APPLICATION

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

### **SSA05-05 • Usefulness of Ultra Low-dose (sub mSv) Chest CT Using iDose4 Iterative Reconstruction for Initial Evaluation of Sharp Fish-bone Esophageal Foreign Body**

**Boram Yi MD (Presenter) ; Joo Sung Sun MD ; Young Gi Min MD ; Kyung Joo Park MD**

#### PURPOSE

To evaluate the usefulness of ultra low dose chest CT (uLDCT) as initial imaging study for sharp fish-bone esophageal foreign body (EFB).

#### METHOD AND MATERIALS

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

#### RESULTS

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

#### CONCLUSION

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

#### CLINICAL RELEVANCE/APPLICATION

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

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

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

#### PURPOSE

To measure the rate of referral for radiological investigation of suspected acute Pulmonary Embolism (PE) and the incidence of PE

detected in these scans, in a large teaching hospital. To observe changes in these measurements over the recent decade.

#### METHOD AND MATERIALS

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

#### RESULTS

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

#### CONCLUSION

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

#### CLINICAL RELEVANCE/APPLICATION

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

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

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

#### PURPOSE

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

#### METHOD AND MATERIALS

A literature search was performed and data on the current use of CTPA in the diagnosis of PE was reviewed. A decision model was constructed for evaluating low and very low risk patients for PE with and without the use of CTPA. The costs and patient utilities for each outcome were plotted to determine the dominant strategy. Strategies are dominant if they have lower costs and better outcomes compared to other strategies based on quality adjusted life years (QALYs). Sensitivity analyses were performed to test the stability of the results over a wide range of clinically relevant values.

#### RESULTS

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

#### CONCLUSION

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

#### CLINICAL RELEVANCE/APPLICATION

Performing CTPA to rule out PE in low and very low risk ED patients increases medical costs and increases patient risk, worsening patient outcomes.

### **SSA05-08 • Variation in Utilization and Positivity Rates of CTPA among Emergency Physicians at an Academic Tertiary Emergency Department**

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

#### PURPOSE

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

#### METHOD AND MATERIALS

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

#### RESULTS

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

#### CONCLUSION

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

#### CLINICAL RELEVANCE/APPLICATION

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

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

**PURPOSE**

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

**METHOD AND MATERIALS**

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

**RESULTS**

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

**CONCLUSION**

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

**CLINICAL RELEVANCE/APPLICATION**

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

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**Vascular/Interventional (Embolotherapy/Guidance Technology)**

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**Sunday, 10:45 AM - 12:15 PM • E350**

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**IR** **VA** **GI**

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**Moderator**

**Constantino S Pena , MD \***

**Moderator**

**Johannes Lammer , MD \***

**SSA23-01 • A Catheter to Curb your Appetite? A Novel Observation of Weight Loss Following Left Gastric Artery Embolization in Humans**

**Andrew J Gunn MD (Presenter) ; Elizabeth J Hamilton ; Rahmi Oklu MD, PhD**

**PURPOSE**

Suppressing serum levels of ghrelin, a neuropeptide with powerful appetite-stimulating effects produced in the gastric fundus, is an intriguing potential means of controlling body weight. Since left gastric artery, which preferentially supplies the gastric fundus, is sometimes embolized in interventional radiology procedures, we assessed post-procedural weight loss in patients after left gastric artery embolization.

**METHOD AND MATERIALS**

Retrospective analysis of electronic medical records of patients who underwent left gastric artery embolization for upper gastrointestinal (GI) bleeding were compared to age-matched controls of similar patients that had undergone embolization of an artery other than left gastric artery for upper GI bleeding. Patients were included in the analysis if they had a recorded weight within two weeks prior to the embolization and within three months after the procedure. Differences in post-procedural weight loss between the groups were evaluated by a student's t test.

**RESULTS**

Fifteen patients (mean age: 66.1 years) were included in the experimental group analysis while eighteen patients (mean age: 63.5 years) were included in the control group analysis. The mean pre- and post-procedural weights in the experimental group were 189.1 lbs and 174.5 lbs, respectively, representing a 7.9% decrease in body weight. The mean pre- and post-procedural weights in the control group were 164.7 lbs and 162.8 lbs, respectively, representing a 1.2% decrease in body weight. The post-procedural weight loss of the experimental group was significantly greater than that observed in the control group (P=0.001).

**CONCLUSION**

Patients lose significantly more weight after left gastric artery embolization than following embolization of other arteries for upper GI bleeding. The current data suggests that body weight can be potentially modulated via left gastric artery embolization in humans.

**CLINICAL RELEVANCE/APPLICATION**

Left gastric artery embolization results in weight loss in humans, which is a novel observation. These findings may lead to a role for the interventional radiologist in the treatment of obesity.

**SSA23-02 • Transarterial Embolization of Renal Artery Pseudoaneurysms Following Partial Nephrectomy**

**Nakul Gupta MD (Presenter) ; Anish A Patel ; Kamran Ahrar MD ; Judy U Ahrar MD ; Alda L Tam MD \* ; Michael J Wallace MD \* ; Sanjay Gupta MD**

**PURPOSE**

To describe the presentation, endovascular management, outcome, and effect on renal function of selective transarterial embolization of renal artery pseudoaneurysms and arteriovenous (AV) fistulae in patients following open or laparoscopic partial nephrectomy.

**METHOD AND MATERIALS**

The medical and imaging records of 25 patients who were referred for embolization of renal artery pseudoaneurysms or AV fistulae after partial nephrectomy were retrospectively reviewed for the following parameters: size and number of primary tumors, presenting symptoms, number and type of angiographic abnormalities, embolization technical details, outcome, and estimated glomerular filtration rates (eGFRs) prior to and at multiple time points following embolization.

**RESULTS**

24 patients had primary renal tumors, 1 patient had a pancreatic tumor directly invading the kidney. The median time between surgery and presentation was 11 days (range, 1 day to 502 days; mean, 38 days). Most patients (n=23; 92%) were symptomatic, presenting with gross hematuria, flank pain, or both. In 2 patients, pseudoaneurysms were found incidentally on follow up CT scans. Angiography revealed pseudoaneurysms with (n=5) or without (n=20) AV fistulae. 16 patients (64%) had multiple pseudoaneurysms, often involving

multiple segmental renal vessels. Selective embolization was performed with coils alone (n=20) or in combination with cyanoacrylate glue (n=5). Multiple vessels were embolized in 14 patients (56%). Cessation of bleeding was achieved after one (n=22) or two (n=3) embolization sessions in all patients. The median follow-up was 14 months. The mean eGFR values (in mL/min/1.73m<sup>2</sup>) prior to embolization, 2-7 days after embolization and at last follow-up were 59.2, 63.4, and 66.6, respectively. One patient had transient worsening of renal function 3 days after embolization.

#### CONCLUSION

Most patients with renal artery pseudoaneurysms after partial nephrectomy present in the immediate postoperative period with hematuria and/or flank pain. The majority of these patients show multiple pseudoaneurysms, often requiring selective embolization of multiple vessels. Transarterial embolization is a safe and effective treatment option with no long-term adverse effect on renal function.

#### CLINICAL RELEVANCE/APPLICATION

Transarterial embolization is a safe and effective treatment for renal artery pseudoaneurysms resulting from partial nephrectomy with no long-term adverse effect on renal function.

### SSA23-03 • Particle only Embolization vs. Particle Embolization with Additional Plug/Coil Embolization - Comparison of Future Liver Remnant Volume Gain

**Dominik Geisel MD ; Dirk Schnapauff MD ; Martin Stockmann MD ; Maciej Malinowski ; Timm Denecke MD ; Bernhard Gebauer MD (Presenter) \***

#### PURPOSE

To analyze volume gain of the future liver remnant (FLR) after right portal vein embolization (PVE) in patients who received particle only embolization compared to patients who received particle embolization with additional central plug and / or coil embolization.

#### METHOD AND MATERIALS

Patients who received PVE in our institution were retrospectively analyzed. Right PVE was performed either with particle only (PO) embolization or additional central plug and/or coil embolization (CP/C). All patients enrolled had a CT or MRI scan before PVE and before operation, which were used for volumetry of the future liver remnant (FLR).

#### RESULTS

Of 75 patients 40 had PO embolization and 35 additional CP/C embolization. Age, sex, tumor entities and time from PVE to preoperative imaging were comparable in both groups. Tumor entities included cholangiocarcinoma (n = 52), metastasis from colorectal cancer (n = 14), hepatocellular carcinoma (n = 2) and other entities (n = 7). FLR volume before PVE was 329 ± 121 ml in the PO group and 333 ± 135 ml in the CP/C group and 419 ± 135 ml respectively 492 ± 165 ml before operation. Average volume gain was significantly higher in the CP/C than in the PO group with 53.3 ± 34.5 % vs. 30.9 ± 28.8 % (p = 0.002).

#### CONCLUSION

Right portal vein embolization with additional central plug and/or coil embolization leads to a significantly higher gain in FLR volume than embolization with particles alone.

#### CLINICAL RELEVANCE/APPLICATION

Right portal vein embolization with additional central plug and/or coil embolization should be preferred over particle only embolization.

### SSA23-04 • Experimental Study of Selective Portal Vein Embolization for Nonalcoholic Steatohepatitis in Rabbit Model

**Sadao Hayashi MD (Presenter) ; Yasutaka Baba MD ; Shunichiro Ikeda BS ; Hiroaki Nagano ; Tetsuya Shinohara ; Michiyo Higashi PhD ; Ryoza Kamimura ; Toshihiro Nakazono ; Teruo Komokata ; Masayuki Nakajo PhD**

#### PURPOSE

Portal vein embolization (PVE) is now widely accepted as a useful preoperative procedure in selected patients undergoing extended hepatectomy. However, the influence of PVE on the liver parenchyma with steatohepatitis has not been fully elucidated. To evaluate the influence of PVE on the rabbit liver parenchyma with nonalcoholic steatohepatitis (NASH) compared with normal liver .

#### METHOD AND MATERIALS

Seventeen Male New Zealand rabbits were divided randomly into the normal control group (n=6) which was fed with a standard diet for 2 weeks and the NASH group (n=11) which was fed with a high-fat diet (standard diet+10%lard+2%cholesterol) for 8 weeks. Thereafter, PVE was performed for the left lobe of each group with 1ml absolute ethanol and micro coils. All procedure were performed successfully. Rabbits were sacrificed 2 weeks after the PVE. All hepatic specimens were examined by HE staining and immunohistochemical staining of heat shock protein 70 (HSP70). NASH stage, NASH grade and sinusoidal obstruction syndrome (SOS) score were evaluated used by HE staining. When less than 20% were stained, the specimen was considered as HSP expression negative.

#### RESULTS

Two of 11 NASH rabbits died of liver failure 2 days after PVE. The embolized lobe showed significantly higher NASH stage (p=0.43) and grade (p=0.009) and severer SOS score (p=0.03) in the NASH group than in the normal control group. HSP70 expression was significantly lower in the NASH embolized lobe than in the normal control embolized lobe (p=0.04).

#### CONCLUSION

The rabbit fed with the present high fat diet can be a NASH model. PVE induced severer sinusoidal obstruction damage in the embolized steatohepatitis lobe than in the embolized normal lobe. HSP70 induction in the embolized lobe was suppressed in the NASH model. These findings suggest that the same severe damage may occur in the embolized lobe and the risk of unexpected fatal liver damage cannot be excluded in the patients with NASH after PVE.

#### CLINICAL RELEVANCE/APPLICATION

PVE should be performed carefully even for the patients with NASH.

### SSA23-06 • Needle Interventions in a Phantom Model: Real-time 3D Fluoroscopy Guidance Using Cone-beam CT versus Conventional CT Guidance

**Noboru Maeda (Presenter) ; Keigo Osuga MD ; Masahisa Nakamura MD ; Kentaro Kishimoto ; Kaishu Tanaka ; Yusuke Ono ; Hiroki Higashihara MD ; Noriyuki Tomiyama MD, PhD**

#### PURPOSE

Cone-beam CT (CBCT) guided targeting system or XperGuide (Philips Medical Systems) is a real-time 3D needle navigation system on live fluoroscopy overlapped with CBCT image as a practical tool. The purpose of this study was to evaluate the accuracy and procedure time of this system compared to conventional CT guidance technique using a phantom model.

#### METHOD AND MATERIALS

A phantom was made of corn flour and clay that contained multiple 1cm kneaded erasers as targets. The target can be recognized at CBCT and CT images, but invisible under X-ray fluoroscopy. The needle path reaching the target was planned on CBCT or CT images of the phantom on 3D-workstation. Four interventional radiologists inserted a 19G 20cm needle to aim at separately five targets in different set angles under XperGuide or conventional CT guidance in one session. Each interventional radiologist performs needle interventions totally in two sessions under XperGuide and in two sessions under conventional CT guidance. To verify the accuracy of the puncture, the gap or distance between the needle tip and the center of the target was measured on CBCT or CT images obtained after each puncture. Procedure time was also measured.

#### RESULTS

All targets were successfully targeted with the first needle pass in all sessions using both techniques by four interventional radiologists. Mean distance from the surface puncture point to the target was 104±13 mm and 101±17 mm (p=0.54), mean gap was 1.88±0.83 and 4.06±1.22 mm (p

#### CONCLUSION

CBCT guided targeting system or XperGuide allows more accurate lesion targeting and quicker needle interventions in a phantom model compared to conventional CT guidance.

#### CLINICAL RELEVANCE/APPLICATION

CBCT guided targeting system or XperGuide allows accurate lesion targeting and quick needle interventions. This system will improve needle interventions.

### SSA23-07 • 3T MRI-guided Transperineal Targeted Prostate Biopsy Using a Robotic Needle Guidance Template

**Sang-Eun Song** ; **Kemal Tuncali MD** ; **Junichi Tokuda PhD** ; **Andriy Fedorov PhD** ; **Tobias Penzkofer MD \*** ; **Clare M Tempany-Afdhal MD** ; **Fiona M Fennessy MD, PhD** ; **Nobuhiko Hata PhD (Presenter) \***

#### PURPOSE

Conventional needle guidance templates used in MRI-guided targeted prostate biopsy have limited targeting accuracy, typically 5 mm intervals, and are prone to human error in selecting holes. To overcome such problems, we developed and tested a motorized needle guidance template (Smart Template) that allows automated targeting without restriction in a 3T MRI.

#### METHOD AND MATERIALS

Fifteen men with suspicion of prostate cancer underwent 3T wide-bore MRI-guided transperineal targeted prostate biopsy in the lithotomy position using Smart Template and 3D Slicer navigation software. Target lesions were preprocedurally identified on multi-parametric MRI (mpMR) by three radiologists. The targets were re-identified on intra-procedural MRI through registration. The navigation software provided the Smart Template's guidance position and needle placement depth for each target. Insertion was performed manually and if needed, the guidance position was adjusted to achieve a satisfactory needle placement confirmed by MRI.

#### RESULTS

All procedures were performed successfully without adverse events and tissue samples were collected from targeted lesions in all cases. 2 to 6 targets were selected per patient, and an average of 2.4 ± 0.9 tissue samples were obtained from each target. The mean procedural time was 122 ± 27 min including 55 ± 18 min of in-MRI preparation time, which is similar to that of using a conventional template. 10 of the 47 sampled targets were positive for malignant tissue (21.3%), resulting in prostate cancer diagnosis for 53.3% (N = 8) of the patients.

#### CONCLUSION

Smart Template has been successfully integrated into the procedural workflow of existing MRI-guided transperineal targeted prostate biopsy. The robotic needle guidance demonstrated unrestricted access to any part of the prostate gland volume without noticeable image degradation, complexity or significant prolongation of the procedural time.

#### CLINICAL RELEVANCE/APPLICATION

A robotic needle guidance template has been used for 3T MRI-guided transperineal targeted prostate biopsy to aid needle placement.

### SSA23-08 • Real Time Image Fusion with Contrast Enhanced CT, 18FDG-PET and US in Liver Percutaneous Ablations and Biopsies

**Giovanni Mauri MD (Presenter)** ; **Luca Cova MD** ; **Tania Tondolo** ; **Tiziana Ierace MD** ; **Enzo Di Mauro** ; **S. Nahum Goldberg MD \*** ; **Luigi Solbiati MD**

#### PURPOSE

To report our preliminary experience with real time image fusion between contrast enhanced CT, 18FDG-PET and US in liver percutaneous ablations and biopsies

#### METHOD AND MATERIALS

24 patients with liver lesions detectable only at 18FDG-PET underwent percutaneous ablation (10 patients) or biopsy (14 patients) guided by a novel image fusion system that combines real-time US with fusion to previously acquired and fused contrast enhanced CT and 18FDG-PET images based upon magnetic field tracking and computer reconstruction of the targeting path (Esaote, Genoa, Italy). 18FDG-PET/CT was performed at 24 hours to assess the technical efficacy of thermal ablations (i.e. absence of uptake). Histological results (i.e. adequacy of the sample) was used to assess the result of percutaneous biopsies.

#### RESULTS

In all cases it was possible to obtain correct fusion between contrast enhanced CT, 18FDG-PET and US and to perform the procedure as planned.

At 24 hours 8/10 (80%) treated lesions demonstrated absence of uptake at 18FDG-PET/CT, while two lesions demonstrated partial peripheral uptake, being considered correctly targeted but incompletely ablated. A diagnostic sample was obtained in 12/14 (86%) patients who underwent percutaneous biopsy guided with this technique. No major complications occurred.

#### CONCLUSION

Real time image fusion between contrast enhanced CT, 18FDG-PET and US is feasible and allow for a precise targeting of many tumors detectable only at 18FDG-PET.

#### CLINICAL RELEVANCE/APPLICATION

This method holds the potential for offering ablation and biopsy to additional patient populations.

### SSA23-09 • Development and Clinical Evaluation of a Three-dimensional Ultrasound System for Pre-operative Assessment and Guiding Percutaneous Treatment of Focal Liver Tumors

**Hamid Reza Sadeghi Neshat MSc (Presenter)** ; **Derek W Cool MD, PhD \*** ; **Jeffrey Bax BENG \*** ; **Kevin Barker** ; **Lori Gardi** ; **Nirmal Kakani MD** ; **Aaron Fenster PhD \***

#### CONCLUSION

Our 3D US system improves capabilities of conventional US by facilitating targeting of lesions identified in other modalities. Ongoing work includes automatic probe tracking and motion compensation.

#### Background

Image-guided percutaneous ablation is a standard treatment for focal liver tumors deemed inoperable and to maintain eligibility for patients on transplant waitlists. Radiofrequency (RFA), microwave (MWA) and cryo-ablation technologies are all delivered via a needle-shaped probe inserted directly into the tumor. Planning is mostly based on contrast CT/MRI. While intra-procedural CT (iCT) is commonly used to confirm the intended probe placement, 2D ultrasound (US) remains the main imaging modality for needle guidance, and in some centers is the only modality used. Correlation of the intraoperative 2D US with iCT or pre-operative imaging is essential for accurate needle placement, however, correspondence can be challenging given the limited field-of-view (FOV) in 2D US. We have developed a passive tracking arm with motorized scan-head and software tools to improve guiding capabilities of conventional US by large FOV 3D US scans that can be overlaid and compared to planning and iCT.

#### Evaluation

The developed scanner was tested on phantoms to confirm accuracy of 3D measurements and probe localization as compared to CT. For phase 1 clinical evaluation (IRB approved), a total of 17 tumors (1.0-4.5cm) were treated using 1-3 RFA or MWA probes without

re-intervention in 14 cases. Contrast CT prior to ablation (for tumor measurements) and iCT after each probe insertion (for localization measurements) were acquired. Each CT was followed by a 3D US for comparison. 3D US and CT measurements corresponded well with tumor volume, angle and distance between probes differing by  $7.7 \pm 4.5\%$ ,  $4.2 \pm 3.2\%$  and  $2.1 \pm 1.3\text{mm}$  respectively.

#### Discussion

Mechanically tracked 3D US provided comparable measurement results to CT in a single scan (3-8 seconds). The main limitation is for US occult tumors. In such cases, fusion of the US with the planning CT can be used to provide an insertion roadmap. 3D US facilitates co-registration by providing more structures visible in both modalities (e.g. vessels, surfaces) and tracker coordinates.

## Vascular/Interventional (Portal Interventions/TIPS)

Sunday, 10:45 AM - 12:15 PM • E352



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**SSA24** • AMA PRA Category 1 Credit™:1.5 • ARRT Category A+ Credit:1.5

#### Moderator

**Wael E Saad**, MBBCh \*

#### Moderator

**Thomas-Evangelos G Vrachliotis**, MD, PhD

### SSA24-01 • Portal Vein Thrombosis after Tips with the Viatorr Stent Graft: Imaging Frequency and Correlation with Site of Puncture

**Jorge E Lopera** MD (Presenter) \* ; **Venkata S Katabathina** MD ; **Martin Goros** ; **Brian T Bosworth** MD ; **Deepak Garg** MBBS, MD ; **Ghazwan M Kroma** MD ; **Andres Garza** ; **Rajeev Suri** MD

#### PURPOSE

To study the incidence of portal vein thrombosis (PVT) after elective Tips using the Viatorr stent graft and determine if there is any potential relationship between the puncture site and development of PVT.

#### METHOD AND MATERIALS

A retrospective review of medical records of patients that underwent elective Tips with the Viatorr stent graft was performed. Contrast enhanced cross sectional imaging studies, performed within 1 year after Tips were evaluated for PVT. The puncture site for Tips was determined in direct portograms and classified as central or peripheral. Any potential relationship between the puncture site and the presence of PVT was determined.

#### RESULTS

Elective Tips with the Viatorr was performed in 48 patients (ages 28-70 mean 54 ). Follow-up imaging demonstrated that the presence of branch PVT was very frequent (38/48, 79%), and affected the right anterior (n=6), right posterior (n=25) or left (n=7) portal veins. There were no main portal vein thromboses. Central punctures in 12 patients were associated with PVT in 9 occasions. More peripheral punctures at the confluence of the right portal branches in 22 patients, or in a more peripheral right branch in 14 patients, were associated with segmental PVT in 17 and 12 patients, respectively. In only 1 patient there was a technical problem with stent placement. Overall there was no correlation between the puncture site and the presence of PVT ( Fisher Exact test  $p=0.1$  ).

#### CONCLUSION

Thrombosis of major portal vein branches is a very frequent imaging finding after elective Tips with the Viatorr stent graft. There was no correlation between the puncture site, central or peripheral , and the presence of PVT.

#### CLINICAL RELEVANCE/APPLICATION

Thrombosis of major portal vein branches is a frequent imaging finding after elective Tips with the Viatorr stent. However, there is not correlation between PVT and the site of puncture .

### SSA24-02 • The Outcome of Shunt Reduction after TIPS by the Parallel Technique: A Prospective Study

**Bart De Keyzer** MD (Presenter) ; **Frederik Nevens** MD, PhD ; **Sam Heye** MD ; **Johan Vaninbrouckx** MD ; **Chris Verslype** MD, PhD ; **David Cassiman** MD, PhD ; **Wim Laleman** ; **Geert Maleux** MD, PhD

#### PURPOSE

Transjugular intrahepatic portosystemic shunt (TIPS) placement became the standard treatment for a subcategory of patients with refractory ascites and variceal bleeding. It has the disadvantage of provoking chronic hepatic encephalopathy (HE) and, in some patients with limited liver function, TIPS-induced liver failure (LF). Reduction of the diameter of the TIPS stent is feasible by the parallel technique. However, the experience is still limited.

#### METHOD AND MATERIALS

TIPS reduction was performed by the placement of a 10 mm self-expanding stent along with a 5-6-7 mm balloon-expandable stent. After a learning group of 17 patients (Maleux G, JVIR 2007), 55 patients were included in this prospective study. Baseline characteristics included age, gender, cause of cirrhosis, MELD score, indication for TIPS, time interval between TIPS and reduction, and pressure gradient before and after reduction.

#### RESULTS

Patients with medical therapy resistant chronic HE: improvement of HE = 25/34 (74%), recurrence of initial indication = 9/34 (26%) and six month survival = 29/34 (85%). Patients with TIPS-induced liver failure: improvement 11/21 (52%) and survival 11/21 (52%), three of these patients received a liver transplantation.

#### CONCLUSION

Stent reductions with the parallel technique improved chronic hepatic encephalopathy in 74% of the patients and offered them a 6 months survival of 85%. In patients who developed TIPS-induced liver failure, 52% recovered and for this group, TIPS reduction can serve as a bridge to liver transplantation.

#### CLINICAL RELEVANCE/APPLICATION

TIPS-induced hepatic encephalopathy refractory to medical therapy can be improved by shunt reducing techniques in a majority of cases.

### SSA24-03 • Hepatic Infarction Following Transjugular Intrahepatic Portosystemic Shunt: An Analysis of Pathogenesis and Clinical Outcomes

**Fredrik J Balldin** MD (Presenter) ; **Jorge E Lopera** MD \* ; **Ryan R Scott** MD

#### PURPOSE

To assess clinical outcomes and examine potential factors leading to hepatic infarction following TIPSS .

#### METHOD AND MATERIALS

A retrospective review of all patients with follow-up cross sectional imaging after TIPSS was performed. The outcomes of patients with imaging findings suggestive of hepatic infarction were analyzed along with technical, demographic, and clinical data.

## RESULTS

Out of 62 total patients with cross-sectional imaging after TIPSS performed between 6/2008 and 4/2012, seven (5 males and two females, average age of 54.7 years old (range 44-66)) were identified with imaging (6 CT, 1MRI) suggestive of hepatic infarction. All patients received PTFE stent-grafts. Average pre-TIPSS MELD score was 13.2 (range 6-20) and average post-TIPSS MELD score was 21.2 (range 9-38). Four patients developed worsening liver failure, of which two died early and two received liver transplants. One died of complications related to recurrent upper GI bleeding, one survived with intermittent hepatic encephalopathy, and one patient was lost to follow-up shortly after the procedure. Follow-up imaging revealed 5 patients had thrombosis of right portal vein branches and two had right hepatic vein thrombosis.

## CONCLUSION

Hepatic infarction following TIPSS is a rare complication with high a mortality rate that may be associated with right portal vein and/or hepatic vein thrombosis.

## CLINICAL RELEVANCE/APPLICATION

Currently there are only case studies of hepatic infarction after TIPSS. This case series aims to examine causes of this potentially fatal complication while analyzing the outcomes in 7 patients.

### **SSA24-04 • Portal Vein Thrombosis after Elective TIPS. Incidence in Follow-up Imaging and Clinical Significance**

**Jorge E Lopera MD (Presenter) \* ; Venkata S Katabathina MD ; Brian T Bosworth MD ; Martin Goros ; Andres Garza ; Ghazwan M Kroma MD ; Rajeev Suri MD**

## PURPOSE

To study the incidence and clinical significance of portal vein thrombosis (PVT) in follow-up imaging after elective transjugular intrahepatic portosystemic shunt (TIPS).

## METHOD AND MATERIALS

A retrospective review of medical records of patients that underwent elective TIPS was conducted. Contrast enhanced cross sectional images, obtained within 1 year after TIPS, were compared with previous axial images (n=59) or direct portograms (n=3) in order to assess the patency of the main portal vein (PV) and its major branches. The branches analyzed were the right anterior (RAPV), right posterior (RPPV), left (LPV) and main (MPV) portal veins. The presence of associated parenchymal changes was also recorded. Any possible association between PVT and MELD score, and PVT and major adverse events after TIPS, was also studied.

## RESULTS

Sixty-two patients (15 female, 47 male, ages: 28-70, mean 54) were included in the study. Follow-up cross sectional images were obtained 1-346 days (mean 92 days) after TIPS. The incidence of PVT was 19 % for RAPV, 51% for the RPPV, 11% for the LPV and 1 % for the MPV. Combined thrombosis of two major branches was observed in 6 and three branches in 4 patients. Associated lobar parenchymal changes were lobar infarcts in 7 and heterogeneous contrast enhancement in 9 patients. The mean MELD score was 12.8 before and 16.8 one month after TIPS. Major adverse events within 6 months included hepatic encephalopathy requiring hospital admission in 18 and death in 8 patients. There was no significant correlation between PVT and the post-TIPS MELD score, or PVT and major adverse events after TIPS.

## CONCLUSION

Thrombosis of major branches of the PV is a very common imaging finding after elective TIPS that can be associated with parenchymal changes. In most patients, branch PVT has no clinical significance.

## CLINICAL RELEVANCE/APPLICATION

Thrombosis of major PV branches is a common imaging finding after elective TIPS. In most patients, branch PVT has no clinical significance.

### **SSA24-05 • Treating Portal Systemic Encephalopathy with Balloon-occluded Retrograde Transvenous Obliteration (BRTO) - A Road Less Travelled**

**Amar Mukund (Presenter) ; S. Rajesh MBBS, MD ; Ankur Arora MD, FRCR ; Shiv Sarin**

## PURPOSE

To evaluate the efficacy of BRTO using foam sclerotherapy in managing symptoms arising due to spontaneous large porto-systemic shunts.

## METHOD AND MATERIALS

20 sessions of BRTO was performed in 18 patients using sodium tetradecyl sulphate foam. All patients had cirrhosis along with history of recurrent hepatic encephalopathy requiring hospital admission. Porto-systemic communication in the form of gastro/lieno-renal shunt was present in all cases and seen on pre procedure computed tomography scans. Clinical and lab parameters including arterial ammonia level were evaluated before and after the procedure in all patients.

## RESULTS

Technical success was achieved in 18 of 20 sessions (90%). Complete obliteration of varices was seen in 15 of 18 patients (83%) and partial obliteration in remaining 3, on follow up imaging. Immediate clinical improvement of hepatic encephalopathy was observed in 16 of 18 patients (89%) with post procedure decrease in serum ammonia levels, two patients had delayed improvement. Post-procedure complication consisting either of ascites, septicemia with acute kidney injury or deranged liver function tests was encountered in 5 patients. All the patients were clinically and symptomatically better on discharge and up to a follow up of 18 months (one month and thereafter 3, 6, 12, 18 months).

## CONCLUSION

Our experience suggests portal systemic hepatic encephalopathy refractory to medical management can be effectively treated by BRTO.

## CLINICAL RELEVANCE/APPLICATION

This study shows that BRTO may be offered as an alternative treatment to patients having recurrent portal systemic encephalopathy refractory to medical management.

### **SSA24-06 • The Comparison of Balloon-occluded Retrograde Transvenous Obliteration for Gastric Varices Using Liquid and Foam Sclerosants**

**Jun Koizumi MD, PhD (Presenter) ; Tatsuya Sekiguchi ; Tamaki Ichikawa MD ; Chihiro Itou ; Takuya Hara MD ; Bertrand Janne d'Othee MD, MPH**

## PURPOSE

Liquid ethanolamine oleate which has been used traditionally for balloon-occluded retrograde transvenous obliteration (BRTO) of the gastric varices (GV) may cause severe complications including hemolysis, allergy, etc. if overdosed. Thus, we introduced foam sclerotherapy to reduce the dose and compared the safety and efficacy of BRTO using liquid and foam sclerosants.

## METHOD AND MATERIALS

Forty three patients with gastric varices were performed BRTO since October 2001. Of these, three patients were excluded because simultaneous TACE or PSE was performed. Twenty patients using liquid ethanolamine oleate with iodine contrast (EOI, Fig.1) before March 2005 and twenty patients using polidocanol foam (POF, Fig.2) after May 2005 were included in this study. The success rates, side effects and complication rates were compared among the two groups.

## RESULTS

Complete stasis of the gastric varices was obtained in all patients of both groups. Abdominal symptoms during BRTO were significantly (p 38.0) was also significantly (p

## CONCLUSION

Foam polidocanol provided less invasive BRTO than liquid ethanolamine oleate with comparative clinical success.

## CLINICAL RELEVANCE/APPLICATION

EOI which is traditionally used in BRTO may cause hemolysis and require haptoglobin. In the U.S. EOI is now replaced by foam sclerosant. This comparative study supports safer properties of foam.

### SSA24-07 • Clinical Efficacy of Portal Venous Stent Placement for Symptomatic Portal Hypertension Caused by Malignant Tumor Invasion

**Takaaki Hasegawa** (Presenter) ; **Haruyuki Takaki** MD ; **Atsuhiko Nakatsuka** MD ; **Junji Uraki** MD ; **Takashi Yamanaka** MD ; **Masashi Fujimori** MD ; **Hajime Sakuma** MD \* ; **Shuji Isaji** ; **Koichiro Yamakado** MD, PhD

## PURPOSE

To evaluate clinical outcomes of portal venous stent placement in patients with symptomatic portal hypertension caused by malignant tumor invasion.

## METHOD AND MATERIALS

From July 2005 to January 2013, eleven patients with portal venous stenosis or occlusion caused by bile duct cancer (n=6), pancreatic cancer (n=4), and nodal metastasis from colon cancer (n=1) underwent stent placement because of gastrointestinal bleeding (n=4), ascites (n=4), liver dysfunction (n=2), and hypersplenism (n=1). Stents were placed across the stenotic (n=7) or occluded (n=4) lesions after percutaneous transhepatic portography. Technical success, changes in portal venous pressure, symptoms, complications, stent patency, and survival were evaluated. Complications were evaluated by using Common Terminology Criteria for Adverse Events (CTCAE).

## RESULTS

Stent placement was technically successful in all patients (technical success rate: 100%, 11/11). The mean portal venous pressure gradient decreased from 12.6±4.8 mmHg (range, 5-20 mmHg) to 0.5±1.0 mmHg (range, 0-3 mmHg) (p

## CONCLUSION

Portal venous stent placement is feasible, safe, and effective technique to relieve symptomatic portal hypertension caused by malignant tumor invasion.

## CLINICAL RELEVANCE/APPLICATION

Portal venous stent placement is an effective treatment option for patients with portal hypertension caused by malignant tumor invasion.

### SSA24-08 • Metallic Stent Placement for the Treatment of Hepatic Venous Outflow Block after Living-Donor-Liver Transplantation

**Masashi Fujimori** MD (Presenter) ; **Shugo Mizuno** ; **Atsuhiko Nakatsuka** MD ; **Haruyuki Takaki** MD ; **Junji Uraki** MD ; **Takashi Yamanaka** MD ; **Takaaki Hasegawa** ; **Hajime Sakuma** MD \* ; **Shuji Isaji** ; **Koichiro Yamakado** MD, PhD

## PURPOSE

To retrospectively evaluate the clinical efficacy of metallic stent placement for the treatment of hepatic venous outflow block after living-donor-liver transplantation (LDLT).

## METHOD AND MATERIALS

This study was approved by our institutional review board, which waived the requirement for informed consent to use data for research purposes. From 2002 to 2012, 15 patients with a mean age of 51±30.8 years (range, 4-69 years) underwent stent placement for the treatment of outflow block 1-341 days after LDLT with a mean interval of 24±54.7 days. Venous stenosis with a pressure gradient of 10mmHg or more was found in the inferior vena cava in 7 patients, hepatic vein in 7 patients, and in both in 1 patient. Stents were percutaneously placed across stenosis. Technical success (pressure gradient < 3mmHg), complication, improvement in clinical manifestation, stent patency, and survival were evaluated.

## RESULTS

Technical success was achieved in all 15 patients (100%, 15/15). There was no death or major complications related to stent placement. The mean pressure gradient significantly decreased from 13±8mmHg (range, 10-24 mmHg) to 0.8±2mmHg (range, 0-2 mmHg) (p

## CONCLUSION

Stenting is a safe and useful treatment to resolve outflow block after LDLT and helps to improve prognosis of such patients.

## CLINICAL RELEVANCE/APPLICATION

Metallic stent placement is a safe and useful treatment to resolve hepatic venous outflow block after LDLT and helps to improve prognosis of such patients.

### SSA24-09 • Optimal Protocol of Scanning Mode in the Portal Vein Angiography with a Low-Concentration Contrast Medium

**Yan Liang** MMed ; **Zhiren Chen** MD (Presenter) ; **Dongbin Shi** ; **Yan Wang** ; **Bin Li** ; **Huizhi Cao** ; **Ying Tong**

## PURPOSE

To explore the optimal protocol of CT scanning mode in the portal vein angiography with a low-concentration contrast medium.

## METHOD AND MATERIALS

63 patients underwent enhanced urinary CT scan. All the patients were divided into 3 groups according to different body mass index (BMI). 21 patients of group A (BMI=22) received 80-100kVp CT scan, automatic exposure control (3D Auto mA) and pitch of 0.984. All the images were reconstructed with adaptive statistical iterative reconstruction algorithm. 14 patients of group B (BMI=26) received single-source dual-energy spectral CT (sDECT) scan at the pitch of 1.375. Monochromatic images were reconstructed and optimal keV with best contrast-to-noise (CNR) was calculated. Another 28 patients of group C with routine 120 kVp CT scan. Low concentration of iodixanol (270mg I/ml) was used in group A and B, and high concentration of iopamidol (370 mg I/ml) was adopted in group C. 70 ml of total amount of contrast was injected at 2.7ml/s. ROIs were placed on abdominal aorta, renal artery, superior mesenteric artery and portal vein. Signal-to-noise ratio (SNR) and CNR was calculated.

## RESULTS

In low-kVp Group, the CNR and SNR were (8.12±3.09) and (14.72±4.05) for trunk of portal vein, (6.59±2.13) and (13.40±4.68) for its left branch, and (7.24±2.19) and (13.56±4.99) for its right branch respectively. In sDECT Group, the CNR and SNR were (8.68±2.69) and (13.38±3.06) for trunk of portal vein, (9.31±2.88) and (13.58±3.21) for its left branch, and (9.53±2.66) and (13.72±3.03) for its right branch respectively. In 120kVp Group, the CNR and SNR were (6.68±3.41) and (13.13±4.36) for trunk of portal vein, (6.22±1.98) and (12.82±4.11) for its left branch, and (7.09±2.04) and (12.55±4.36) for its right branch respectively. The image quality was slightly higher in sDECT Group than routine 120kVp Group and low-kVp Group, but no significantly different was found in among three groups (P>0.05). Compared with that in 120kVp Group (7.23±1.53mGy), the radiation dose index was significantly lower in low-kVp Group (4.75±1.39 mGy) (P

## CONCLUSION

With a low-concentration contrast medium, the low-kVp and sDECT scanning mode is rationally via BMI without sacrificing image quality.

## CLINICAL RELEVANCE/APPLICATION

With low kVp and spectral CT imaging of low iodine concentration or 120kVp of moderate iodine concentration, higher intravascular enhancement can be achieved with good vessel display.





LL-VIS-SUA • AMA PRA Category 1 Credit™:0.5

Host

Thomas-Evangelos G Vrachliotis, MD, PhD

**LL-VIS-SU2A • Pancreatic Drainage 101 - Radiation Exposure: How Much and What Can We Do about It?****Justin M Owens MD (Presenter); Jessica Caraway MD; Michael C Gates MD; David R Wallace MD; Daniel V Do MD; Horacio R D'Agostino MD; Katherine S Crow MS**

## PURPOSE

Patients undergoing percutaneous drainage (PD) of pancreatic fluid collections (PFCs) experience multiple imaging studies using ionizing radiation. The purpose of this study is to evaluate radiation exposure during initial diagnosis, image-guided percutaneous drainage (IGPD), post-drainage monitoring/revision and follow up.

## METHOD AND MATERIALS

An IRB-approved, retrospective study was performed of 101 patients (73 male, 28 female; mean age 46.5 years) who underwent IGPD of PFCs from December 12, 2002 to July 17, 2012. Pancreatitis causes were alcoholism ( $n=41,40.2\%$ ), trauma ( $n=25,24.5\%$ ), gallstones ( $n=21,20.6\%$ ), hypertriglyceridemia ( $n=8,7.8\%$ ), drugs ( $n=1,1\%$ ) and unknown ( $n=6,5.9\%$ ). Imaging studies were categorized as diagnostic (pre-drainage), procedural (image-guidance), post-drainage (with drainage catheters) and follow up (catheters removed). All imaging studies were recorded per patient on a spreadsheet for radiation exposure analysis.

## RESULTS

The series included a total of 810 imaging studies: CT, 577 (71.2%); fluoroscopy, 229 (28.3%); US, 4 (0.5%). There were 156 diagnostic: CT, 154 (98.7%); US, 2 (1.3%); 176 procedural: CT, 26 (14.8%); fluoroscopy/US, 150 (85.2%); 393 post-drainage: CT, 314 (79.9%); fluoro, 79 (20.1%); 85 follow up: CT, 83 (97.6%); fluoro, 0; US, 2 (2.4%). Post-drainage imaging accounted for the highest radiation exposure; exposure was negligible in the follow up period.

## CONCLUSION

Our findings suggest pancreatitis patients undergoing IGPD of PFCs receive substantial radiation exposure. While the potential for long-term harm is ever present with any study that utilizes ionizing-radiation, this exposure risk is greatly outweighed by the benefit provided through minimally invasive management and the excellent resolution rate it achieves. Assertive post-drainage indication of CT and fluoroscopy may further decrease radiation exposure to these patients, thus improving the overall risk-to-benefit ratio.

## CLINICAL RELEVANCE/APPLICATION

The findings of this study serve to increase radiation exposure awareness of both clinicians and radiologists. By doing so, more strategic monitoring can be accomplished using optimized modalities.

**LL-VIS-SU3A • Contrast Enhanced Ultrasound for Early Assessment of Transarterial Chemoembolization of Hepatocellular Carcinoma using Drug Eluting Beads: Preliminary Safety and Efficacy****John R Eisenbrey PhD (Presenter); Colette Shaw MBBCh; Andrej Lyshchik MD; Daniel A Merton; Priscilla Machado MD; Laura Pino; Daniel B Brown MD\*; Flemming Forsberg PhD\***

## PURPOSE

To evaluate the safety and utility of contrast-enhanced ultrasound (CEUS) imaging for early efficacy assessment of transarterial chemoembolization (TACE) of hepatocellular carcinoma (HCC) using drug-eluting beads.

## METHOD AND MATERIALS

Following IRB approval, 9 patients with a total of 12 previously untreated tumors scheduled for TACE with 100-300  $\mu$ m doxorubicin-eluting beads underwent CEUS exams the morning prior to TACE, 1-2 weeks post TACE, and the morning prior to routine imaging follow-up (multiphase contrast enhanced MRI or CT 1 month post TACE) and CT/MR results were evaluated using mRECIST criteria. Ultrasound imaging was performed using a Sequoia 512 scanner with 4C probe (Siemens Medical Solutions, Mountain View, CA). Following baseline imaging, patients received a bolus injection of 0.6-0.7 ml of Definity (Lantheus Medical Imaging, N. Billerica, MA) followed by 10 ml saline flush and were imaged using Cadence Pulse Sequencing (Siemens). In patients with multiple tumors, injection was repeated. All imaging parameters were kept constant at follow-up. Microbubble enhancement pattern and size of the embolized area were compared to the reference imaging standard.

## RESULTS

One case of lower back pain and no other adverse events were reported over the 17 CEUS exams performed to date. All 12 tumors showed microbubble enhancement prior to treatment. One patient was excluded after being reassigned for alternative treatment. A total of 4 patients with 4 lesions have completed the study to date. CEUS findings at 1-2 weeks persisted on CEUS at one month post treatment (3 consistent non-enhancing / 1 consistent partially enhancing lesions; average change after treatment of non-enhancing area along longest diameter =  $2 \pm 1.8$  mm). In all 4 cases microbubble enhancement within the tumor (3 complete embolization, 1 partial response) correlated with the reference imaging standard.

## CONCLUSION

Preliminary results suggest that results of CEUS at 1-2 weeks post TACE correlate well with routine MRI or CT imaging performed 1 months post treatment. Therefore, treatment outcomes may potentially be evaluated earlier with CEUS.

## CLINICAL RELEVANCE/APPLICATION

CEUS may provide an earlier and safer means of drug eluting beads TACE treatment response evaluation.

**LL-VIS-SU4A • Portal Vein Thrombosis after Tips with the Viatorr Stent Graft: Imaging Frequency and Correlation with Site of Puncture****Jorge E Lopera MD (Presenter)\*; Venkata S Katabathina MD; Martin Goros; Brian T Bosworth MD; Deepak Garg MBBS, MD; Ghazwan M Kroma MD; Andres Garza; Rajeev Suri MD**

## PURPOSE

To study the incidence of portal vein thrombosis (PVT) after elective Tips using the Viatorr stent graft and determine if there is any potential relationship between the puncture site and development of PVT.

## METHOD AND MATERIALS

A retrospective review of medical records of patients that underwent elective Tips with the Viatorr stent graft was performed. Contrast enhanced cross sectional imaging studies, performed within 1 year after Tips were evaluated for PVT. The puncture site for Tips was determined in direct portograms and classified as central or peripheral. Any potential relationship between the puncture site and the presence of PVT was determined.

## RESULTS

Elective Tips with the Viatorr was performed in 48 patients (ages 28-70 mean 54 ). Follow-up imaging demonstrated that the presence of branch PVT was very frequent (38/48, 79%), and affected the right anterior (n=6), right posterior (n=25) or left (n=7) portal veins. There were no main portal vein thromboses. Central punctures in 12 patients were associated with PVT in 9 occasions. More peripheral punctures at the confluence of the right portal branches in 22 patients, or in a more peripheral right branch in 14 patients, were associated with segmental PVT in 17 and 12 patients, respectively. In only in 1 patient there was a technical problem with stent placement. Overall there was no correlation between the puncture site and the presence of PVT ( Fisher Exact test p=0.1) .

## CONCLUSION

Thrombosis of major portal vein branches is a very frequent imaging finding after elective Tips with the Viatorr stent graft. There was no correlation between the puncture site, central or peripheral , and the presence of PVT.

## CLINICAL RELEVANCE/APPLICATION

Thrombosis of major portal vein branches is a frequent imaging finding after elective Tips with the Viatorr stent. However, there is not correlation between PVT and the site of puncture .

## **LL-VIE-SU5A • Endovascular Abdominal Aortic Aneurysm Repair Made Simple: Patient and Device Selection, Technique, and Procedure Specific Complications**

**Yolanda Bryce MD (Presenter) ; Philip A Rogoff MD ; Donald F Romanelli MD ; Ralph L Reichle MD**

## PURPOSE/AIM

The purpose of this exhibit is: 1. To review the benefits of endovascular repair of abdominal aortic aneurysms. 2. To review available clinical assessment scoring systems for appropriate patient selection. 3. To review vascular anatomy and its severity scoring. 4. To review available prostheses and their appropriate usages including suprarenal and infrarenal fixation. 5. To review the appropriate technique including preprocedural imaging, the procedure, and post procedural imaging. 6. To review procedure specific complications.

## CONTENT ORGANIZATION

Benefits of endovascular repair of abdominal aortic aneurysms. Patient selection -Clinical assessment scoring -Vascular anatomy scoring Device selection Procedure technique -Preprocedural imaging -Ancillary procedures -Procedure technique -Postprocedural follow-up Procedure specific complications -Prosthesis thrombosis -Prosthesis migration -Type 1, 2, 3, 4, and 5 endoleaks -Aneurysm sac rupture.

## SUMMARY

The major points of the exhibit are: 1. The importance of preprocedural planning including appropriate patient and device selection. 2. The importance of appropriate technique. 3. The importance of the knowledge of and follow-up for procedure-specific complications.

## **LL-VIE-SU6A • The Radiographic Natural History of Aortic Dissection**

**Timothy Huber MD (Presenter) ; John F Angle MD \***

## PURPOSE

While there has been much written about the identification and management of aortic dissection, less work has been done examining the transition from normal aorta to dissection. This study investigates the natural history of aortic dissection, as it appears in medical imaging, to better understand the types of aortas that dissect, and the manner in which they do so.

## METHOD AND MATERIALS

The UVA clinical data repository and PACS were searched to identify adult patients with a history of aortic dissection who had imaging between 2003 and 2012. The clinical history and imaging were reviewed to identify patients who had undergone CTA of the aorta before and after dissection. These images were reviewed to identify the location of the dissection flap, and to compare the morphology and atheroma burden before and after dissection.

## RESULTS

The patients identified showed four patterns of progression. One group of patients, with underlying connective tissue disease, showed proximal dissection with a rapid time course. A second group consisted of patients with an underlying history of vascular disease. These patients demonstrated multiple large atheromas, one of which eventually dissected. In a third group, patients showed a progression from intramural hematoma to penetrating aortic ulcer to aortic dissection. The fourth group included younger patients with low atheroma burden. In these patients, a small plaque progressed rapidly to dissection.

## CONCLUSION

Aortic dissection remains difficult to predict, both in terms of which patients will dissect, and where they will dissect. After comparison of the imaging of aortas both before and after dissection, several patterns of progression to dissection were identified. One of these groups consisted of younger patients with little vascular calcification, who dissected rapidly. This may suggest a population of patients who are at risk for dissection, but present few clinically apparent risk factors. This study also demonstrates that there is not a single pattern of progression to dissection. Instead, there appear to be subtypes of dissection, each of which are predisposed to dissect in different locations, along different time courses.

## CLINICAL RELEVANCE/APPLICATION

There are several distinct patterns of progression to aortic dissection that each affect a unique patient population, one of which includes younger, healthier patients.

## **LL-VIE-SU7A • Simple and Easy to Implement Tips for Dramatic Dose Reduction in CT Guided Interventional Procedures: Breaking the One mSV Barrier!**

**Ramit Lamba MD ; Kunal Sidhar MD (Presenter) ; Puneet Bhargava MD ; Michael T Corwin MD ; Chandana G Lall MD**

## PURPOSE/AIM

1. Discuss and illustrate several simple and easy to implement strategies that will result in dramatic dose reduction for CT guided interventional procedures. 2. Illustrate how careful attention and meticulous planning can routinely result in a dose of less than 1mSv during CT guided interventional procedures.

## CONTENT ORGANIZATION

1. Overview of image guided procedures. 2. Appropriate choice of guidance modality. 3. Typical doses during CT guided interventional procedures. 4. Risks of cumulative and high radiation exposure over a limited territory. 5. Structure and challenges of a CT guided interventional procedure. 6. Strategies for decreasing dose at different steps of the procedure. 7. How to achieve consistent breath holds during the procedure. 8. Tips on accurate needle placement. 9. Illustrate use of a mobile app to measure the angle of the needle during placement. 10. Choosing the simplest factors for dose economy. 11. Utility and indications of post procedure scans. 12. Illustrate examples of procedures routinely performed at a dose of less than 1mSv.

## SUMMARY

After review of this exhibit, radiologists performing CT guided interventional procedures will be able to routinely implement 1) new techniques for accurate needle placement and 2) simple and easy to use dose reduction strategies into their practice.



**LL-VIS-SUB** • AMA PRA Category 1 Credit™:0.5

### **LL-VIS-SU1B • Optimizing Image Quality of Abdomen CT Venography by Model-based Iterative Reconstruction**

**Yuefeng Liu MD (Presenter) ; Hongzhi Cao MD**

#### **PURPOSE**

To explore the value of model-based iterative reconstruction (MBIR) in optimizing image quality of abdomen CT venography (CTV).

#### **METHOD AND MATERIALS**

Totally 27 consecutive patients were chosen and underwent plain and contrast-enhanced abdomen CT with automated tube current modulation (ACTM). The images were reconstructed with filtered back projection (FBP group), adaptive statistical iterative reconstruction (ASiR group) 50% and MBIR (MBIR group), respectively. Image noises and CT values of muscle, fat tissue, liver, kidney and spleen, as well as CNR for portal veins, inferior vena cava, pancreatic veins and splenic veins were measured. The image quality was evaluated using 5-point scale. Those results among the 3 different reconstructions were compared by one-way ANOVA and Wilcoxon signed-rank tests.

#### **RESULTS**

#### **CONCLUSION**

MBIR can improve the overall image quality and has potential in decreasing radiation dose of abdomen CTV.

#### **CLINICAL RELEVANCE/APPLICATION**

MBIR can improve the overall image quality and has potential in decreasing radiation dose of abdomen CTV.

### **LL-VIS-SU2B • Use of Ultrasound Doppler to Optimize the Table Speed of Lower Extremity CT Angiography Protocols**

**Lei Zhang MD (Presenter) ; Yanhui Yang MD ; Dong Xu ; Kuncheng Li MD**

#### **PURPOSE**

We evaluated the relative efficacy of different table speeds predetermined by using the flow velocity measured by ultrasound Doppler in patients with suspected peripheral arterial occlusive disease (PAOD) who underwent computed tomography angiography of the lower extremity arteries.

#### **METHOD AND MATERIALS**

This prospective study enrolled 40 patients with suspected PAOD. The average aorta-popliteal artery flow velocity was measured by ultrasound of average flow velocity of the suprarenal aorta, aortic bifurcation, common and external iliac arteries, common and superficial (proximal/middle/distal) femoral arteries, and the popliteal artery ((Vaorta+ Vaorta2+ VCCA+ VSFA1+ VSFA2+ VSFA3+ VPOPA)/ 7). The table speed was adjusted to be equivalent to the measured arterial flow velocity between the supraceliac aorta and popliteal artery. Adequate vascular opacification was measured for attenuation in the suprarenal and infrarenal abdominal aorta, and in the arteries of the lower extremities. Venous contamination was also measured. Twenty patients also underwent two monitoring scans at the level of the suprarenal aorta and popliteal artery separately to measure the aorta-popliteal bolus transit time and speed.

#### **RESULTS**

The flow velocity from ultrasound Doppler and two monitoring scans was similar. CT angiographic images were of good quality in 39 cases, whereas prominent enhancement of abdominal veins was observed in one case.

#### **CONCLUSION**

Aligning flow velocity measured by US Doppler and table speed allows adequate arterial opacification and minimal venous contamination.

#### **CLINICAL RELEVANCE/APPLICATION**

Aligning flow velocity measured by US Doppler and table speed allows adequate arterial opacification and minimal venous contamination.

### **LL-VIS-SU3B • Valproic Acid as an Imageable, Multifunctional Chemoablative Agent**

**John Valesano BS (Presenter) ; Erik N Cressman MD**

#### **PURPOSE**

To study the effects of valproic acid (VPA), a known inhibitor of histone deacetylase, in ex-vivo porcine hepatic tissue, to characterize it by imaging, and to compare it to acetic acid, a known ablative agent.

#### **METHOD AND MATERIALS**

VPA neat or diluted in diglyme and aqueous sodium valproate (NaVPA) solutions were prepared and injected into fresh ex vivo porcine hepatic tissue. Diglyme and acetic acid (50% and matching dilutions) served as controls. The imaging characteristics of the differing solutions were assessed by CT and MRI both in-vitro and ex-vivo. The amount of coagulation necrosis was noted using histology and gross pathology.

#### **RESULTS**

VPA was fully miscible in diglyme and both it and NaVPA caused clearly visible zones of coagulation. Lesions from pure VPA and dilutions of VPA in diglyme were visible on CT imaging as areas of low attenuation while those created by the other conditions were at best faintly detectable or functionally invisible on CT. No useful differences were noted in tissue at MRI. Grossly, the lesions created by pure valproic acid were larger than any of the lesions created by the varying dilutions of VPA in diglyme and similar in size to the equivalent amount of acetic acid. Histologically, VPA caused more hepatocellular shrinkage, increased nuclear damage, and larger areas of cell lysis than acetic acid. In-vitro studies revealed that pure VPA had a CT attenuation value of -139 Hounsfield Units (HU) while NaVPA was measured at 54 HU.

#### **CONCLUSION**

VPA and NaVPA are both capable of causing coagulation necrosis in hepatic tissue, and zones of coagulation from VPA are readily detectable in tissue using CT imaging without any added contrast agent. Given these findings and the intrinsic pharmacologic activity of VPA, further investigation seems warranted.

#### **CLINICAL RELEVANCE/APPLICATION**

Valproic acid is a chemoablative agent imageable by CT that may prove superior to current agents for the ablation of hepatocellular carcinoma due to its additional pharmacological benefits.

### **LL-VIS-SU4B • Coil Embolization of the Splenic Artery: Impact on Splenic Volume and Factors Contributing to Volume Preservation**

**Stephen R Preece MD (Presenter) ; Paul V Suhocki MD ; John Yoo ; Kingshuk Choudhury PhD ; Tony P Smith MD ; Charles Y Kim MD \***

#### **PURPOSE**

Splenic artery embolization can be performed as an alternative to splenectomy in the setting of splenic injury or splenic artery pathology. However, the impact on splenic function is not well understood. The purpose of this study is to determine the impact of coil embolization of the splenic artery on splenic volume based pre- and post-embolization CT imaging as well as hemofiltration function.

## METHOD AND MATERIALS

Splenic artery embolization was performed on 148 consecutive patients over an 8 year period for various indications in this IRB approved retrospective study. Sixty patients (36 males, mean age 49 years) had contrast-enhanced CT before and after coil embolization of the splenic artery. The mean time between embolization and last follow up CT was 355 days. Pre and post-embolization splenic volumes were calculated with volume rendering software. The presence of Howell-Jolly bodies was ascertained on lab tests.

## RESULTS

Splenic artery embolization resulted in a mean decrease in splenic volume by 15% (range -88% to +158%). Splenic volumes on CT scans performed within 30 days of embolization did not change significantly after embolization but after 30 days the mean percentage reduction was 21% (p=0.004). Embolization of the distal splenic artery resulted in a 30% splenic volume reduction (p=0.003) whereas splenic volumes did not change significantly after proximal embolization. Both traumatic and nontraumatic indications resulted in similar degree of volume loss, although pre-embolization splenic volumes were significantly smaller in trauma patients (p=0.029), and more trauma patients underwent distal embolization (p=0.005). Multivariate analysis revealed that only coil location significantly impacted splenic volume reduction. Three patients transiently had Howell-Jolly bodies after embolization. No patients required repeat embolization or splenectomy.

## CONCLUSION

Coil embolization of the main splenic artery results in only a modest degree of splenic volume loss with retention of hemofiltration function. These findings support the growing body of literature that some degree of splenic function is maintained after splenic artery embolization.

## CLINICAL RELEVANCE/APPLICATION

Splenic artery embolization for trauma and splenic artery pathology is likely preferable to splenectomy when feasible considering that at least some degree of splenic function is retained.

### **LL-VIE-SU5B • Classification of Peripheral Arterial Disease Lesions and Their Mimics: The Role of the Interventional Radiologist**

**Yolanda Bryce MD (Presenter) ; Philip A Rogoff MD ; Ralph L Reichle MD ; Donald F Romanelli MD**

#### PURPOSE/AIM

The purpose of this exhibit is: 1. To review the risk factors of peripheral arterial disease. 2. To review the Trans-Atlantic Inter-Society Consensus classification of peripheral arterial disease lesions in pictorial form and their potential treatments. 3. To review the mimics of peripheral arterial disease in pictorial form including arteritis, Buerger's disease, popliteal entrapment syndrome, popliteal adventitial disease, popliteal aneurysm, fibromuscular dysplasia, peripheral emboli, keys to distinguish them from peripheral arterial disease, and their potential treatments

#### CONTENT ORGANIZATION

1. Risk factors for peripheral arterial disease. 2. Transatlantic Inter-Society Consensus (TASC) classification of aortoiliac lesions and their potential treatments. 3. TASC classification of femoral popliteal lesions and their potential treatments. 4. TASC classification of infrapopliteal lesions and their potential treatments. 5. Mimics of peripheral arterial disease and their potential treatments.

#### SUMMARY

The major teaching points of this exhibit are: 1. TASC classification of peripheral arterial disease lesions and their potential treatments. 2. Mimics of peripheral arterial disease and their potential treatments including

### **LL-VIE-SU6B • A Review of Surgical Principles and Techniques for Interventional Radiologists**

**Kevin Ching MD (Presenter) ; Christopher J Friend MD ; Kevin M McCluskey MD**

#### PURPOSE/AIM

For the majority of radiologists, formal surgical training exists only from clerkships during medical school. As interventional radiology has evolved into the clinically focused specialty it has become today, a review of fundamental surgical principles and proper techniques is beneficial for all IR physicians and their patients.

#### CONTENT ORGANIZATION

1. Preoperative care: indications for pre-procedure antibiotics, skin preparation, and proper draping. 2. Physician safety: handling of needles and sharps. 3. Pain management: local, intravenous, and oral analgesics with a review of dosing, side effects, and contraindications for each. 4. Wound closure: absorbable vs. non-absorbable suture, cutting vs. tapered suture needles, and proper suturing techniques to minimize formation of scars. 5. Identifying and managing infected wounds: debridement, packing, and antibiotics. 6. When things go wrong: resuscitation, surgical airways, large bore chest tubes, and emergency interventions.

#### SUMMARY

Use of proper surgical technique and principles is critical for interventional radiologists in practice. Understanding these techniques allows the IR physician to play a more sophisticated role in patient care, improve patient safety, and potentially develop new minimally invasive therapies.

### **LL-VIE-SU7B • Interventional Options for Patients with Chronically Embedded IVC Filters and Occluded or Severely Stenotic Inferior Vena Cava and/or Iliac Veins**

**Akhilesh K Sista MD (Presenter) ; David W Trost MD ; Bradley B Pua MD \* ; Ronald S Winokur MD ; David C Madoff MD**

#### PURPOSE/AIM

IVC filters are commonly placed for various indications. In spite of the recent movement to retrieve filters at early time points post-placement, many remain in place for extended periods of times. In select patients, the filter causes marked caval fibrosis, narrowing, and sometimes occlusion that frequently extends into the iliac system. Here, we present several interventional techniques to remove chronically embedded filters and recanalize the IVC and iliac veins.

#### CONTENT ORGANIZATION

I. Indications for caval filtration II. Long-term complications of caval filtration III. Incidence/prevalence of caval stenosis or occlusion following placement IV. Clinical presentation of caval stenosis -- recurrent thrombosis, post-thrombotic syndrome V. Filter removal techniques VI. Iliocaval recanalization techniques VII. Complications and patient follow-up

#### SUMMARY

After viewing this exhibit, the viewer will have a better understanding of this grave late complication of IVC filter placement, as well as the interventional options to remove the filter and recanalize the stenosis or occlusion.

### **LL-VIE1271-SUB • Anatomy, Hemodynamic Classification, and Management of Duodenal Varices: A Hemodynamic Classification Based Approach**

**Wael E Saad MBBCh (Presenter) \* ; Stephen Caldwell MD**

#### PURPOSE/AIM

- To describe the clinical presentation and pathogenesis of duodenal varices (DV)
- To detail the varying anatomy, pathology and hemodynamics of DVs
- To introduce the newly published classification system

- To discuss the hemodynamic classification based approach to management
- To detail the technical procedures in the management of DVs

#### CONTENT ORGANIZATION

Clinical presentation Pathology and natural history Anatomy and Hemodynamics Hemodynamic and anatomical classification system based on splanchnic (meso-portal) venous occlusion and the type of collateralization (porto-portal vs. porto-systemic vs. a combination). Management approach based on the hemodynamic classification above. Detailed technical procedures (with exemplary high quality images and photographs) of novel procedures. This includes:

- Surgery
- Decompression by recannulation of splanchnic occlusion
- Decompression with porto-systemic shunts (including TIPS)
- Sclerosis of varices
- Combinations of the above

#### SUMMARY

Duodenal varices are difficult to manage and various treatment options have been used with varying results. A large part of the disparity in the literature is poor standardization of descriptive anatomy and hemodynamics. This is a systematic approach to describe a anatomy/hemodynamic based management algorithm.

### LL-VIE1287-SUB • Techniques and Approaches of Pediatric Vascular Interventional Procedures

**Terrence Metz MD (Presenter) ; Stephen A Vartanian MD ; Nghia Vo MD**

#### PURPOSE/AIM

An overview of pediatric vascular interventional procedures presenting the differences in the pediatric versus adult populations and what techniques could be useful when performing a procedure on the pediatric patient.

#### CONTENT ORGANIZATION

A. How to address the pediatric patient and parent regarding the procedure itself (what to expect, anesthesia concerns, recovery). B. Describe categories of pediatric vascular interventions: Venous (PICC, dialysis, etc.), Arterial (Angiogram, embolization, etc.) and Lymphatic (Sclerotherapy, chylogram, etc.) C. Choosing the best anatomic access point in relation to the procedural goal for pediatric needs. D. Anatomic figures for each category showing access point and related structures. E. Technique of access for each procedure including equipment choices and positioning. F. Post-procedural care including possible complications.

#### SUMMARY

This presentation will provide an overview on techniques in pediatric vascular interventions with the following goals: 1. Present components of the pre-procedural discussion with the parents and pediatric patient undergoing vascular intervention. 2. Provide helpful vascular techniques, positioning and device options specific to the pediatric patient. 3. Raise awareness of the various pediatric vascular interventions performed by the interventionalist.

### Renal Ultrasound and Doppler (An Interactive Session)

**Sunday, 02:00 PM - 03:30 PM • E450B**

**US** **VA** **GU**

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**RC110 • AMA PRA Category 1 Credit™:1.5 • ARRT Category A+ Credit:1.5**

#### RC110A • Masses and Parenchymal Diseases

**John J Cronan MD (Presenter)**

#### LEARNING OBJECTIVES

- 1) Optimize the information available from ultrasound related to chronic renal disease.
- 2) Assess the finding related to acute renal injury.
- 3) Define ultrasound's role in assessment of renal masses.

#### ABSTRACT

Ultrasound is the primary imaging technique to evaluate the kidneys when acute kidney injury occurs (AKI). We will look at techniques to optimize the evaluation of the kidneys and help clinical decision processes. Identification of chronic /irreversible renal signs is critical in patient management.

Renal mass assessment remains simple, cyst vs. non-cyst.

#### RC110B • Renal Doppler

**John S Pellerito MD (Presenter)**

#### LEARNING OBJECTIVES

- 1) Learn techniques and protocols for Doppler evaluation of the renal arteries.
- 2) Optimize abdominal Doppler studies.
- 3) Recognize the role of Doppler in evaluation of renal stents.

#### ABSTRACT

Evaluation of the renal arteries and kidneys is an integral component of the workup of renal insufficiency and hypertension. Doppler ultrasound examination is proven valuable in the detection of renal artery stenosis and occlusion. Doppler ultrasound has multiple advantages over CT or MR angiography: noninvasive, no radiation and does not require administration of contrast material. This program will discuss the techniques and protocols needed for successful renal artery evaluation with Doppler ultrasound. Tips to optimize the examination will be provided. There will also be a discussion of the evaluation of renal artery stents.

#### RC110C • Renal Transplants

**Deborah J Rubens MD (Presenter)**

#### LEARNING OBJECTIVES

- 1) Review the normal parenchymal and vascular anatomy of renal transplants including their normal Doppler parameters.
- 2) Identify the most common causes of renal transplant complications and criteria for their diagnosis.
- 3) Outline some of the pitfalls in transplant ultrasound imaging and when to use CT, MR and/or angiography in addition to ultrasound.

#### ABSTRACT

This lecture will review the anatomy and pathophysiology of renal transplants. The role of ultrasound imaging in assessment of acute as well as chronic renal transplant dysfunction will be elucidated. The performance of Doppler ultrasound will be highlighted regarding vascular stenosis and occlusion, parenchymal perfusion, and planning and assessing organ biopsy. Doppler techniques to avoid false negative and false positive studies will be emphasized. Controversial parameters will be stressed, in particular the use of absolute velocities versus ratios in the diagnosis of renal artery stenosis. Surgical emergencies will be highlighted, and the role of correlative imaging with CT, MR and/or angiography will be addressed.

## Thoracic Aorta: Key Concepts (An Interactive Session)

Sunday, 02:00 PM - 03:30 PM • S105AB

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**RC112** • AMA PRA Category 1 Credit™:1.5 • ARRT Category A+ Credit:1.5

### RC112A • Transcatheter Aortic Valve Replacement (TARV)

**Paul Schoenhagen MD** (Presenter)

#### LEARNING OBJECTIVES

- 1) Discuss Pathophysiology and Prevalence of Symptomatic Severe Aortic Stenosis.
- 2) Discuss Transcatheter Treatment Options (TAVR).
- 3) Discuss Critical Role of Imaging in the Context of TAVR.

### RC112B • The Spectrum of Type A Dissections

**Anne S Chin MD** (Presenter)

#### LEARNING OBJECTIVES

- 1) Review the pathology, epidemiology, and natural history of acute type A aortic dissection.
- 2) Describe the imaging strategies and diagnostic information sought in patients with acute aortic syndromes.
- 3) Review the recent classification of acute aortic dissection.
- 4) Illustrate imaging findings of the spectrum of acute type A aortic dissection, with a focus on recognizing subtle CT angiographic findings related to the lesser known 'Class 3' aortic intimal tear or 'limited dissection.'

#### ABSTRACT

The traditional Stanford classification distinguishes between dissections involving the ascending aorta (Type A) from those that do not involve the ascending aorta (Type B). Type A aortic dissection is rare, but remains the most lethal of aortic disorders requiring prompt surgical intervention. The common pathologic denominator in patients with acute dissection is an abnormal aortic media ('cystic medial necrosis') which can be found in genetic/inherited diseases (e.g. Marfan's) but also in patients with severe hypertension. The CT imaging strategy of suspected acute aortic syndrome should always include (i) non-enhanced images to assess for intramural hematoma (IMH); when the index of suspicion for aortic dissection is high, also consider (ii) EKG-gating for motion-free evaluation of the aortic root/ascending aorta, and (iii) including common femoral arteries in the CTA scan range to assess lesion extent and identify a percutaneous access route. The spectrum of aortic dissection has recently been classified as the following: Class 1 classic dissection with true and false lumen separated by an intimal flap; Class 2 IMH; Class 3 discrete or limited dissection; Class 4 penetrating atherosclerotic ulcer (PAU); and Class 5 iatrogenic/traumatic. A clarification and modified conceptual classification of aortic dissection will be provided, along with illustrative examples of these aortic lesions. Particular focus will be given to the lesser known Class 3 'limited dissection' which is described as a subtle and eccentric bulge of the aortic wall. While it has been reported to elude current imaging techniques, emphasis will be made on recognizing subtle CTA imaging findings characteristic of this uncommon but important dissection variant.

### RC112C • Surgical Procedures and Complications

**Terri J Vrtiska MD** (Presenter)

#### LEARNING OBJECTIVES

- 1) Describe common indications for surgical intervention in aortic disease including aneurysm, vasculitis, infection, trauma and connective tissue disorders.
- 2) Identify key CTA features of the normal postoperative aorta.
- 3) Present the characteristic CTA findings for complications of postoperative aortic repair including disease progression, thrombosis, stenosis, infection, pseudoaneurysm, aorto-enteric fistula and aortic rupture.

#### ABSTRACT

## Imaging and Endografts

Monday, 08:30 AM - 10:00 AM • S504AB

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**RC212** • AMA PRA Category 1 Credit™:1.5 • ARRT Category A+ Credit:1.5

### RC212A • TEVAR Indications and Outcomes

**Michael D Dake MD** (Presenter) \*

#### LEARNING OBJECTIVES

- 1) Understand the current applications of thoracic endografts for management of thoracic aortic pathologies.
- 2) Recognize the benefits and existing limitations of current endograft technologies for treatment of different aortic lesions.
- 3) Identify the complications and failure modes of TEVAR.
- 4) Know the current outcome metrics typically evaluated after TEVAR treatment of thoracic aneurysms and aortic dissections.
- 5) List the important imaging findings and criteria currently used to assess the suitability of aortic anatomy for TEVAR.

### RC212B • New Endografts for AAA

**Constantino S Pena MD** (Presenter) \*

#### LEARNING OBJECTIVES

- 1) Discuss the status of established AAA endografts.
- 2) Discuss new endografts for the treatment of AAA. Particularly discuss areas of improvement over established endografts.
- 3) Present data on novel endografts being developed.

### RC212C • Post Endograft Essentials

**Geoffrey D Rubin MD** (Presenter) \*

#### LEARNING OBJECTIVES

- 1) To better select the best imaging modality for assessing stent-grafts.
- 2) To assure that CT acquisition technique is optimized for endoleak detection.
- 3) To learn how to identify structural failures in endografts.

## Mentored Case Approach to Pediatric Cardiovascular Disease 1: Vascular Disease (An Interactive Session)

Monday, 08:30 AM - 10:00 AM • E353B

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**RC224** • AMA PRA Category 1 Credit™:1.5 • ARRT Category A+ Credit:1.5

**Director**

**S. Bruce Greenberg**, MD

**Director**

**Rajesh Krishnamurthy**, MD \*

**S. Bruce Greenberg**, MD

**Cynthia K Rigsby**, MD

**Taylor Chung**, MD

LEARNING OBJECTIVES

1) Understand the morphology, treatment, and long term complications of treated and untreated congenital heart disease via an interactive mentored-case approach with audience response system. 2) Highlight appropriateness of MRI and CT with regard to technique, pitfalls, indications and critical imaging findings that affect management for common imaging scenarios, including vascular rings and slings, coarctation, aortopathy, coronary anomalies, and congenital pulmonary arterial and venous anomalies. 3) Provide an opportunity for general radiologists, pediatric radiologists and cardiac imagers who have limited exposure to this area in their workplace an opportunity to refresh their pediatric cardiovascular imaging skills in a focused manner.

**Interventional Radiology Series: Peripheral and Visceral Occlusive Disease**

**Monday, 08:30 AM - 12:00 PM • E352**

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**VSIR21** • AMA PRA Category 1 Credit™:3.25 • ARRT Category A+ Credit:3.75

**Moderator**

**Albert A Nemcek**, MD \*

LEARNING OBJECTIVES

1) Describe recent evidence concerning the use of renal denervation for malignant hypertension. 2) Explain the use of stent grafts in vascular disease. 3) Describe three pitfalls of CTA or MRA in peripheral vascular disease. 4) Outline 3 recommendations for endovascular treatment of peripheral vascular disease. 5) List two important studies published on vascular disease in the past year.

**VSIR21-01 • CTA and MRA for PVD: Pitfalls of Peripheral Vascular CTA and MRA -Don't Make These Mistakes!**

**Barry Stein** MD (Presenter)

LEARNING OBJECTIVES

View learning objectives under main course title.

ABSTRACT

CTA and MRA are accepted powerful non invasive vascular imaging modalities to assess for peripheral vascular disease. Both modalities have their niche clinical indications and both have their pitfalls. The presentation will elaborate on how to avoid these pitfalls illustrating the genesis of these with study acquisition, data post processing and image interpretation.

**VSIR21-02 • In Vivo Quantification of Total Atherosclerotic Burden: Prognostic Accuracy of Whole Body CTA in Relation to Traditional Cardiovascular Risk Index and 8-year Follow-up**

**Fulvio Zaccagna** MD (Presenter) ; **Alessandro Napoli** MD ; **Gaia Cartocci** ; **Vincenzo Noce** MD ; **Maurizio Del Monte** ; **Carlo Catalano** MD

PURPOSE

To investigate if mid-term prognostic value of WB-CTA to predict cardiovascular (CV) events in asymptomatic patients with CV risk factors can be superior to traditional method of risk stratification and can more accurately guide primary preventive strategies in asymptomatic patients.

METHOD AND MATERIALS

341 patients with CV risk factors (mean age 63.39±10.4[34-89]) underwent WB-CTA (detector configuration: 64x0.6mm) with an adapted contrast injection protocol (Iomeprol-400, 400mgI/ml; 70+50ml@4ml/s). For the evaluation of atherosclerotic burden the coronary arteries were divided into 15 segments and the extra-coronary arteries into 32 segments and detected stenoses were graded using a 5-point scale (0-4 normal-occlusion; 5 aneurysm). An atherosclerosis burden score (ABS) was generated for each individual and correlated to traditional CV risk (Framingham risk index; FRI). ABS and FRI were compared using Kaplan-Meier survival analysis, ROC analysis and stepwise multivariable Cox proportional hazards regression models.

RESULTS

At baseline mean ABS was 19.5±20.1 and mean FRI was 12±10.7; 64.5±11.3 months after WB-CTA all patients received an interview to determine health status during this period. According to Kaplan-Meier curves, mean event-free time was of 86.3±6.4m for ABS

CONCLUSION

WBCTA-derived ABS reflects real atherosclerotic burden and provides superior risk stratification and event prediction with respect to FRI; hard event prediction was significantly associated to age, ABS and therapy but not to FRI.

CLINICAL RELEVANCE/APPLICATION

WB-CTA allows non-invasive and more accurate risk stratification than FRI; thus, ABS could guide primary therapeutic interventions in a more robust and accurate manner than traditional risk methods

**VSIR21-03 • Whole Body Contrast Enhanced Magnetic Resonance Angiography Screening for Sub-clinical Atherosclerotic Disease**

**Graeme Houston** MD, FRCR (Presenter) \* ; **Matthew Lambert** MBBCh, MRCP \* ; **Jonathan Weir-McCall** MBBCh, FRCR ; **Stephen Gandy** ; **Shona Matthew** BSc, PhD \* ; **Richard D White** MBChB, FRCR ; **Jil J Belch** ; **Alan D Struthers** ; **Frank Sullivan** ; **Roberta Littleford** PhD

PURPOSE

The Tayside Screening for Cardiac Events (TASCFORCE) study assessed the ability of a number of biomarkers to identify subclinical atherosclerosis in individuals free from, and at low risk of cardiovascular (CV) disease. The CV imaging biomarker studied was a whole body atheroma score derived from whole body contrast enhanced magnetic resonance angiography (WBCE-MRA).

METHOD AND MATERIALS

5000 volunteers > 45 yrs with no history of CV disease, a 10 year risk of CV disease less than 20% as assessed by the ASSIGN CV risk score and a B-type natriuretic peptide (BNP) greater than their gender specific median were invited. Of 1651 volunteers, 34 were ineligible due to safety issues, 107 were claustrophobic, and 1510 (91.4%) completed the 3T MRI (Siemens Trio, Erlangen, DE) MRI. WBCE-MRA was acquired from skull vertex to feet using following intravenous injection gadolinium gadoterate meglumine (Dotarem, Guerbet, FR). The subtracted WBCE-MRA data comprised 31 anatomical arterial segments. Each segment was scored according to the extent of luminal narrowing: 0 normal, 1

RESULTS

277 of 46,810(0.5%) arterial segments were un-interpretable due to poor quality images, or anatomical variation. Only 606 (40.1%)

participants had a normal WBAS. The distribution of arterial abnormalities was head, neck and thorax in 403 (26.7%), abdominal 361 (24.0%) and peripheral arteries 366 (24.2%) of volunteers. The number of volunteers with WBAS of 1-267 (18%), 2-204 (13.5%), 3-117 (7.8%), 4-86 (5.7%), 5-68 (4.5%), 6-47 (3.1%), >7 -114 (7.6%) volunteers respectively. Of the affected segments detected 1644 (76%) were < 50% stenosis, 234 (11%) were 50-75% stenosis, 161 (7.5%) were 70-99% stenosis, 80 (3.7%) were occluded and 32 (1.5%) were aneurysmal vessels.

#### CONCLUSION

WBCE-MRA demonstrates the presence of atherosclerosis in 60% of asymptomatic people at low risk of cardiovascular disease based on accepted risk factors. The severity of disease ranged from

#### CLINICAL RELEVANCE/APPLICATION

Cardiovascular events occur in low risk people. WBCE-MRA demonstrates the sites and severity of atherosclerotic lesions in asymptomatic low risk individuals that may allow preventative therapy.

### VSIR21-04 • Recommendations for Endovascular Treatment of PVD in 2013

**Johannes Lammer MD (Presenter) \***

#### LEARNING OBJECTIVES

1) To learn the indications for interventions in PAD. 2) To learn the technique and devices for aortoiliac treatment. 3) To learn the technique and devices for femoropopliteal artery treatment. 4) To learn the technique and devices for below the knee (BTK) treatment. 5) To learn the results of most recent trials. 6) To learn the medical treatment after intervention.

#### ABSTRACT

To learn the indications for interventions in PAD To learn the technique and devices for aortoiliac treatment To learn the technique and devices for femoropopliteal artery treatment To learn the technique and devices for below the knee (BTK) treatment To learn the results of most recent trials To learn the medical treatment after intervention

### VSIR21-05 • Influence of Tube Voltage Reduction on Image Quality in MDCTA of Arterial Stents Using Model-based Iterative Reconstruction: A Phantom Study

**Jochen M Grimm MD (Presenter) ; Lucas L Geyer MD \* ; Daniel Maxien MD ; Zsuzsanna Deak MD ; Fabian Mueck ; Michael K Scherr MD ; Stefan Wirth MD \***

#### PURPOSE

To evaluate dose saving potential and impact on image quality of tube voltage reduction in MDCT imaging of arterial stents using model-based iterative reconstruction (MBIR) compared to adaptive statistical iterative reconstruction (ASIR) in an anthropomorphic phantom.

#### METHOD AND MATERIALS

Different coronary stents were filled with iodinated contrast medium, placed in a thoracic Alderson-Rando phantom and scanned at 120, 100 and 80 kVp at fixed tube currents (200, 100, 50mA). Luminal attenuation values (HU) and standard deviation (image noise; IN) were measured, contrast- (CNR) and signal-to-noise ratio (SNR) were calculated for ASIR and MBIR. Image quality (IQ) was assessed by two blinded radiologists using a 4-point scale. Wilcoxon's test was used for statistical evaluation.

#### RESULTS

Average IQ using MBIR was superior compared to ASIR at 120 and 100 kVp (p

#### CONCLUSION

MBIR performed superior to ASIR at 120 and 100kVp independent of tube current. At 80kVp, ASIR performed slightly better than MBIR, especially at lower tube currents, without reaching statistical significance. Best relation between IQ and CTDI was found using MBIR at 100kVp and 50mA, delivering an image quality superior to the best ASIR image at only 16% of its CTDI.

#### CLINICAL RELEVANCE/APPLICATION

MBIR significantly outperforms ASIR at 100 and 120 kVp. Tube current can be greatly reduced without sacrificing image quality while tube voltage should not be reduced below 100 kV.

### VSIR21-06 • Impact of a Novel CT-based Calcium Scoring System of the Lower Extremity Arteries on Primary Patency Rates after Endovascular Interventions for Peripheral Arterial Disease: Preliminary Results

**Holly L Nichols BS (Presenter) ; Stacey Schriber ; Charles Y Kim MD \***

#### PURPOSE

For lower extremity artery lesions, the type and extent of associated calcification has been shown to affect immediate post-angioplasty results but the impact on long-term patency is unknown. The purpose of this project is to utilize a novel calcium scoring system to characterize arterial lesions and correlate with the primary patency rate after endovascular interventions.

#### METHOD AND MATERIALS

We reviewed our procedural database between 1/2005 - 12/2009 for lower extremity arteriograms that included an intervention on a stenosis or occlusion. Patients were included if there was no more than one lesion per leg and if a CTA of the lower extremities was performed within the preceding 6 months. A total of 66 lesions were identified in 47 patients (22 males, mean age 63 years). Each treated lesion was reviewed on the CTA for calcium scoring. Calcium morphology was described as none, thin linear, thick linear, or bulky. The percent circumference was scored as none, 1-50%, 51-95%, or >95%. Primary patency was determined by recurrence of symptoms in that extremity or development of 50%+ stenosis at the treated site based on CTA or conventional angiography if available. Patency estimation was performed using the Kaplan-Meier method and compared using the log rank test. The cutoff for statistical significance was a p-value = 0.05.

#### RESULTS

Of 66 treated lesions, 54 underwent stenting and 12 underwent angioplasty, without significant difference in patency (p=0.76). Overall, no significant difference in patency was identified based on morphology score alone (p=0.74) or circumference score alone (p=0.13). Subanalysis of extensive calcifications (thick linear or bulky morphology with >50% circumference), eccentric calcifications (thick linear or bulky with 1-50% circumference), or bulky eccentric calcifications stratified by arterial distribution revealed that only bulky eccentric calcifications in the SFA distribution resulted in a significantly decreased patency rate (p=0.03).

#### CONCLUSION

Our preliminary findings suggest that this proposed calcium scoring system is predictive of post-intervention patency outcomes in the SFA distribution. Additional data is needed to fully evaluate this correlation.

#### CLINICAL RELEVANCE/APPLICATION

Calcium scoring of atherosclerotic lesions may be predictive of post-intervention patency rates, which can help determine whether endovascular therapy should be performed for a given lesion.

### VSIR21-07 • Robust 3D MRI Segmentation of Superficial Femoral Artery for Morphological Analysis of Peripheral Arterial Disease Plaque Burden

**Eranga Ukwatta MENG (Presenter) ; Jing Yuan ; Bernard Chiu ; Wu Qiu ; Martin Rajchl ; Aaron Fenster PhD \***

#### PURPOSE

Current luminographic techniques have limited utility in the longitudinal assessment of peripheral arterial disease (PAD). With the advent



of fast and non-invasive 3D black-blood MRI sequences, such as 3D motion-sensitized driven equilibrium (MSDE) prepared rapid gradient echo sequence (3D MERGE), superficial femoral artery (SFA) vessel wall can be evaluated up to 50 cm coverage for generating morphological measurements of PAD plaque burden. This study aims develop and evaluate a fast and precise algorithm for segmentation of the femoral artery outer wall and lumen from 3D MR images.

#### METHOD AND MATERIALS

Using multi-planar reformatting software, the user selects approximate mid-points on transverse cross-sections of the artery 30 mm apart. The user selected points are then connected using the live-wire algorithm to find the rest of the points on the medial axis. The 3D image is then reoriented using the medial axis of the artery. A novel algorithm was then applied to jointly delineate the SFA lumen and outer wall surfaces from 3D black-blood MR images in a global optimization manner, while enforcing the spatial consistency of the reoriented MR slices along the medial axis of the SFA. The accuracy of the algorithm was evaluated with respect to the manual segmentation. Our data set comprised of 355 2D slices extracted from 10 3D MR images from seven subjects. Five of these subjects were symptomatic with intermittent claudication.

#### RESULTS

The algorithm required only 1.8 min of total time to segment a 3D MR image compared to 70-80 min of user time for manual segmentation. The algorithm yielded Dice coefficients of  $89.1 \pm 3.7\%$  and  $85.4 \pm 3.4\%$  and mean absolute boundary distances of  $0.44 \pm 0.1$  mm and  $0.40 \pm 0.1$  mm, and maximum absolute boundary distances of  $0.97 \pm 0.23$  mm and  $0.87 \pm 0.13$  mm for the SFA outer wall and lumen. The reproducibility of the algorithm was computed using five repeated segmentations and the algorithm yielded intra-class correlation coefficient of 0.95 and coefficient of variation of 6.69% for generating vessel wall area.

#### CONCLUSION

The algorithm requires only 2-3% of the time required for manual segmentation, which significantly alleviates measurement burden while maintaining high accuracy and reproducibility.

#### CLINICAL RELEVANCE/APPLICATION

The algorithm is suitable for generating morphological measurements of PAD plaque burden with high accuracy and reproducibility and it requires only 2-3% of time required for manual segmentation.

### VSIR21-08 • Stent Grafts Explained

**Lindsay S Machan MD (Presenter) \***

#### LEARNING OBJECTIVES

View learning objectives under main course title.

### VSIR21-09 • Updates in Vascular Disease

**Albert A Nemcek MD (Presenter) \***

#### LEARNING OBJECTIVES

View learning objectives under main course title.

### VSIR21-10 • Effect of Renal Sympathetic Denervation on Left Ventricular Hypertrophy in Patients with Medication-resistant Hypertension: 1 Year Follow-up with Cardiac Magnetic Resonance Imaging

**Willemien Verloop MD ; Eva Vink MD ; Peter Blankestijn MD, PhD ; Evert-Jan Vonken MD, PhD ; Michiel Voskuil ; Tim Leiner MD, PhD (Presenter) \***

#### PURPOSE

Renal denervation (RDN) is designed to decrease sympathetic activity and has shown to be an effective treatment for hypertension. The effects of RDN on the heart are largely unknown. Aim of the current study was to investigate the effect of RDN on left ventricular hypertrophy, which is an indicator of end organ damage.

#### METHOD AND MATERIALS

#### RESULTS

#### CONCLUSION

Overall, RDN is not associated with a significant decrease in LV myocardial mass at 1 year after the procedure, although there are large differences between individuals. There is no clear linear relationship between change in blood pressure and LV myocardial mass at 1 year after RDN.

#### CLINICAL RELEVANCE/APPLICATION

There are large interindividual differences in the effect of renal denervation on blood pressure. There is no clear linear relationship between blood pressure change and change in LV myocardial mass.

### VSIR21-11 • Wrap Up and Discussion

#### LEARNING OBJECTIVES

View learning objectives under main course title.

## Cardiac CT Mentored Case Review: Part II (In Conjunction with the North American Society for Cardiac Imaging) (An Interactive Session)

Monday, 10:30 AM - 12:15 PM • S406A



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**MSMC22 • AMA PRA Category 1 Credit™:1.75 • ARRT Category A+ Credit:2**

#### Moderator

**Geoffrey D Rubin , MD \***

#### Moderator

**Vincent B Ho , MD, MBA \***

#### LEARNING OBJECTIVES

1) Understand how to interact with 4D cardiac CTA data for proper interpretation. 2) Compare methods for characterizing coronary stenoses and learn what is most appropriate in various situations.

### MSMC22A • Coronary Artery Disease I: Native Vessel Disease

**Geoffrey D Rubin MD (Presenter) \***

#### LEARNING OBJECTIVES

View learning objectives under main course title.

## MSMC22B • Coronary Artery Disease II: Native Vessel Disease

**Smita Patel** MBBS (Presenter)

### LEARNING OBJECTIVES

View learning objectives under main course title.

### ABSTRACT

## MSMC22C • Valves and Cardiac Function

**Andrew J Bierhals** MD (Presenter)

### LEARNING OBJECTIVES

View learning objectives under main course title.

### ABSTRACT

Cardiac CT can provide information on valves and function when retrospective ECG gating is used in the acquisition. These studies require extensive image post-processing to accurately depict the moving structures. This presentation will highlight basic image acquisition as well as the evaluation of normal and abnormal patients.

## Vascular/Interventional (Chemoembolization)

**Monday, 10:30 AM - 12:00 PM • E351**

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**SSC16 • AMA PRA Category 1 Credit™:1.5 • ARRT Category A+ Credit:1.5**

### Moderator

**S. William Stavropoulos**, MD \*

### Moderator

**Kenneth J Kolbeck**, MD, PhD

## SSC16-01 • Influence of Hepatic Artery Embolization on Tumor Growth and Metastatic Potential in a Rat Orthotopic Hepatoma Model

**Guang Zhi Wang** PhD, MD (Presenter) ; **Zhu Ting Fang** ; **Wei Zhang** ; **Jianhua Wang**

### PURPOSE

To examine if transarterial embolization (TAE) enhance the metastatic potential of the residual HCC, and investigate the mechanisms underlying the effects of embolization with a rat model of orthotopic hepatocellular carcinoma.

### METHOD AND MATERIALS

All protocols were approved by the animal research committee of Fudan University and met NIH guidelines. In vitro study, the hepatoma cell line McA-RH7777 marked by GFP (Green Fluorescent Protein) were cultured under hypoxic and normoxic conditions. Forty male buffalo rats were implanted with McA-RH7777 tumor in the left lateral lobe of liver. After laparotomy and retrograde placement of catheter into the gastroduodenal artery (14 days after implantation), TAE used with lipiodol (0.2 ml/kg) were performed. Tumor volumes were measured before (on day 14) and after (on day 28) treatment with magnetic resonance imaging (MRI). Tumor growth and lung metastases were further observed using fluorescence imaging and the macroscopic characteristics were correlated with histological findings. The migration and invasion of HCC was observed by invasion assays in vitro. The molecular changes of hypoxia-inducible factor (HIF)-1 $\alpha$ , VEGF, E-cadherin, N-cadherin, and vimentin in residual tumor cells were evaluated by western blot, PCR, or immunohistochemistry in vitro and in vivo respectively. The Mann-Whitney U-test or  $\chi^2$  was used for statistical comparisons.

### RESULTS

In vitro invasion assay indicated that the numbers of invading hypoxic McA-RH7777 cells were  $30.8 \pm 4.74$ , which were significantly higher than normoxic cells ( $10.3 \pm 3.59$ ,  $P < .05$ ). Successful implantation was achieved in all rats, which was confirmed by MRI. The metastatic potential of tumor cells by hypoxia or interventional procedure was enhanced by significantly reducing the expression of E-cadherin and up-regulation of HIF-1 $\alpha$ , VEGF, N-cadherin, and vimentin in vitro and in vivo. But the number of metastatic lung nodules were  $11.37 \pm 4.26$  in TAE group and  $9.3 \pm 3.8$  in control group, which showed no significant different ( $P = .057$ ).

### CONCLUSION

Hypoxia always occurring residual tumor after the TAE can increase invasiveness and metastatic potential of HCC, and targeting to the molecular changes induced by hypoxia may augment the therapeutic effects of TAE.

### CLINICAL RELEVANCE/APPLICATION

The study may help to design of mechanism-based combination therapies or new therapeutic regimes to improve the effect of TACE in the clinical treatment of HCC.

## SSC16-02 • Bimodal Treatment of Aerobic and Glycolytic Metabolism by Particle Embolization Combined with Anti-glycolytic Compound Improves Treatment of N1-S1 Hepatocellular Mouse Model

**John R Haaga** MD (Presenter) ; **Hanping Wu** MD, PhD

### PURPOSE

To determine if combination treatment of aerobic metabolism by embolization and antiglycolytic drugs compared to embolization alone provides better treatment of N1-S1 hepatocellular carcinoma in a rat model.

### METHOD AND MATERIALS

Two separate laparotomies were performed, one for subcapsular tumor implant and the second for retrograde placement of catheter into the gastroduodenal artery for 5 different treatments. Treatments were: 1) Control (n=5, 1ml NS); 2) TAE (n=4, 10mg 50-150 $\mu$ m PVA particle in 1ml NS), 3) TAE+AG-B (n=5, 10mg PVA in 1ml AG-B); 4) TAE+AG-F (n=5, 10mg PVA+30mg AG-F in 1 ml NS); 5) TAE+AG-C (n=5, 10mg PVA+30mg AG-C in 1 ml normal saline). Tumor length (L), width (W), and height (H) was measured by 2D-ultrasound before treatment and twice a week till 4 weeks after treatment. Tumor volume (V) was calculated by the formula:  $V = 0.5 * L * W * H$ . Relative tumor volume after treatment was calculated as the percentage of pre-treatment tumor volume. Kruskal-Wallis test was used to compare the difference of relative tumor volume between 5 groups on each observation time point.

### RESULTS

The initial tumor sizes in each group were statistically not significantly different. Three animals in the control group were euthanized before the end of observation due to rapid tumor growth and anorexia. In TAE group, one kept growing after treatment. In other 3 animals, the tumor volume increased in the early observation time points (1 within 1 week, 2 within 2 weeks) and then shrunk. In other 3 TAE+AG groups, the tumor volumes decreased after treatment with significant differences between control group and 3 TAE+AG groups on all observation time point except TAE+AG-F group on 3.5 and 4 weeks. At 4 weeks after treatment, the median relative tumor volumes were 3,174.5% in control group, 58.2% in TAE group, 9.6% in TAE+AG-B group, 23.8% in TAE+AG-F group, and 13.4% in

TAE+AG-C group.

#### CONCLUSION

Bimodal embolic treatment of hepatocellular cancer is more effective than embolic Rx alone. Further study of these propriety agents is warranted because agents target enzymes specific to cancer. Optimization of drug form, dose and route administration (IV, oral) are needed. Safety studies must be completed before human use.

#### CLINICAL RELEVANCE/APPLICATION

Clinical relevance is enormous. Agents should be effective against all cancers with little effect on normal tissues. Mode of delivery can be arterial, intravenous and/or oral. Challenge is funding.

### **SSC16-03 • Effects on Apoptosis in Rabbit Hepatic VX2 Carcinoma after Transcatheter Arterial Chemoembolization Using Alginate Microspheres-Adriamycin (ADM): Experimental Study**

**Kaiyuan Xu** (Presenter)

#### PURPOSE

To evaluate effects on the apoptosis of transcatheter arterial chemoembolization (TACE) with alginate microsphere-adriamycin in experimentally induced liver tumor.

#### METHOD AND MATERIALS

Thirty New Zealand White rabbits were randomly divided into five groups and VX2 carcinoma was grown in the left lobes of the livers. TACE was performed with normal saline (Group A), alginate microsphere (Group B), alginate microsphere-adriamycin (Group C), Lipiodol (Group D), and Lipiodol-adriamycin (Group E). Three weeks later, the animals were killed and apoptotic index were calculated on the basis of findings. Effects on intrahepatic and distal metastasis in all groups were examined.

#### RESULTS

#### CONCLUSION

Alginate microspheres can potentially serve as embolizing agents and drug delivery vehicles for local slow-release. With embolization and chemotherapy effect of doxorubicin, alginate microspheres induce and promote apoptosis of tumor cells, which reduce residual areas of tumor, the recurrence rate and metastasis rate.

#### CLINICAL RELEVANCE/APPLICATION

Chemoembolization with Alginate microsphere-ADM is an effective antitumor treatment of hepatic carcinoma.

### **SSC16-04 • Evaluation of a Combined Protocol of Sorafenib and Transarterial Chemoembolization (TACE) vs. TACE vs. Sorafenib Protocol Alone in Advanced Stage Hepatocellular Carcinoma (HCC): Retrospective Study at Three German Liver Centers**

**Thomas J Vogl MD, PhD** (Presenter); **Jorg Trojan MD**; **Markus Goller**; **Mark Op Den Winkel**; **Eckart Schott**; **Martin W Welker**; **Stefan Zangos MD**; **Wolf-Otto Bechstein**; **Stefan Zeuzem MD**; **Frank T Kolligs MD**

#### PURPOSE

To compare combined Sorafenib and transarterial chemoembolization (TACE), TACE alone and Sorafenib alone for treatment of patients with advanced hepatocellular carcinoma (HCC) according to the Barcelona Clinic Liver Cancer (BCLC) stage C.

#### METHOD AND MATERIALS

In this retrospective multicenter cohort study 185 patients with BCLC stage C who were treated with Sorafenib and TACE (group A, n=50), with TACE alone (group B, n=59) or with Sorafenib alone (group C, n=76) were retrospectively analyzed for comparison from January 2007 to October 2012. Portal vein infiltration, extrahepatic metastases, time-to-progression and overall survival were evaluated. For patients of group A adverse events were also documented.

#### RESULTS

Portal vein infiltration was documented in 32% of patients in group A, 36% in group B, and 37% in group C. Extrahepatic metastases were present in 60% (group A), 34% (group B), and 49% (group C). Median time-to-progression was 6.3 months in group A [95%-confidence interval (CI): 4.3-8.3], 5.4 months in group B (95%-CI: 3.5-7.3) and 3.5 months in group C (95%-CI: 3.1-3.9). Median overall survival was 17.0 months in group A (95%-CI: 13.5-20.5), 11.0 months in group B (95%-CI: 8.1-13.9) and 9.0 months in group C (95%-CI: 7.0-11.0). The most common adverse events in the combined treatment of Sorafenib and TACE were diarrhea (54%), hand-foot-skin reactions (40%) and fatigue (36%). Due to adverse events the Sorafenib dose was reduced in 86% of patients in group A and stopped in 6%.

#### CONCLUSION

The combined treatment of Sorafenib and TACE seems to be a promising treatment option in patients with HCC in BCLC stage C, especially if extrahepatic metastases are present. However, further prospective or randomized studies are necessary.

#### CLINICAL RELEVANCE/APPLICATION

The combined therapy of Sorafenib and TACE is a relevant therapy option for patients in advanced stages of HCC.

### **SSC16-05 • Quantitative Measurement of the Hepatic Blood Flow before and after Transcatheter Arterial Chemoembolization of Hepatocellular Carcinoma**

**Yi-Yang Lin MD** (Presenter); **Rheun-Chuan Lee MD**; **Hsiuo-Shan Tseng**; **Chien An Liu MD**; **Wan-Yuo Guo MD, PhD** \* ; **Cheng-Yen Chang MD**

#### PURPOSE

To quantitatively measure the hemodynamic change of hepatic artery before and after transcatheter arterial chemoembolization (TACE) of hepatocellular carcinoma (HCC) by quantitative color-coding analysis (QCA).

#### METHOD AND MATERIALS

This prospective study was performed from December 2012 to February 2013. 64 patients (mean 67.5 year old; male 50, female 14) who were diagnosed with HCC and underwent TACE with doxorubicin and lipiodol emulsion or with microspheres were enrolled if superselective segmental TACE was technically feasible. The endpoint of TACE was sluggish of antegrade arterial flow. QCA (syngo iFlow; Siemens) was used to determine the maximal density time (Tmax) of selected intravascular region of interest (ROI). Relative Tmax (rTmax) was defined as the Tmax at the selected ROI minus the time of contrast medium spurting from the catheter tip. The catheter tip was placed in common hepatic artery, proper hepatic artery or lobar hepatic arteries before and after TACE with the same acquisition and injection protocols. The rTmax of treated and proximal hepatic arteries were analyzed before and after embolization.

#### RESULTS

The pre- and post-treatment rTmax of the landmarks at the treated segmental artery and proximal right hepatic artery were 1.84~2.08s, 2.7~3.59s (p < 0.001) and 1.4~1.64s, 1.55~1.89s (p

#### CONCLUSION

QCA is feasible to quantify embolization endpoint by comparing the rTmax in selected hepatic arteries before and after TACE. The rTmax of treated segmental artery was significant prolonged after optimized procedures.

#### CLINICAL RELEVANCE/APPLICATION

QCA is able to quantitatively determine the adequate embolization endpoint in HCC patients.

## SSC16-06 • Does Safety Margin Reduce Local Recurrence in C-arm CT-assisted Chemoembolization for Small Nodular Hepatocellular Carcinoma?

**Hyo-Jin Kang** (Presenter) ; **Jin Wook Chung MD \*** ; **Hyo-Cheol Kim MD** ; **Hwan Jun Jae MD** ; **Saebeom Hur MD**

### PURPOSE

To test the hypothesis that safety margin may reduce local recurrence in superselective chemoembolization for small nodular hepatocellular carcinoma (HCC).

### METHOD AND MATERIALS

To test the hypothesis, the consecutive patients who underwent both C-arm CT assisted superselective chemoembolization using an iodized oil for small nodular (1-3cm in size and 3 or less in number) HCC as the initial treatment and immediate thin-section iodized-oil CT were identified from the prospectively registered electronic database. From March 2009 to March 2011, 96 nodules in 80 patients (60 men, 20 women; mean age, 61.5 years) were included in this study. On immediate iodized-oil CT, we analyzed the presence or absence of defect in iodized-oil uptake in the tumor and completeness of safety margin in the surrounding liver parenchyma. Univariate and multivariate analyses were performed to determine prognostic factors for local recurrence. Potential determinant factors included Child-Pugh class, tumor size, tumor vascularity, definition of tumor boundary, tumor depth from surface to hilum, selectivity of chemoembolization, pattern of oily portogram, lipiodol uptake intensity, and lipiodol uptake homogeneity.

### RESULTS

The median follow-up time was 26.4 months (range, 1-46.1 months). 37 nodules in 33 patients showed local recurrence. 1- and 2-year cumulative local recurrence rates were 61.9% and 81%, 9.3% and 20.2% for nodules with defect (n=21) and for nodules without defect (n=75), respectively (p=.000). Among the 75 nodules without defect, 1- and 2-year cumulative local recurrence rates were 11.1% and 22.2%, 7.7% and 17.9% and for nodules with complete safety margin (n=36) and for nodules with incomplete safety margin (n=39), respectively (p=.901). In multivariate analyses using Cox proportional hazard model, lipiodol uptake homogeneity (HR = 0.266; 95% CI: 0.11, 0.65; P < .05), lipiodol uptake defect (HR =3.76; 95% CI: 1.53, 9.27; P < .05) remained significant in local recurrence.

### CONCLUSION

In case of complete lipiodol uptake in the tumor, safety margin did not affect local recurrence rate in C-arm CT assisted chemoembolization for HCC.

### CLINICAL RELEVANCE/APPLICATION

In case of complete lipiodol uptake in the tumor, additional effort to ensure complete safety margin as in RF ablation is not justified in superselective chemoembolization for small nodular HCC.

## SSC16-07 • Volumetric Tumor Assessment Predicts Survival in Patients Treated with Transarterial Chemoembolization for Hepatocellular Carcinoma

**Vania Tacher MD** (Presenter) ; **Mingde Lin PhD \*** ; **Nikhil Bhagat MD** ; **Constantine Frangakis** ; **Hooman Yarmohammadi MD \*** ; **Rafael Duran MD** ; **Michael Chao** ; **Rongxin Chen** ; **Zhijun Wang MD** ; **Jean-Francois H Geschwind MD \***

### PURPOSE

Tumor response in patients with hepatocellular(HCC) treated by transarterial chemoembolization(TACE) can be measured quantitatively using 3D quantitative European Association for the Study of the Liver (qEASL) and volumetric Response Evaluation Criteria in Solid Tumor (vRECIST). The purpose of this study was to demonstrate that qEASL and vRECIST can be used to predict patient survival.

### METHOD AND MATERIALS

Tumor response using pre and post TACE MRI was assessed on 84 consecutive patients treated with a first session of TACE for HCC. The entire tumor volume was used for vRECIST and the enhancing portion of the tumor volume for qEASL analysis. Targeted tumor response (TTR) and overall tumor response (OR) revealed two distinctive groups of patients: responder (R) and non-responder (NR). For TTR using vRECIST, R was defined as patients with a decrease sum of target tumor (TT) volumes beyond 30%. For TTR using qEASL analysis, R was defined as patients with a decrease, beyond 50%, of the sum of TT qEASL volume. vRECIST and qEASL OR were determined based on TTR, non-TTR and on potential new lesion on post-TACE MRI. Survival difference between R and NR for TTR and OR as defined by vRECIST and qEASL were explored by Kaplan Meier survival analysis.

### RESULTS

131 TT, 32 non-TT and 9 new lesions were evaluated from 84 HCC patients. Mean tumor volume and mean enhancing volume decreased from 235±475cm<sup>3</sup> and 206±414cm<sup>3</sup> to 120±250cm<sup>3</sup> and 97±215cm<sup>3</sup>, respectively. Using vRECIST, both TTR and OR showed n=8(10%) R with a mean survival time of 45±18 months, and n=76(90%) NR with a mean survival time of 27±3 months. There was no statistical survival difference between R and NR for vRECIST TTR and OR (p=0.177). According to qEASL analysis, both TTR and OR showed n=30(36%) R and n=54(64%) NR. Mean survival times based on qEASL TTR was 42±4 months for R and 23±3 months for NR and on qEASL OR was 42±8 months for R and 23±3 months for NR. qEASL TTR and OR analysis showed that survival times between R and NR were statistically different with p= 0.014 and p=0.018, respectively.

### CONCLUSION

The 3D tumor enhancement assessment, qEASL can be used to assess target tumor response and overall tumor response and can predict survival in HCC patients after the first TACE session.

### CLINICAL RELEVANCE/APPLICATION

3D tumor enhancement assessment model can be used to assess target tumor response and overall tumor response and predict survival in HCC patients after the first TACE session.

## SSC16-08 • Assessing Viable Tissue within Hepatocellular Carcinoma (HCC) Lesions after Locoregional Therapy: A Comparison between Modified RECIST (mRECIST) and Volumetric Quantification

**Fernanda D Gonzalez Guindalini MD \*** ; **Adeel R Seyal MD** (Presenter) \* ; **Marcos P Botelho MD \*** ; **Hamid Chalian MD** ; **Riad Salem MD, MBA \*** ; **Vahid Yaghmai MD**

### PURPOSE

mRECIST is used to assess HCC response to locoregional therapy. We compared the accuracy of mRECIST to volumetric viable tissue quantification in HCC after locoregional therapy.

### METHOD AND MATERIALS

This HIPAA compliant retrospective study was IRB approved. Twenty-four HCCs were evaluated in 24 patients by triphasic MDCT scans performed before and three months after 90Y-radioembolization. The percentage of change in viable tissue within the tumor, defined as enhancing areas on arterial phase, was quantified based on mRECIST and volumetrically using segmentation software. Results were compared using the paired t-test, Bland-Altman plots and concordance correlation coefficient. The agreement between the methods in the assessment of treatment response was examined by kappa (k) statistics.

### RESULTS

A significant difference in percentage of residual viable tissue was observed between the two methods (P=0.008). There was wide difference in measurements between the methods with a bias of 49.0% (95%CI: -96.9% to 194.9%). Correlation between mRECIST and volumetric measurement was poor, pc=0.54. Poor agreement was demonstrated between the two techniques when assessing response based on percentage of change in viable tissue (k = 0.34, 95% CI: 0.148-0.543).

### CONCLUSION

There is poor agreement between mRECIST and volumetric quantification when assessing response to locoregional therapy in HCC.

#### CLINICAL RELEVANCE/APPLICATION

Necrosis in treated HCC can have heterogeneous distribution. Volumetric quantification of viable tumor demonstrated better agreement between readers and yielded different results compared with mRECIST.

### **SSC16-09 • Estimation of the Prognosis of Hepatocellular Carcinoma Treated with Hepatic Arterial Chemoembolization: Comparison of Nine Prognostic Staging Systems**

**Yasutaka Baba MD (Presenter) ; Sadao Hayashi MD ; Shunichiro Ikeda BS ; Masayuki Nakajo PhD**

#### PURPOSE

To examine various prognostic staging systems estimating the prognosis of patients with hepatocellular carcinoma (HCC) treated with hepatic arterial chemoembolization (HACE).

#### METHOD AND MATERIALS

The subjects were 1040 patients (Male:714 , Female:326 ) with the mean age of 67.5 (range, 17 - 93 years) treated with HACE for HCC from January 1990 to December 2009. HACE was principally done selectively using anticancer drugs mixing with iodized-oil and gelatin sponge. Factors determining survival were analyzed by univariate and multivariate analyses using the Kaplan-Meier method and Cox proportional hazard regression models. Nine prognostic staging systems (Child Pugh classification[CPC], UICC TNM, Japan Integrated Staging score [JIS], Okuda score [Okuda], Cancer of the Liver Italian Program [CLIP], Barcelona Clinic Liver Cancer [Barcelona], Japanese TNM [JTNM], Japanese Liver Damage[JLD], Tokyo score[Tokyo]) were compared about the discriminatory capacity, which was tested by the linear trend. Moreover, the likelihood ratio test was used to investigate the additional homogeneity of survival within scores.

#### RESULTS

The mean survival period was 33 months. In a multivariate analysis, tumor number ( $\geq 4$ ), tumor diameter ( $\geq 3$ cm), vascular invasion (+), ascites (+), albumin(

#### CONCLUSION

CLIP was the most informative prognostic staging system for estimating the long term survival of patients with HCC treated with HACE.

#### CLINICAL RELEVANCE/APPLICATION

Among 9 prognostic staging systems, CLIP may be the most important prognostic system for estimating the prognosis of patients with HCC treated with HACE.

## **Vascular/Interventional - Monday Posters and Exhibits (12:15pm - 12:45pm)**

### **Monday, 12:15 PM - 12:45 PM • Lakeside Learning Center**



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#### **LL-VIS-MOA • AMA PRA Category 1 Credit™:0.5**

##### **Host**

**Sarah B White , MD**

#### **LL-VIS-MO1A • Low Dose Runoff CTA: Effect of Hybrid Iterative Reconstruction Technique on Quantitative and Qualitative Image Parameters**

**Evgeny Kondratyev MD (Presenter) ; Grigory Karmazanovsky MD ; Vadim Shirokov ; Anna Kalinina**

#### PURPOSE

To evaluate the effect of hybrid iterative reconstruction (HIR) on qualitative and quantitative parameters of data obtained using low dose run-off CTA.

#### METHOD AND MATERIALS

90 patients were divided into three groups. The scanning protocol was 120kVp 200mAs in first group, 80kVp 200mAs in second group, and 120kV 50mAs in third group, data from second and third group was reconstructed using both FBP and three levels of HIR. For quantitative and qualitative evaluation we used effective dose, visual scores (1-3), mean arterial attenuation, noise, contrast-to-noise ratio (CNR) in three arterial segments.

#### RESULTS

The BMI ranged from 21 to 38 kg/m<sup>2</sup> and was not significantly different between groups ( $p > 0.05$ ). The mean intraarterial attenuation was significantly higher in second group ( $448 \pm 76$ HU,  $p$

#### CONCLUSION

Average radiation dose reduction up to 77% was achieved using 80kV and 50mAs protocol providing sufficient image quality. Application of the 80kV protocol in people with BMI  $> 30$  is limited, especially in evaluation of aorto-iliac segment due to higher noise and attenuation levels. While at 50mAs protocol such limitation is not observed. Iterative reconstruction significantly improve image quality, reduce noise and artifacts, allowing us to expand indications for low-dose studies, including overweight and obese patients.

#### CLINICAL RELEVANCE/APPLICATION

Low dose run-off CTA of peripheral vessels using 80kV or 50mAs and hybrid iterative reconstruction provides up to 77% dose reduction and sufficient image quality.

#### **LL-VIS-MO2A • Optimal Scanning Parameters for Non-contrast-enhanced Time-spatial Labeling Inversion-pulse MR Angiography of Renal Arteries**

**Xuan Wang MD (Presenter) ; Huadan Xue MD ; Zhengyu Jin MD ; Xinzhi Zhao**

#### PURPOSE

To study the impact of inversion time(TI), respiratory rate(RR) and slice thickness(ST) on image quality and acquisition time for non-contrast-enhanced (non-CE) renal MR Angiography with true steady-state free-precession (SSFP) and time spatial labeling inversion pulse (Time-SLIP).

#### METHOD AND MATERIALS

Two sets of young healthy adults were examined. Voice recorder was applied to regulate RR. Set A contained 23 subjects. Six Time-SLIP sequences were performed on each subject, with a fixed TI of 1200ms. For three coronal sequences, the RR was free, 10 and 15 breaths per minute(bpm) respectively, with a ST of 2.5mm. For three axial sequences, the ST and RR settings were 2.0mm with free breath, 2.0mm with 10 bpm and 2.5mm with 10bpm respectively. Set B contained 22 subjects. Four coronal sequences with different TI were performed, as 700, 900, 1200 and 1500 ms respectively. The ST and RR were fixed as 2.5mm and 15 bpm.

#### RESULTS

Set A (Figure) showed that a RR of 15bpm setting demonstrated superior quality to free breathing one. It also had significantly shorter scan time without decreased image quality compared to RR of 10bpm. For ST comparison, 2.5mm had shorter time than 2.0 mm without loss of image quality. Set B showed a TI of 900ms had better image quality than others with significant differences in most of the comparisons.

#### CONCLUSION

Non-CE TIME-SLIP MRA showed excellent visualization of renal arteries. A protocol with RR of 15bpm and ST of 2.5mm is favorable since it can both shorten the acquisition time and improve image quality. For young health adults, A TI of 900 ms is the optimal choice.

#### CLINICAL RELEVANCE/APPLICATION

The optimal parameters determined from this study could improve image quality and shorten scan time for non-CE renal MR angiography.

### LL-VIS-MO3A • Remodeling of Focal Contrast Enhancement Communicating with Aortic Branch Arteries in Intramural Hematoma

**Kumi Ozaki** (Presenter) ; **Hiroshi Ohtake** ; **Toshifumi Gabata** MD ; **Yoshihiro Sanda** ; **Tetsuya Fukuda** ; **Yoshiaki Morita** ; **Masahiro Higashi** MD ; **Hiroaki Naito** MD, PhD

#### PURPOSE

To analyze the prevalence, location, morphology, and remodeling of focal contrast enhancement communicating with aortic branch arteries in acute intramural hematoma (IMH) and compare findings with those of focal contrast enhancement not communicating with aortic branch arteries.

#### METHOD AND MATERIALS

#### RESULTS

There were 104 communicating lesions in 52 patients and 72 non-communicating lesions (corresponding approximately to ulcer-like projection) in 63 patients. Communicating lesions were frequently seen (38.5%), and more than one communicating lesion was seen in the majority of patients (68.8% vs. 11.1%, p

#### CONCLUSION

In intramural hematoma, most regions of focal contrast enhancement communicating with aortic branch arteries are completely or partially resorbed during follow-up, and are not associated with intervention.

#### CLINICAL RELEVANCE/APPLICATION

In intramural hematoma, most regions of focal contrast enhancement communicating with aortic branch arteries are completely or partially resorbed, and are not associated with intervention.

### LL-VIS-MO4A • Developments of New Percutaneous Lithotripsy Techniques for Removal of Common Bile Duct Stones

**Baojie Wei** MD, PhD (Presenter) ; **Yanfeng Meng** MD ; **Feng Zhang** MD, PhD ; **Xia Wu** ; **Patrick Willis** ; **RenYou Zhai** MD ; **Wayne L Monsky** MD, PhD \* ; **Xiaoming Yang** MD, PhD

#### PURPOSE

To develop new techniques for percutaneous removal of common bile duct (CBD) stones using three lithotripsy systems, including a pneumatic, an electrohydraulic, and an electromagnetic lithotripters with various stone catchers.

#### METHOD AND MATERIALS

For in-vitro confirmation, a water phantom with a 6.0mm glass tube was built to simulate the cystic duct and CBD. A human gallstone was placed into the tube. An 11 Fr custom balloon occlusion sheath (BOS) was positioned and inflated to occlude the proximal tube. A stone catcher of the three lithotripsy systems was advanced through the BOS into the tube, to grasp the stone and then restrict it within the XCOIL encapsulator (XE) or a basket. A lithotripsy probe was advanced into the XE or basket, where the stone was broken. Fragments were then extracted through the BOS. Each of three lithotripsy procedures was repeated for 10 times. For in-vivo validation, via a transcystic approach, human gallstones were implanted into CBDs of 21 pigs (7 pigs×3 lithotripsy systems). Under fluoroscopy, a stone catcher and a lithotripsy probe of three lithotripsy systems were placed into the CBD, to break and remove the stone. Pre- and post-cholangiograms were obtained to confirm the successes of the implantation, breaking and removal of these stones. After the experiments, the pigs were euthanized and CBDs were harvested for histology.

#### RESULTS

Of the in-vitro experiment, an average pulse at 9.5 were required to break these stones. The average skin-to-skin lithotripsy time was 6.5 min. The average stone fragment length was at 2.1 mm compared to the pre-lithotripsy stone length at 5.1 mm (p

#### CONCLUSION

The three new lithotripsy techniques are feasible and safe for breaking and removal of CBD stones, which establishes groundwork for their further clinical application.

#### CLINICAL RELEVANCE/APPLICATION

The development of these percutaneous lithotripsy techniques may open new avenues to efficiently remove common bile duct stones.

### LL-VIS-MO5A • Bimodal Treatment of Aerobic and Glycolytic Metabolism by Particle Embolization Combined with Anti-glycolytic Compound Improves Treatment of N1-S1 Hepatocellular Mouse Model

**John R Haaga** MD (Presenter) ; **Hanping Wu** MD, PhD

#### PURPOSE

To determine if combination treatment of aerobic metabolism by embolization and antiglycolytic drugs compared to embolization alone provides better treatment of N1-S1 hepatocellular carcinoma in a rat model.

#### METHOD AND MATERIALS

Two separate laparotomies were performed, one for subcapsular tumor implant and the second for retrograde placement of catheter into the gastroduodenal artery for 5 different treatments. Treatments were: 1) Control (n=5, 1ml NS); 2) TAE (n=4, 10mg 50-150µm PVA particle in 1ml NS), 3) TAE+AG-B (n=5, 10mg PVA in 1ml AG-B); 4) TAE+AG-F (n=5, 10mg PVA+30mg AG-F in 1 ml NS); 5) TAE+AG-C (n=5, 10mg PVA+30mg AG-C in 1 ml normal saline). Tumor length (L), width (W), and height (H) was measured by 2D-ultrasound before treatment and twice a week till 4 weeks after treatment. Tumor volume (V) was calculated by the formula:  $V = 0.5 * L * W * H$ . Relative tumor volume after treatment was calculated as the percentage of pre-treatment tumor volume. Kruskal-Wallis test was used to compare the difference of relative tumor volume between 5 groups on each observation time point.

#### RESULTS

The initial tumor sizes in each group were statistically not significantly different. Three animals in the control group were euthanized before the end of observation due to rapid tumor growth and anorexia. In TAE group, one kept growing after treatment. In other 3 animals, the tumor volume increased in the early observation time points (1 within 1 week, 2 within 2 weeks) and then shrunk. In other 3 TAE+AG groups, the tumor volumes decreased after treatment with significant differences between control group and 3 TAE+AG groups on all observation time point except TAE+AG-F group on 3.5 and 4 weeks. At 4 weeks after treatment, the median relative tumor volumes were 3,174.5% in control group, 58.2% in TAE group, 9.6% in TAE+AG-B group, 23.8% in TAE+AG-F group, and 13.4% in TAE+AG-C group.

#### CONCLUSION

Bimodal embolic treatment of hepatocellular cancer is more effective than embolic Rx alone. Further study of these propriety agents is warranted because agents target enzymes specific to cancer. Optimization of drug form, dose and route administration (IV, oral) are needed. Safety studies must be completed before human use.

#### CLINICAL RELEVANCE/APPLICATION

Clinical relevance is enormous. Agents should be effective against all cancers with little effect on normal tissues. Mode of delivery can be arterial, intravenous and/or oral. Challenge is funding.

## LL-VIE-MO6A • Angio-CT System: Reasons Why It is Useful in Non-vascular Interventions

**Miyuki Sone MD (Presenter) ; Yasuaki Arai MD \* ; Yoshito Takeuchi MD ; Shunsuke Sugawara ; Hirotaka Tomimatsu ; Shinichi Morita ; Daisuke Okamoto MD**

### PURPOSE/AIM

Angio-CT system is equipment combining c-arm angiography system and CT scanner with a same sliding table. The aims of this exhibit are:

1. To review the reasons why Angio-CT is useful in non-vascular interventions
2. To provide a case-based review of challenging non-vascular interventions using Angio-CT

### CONTENT ORGANIZATION

1. Background of image guidance in non-vascular interventions

- Treatment target does not always have anatomical landmark or baseline for needle puncture
- Fluoroscopy is superior in guiding device manipulation with its real-time capability
- CT is superior in confirming the position of the target and the device with its cross-sectional and 3-D information

2. Reasons why Angio-CT is useful

- Planning of access with CT, manipulation of device with fluoroscopy, and confirmation with CT can be performed alternately and repeatedly
- In the absence of anatomical landmark, a fine needle is used as a baseline and accurate puncture can be performed with tandem technique

3. Case-based review of challenging procedures

- Use of anatomical landmark
- Use of tandem technique
- Spacing vital organs from the target

### SUMMARY

Angio-CT is useful in non-vascular interventions because alternate use of fluoroscopy and CT is available. This exhibit reviews the features of Angio-CT and its clinical use.

## LL-VIE-MO7A • Parastomal Varices: Diagnosis, Treatment, and Outcomes

**Annie K Lim DO (Presenter) ; Joshua D Dowell MD, PhD ; Gregory E Guy MD ; Bill S Majdalany MD**

### PURPOSE/AIM

To review the epidemiology, diagnosis, and various treatment methods for parastomal varices.

### CONTENT ORGANIZATION

Epidemiology and pathophysiology of parastomal varices will be reviewed. The numerous methods that have been described in the literature for treatment include: direct compression, medical optimization, percutaneous or transhepatic embolization, TIPS, surgical stomal revision, and superficial sclerotherapy. Each therapeutic option has associated complications and contraindications. Current literature and outcome data will be reviewed and an algorithm for patient specific treatment approach will be proposed.

### SUMMARY

Esophageal and gastric varices are a common manifestation of portal hypertension with an accepted treatment algorithm. Already, 30% of patients with both portal hypertension and urinary or enteric diversion will develop parastomal varices. With the advent of life prolonging treatments, which can give rise to portal hypertension, this population may increase. Although bleeding from these varices has a relatively low overall mortality, significant morbidity exists in the form of repeated hospitalizations and transfusions. Patient specific treatment approach is reviewed.

## LL-VIE1289-MOA • Irreversible Electroporation in the Abdomen: A Primer for Interventionalists

**Avinash R Kambadakone MD, FRCR (Presenter) ; Raul N Uppot MD ; Rahmi Oklu MD, PhD ; Debra A Gervais MD \* ; Ronald S Arellano MD**

### PURPOSE/AIM

Irreversible electroporation is an exciting new technology which is finding increasing applications in the treatment of tumors of the liver, kidney and the pancreas. The purpose of this exhibit is to discuss the principles, indications, technique and performance of irreversible electroporation in the abdomen using a pictorial review.

### CONTENT ORGANIZATION

1. Brief review of the principles and technique of irreversible electroporation
2. Discuss the relevant anatomical considerations for successful performance of IRE
3. Discuss the indications for IRE in various tumors in the liver, kidney and pancreas
4. Describe the step-by-step interventional technique for CT guided IRE.
5. Illustrate the technique by citing examples from routine and challenging cases in a pictorial review with the tips and tricks for successful placement.
5. Discuss the patient care issues before, during and after procedure including management of complications

### SUMMARY

Irreversible electroporation is an exciting new technology with immense potential in the treatment of hepatic, pancreatic and renal tumors. A proper understanding of the indications, principles and technique of this procedure is essential to ensure a successful outcome.

## LL-VIE1288-MOA • Chest Complications of Abdominal Interventions

**Florian J Fintelmann MD (Presenter) ; Selim R Butros MD ; Subba R Digumarthy MD ; Ashraf Thabet MD ; Jo-Anne O Shepard MD \* ; Debra A Gervais MD \* ; Diane A Levis ; Peter R Mueller MD \***

### PURPOSE/AIM

A variety of abdominal interventions can result in complications in the chest. Our exhibit presents a pictorial illustration of such procedures with their respective intrathoracic complications. Preventive measures and management will be discussed.

### CONTENT ORGANIZATION

1. Review anatomy of upper abdomen in relationship to pleural space and mediastinal structures. 2. Illustrate fundamentals of abdominal procedures with potential chest complications:

- Ablation of liver, kidneys or adrenal glands
- Biopsy of liver, kidneys, adrenal glands or retroperitoneum
- Biliary drainage, nephrostomy, and right and left subphrenic abscess drainage

3. Examples of thoracic complications such as pneumothorax, hemothorax, empyema, pericardial tamponade, and leak of bile, lymph or urine into the pleural space. 4. Discussion of pre- and intra-procedural preventive measures such as patient positioning, gantry angulation and hydrodissection. 5. Discussion of management of said complications.

## SUMMARY

This exhibit educates interventional radiologists how to prevent, recognize and manage chest complications related to a variety of abdominal procedures.

## Vascular/Interventional - Monday Posters and Exhibits (12:45pm - 1:15pm)

Monday, 12:45 PM - 01:15 PM • Lakeside Learning Center

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LL-VIS-MOB • AMA PRA Category 1 Credit™:0.5

### LL-VIS-MO1B • Comparison of Conventional and Simulated Reduced-tube Current MDCT for Evaluation of Endovascular Aortic Aneurysm Repair: A Pilot Study

Ryan H Sydnor MD (Presenter) ; Kingshuk Roychoudhury ; Claire A Bridges ; Jared D Christensen MD ; Carlos J Guevara MD ; Amy M Neville MD ; Tony P Smith MD ; David R Sopko MD ; Donald P Frush MD

#### PURPOSE

To assess the impact of simulated CT tube current reduction on radiologists' interpretation of CT angiograms (CTAs) following endovascular repair (EVAR) of the abdominal aorta.

#### METHOD AND MATERIALS

The gold standard for this study consisted of 45 standard-dose CTA examinations (64-slice GE VCT, 2 x 128-slice Siemens SOMATOM Definition Flash; non-contrast and arterial phase contrast-enhanced scans of the abdomen and pelvis) performed for evaluation of the aorta following EVAR. Of these, 26 underwent simulated 50% mA reduction and 29 underwent simulated 75% mA reduction using a validated mA reduction (noise insertion) software program. Three blinded, experienced faculty radiologists interpreted the 100 randomized studies for the presence of an endoleak, endoleak type, maximum aortic measurements, and subjective level of noise. Finally, reader confidence in detecting or excluding an endoleak was recorded for each image set.

#### RESULTS

Using the consensus vote (Y or N) regarding the presence of an endoleak for each full-dose examination as the gold standard, 81% (21/26) of simulated 50% mA-reduction and 76% (22/29) of simulated 75% mA-reduction scans were positive for endoleak. Sensitivity for endoleak diagnosis was not significantly different at 82% with 50% mA reduction and 89% with 75% mA reduction. Reader agreement for the presence of endoleak for the full-mA, 50% mA-reduction and 75% mA-reduction exams was 57%, 55% and 64%, respectively; thus, agreement did not significantly change with decreasing CT dose. Mean absolute measurement error for aortic cross-sectional area (cm<sup>2</sup>) was 4.4 for the 75% mA-reduced exams, compared to 2.4 for the 50% mA-reduced exams ( $p < 0.001$ , repeated measures ANOVA). Reader confidence decreased as the mA decreased, with average ratings of 4.73 for 100% mA, 4.66 for 50% mA and 4.32 for 25% mA exams ( $p < 0.001$ ).

#### CONCLUSION

The results of this pilot study did not show a significant reduction in endoleak detection with simulated CT dose reduction; however, a follow-up study with a larger sample size may be necessary in order to detect significant differences with subtle leaks. Decreasing dose did result, however, in a significant decrease in reader confidence and increase in average measurement error.

#### CLINICAL RELEVANCE/APPLICATION

In order to minimize cumulative radiation dose, it is important to establish CT dose reduction thresholds above which diagnostic image quality can be maintained.

### LL-VIS-MO2B • Effect of Sorafenib Combined with Transcatheter Arterial Embolization on the Therapeutic Outcome of Rabbit Hepatic Tumors

Lingxiang Ruan PhD, MD (Presenter) ; Shunliang Xu ; Jingfeng Zhang PhD, MD

#### PURPOSE

Transcatheter arterial embolization (TAE) could result in more severe hypoxia and affected the microcirculation of hepatic tumor, which lead to tumor recurrence and metastasis at some extent. Sorafenib, the first systemic drug approved for advanced hepatocellular carcinoma (HCC) patients, is mainly used for the prevention of HCC recurrence and metastasis. Tumor micro-circulation has a close relationship with the growth, development, invasion, metastasis and prognosis of hepatic carcinoma. This study was to verify the hypothesis that sorafenib combined with TAE could improve the therapeutic outcome of pure TAE.

#### METHOD AND MATERIALS

A total of twenty-four New Zealand White rabbits were successfully implanted with VX2 tumor in liver and divided into three group at random, such as pure Lipiodol-based TAE group (n = 8), sorafenib combined with TAE group (n = 8) and pure sorafenib group (n = 8). Tumors were received TAE with Lipiodol, and / or oral administration of sorafenib after implanting for two weeks. One, two, and four weeks after TAE, animals were humanely killed, and tumor samples were collected for immunohistochemical staining with CD34. Expression level of HIF-1 $\alpha$  protein was evaluated, and micro vascular density (MVD) was calculated.

#### RESULTS

#### CONCLUSION

Sorafenib suppressed the development of tumor recurrence and metastasis through extracellular signal-regulated kinase signaling caused by elevated levels of growth factors, which could enhance the therapeutic outcome in combination with TAE against liver tumors.

#### CLINICAL RELEVANCE/APPLICATION

Sorafenib could enhance the therapeutic outcome in combination with TAE against liver tumors.

### LL-VIS-MO3B • Evaluation of Portal Vein System in Patients after Liver Transplantation by Unenhanced MR Angiography Using Spatial Labeling with Multiple Inversion Pulses Sequence and by CT Portography

Hao Tang (Presenter) ; Daoyu Hu MD, PhD ; Zi Wang

#### PURPOSE

The objective of this study was to evaluate the diagnostic performance of unenhanced MR Angiography using spatial labeling with multiple inversion pulses sequence (SLEEK) in comparison with CT portography in the detection of Portal Vein System in patients with liver transplantation.

#### METHOD AND MATERIALS

22 patients, 21 men and 1 women (mean age 44.3 years; age range, 15-51 years). Unenhanced MRA using SLEEK was performed on a 1.5-T MRI system for assessing portal vein system in 22 patients with liver transplantation. Then all patients underwent 16-slice CT portography within 1-4 days. The ability to present the portal vein system and to reveal portal vein system disease with SLEEK was evaluated by two experienced radiologists and was compared with CT portography results using a joint reading performed in consensus.

#### RESULTS



22 patients with liver transplantation underwent SLEEK MRA. A total of 20 portal veins were successfully assessed, including 16 normal portal veins, 4 with stenoses. Nineteen of the 20 patients were performed end-to-end anastomosis between the donor's and recipient's portal veins. One of the 20 patients was performed end-to-end anastomosis between the donor's portal vein and recipient's inferior vena cava. There was excellent correlation between SLEEK and CT portography in presenting the diameter of portal vein ( $r = 0.92$ ;  $p < 0.05$ ). SLEEK was superior to CT portography in revealing the third- and fourth-order segmental branches in the hepatic parenchyma ( $p < 0.05$ ). SLEEK has the advantage of avoiding interference from ribs, arterial and venous system enhancement.

#### CONCLUSION

The SLEEK has a comparable ability in demonstrating portal vein system in patients with liver transplantation as well as CT portography does. It can provide helpful information for surgeons to make an accurate postoperative assessment. Unenhanced MRA using SLEEK is relatively inexpensive and is not associated with renal complications. It can be as a good choice for screening portal vein system in patients with liver transplantation, especially in patients with renal insufficiency.

#### CLINICAL RELEVANCE/APPLICATION

The SLEEK has a comparable ability in demonstrating portal vein system in patients with liver transplantation as well as CT portography does. It can provide helpful information for surgeons to make an

### LL-VIS-MO4B • Study on a Combined Protocol of Chemoembolization and Microwave Ablation: Treatment of Hepatocellular Carcinoma in Rats

**Thomas J Vogl MD, PhD (Presenter) ; Jun Qian MD ; Ulli Imlau ; Yousef Hamidavi ; Huedayi Korkusuz MD ; Elsie Oppermann ; Wolf-Otto Bechstein**

#### PURPOSE

To assess the effect of transcatheter arterial chemoembolization (TACE) combined with microwave ablation for the treatment of hepatocellular carcinoma in an animal model.

#### METHOD AND MATERIALS

All experiments were approved by the German government and the institutional animal research review board. After subcapsular liver implantation of Morris Hepatoma 3924A in 30 ACI rats, the animals were randomly assigned to three interventional treatment groups as follows: (A) TACE (0.1 mg of mitomycin + 0.1 ml of lipiodol + 5.0 mg of degradable starch microspheres) + microwave ablation (2450MHz; 35 W, 45 s) (n=10); (B) TACE alone (control group 1, n=10); (C) microwave ablation alone (control group 2, n=10). Tumor volume before (V1) and after the treatment (V2) was assessed by MRI and the tumor growth ratio (V2/V1) was calculated. Immunohistochemical analysis was performed for quantification of positive MMP-9 and VEGF tumor cells in each treatment.

#### RESULTS

Mean tumor growth ratio was  $1.3385 \pm 0.1949$  in group A,  $3.1901 \pm 0.1323$  in group B, and  $4.1779 \pm 0.1862$  in group C, respectively. Compared with the ratio in groups B and C (controls), the ratio in group A showed significant reduction in tumor growth (P

#### CONCLUSION

Treatment with combined TACE/microwave ablation, compared with the treatment of TACE or microwave ablation alone, significantly inhibits tumor growth and intrahepatic metastases in an animal model of hepatocellular carcinoma.

#### CLINICAL RELEVANCE/APPLICATION

Transarterial chemoembolization in combination with microwave ablation are relevant treatment options in hepatocellular carcinoma

### LL-VIS-MO5B • Quantification of Lower Leg Arterial Calcifications by High-Resolution Peripheral Quantitative Computed Tomography (HR-pQCT)

**Janina M Patsch MD, PhD (Presenter) ; Martin A Zulliger \* ; Gundula Edelhauser MD ; Thomas M Link MD, PhD \* ; Michael Weber ; Christian Loewe MD \***

#### PURPOSE

HR-pQCT is a low-radiation-dose, in-vivo research tool primarily designed for the assessment of bone geometry, density and microarchitecture of the distal extremities. Vascular calcifications are frequently observed as incidental findings but quantitative analysis of vascular calcifications captured by HR-pQCT has not been performed yet. The objectives of our study were to validate a quantitative tool for the assessment of lower leg arterial calcifications (LLAC) by HR-pQCT and to test method reliability.

#### METHOD AND MATERIALS

#### RESULTS

Agatston score was low in 24% (0-10HU), intermediate in 35% (11-400HU), and high in 41% of patients (>400HU). 76% had LLAC in HR-pQCT. Comparing LLAC (HR-pQCT) and CAC (MDCT), there were positive correlations between LLAC mass and CAC as measured by Agatston score, mass score, and volume score (Spearman's  $\rho=0.6$ ;

#### CONCLUSION

#### CLINICAL RELEVANCE/APPLICATION

Based on low radiation dose and significant associations with CAC, LLAC assessment might be a novel, patient-friendly, quantitative measure applicable to epidemiological and cardiovascular research.

### LL-VIE-MO6B • Applications of Dual-Energy CT in Vascular Imaging

**Sivasubramanian Srinivasan MD, FRCR (Presenter) ; Hui Seong Teh MBBS, FRCR ; Ashish Chawla MD, MBBS ; Jerome I Bosco MD, MBBS**

#### PURPOSE/AIM

To illustrate the usefulness of Dual-Energy computed tomography(CT) in imaging of vessels involving various anatomical region from head to extremities. To discuss the pitfalls of Dual energy CT

#### CONTENT ORGANIZATION

- Introduction.
- Review of Dual Energy CT in imaging the vessels of head and neck, chest, abdomen and pelvis and extremities with case examples.
- Virtual Non-contrast images, automated dual-energy bone removal and plaque removal.
- Advantages of advanced integrated tools(syngo.via™) with RIS-PACS which aid in faster and efficient post-processing techniques.
- Pitfalls.

#### SUMMARY

- Dual energy CT helps in faster post-processing with lesser radiation dose compared to the conventional CT angiography. Automated Dual-energy based bone removal tool is very effective especially in the head and neck, for elimination of the skull base. Plaque removal tool is highly useful in Carotid arteries and arteries of the lower extremities. Virtual non-contrast images are useful to rule out bleed, to assess extravascular structures and also to rule out hyperdense non-iodine material within the lumen. Pitfalls include incomplete bone subtraction in few areas, inefficient hard plaque removal in the infrapopliteal arteries and increased noise in obese patients.

## LL-VIE-MO7B • Current Percutaneous Vascular Closure Techniques and Associated Complications

**Amit Bhakoo MD (Presenter) ; Brandon P Olivieri MD ; Mohammed Ezuddin ; Anne Beasley ; Robert E Beasley MD**

### PURPOSE/AIM

An increase in the number of endovascular procedures performed over the past decade has led to the development of new techniques intended to improve the efficacy and safety of vascular closure. Knowing the mechanism of action, components, risk-benefit and complication profiles unique to each closure technique is important for the reduction of adverse events. Further, an understanding of imaging findings and treatment options for vascular access-related complications is crucial for safe patient care.

### CONTENT ORGANIZATION

Compare and contrast mechanisms of action of current vascular closure techniques.

Review risk-benefit profiles of closure techniques (manual compression, hemostasis pads, compression devices, passive and active vascular closure devices).

Describe multimodality imaging findings and treatment options of vascular access complications (pseudoaneurysm, arteriovenous fistula, access site/retroperitoneal hematoma, and arterial dissection/occlusion).

### SUMMARY

Having a thorough understanding of various closure techniques is important for the reduction of adverse events in endovascular procedures. The participant will gain understanding of the efficacy, complication and risk-benefit profiles for currently available percutaneous vascular closure techniques, as well as the imaging findings and treatment options of their associated complications.

## Cardiac CT Mentored Case Review: Part III (In Conjunction with the North American Society for Cardiac Imaging) (An Interactive Session)

**Monday, 01:30 PM - 03:05 PM • S406A**



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**MSMC23 • AMA PRA Category 1 Credit™:1.5 • ARRT Category A+ Credit:1.5**

### Moderator

**James P Earls , MD \***

### Moderator

**U. Joseph Schoepf , MD \***

## MSMC23A • Pulmonary Veins and Pericardium

**Jacobo Kirsch MD (Presenter)**

### LEARNING OBJECTIVES

1) Describe normal versus anomalous pulmonary venous anatomy. 2) Understand the imaging findings of complications of ablation for atrial fibrillation. 3) Describe abnormalities of the pulmonary veins identifiable on routine CT. 4) Identify the most common pericardial abnormalities evaluated with CT.

## MSMC23B • Coronary Artery Disease III: Native Vessel Disease

**Elliot K Fishman MD (Presenter) \***

### LEARNING OBJECTIVES

1) Understand pathology of the native coronary arteries beyond simple plaque disease. Topics will include coronary artery aneurysms, anomalies, and fistulae. 2) How to optimize the study performance and interpretation will be addressed as well.

### ABSTRACT

The goal of this session is to learn how to interpret pathology involving the coronary arteries beyond the detection of coronary artery stenosis. Focus on exam acquisition protocols, study interpretation protocols, and minimizing radiation dose are addressed. Specific topics addressed will also include coronary artery aneurysm, myocardial bridging, anomalous coronary arteries as well as vasculitis. Potential pitfalls will be addressed and pearls for study optimization will also be discussed.

## Cardiac CT Mentored Case Review: Part IV (In Conjunction with the North American Society for Cardiac Imaging) (An Interactive Session)

**Monday, 03:30 PM - 06:00 PM • S406A**



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**MSMC24 • AMA PRA Category 1 Credit™:2.5 • ARRT Category A+ Credit:3**

### Moderator

**Arthur E Stillman , MD, PhD**

### Moderator

**Frank J Rybicki , MD, PhD \***

### LEARNING OBJECTIVES

1) To understand the clinical indications for retrospective ECG gated cardiac CT. 2) To illustrate methods to assess myocardial function from cine cardiac CT images. 3) To illustrate methods to assess normal and abnormal valvular function from cine cardiac CT images.

### ABSTRACT

The mentored case review provides the opportunity for the attendees to learn the image acquisition, post-processing, and diagnosis for a wide variety of cardiac diseases commonly encountered in CT.

## MSMC24A • Coronary Artery Disease and Incidental Noncardiac Findings

**Jill E Jacobs MD (Presenter)**

### LEARNING OBJECTIVES

1) Identify and evaluate coronary plaques and stenosis. 2) Identify and characterize common incidental extracardiac findings on coronary CT angiography.

## MSMC24B • Adult Congenital Heart Disease

**S. Bruce Greenberg MD (Presenter)**

### LEARNING OBJECTIVES

1) Understand the increasing incidence and morbidity of congenital heart disease in adults. 2) Understand the long term complications of treated and untreated congenital heart disease. 3) Describe CT techniques for imaging adults with congenital heart disease. 4) Demonstrate morphologic changes in the heart and great vessels in untreated, palliated and corrected congenital heart disease.

## MSMC24C • Coronary Artery Disease IV: Native Vessel Disease and Arterial and Venous Bypass Grafts

**Harold I Litt MD, PhD (Presenter) \***

### LEARNING OBJECTIVES

1) Identify focal areas of stenosis in the coronary arteries on CT. 2) Understand how to minimize artifacts to improve accuracy on coronary CT. 3) Describe common extracardiac incidental findings on coronary CT.

### ABSTRACT

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## Acute Abdominal Vascular Diseases

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**Tuesday, 08:30 AM - 10:00 AM • E350**

**CT VA GI**

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**RC312 • AMA PRA Category 1 Credit™:1.5 • ARRT Category A+ Credit:1.5**

### RC312A • Aortic Branch Dissections

**Dominik Fleischmann MD (Presenter) \***

### LEARNING OBJECTIVES

1) Review the epidemiology of aortic side-branch dissections, which can occur as a complication of aortic dissection, or as isolated spontaneous dissections of the visceral or renal arteries. 2) Explain the pathophysiology of side branch malperfusion syndromes. 3) Present the key imaging features which distinguish between the two main mechanisms of side branch malperfusion: local obstruction versus inflow obstruction.

### ABSTRACT

Dissections of aortic side branches is a common complication of Type A and Type B acute aortic dissection which substantially increases mortality. It is important to understand the pathophysiology and the two principle mechanisms of side branch malperfusion in aortic dissection: flow obstruction can be due to (A) local abnormalities, such as occlusive dissection flaps, blind ending false lumen with true lumen occlusion ('windsock'), or frank thrombosis. Side-branch malperfusion may also occur due to (B) limited inflow: The classic situation is complete true lumen collapse in the upstream aorta, resulting in underperfusion of all downstream branches supplied by the true lumen. While local obstructions are most commonly treated by stent placement into the diseased side branch, inflow-lesions typically require surgical or endovascular repair of the upstream aorta. Spontaneous dissections of the celiac, mesenteric, or renal arteries are relatively rare events, and typically present with acute abdominal or flank pain. Dissections of side branch arteries can lead to ischemic complications or to frank rupture. Patients presenting with mesenteric or renal artery dissection require a thorough workup to identify genetic disorders (notably Ehlers Danlos IV), inflammatory conditions (vasculitis), and other entities such as fibromuscular dysplasia and segmental arterial mediolysis (SAM).

### RC312B • Symptomatic Aneurysms

**W. Dennis Foley MD (Presenter)**

### LEARNING OBJECTIVES

1) To detail the anatomic location and clinical presentation of symptomatic aneurysms. 2) To review appropriate imaging strategies using CT angiography. 3) To emphasize physiologic support and patient monitoring while in the imaging environment. 4) To utilize appropriate anatomic coverage in CT angiography procedures for both the diagnosis of symptomatic aneurysms and surgical and endovascular planning. 5) To detail the role of 2D and 3D image processing in the emergency situation for anatomic diagnosis and treatment planning.

### ABSTRACT

Symptomatic aneurysms cover the spectrum of arterial aneurysms presenting with a) localized symptoms secondary to aneurysm expansion and possible rupture b) regional symptoms secondary to dissection and embolism and c) systemic cardiovascular dysfunction related to hypotension and organ dysfunction. Common clinical scenarios include aneurysm rupture ♦ most commonly abdominal aortic, popliteal and abdominal visceral aneurysms as well as thoracoabdominal aortic dissection. Symptomatic aneurysms may also occur in patients with known arterial pathology including connective tissue disorders such as Marfan ♦s and Ehlers-Danlos syndrome and Takayasu aortitis/arteritis. Patients with suspected rupture of abdominal aortic or iliofemoropopliteal artery aneurysms may initially be evaluated by sonography. However, in all circumstances, CT angiography due to its robust implementation and high-resolution imaging of the vasculature and regional anatomy that allows for planning of endovascular and surgical intervention is the preferred technique. CT Angiographic protocols appropriate to the suspected anatomic location of the aneurysm that provide an adequate roadmap for endovascular or surgical intervention are employed. Extended coverage is particularly important in patients with suspected thoracoabdominal aortic dissection or aneurysms associated with peripheral embolism. Cardiac gating should be utilized in any patient with a suspected type A aortic dissection or rupture of an ascending aortic aneurysm. Aortic, cardiac and coronary artery imaging are integral to the evaluation and management of these patients. A particular subset of the ♦symptomatic aneurysm♦ is post-trauma aortic disruption, usually thoracic in which diagnosis of traumatic aneurysm is critical and the aneurysm is associated with additional sites of soft tissue and skeletal trauma. Guidelines for endovascular or surgical intervention or non invasive management with serial CT Angiographic imaging will be discussed.

### RC312C • Mesenteric Ischemia

**Iain D Kirkpatrick MD (Presenter)**

### LEARNING OBJECTIVES

1) Discuss the various categories of mesenteric ischemia (arterial occlusive, embolic, venous thrombotic, and nonocclusive), and the pathophysiologic basis behind the imaging findings in each case. 2) Understand the basis behind modern CT protocols for mesenteric ischemia, particularly the biphasic examination with CT mesenteric angiography. 3) Demonstrate techniques to rapidly analyze a mesenteric CT angiographic dataset. 4) Review the CT signs of mesenteric ischemia and their sensitivity and specificity. 5) Evaluate the current literature on mesenteric ischemia and discuss optimal diagnostic criteria.

### ABSTRACT

Acute mesenteric ischemia (AMI) is a life-threatening condition said to affect up to 1% of patients presenting with an acute abdomen, and it carries a mortality rate ranging between 59-93% in the published literature. Time to diagnosis and surgical treatment are the only factors which have been shown to improve mortality, and evidence shows that the clear test of choice for AMI is now biphasic CT. Water is preferably administered as a negative contrast agent, followed by CT mesenteric angiography and then a portal venous phase exam. Diagnostic accuracy is significantly improved by analysis of the CT angiogram for arterial stenoses or occlusions, evidence of emboli, or angiographic criteria of nonocclusive ischemia. It is the use of CT angiography in addition to routine portal phase imaging which has pushed the sensitivity and specificity of the test to >90% in recent published articles. Other nonangiographic CT findings that are relatively specific for AMI in the appropriate clinical setting include pneumatosis intestinalis, portal or mesenteric venous gas or thrombosis, and decreased bowel wall enhancement. Bowel wall thickening, mesenteric stranding, ascites, and mucosal hyperenhancement are more nonspecific findings which may also be seen. Nonocclusive ischemia may be the most difficult form to diagnose, and findings of shock abdomen can aid in identification. Knowledge of the patient's clinical history is critical not only for the selection of an appropriate study protocol but also for interpretation of the imaging findings in context.

## RC312D • CTA of Gastrointestinal Bleeding

**Jorge A Soto MD (Presenter) \***

### LEARNING OBJECTIVES

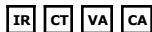
1) To review the appropriate implementation of CT angiography in the evaluation of patients presenting with acute lower intestinal bleeding. 2) To describe the technical details that are necessary for acquiring good quality CT angiography examinations. 3) Illustrate the characteristic CT angiographic findings of active or recent bleeding with specific examples of multiple etiologies.

### ABSTRACT

Acute gastrointestinal bleeding is a serious condition that may threaten a patient's life depending on the severity and duration of the event. Precise identification of the location, source and cause of bleeding are the primary objective of the diagnostic evaluation. Implementation of colonoscopy in the emergency setting poses multiple challenges, especially the inability to adequately cleanse the colon and poor visualization owing to the presence of intraluminal blood clots. Scintigraphy with technetium 99m-labeled red blood cells is highly sensitive but also has some limitations, such as the inability to precisely localize the source of bleeding and determine its cause. Properly performed and interpreted CT angiography examinations offer logistical and diagnostic advantages in the detection of active hemorrhage. A three-phase examination (non-contrast, arterial and portal venous) is typically performed. Potential technical and interpretation pitfalls should be considered and will be explained. The information derived from CT angiography helps direct therapy and select the most appropriate hemostatic intervention (when necessary): endoscopic, angiographic, or surgical. Precise anatomic localization of the bleeding point also allows a targeted endovascular embolization. The high diagnostic performance of CT angiography makes this test a good alternative for the initial emergent evaluation of patients with acute lower intestinal bleeding.

## Cardiac CT Angiography (A Practical Guide) (How-to Workshop)

**Tuesday, 08:30 AM - 10:00 AM • E260**



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**RC350 • AMA PRA Category 1 Credit™:1.5 • ARRT Category A+ Credit:1.5**

**Moderator**

**Alison Wilcox, MD \***

### RC350A • Pre-, Peri-, and Postprocedural Care of Cardiac CT Angiography Patients

**Bonnie Garon MD (Presenter)**

### LEARNING OBJECTIVES

1) Review preprocedural patient preparation including appropriate patient selection, beta blockade, contraindications and alternatives beta blockers. 2) Discuss how to manage nonstandard patients (atrial fibrillation, pacemaker, young adults). 3) Periprocedural issues including vasodilation, continued heart rate control, and breathholding requirements. 4) Image acquisition including radiation dose reduction techniques, technique choice, and post CABG patient. 5) Postprocedural complications include contrast reactions and their management.

### ABSTRACT

Cardiac CTA involve slightly more preparation than the standard CT acquisition. Heart rate control is the most important aspect that needs to be addressed prior to the patient arriving in the radiology department. Periprocedural issues mostly involved how to optimize technique while having the lowest radiation dose especially in the new age of dose reduction. Almost as important as heart rate management is how to treat postprocedural complications especially contrast reactions. This presentation will discuss these aspects and include treatment options as well as their alternatives.

### RC350B • Clinical Indications for Cardiac CT Angiography

**Alison Wilcox MD (Presenter) \***

### LEARNING OBJECTIVES

1) What is some of the history behind the indications for cardiac CTA. 2) What are the resources available to decide what the clinical indications are for cardiac CTA which may affect reimbursement and patient care. 3) Effectively deliver information to referring clinicians about the uses of cardiac CTA. 4) Discuss indications for cardiac cta in the ED. 5) Some examples of these clinical indications and how they can be applied in daily practice.

### ABSTRACT

Although there are many studies that prove the usefulness and cost-effectiveness of cardiac CTA, there remains some skepticism in the medical community. Medicare and other private insurance company reimbursements have limited the use of cardiac CTA. Radiologists and referring clinicians need to be aware of the clinical indications for cardiac CTA and what resources are available to them to make these decisions. The resources are available both from radiology and cardiology groups, as well as from the government. This presentation will discuss those resources and provide examples of those indications. In addition a brief discussion of Cardiac CTA in the ED will be included as a potential use to improve patient care and reduce cost to the ED.

### RC350C • Nonatherosclerotic Disease Noted at Cardiac CT Angiography

**Jabi E Shriki MD (Presenter)**

### LEARNING OBJECTIVES

1) Enhance knowledge of normal and abnormal coronary and cardiac anatomy, with an emphasis on differentiating benign from significant variants. 2) Demonstrate the spectrum of nonatherosclerotic congenital and acquired diseases that may affect the coronary arteries. 3) Demonstrate the spectrum of non-atherosclerotic congenital and acquired diseases that may affect the heart.

### ABSTRACT

A variety of non-atherosclerotic conditions are detectable on cardiac CT scans, including diseases of the heart, and disease processes which may affect the coronary arteries, or other vascular structures. Cardiac CT has a number of unique advantages in detecting non-atherosclerotic conditions, including congenital and acquired diseases. The focus of this presentation will be non-atherosclerotic conditions of the coronary arteries and of the heart. Variants of normal and abnormal anatomy of the coronary arteries will be discussed, including tips for identifying when coronary anatomic variants are significant. Acquired, non-atherosclerotic diseases of the coronary arteries will also be discussed. This presentation will also discuss the spectrum of non-atherosclerotic diseases of the heart which may be detected at cardiac CT, including congenital and acquired valvular and cardiac diseases. At the end of this exhibit, the viewer will have a better appreciation for abnormal coronary and cardiac anatomy and the broad spectrum of non-atherosclerotic cardiovascular diseases which may be seen at cardiac CT.

## Doppler US: Visceral, Extremity and Carotid Applications (Hands-on Workshop)

**Tuesday, 08:30 AM - 10:00 AM • E264**



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Shweta Bhatt, MD, MBBS  
Wui K Chong, MD \*  
M. Robert Dejong \*  
Vikram S Dogra, MD \*  
Corinne Deurdulian, MD  
Edward G Grant, MD \*  
Ulrike M Hamper, MD, MBA  
Felix A Hester  
Mark E Lockhart, MD  
Mani Montazemi  
Michelle L Robbin, MD \*  
Ravinder Sidhu, MD  
Leslie M Scoutt, MD \*  
Sadhna Verma, MD \*

#### LEARNING OBJECTIVES

1) Understand basic concepts associated with abdominal, extremity and carotid Doppler. 2) Describe ultrasound techniques, protocols, and diagnostic criteria for evaluation of the carotid arteries. 3) Gain experience in Doppler techniques through personalized hands-on scanning of models with a variety of ultrasound machines. 4) Describe common pitfalls in Doppler examinations.

#### ABSTRACT

This hands-on course will focus on the details that constitute good Doppler technique in the evaluation of vascular flow, specifically within the neck, extremities and abdomen. Technical considerations for optimization of Doppler images will be discussed and the concepts will be applied to abnormalities commonly encountered in patients. Initial brief lectures will begin by discussing common pitfalls in vascular imaging and then followed by basic concepts and techniques of renal Doppler. The majority of the session will give participants an opportunity to scan live models to improve technical skills in color and spectral Doppler. Faculty will be available at multiple stations using a variety of ultrasound machines. Participants will be encouraged to inquire about any areas of interest in the neck, abdomen, pelvis, or extremities during the hands-on component of the course.

URL's

umhamper@jhu.edu

## Interventional Radiology Series: Venous Disease

Tuesday, 08:30 AM - 12:00 PM • E351



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VSIR31 • AMA PRA Category 1 Credit™:3.25 • ARRT Category A+ Credit:3.75

#### Moderator

Scott O Trerotola, MD \*

#### LEARNING OBJECTIVES

1) Describe the use of radiofrequency wire in central venous occlusion. 2) Explain the current role of inferior vena caval filtration in venous disease. 3) Describe the steps involved in creating a quality improvement project related to inferior vena cava filter follow-up. 4) Outline the current approach to diagnosis and treatment of central venous stenosis. 5) Describe the rationale for adrenal vein sampling. 6) List 3 differences between the US and Europe in fistula use and how Fistula First has narrowed that gap.

### VSIR31-01 • Central Venous Stenosis - Why Does It Occur? How Can We Prevent It? Treatment With Conventional Tools

Dheeraj K Rajan MD (Presenter) \*

#### LEARNING OBJECTIVES

1) Describe common causes of central venous stenosis (CVS). 2) Describe preventative measures that may be undertaken to avoid CVS. 3) Describe common tools and techniques for treatment of CVS available to radiologists.

### VSIR31-02 • Central Venous Occlusion Treatment with RF Wire

Marcelo Guimaraes (Presenter) \*

#### LEARNING OBJECTIVES

1) Describe the radio-frequency wire technique in the recanalization of chronic and benign central venous occlusions.

#### ABSTRACT

Purpose: Central venous occlusion is not an infrequent problem in patients who had long-term venous catheters. The recanalization of CVOs using conventional techniques may fail in up to 24% of cases. The radiofrequency wire puncture technique was utilized in symptomatic patients. MandM: Between 2008-2013, 58 patients, ages 26-78 years, presented with swollen arm and/or face secondary to benign CVOs related to tunneled catheters. Coronal chest CTA was used to evaluate the central venous anatomy. First, a pericardium window is selected for potential cardiac tamponade drainage. Simultaneous upper extremity (brachial) and central venograms (femoral approach) are performed to define the CVO. Typically, the RF wire was advanced within a 5-Fr KMP catheter from the cranial venous stump towards a 10 mm snare placed in the caudal stump. The RF wire tip and the snare alignment was checked PA, RAO, LAO. If the RF wire puncture was inadequate, a new location was pursued. Pre-stent 4mm balloon PTA was followed by 9-12mm stent placement. Self-expandable stents were used in the subclavian-brachiocephalic transition and balloon-expandable stents were used in brachiocephalic or SVC lesions. Clinical and venogram F/U were scheduled at 3, 6, 9 and 12 months. Results: 56 patients were successfully treated with RF wire technique. One hemothorax and one cardiac tamponade were successfully treated with drain catheter placement without clinical repercussions. Resolution of symptoms was obtained in 51/56 patients treated in mean follow-up of 16 months. 5/56 patients had stent occluded at 3 months that required balloon angioplasty for successful recanalization and all had improvement of symptoms following the second intervention. Conclusion: RF wire technique is a good alternative in benign CVOs when conventional techniques have failed. It is an alternative in the management of symptomatic patients. Thorough technique must be used in the order to minimize potential complications.

### VSIR31-04 • Prophylactic Placement of an Inferior Vena Cava Filter during Endovenous Intervention for Acute Deep Venous Thrombosis of the Lower Extremity

So Hyun Park (Presenter) ; Se Hwan Kwon MD ; Joo Hyeong Oh MD ; Tae-Seok Seo ; Myung Gyu Song MD

#### PURPOSE

To evaluate the usefulness of an inferior vena cava (IVC) filter during endovenous intervention for acute deep vein thrombosis (DVT) in the lower extremity.

#### METHOD AND MATERIALS

We performed endovenous intervention in 106 patients (M:F=30:76; mean age, 59.8 years) with acute DVT in the lower extremity after placement of an IVC filter between July 2004 and December 2012. In all patients, aspiration thrombectomy was performed, and percutaneous transluminal angioplasty (PTA) or additional stent placement was carried out in six and 88 patients, respectively. We evaluated presence of a trapped thrombus in the IVC filter on final venograms obtained during the procedure (n=106) or on follow-up CT (n=55), respectively. The transverse length of the trapped thrombus was defined as four grades (1-4) divided by the IVC filter diameter

for each 25%. We also evaluated the relationship between thrombus trapping, stenosis of the iliac vein, extended thrombus in the IVC.

## RESULTS

A trapped thrombus in the IVC filter was detected in 46/106 patients (43%) on final venograms or on follow-up CT. A trapped thrombus in the IVC filter was detected in 8/12 patients (75%) after aspiration thrombectomy only, in 4/6 patients after additional PTA (67%), and 34/88 patients after additional stent placement (39%). A trapped thrombus in the IVC filter was observed on venograms in 35/106 patients (33%) and on follow-up CT in 25/55 patients (45%). In 25 trapped thrombi observed on CT images, 11 were not shown on final venograms and were newly detected on CT images. Thrombus sizes were grade 1 in four patients (8.7%), grade 2 in eight patients (17.4%), grade 3 in 22 patients (47.8%), and grade 4 in 12 patients (26.1%). Among 67 patients in whom DVT was detected on CT before the procedure, the incidences of a trapped thrombus in cases with or without an extended thrombus into the IVC on CT images were 13/17 (76.5%) and 18/50 (36.0%), respectively.

## CONCLUSION

Thrombus migration developed frequently during endovenous intervention in patients with DVT in the lower extremity, and IVC filter placement may be useful for prevention of pulmonary thromboembolism.

## CLINICAL RELEVANCE/APPLICATION

IVC filter placement may be useful for prevention of pulmonary thromboembolism.

### VSIR31-05 • IVC Filter Update

**John A Kaufman MD (Presenter) \***

#### LEARNING OBJECTIVES

View learning objectives under main course title.

### VSIR31-06 • Debate - When Should We Be Placing Permanent Filters?

**John A Kaufman MD (Presenter) \* ; Steven M Zangan MD (Presenter)**

#### LEARNING OBJECTIVES

View learning objectives under main course title.

### VSIR31-07 • Filter Follow-Up - PQI

**Steven M Zangan MD (Presenter)**

#### LEARNING OBJECTIVES

View learning objectives under main course title.

### VSIR31-08 • Utility of Preoperative Vascular Mapping to Select Patients at High Risk for Early Thigh Hemodialysis Graft Failure

**Mark D Little MD (Presenter) ; Michael Allon ; Michelle M McNamara MD ; Song Ong ; Mark E Lockhart MD ; Carlton Young ; Michelle L Robbin MD \***

#### PURPOSE

To determine whether noninvasive preoperative evaluation of vascular diameters and calcification can identify patients in whom arteriovenous thigh graft survival is likely to be impaired.

#### METHOD AND MATERIALS

Institutional review board approval was obtained and informed consent was waived. Retrospective analysis, including a qualitative assessment of calcification burden, was performed on 143 chronic hemodialysis patients who received ultrasound vascular mapping prior to thigh graft placement. Severity of pelvic arterial calcification was scored in 80 patients who received peri-operative computed tomography, using a semi-quantitative 5-point scale. Patient characteristics and graft outcomes were examined. Statistical analysis was performed on each group.

#### RESULTS

Preoperative ultrasound screening identified no or mild arterial calcification in 113 of 143 patients (79%) and moderate to severe calcification in 30 of 143 patients (21%). Patients with moderate to severe arterial calcification had significantly increased technical graft failure (hazard ratio=6.59; 95% CI, 2.06-21.05; p=0.002 by Fisher's exact test) and decreased cumulative graft survival (hazard ratio=2.32; 95% CI, 1.48-6.69, p= 0.003 by log rank test) compared to patients with no or mild disease. Cumulative graft survival was not associated with venous diameters (HR 1.06; 95% CI, 0.63-1.80, p=0.82) or arterial diameters (HR 1.19; 95% CI, 0.70-2.03, p=0.43). Low CT calcification score was seen in 74 of 80 hemodialysis patients (93%). Primary technical failure occurred in 3 of 6 patients (50%) with high versus 5 of 74 patients (6.8%) with low calcification score (hazard ratio=7.4; 95% CI, 2.31-23.72, p=0.01). US was more sensitive (64% versus 38%) but less specific (83% versus 96%) than CT in predicting immediate technical graft failure. Positive predictive value of CT and US was 50% and 23%, respectively.

#### CONCLUSION

Preoperative sonographic assessment of thigh vessel diameter and calcification can select patients who need further CT assessment of pelvic calcifications to identify those at higher risk for primary technical graft failure and decreased cumulative graft survival.

#### CLINICAL RELEVANCE/APPLICATION

US can identify moderate or severe arterial calcification where pelvic CT may aid site selection to lessen early technical failure, thereby improving long term hemodialysis thigh graft survival.

### VSIR31-09 • Updates in Dialysis

**Luc A Turmel-Rodrigues MD (Presenter)**

#### LEARNING OBJECTIVES

1) Explain the role of fistula maturation procedures in access intervention and their results. 2) Outline the arguments for and against prophylactic PTA of failing access. 3) Describe recent evidence concerning the use of stent-grafts in failing hemodialysis grafts. 4) Describe three methods of fistula declotting. 5) Describe differences between the US and Europe in fistula use and how Fistula First has narrowed that gap. 6) Explain why many believe a ♦Catheter Last♦ approach may be even more important than ♦Fistula First♦.

#### ABSTRACT

Purpose: to provide information about new radiologic techniques and concepts in the management of dialysis access complications.

Materials and Methods: review of the recent international literature.

Results: In the field of pre-op mapping, non CE-MRA of upper limb vessels is feasible and might be helpful. Anatomy: high origin of forearm arteries is evidenced in 12.8% of patients. In the area of nonmaturing fistulas, cannulation of the elbow artery for angiographic evaluation is safe and effective, dilation of the radial artery gives way to durable results, embolization of venous ♦competing vessels♦ and ♦collaterals♦ is controversial. Dilation: the value of prophylactic dilations is controversial in prosthetic grafts and less controversial in autogenous fistulas. Minimally symptomatic and asymptomatic central vein stenoses/occlusions should not be treated. The value of coated balloons has to be confirmed. Stents: PTFE covered stents are helpful at the venous anastomosis of grafts although their value is controversial in the cephalic arch. Hand ischemia: look at the ulnar artery in forearm fistulas. Excess flow: the reliability and reproducibility of percutaneous banding has to be confirmed. Plugs can be used to occlude arteries, veins and fistulas. Thrombosis: percutaneous thrombectomy is cost-effective, surgical results are improving in autogenous fistulas. Central catheters: several reports of

arterial damages confirm that imaging guidance should be mandatory for insertion.  
Conclusion: recent publications show that our everyday practice is changing and that very few concepts are not subjects to controversy.

### **VSIR31-10 • Excellent Success Rate of Adrenal Venous Sampling after Simple Modification of Routine Protocol**

**Sadahiro Yamamura** (Presenter) ; **Yoshinori Shigematsu** ; **Koichi Yokoyama** ; **Osamu Ikeda MD** ; **Toshinori Hirai MD** ; **Yasuyuki Yamashita MD \***

#### **PURPOSE**

To evaluate efficacy of the modification of adrenal venous sampling (AVS) protocol in comparison with our previous results.

#### **METHOD AND MATERIALS**

Since 2009, 114 patients with primary aldosteronism were subjected to AVS conducted by a single radiologist. From the retrospective reviews of the first 72 patients, AVS protocol was modified and applied prospectively for the latter 42 patients. The criterion for biochemical successful catheterization was cortisol value of more than 200?g/dl and/or an adrenal vein/inferior vena cava cortisol ratio of greater than 5. The blood was drawn at the central adrenal veins with use of ACTH.

#### **RESULTS**

The biochemical success rate (BSR) for the first 72 patients was 91.7 % (66/72), and the causes of the failure in these 6 patients were analyzed. In all six patients, the procedures were unsuccessful on the right side. For 3 patients, the catheter tip slippage was seen during the sampling. Adrenal hemorrhage occurred in 8 patients and AVS was biochemically unsuccessful in 2.

For the latter patients, our routine AVS protocol was modified in two points. First, to avoid catheter tip slippage, the way of catheter tip settlement was changed. Before the modification, in case that the catheter tip was too deep into the adrenal vein, we had moved the tip of the 4F catheter by pulling the catheter. After modification, we moved the 4F catheter tip by pushing the adrenal venous wall with microguidewire through the 4F catheter. The blood was drawn through the space between the microguidewire and 4F catheter by using a Y-shape connector. Second, to avoid adrenal hemorrhage, we used a 5mm cylinder instead of a 10 ml cylinder when fumbling and injecting to the right adrenal vein.

In the latter 42 patients, the BSR was perfect. The incidence of the right adrenal hemorrhage decreased to 2.4 %.

#### **CONCLUSION**

Use of microguidewire, Y-shape connector and smaller cylinder of 5ml improved BSR of AVS with a low risk of right adrenal hemorrhage.

#### **CLINICAL RELEVANCE/APPLICATION**

AVS collecting whole adrenal venous blood with our method will improve the cure rate of the operated patients because it can also guarantee the normal adrenal function of the non-operated side.

### **VSIR31-11 • Non-contrast-Enhanced MR Imaging of Right Adrenal Vein for Adrenal Venous Sampling: Comparison with Multidetector CT Angiography**

**Hideki Ota MD, PhD** (Presenter) ; **Kei Takase** ; **Kazumasa Seiji MD, PhD** ; **Ryo Morimoto** ; **Fumitoshi Satoh MD, PhD** ; **Shoki Takahashi MD**

#### **PURPOSE**

Primary aldosteronism is the main cause of secondary hypertension in younger population and induces renal dysfunction. Adrenal venous sampling (AVS) is essential to localize unilateral or bilateral lesions causing primary aldosteronism. However, catheterization to the right adrenal vein is technically challenging due to its small size and anatomical variations. Identification of the right adrenal vein prior to AVS is important to achieve successful procedure. This study aims to compare detectability of the right adrenal vein by non-contrast-enhanced MR imaging at 3T and multidetector CT angiography.

#### **METHOD AND MATERIALS**

Consecutive 65 patients (mean age, 54.5, range 33-77) scheduled for AVS were included. Sixty-three patients underwent both MR and CT imaging. The remaining two underwent only MR imaging due to high risk of contrast-induced nephropathy. Three-dimensional respiratory-triggered true fast imaging with steady-state precession imaging was acquired in transverse section for MR imaging. Contrast-enhanced four-phase scanning was performed for CT imaging. On both modalities, image quality of the right adrenal vein was evaluated on a five-point scale (1=invisible, 5=excellent). Detectability and image quality were compared using McNemar's test or Wilcoxon signed ranks test.

#### **RESULTS**

Non-contrast enhanced MR imaging demonstrated right adrenal veins in 59 of the 65 patients (91%). In the 63 patients who underwent both examinations, the detectability of the right adrenal vein was significantly higher for CT than MR imaging (100% vs. 90%,  $p=0.04$ ). When all the patients scheduled for AVS were included, the detectability was not significantly different between both modalities ( $p=0.28$ ). CT demonstrated significantly higher image quality than MR imaging ( $p$

#### **CONCLUSION**

CT angiography is a reliable tool for detection of the right adrenal vein. When risks of radiation and contrast-induced complication were taken into account, non-invasive MR imaging becomes a first choice for planning of AVS.

#### **CLINICAL RELEVANCE/APPLICATION**

Non-contrast-enhanced MR as well as CT can demonstrate the right adrenal vein. MR exam is recommended for planning of AVS when risks of radiation and contrast-induced complication was taken into account

### **VSIR31-12 • Adrenal Vein Sampling: You Can Do This (Maybe)**

**Scott O Trotola MD** (Presenter) \*

#### **LEARNING OBJECTIVES**

1) Describe the laboratory profile of candidates for adrenal vein sampling in aldosteronism. 2) List characteristic features and tip-offs for identifying the adrenal veins. 3) Describe the catheter shapes that work most commonly for AVS. 4) Interpret a straightforward set of AVS results. 5) Explain the roles of lateralization index, selectivity index, and contralateral suppression in AVS.

#### **ABSTRACT**

Adrenal vein sampling, by far most commonly performed for aldosteronism, is experiencing a resurgence with recognition that the poor results of the past, particularly with right sided sampling, can be markedly improved with new techniques and materials. This presentation will focus on the technical aspects of AVS, with a strong focus on correct identification of the right and left adrenal veins as well as mimics which can undermine success. Recent advances aimed at improving results even for inexperienced operators will be discussed, including the roles of cone beam CT, preoperative CT, anatomic clues, rapid cortisol assays, and catheter optimization. Typical patient selection, patient preparation and results interpretation will be covered using a case presentation format. Strategies for developing an AVS program will be reviewed. The presentation will focus exclusively on aldosteronism, since other indications for AVS are rare.

### **VSIR31-13 • Wrap Up and Discussion**

#### **LEARNING OBJECTIVES**

View learning objectives under main course title.



**VSPD31** • AMA PRA Category 1 Credit™:3.25 • ARRT Category A+ Credit:3.5

**Moderator**

**Shreyas S Vasanawala**, MD, PhD \*

**Moderator**

**Taylor Chung**, MD

**Moderator**

**Daniel W Young**, MD

**VSPD31-01** • State of the Art MRI and MRI of Congenital Heart Disease

**Frandics P Chan** MD, PhD (Presenter) \*

LEARNING OBJECTIVES

1) To review the MRI environment and anesthesia requirements for pediatric patients with congenital heart disease. 2) To understand what MRI can do that echocardiography or catheter angiography cannot, and how this is used to advantage in congenital heart disease. 3) To explore advanced techniques, such as four-dimensional phase contrast imaging, real-time imaging, and non-contrast coronary angiography, that can expedite and increase the capability of cardiac MRI studies.

ABSTRACT

Cardiac MRI is an established imaging tool for the assessment of congenital heart disease in children and adults. The lack of oncogenic radiation makes MRI the preferred tool over CT. However, in young patients who require general anesthesia, the imager should be familiar with the risks involved. While usually safe, general anesthesia has heightened risk in patients with aortic obstruction, pulmonary hypertension, arrhythmia, and ventricular failure. In current clinical practice, the three-dimensional capability of cardiac MRI is used to accurately assess ventricular volume and function. Flow measurement by two-dimensional phase contrast is used to assess shunt ratio, cardiac output, and valvular regurgitation. Comprehensive cardiac MRI examination for a patient with complex congenital heart disease can be time-consuming, and it requires an MRI operator with considerable skill and knowledge of cardiac anatomy. Four-dimensional phase contrast imaging captures a volume of the cardiac anatomy and flow physiology, which can be analyzed by post-processing, thereby simplifying the scan protocol and shortening the study time. Other advanced MRI techniques include real-time and pseudo-gated imaging for fetal studies, delayed-enhancement of myocardium for endocardial fibroelastosis, and MR coronary angiography for coronary anomalies.

**VSPD31-02** • Clinical Validation of Free Breathing Navigator Triggered Retrospectively Cardiac Gated Cine Steady-state Free Precession (NAV-SSFP) Imaging in Sedated Children

**Lamya A Atweh** MD (Presenter) ; **Amol Pednekar** PhD \* ; **Siddharth P Jadhav** MD ; **Esbén S Vogelius** MD ; **Raja Muthupillai** PhD \* ; **Rajesh Krishnamurthy** MD \*

PURPOSE

The cine steady-state free precession (SSFP) is the preferred sequence for ventricular function evaluation, however it requires suspended respiration which is difficult in sedated children. Many groups perform multi-NSA acquisitions (MN) during free breathing. In this work, we validate a navigator triggered SSFP (NAV-SSFP) sequence that drives the magnetization to steady-state before cardiac gated cine acquisition in the sedated free-breathing pediatric population.

METHOD AND MATERIALS

This prospective study was performed with IRB approval on 20 sedated children with congenital heart disease (age: 7±6 yrs, HR: 97±22 bpm, RespR: 22±9 bpm). The cine SSFP sequence was modified to include respiratory triggering with Navigator [1]. Imaging was performed on a 1.5T MR scanner. Identical imaging parameters were used for MN (4 NSA) and NAV sequences, covering both ventricles in short-axis orientation (TR/TE/flip angle: 3/1.5/60°; acquired voxel size: 1.3-1.6 x 1.3-1.8 x 4-9.5 mm<sup>3</sup>; SENSE acceleration factor: 2; temporal resolution: 30-45 ms). Image quality assessment (Figure 1) and quantitative volumetric analysis was performed by a single blinded user. One-sided Wilcoxon signed rank test and Box plot analysis were performed to compare the clinical scores. Bland-Altman (BA) analysis was performed on LV and RV volumes.

RESULTS

The clinical scores for NAV-SSFP were consistently better than MN-SSFP (Table 1). Total score with equal weights to each clinical score category was significantly better for NAV compared to MN. EDef scores were significantly better for NAV-SSFP than MN-SSFP. ISA scores were identical. The BMC scores were not significantly different. BA analysis for LV volumes indicates that variability between NAV and MN acquisitions is comparable to inter and intra-observer variability reported in the literature (Table 2) [2]. Total scan duration for NAV-SSFP (4.1±1.6 min) was shorter than MN-SSFP (5.2±0.8 min).

CONCLUSION

Modifying the cardiac gated cine SSFP sequence for free-breathing and navigator triggering allows clinically diagnostic images in sedated patients without penalty for contrast, spatio-temporal resolution, or total scan time while significantly decreasing RF duty cycle and improving spatial detail. 1 ISMRM 3938, 2012 2 JMRI 28(39-50), 2008

CLINICAL RELEVANCE/APPLICATION

Free-breathing navigator triggered cine SSFP allows diagnostic images in sedated patients with improved spatial resolution and shorter scan times.

**VSPD31-03** • Noninvasive 4D Pressure Difference Mapping Derived from 4D Flow MRI in Patients with Repaired Aortic Coarctation: Comparison with Young Healthy Volunteers

**Fabian Rengier** MD (Presenter) ; **Michael Delles** DiplEng ; **Joachim Eichhorn** MD ; **Hendrik Von Tengg-Kobligh** MD \* ; **Hans-Ulrich Kauczor** MD \* ; **Roland Unterhinninghofen** PhD ; **Sebastian Ley** MD

PURPOSE

In patients with aortic coarctation, pressure measurements before and after repair currently are obtained by invasive catheterization or by echocardiography using the Bernoulli equation. Purpose of this study was to assess spatial and temporal pressure changes in patients with repaired aortic coarctation compared to young healthy volunteers using 4D flow MRI and derived 4D pressure difference maps.

METHOD AND MATERIALS

4D flow MRI of the thoracic aorta was performed at 1.5T in 13 patients after aortic coarctation repair without recoarctation (mean age 18.8 years, 5 female, 8 male) and 13 healthy volunteers (mean age 22.9 years, 4 female, 9 male). Spatial/temporal resolution was 1.6x1.6x2.1mm<sup>3</sup>/28ms. Using published algorithms and in-house developed image processing software, 4D pressure difference maps relative to the proximal ascending aorta were computed based on the Navier-Stokes equation. The thoracic aorta was divided into four segments: ascending aorta, aortic arch, proximal descending aorta and distal descending aorta. For each segment, spatial pressure range at mid systole and maximum slope of local pressure amplitudes were calculated.

RESULTS

Mean spatial pressure range at mid systole for patients/volunteers was (in mmHg): ascending aorta 1.8/1.6 (p=ns), arch 4.8/1.7 (p=0.02), proximal descending 8.9/1.6 (p

CONCLUSION



Noninvasive 4D pressure difference mapping derived from 4D flow MRI showed significant spatial and temporal changes in patients with repaired aortic coarctation compared to young healthy volunteers, particularly affecting aortic arch and proximal descending aorta, but also distal descending aorta. The technique can characterize such changes not only noninvasively but also in greater detail than echocardiographic pressure gradient measurements.

#### CLINICAL RELEVANCE/APPLICATION

4D pressure difference mapping can characterize spatial and temporal changes of intraluminal aortic pressure and may evolve into a noninvasive alternative to catheterization in coarctation follow-up.

### VSPD31-04 • Assessment of Conduit Size prior to Percutaneous Pulmonary Valve Replacement: Which MR Sequence Is Best?

**Ladonna J Malone MD (Presenter) ; Jane Gralla ; Uyen Truong ; Brian Fonseca ; Thomas Fagan MD ; Lorna Browne MD, FRCR**

#### PURPOSE

The advent of percutaneous pulmonary valve replacement (PVR), providing a nonsurgical approach to the management of severe pulmonary regurgitation in patients with right ventricle to pulmonary artery (RV-PA) conduits, has transformed treatment of patients with repaired congenital heart disease. Cardiac MRI (CMR) is increasingly relied upon to determine candidacy for percutaneous PVR using angiographic size criteria. In order to optimize the CMR assessment, our goal was to determine which pulse sequence had the best agreement with conventional angiographic measurement of the right ventricle to pulmonary artery (RV-PA) conduit obtained during percutaneous PVR.

#### METHOD AND MATERIALS

15 patients had CMR performed prior to percutaneous PVR procedure. Measurements of the narrowest diameter of the RV-PA conduit were obtained on the following sequences: cine gradient echo (GE) at end-systole and at end-diastole, T1 TSE obtained in systole, 3D gadolinium enhanced MRA, and 3D SSFP. Multiplanar reformats using 3D reconstruction software were used to measure both AP and transverse dimensions on 3D sequences, but only AP diameters if an RVOT plane was obtained (cine GE and T1 TSE). These were compared to angiographic measurements using Bland Altman plots and Intraclass Correlation Coefficient (ICC).

#### RESULTS

Cine GE measurements at end-systole had the best agreement with angiogram with a mean difference of 0.8 mm (95% limits of agreement -3.86 to 5.46 and ICC 0.75). The AP dimension on 3D MRA also had a high ICC (0.85) and a relatively narrow 95% limits of agreement (-0.89-5.67), but demonstrated a consistent over-measurement bias with a mean difference from angiogram of 2.39 mm. The 3D SSFP measurements demonstrated the worst agreement, likely due to inherent artifacts in stenosed conduits. Slow flow artifact on T1 TSE impaired accurate measurement in irregularly calcified conduits.

#### CONCLUSION

RV-PA conduit measurements obtained from cine GE at end-systole and 3D MRA demonstrate strongest agreement with conventional angiographic measurements in evaluating percutaneous PVR candidacy.

#### CLINICAL RELEVANCE/APPLICATION

Standardization of RV-PA conduit measurements with improved angiographic agreement should decrease incidence of unsuccessful percutaneous PVR procedures related to failure to meet size criteria.

### VSPD31-05 • Noninvasive Quantification of Aortopulmonary Collateral Flow and Intracardiac Shunt Flow for the Patients who Underwent Bidirectional Glenn Shunting

**Rongpin Wang MD (Presenter) ; Qiping Deng MD ; Meiping Huang MD**

#### PURPOSE

To explore the feasibility of calculating aortopulmonary collateral flow (APCF) and intracardiac shunt flow (ICSF) in patients underwent bidirectional Glenn shunt (BGS) by using phase-contrast MRI (PC-MRI) sequence.

#### METHOD AND MATERIALS

Twenty-two BGS patients (patient group) and 15 healthy volunteers (control group) were performed at 3.0 tesla MR system by using PC-MRI sequence to measure the flow of great vessels of right pulmonary artery (RPA), left pulmonary artery (LPA), ascending aorta (AA), superior vena cava (SVC) and inferior vena cava (IVC). The quantity of AA ( $Q_A$ ), pulmonary ( $Q_P$ ) and venous return ( $Q_V$ ) per minute were calculated by using Report Card software. APCF and ICSF was calculated as the formula:  $APCF = Q_S - Q_V$ ,  $ICSF = 2Q_S - (Q_V + Q_P)$ . The end-diastolic volume index (EDVI) of major ventricle were performed with cine-MRI sequence, and the regurgitation area of atrioventricular valve were measured with ultrasound cardiography. The difference of  $Q_P$ ,  $Q_S$  and  $Q_V$  and blood flow of great vessels intragroup were assessed by using paired samples *t*-test. The relationship of ICSF with EDVI of major ventricle and with the regurgitation area of atrioventricular valve was evaluated with correlation and regression analysis.

#### RESULTS

In control group,  $Q_P$ :  $Q_S$ :  $Q_V$  were found to be 1: 1.009: 0.974. In patient group,  $Q_S$  was found significantly higher than  $Q_V$ , and  $Q_V$  was significantly higher than  $Q_P$ . The blood flow of great vessels in patient group were found to be significantly lower than that of in control group except the flow of AA, while the regurgitation fraction of great vessels in patient group were found to be significantly higher than that of in control group. The APCF ranged from 0.23 to 1.63 l/min/m<sup>2</sup> (mean 0.88 l/min/m<sup>2</sup>), and the ICSF ranged from 0.22 to 1.29 l/min/m<sup>2</sup> (mean 0.61 l/min/m<sup>2</sup>). A positive relationship between ICSF and EDVI and the regurgitation area of atrioventricular valve were found ( $r=0.685$ , and  $r=0.806$ ).

#### CONCLUSION

The parameters of blood flow of great vessels can be reliably measured with PC-MRI sequence on 3.0 tesla MR system. And then, the SPCF and ICSF can be calculated.

#### CLINICAL RELEVANCE/APPLICATION

The APCF and ICSF can be calculated simultaneously in BGS patients by using phase-contrast MRI sequence, which may play an important role for therapeutic decision-making and evaluating prognosis.

### VSPD31-06 • Evaluation of the Pulmonary Vasculature in Mouse Models of Congenital Diaphragmatic Hernias

**Michael Phillips ; Daku Siewe BS (Presenter) ; Joshua C Tan ; Scott Moore ; Sean McLean ; Yueh Z Lee MD, PhD \***

#### PURPOSE

Congenital diaphragmatic hernia (CDH) is a common birth defect that leads to pulmonary hypertension. Decreased arterial development in the lung contributes to the pulmonary hypertension observed in CDH. The Slit3 knockout mouse is a viable mouse model for CDH that develops pulmonary hypertension (PHtn). We sought to quantitatively assess pulmonary artery blood vessel development using specimen CT scanning of the perfused pulmonary vasculature of mouse models of CDH.

#### METHOD AND MATERIALS

We perfused the pulmonary vasculature of 3 month old Slit3 wild type mice (no hernia) to Slit3 knock mice (CDH/PHtn) using a radio-opaque material (microfil) with density tailored to minimize venous contamination. Vessel overfill was determined through examination by microscope. The mouse lungs with the filled vasculature were excised and scanned on a specimen scanner (Scanco microCT 40) at 8 micron resolution. The data was transferred for offline analysis using iNtuition (Terarecon). Vessel branching, length and diameter were measured.

#### RESULTS

5 wildtype (Slit3) and 5 CDH (Slit3 KO) were scanned. Severe hypoplasia was evident in the lungs from the CDH mice. Total lung volume was decreased in the knockout mice, consistent with the presence of a CDH. Vessel overfill The pulmonary vasculature was also altered, reflecting the abnormal development. Branch by branch vessel quantitation analysis is ongoing.

#### CONCLUSION

Quantitative analysis of pulmonary vasculature specimens from mice is readily feasible, providing a powerful new tool for the evaluation of mouse models of disease that affect the lung and lung development. We hope to combine our novel methods of in-vivo and ex-vivo imaging of these mouse models of CDH to add to the armamentum of pediatric radiologists. Though the imaging and analysis approaches are demonstrated in mice, the techniques may be readily translatable to clinically relevant imaging.

#### CLINICAL RELEVANCE/APPLICATION

Quantitative measures of the pulmonary vasculature are possible in mouse models of CDH, enabling a powerful tool for the evaluation of treatment effects that may be translated into children with CDH.

### **VSPD31-07 • High Temporal versus High Spatial Resolution in MR Quantitative Pulmonary Perfusion Imaging of 2-year Old Children after Congenital Diaphragmatic Hernia Repair**

**Meike Weidner** (Presenter) ; **Frank G Zoellner** ; **Claudia Hagelstein** MD ; **Stefan O Schoenberg** MD, PhD \* ; **Katrin Zahn** ; **Thomas Schaible** ; **Lothar R Schad** PhD ; **Wolfgang Neff** MD, PhD

#### PURPOSE

Congenital diaphragmatic hernia (CDH) leads to lung hypoplasia. Using dynamic contrast enhanced (DCE) MR imaging, lung perfusion can be quantified. As according to simulations absolute MR perfusion values depend on temporal resolution, we compared two different MR protocols to investigate firstly if impaired ipsilateral lung perfusion is present with both protocols in 2-year old children after CDH repair, secondly if simulation results can be confirmed and thirdly which protocol should be preferred.

#### METHOD AND MATERIALS

DCE-MRI was performed in 36 children after CDH repair using a 3D TWIST sequence. Two MR protocols were applied: protocol A (n=18) based on a high spatial (3.0sec; voxel size: 1.25x1.25x1.25mm<sup>3</sup>) and protocol B (n=18) on a high temporal resolution (1.5sec; voxel size: 2x2x2mm<sup>3</sup>). 0.05mmol/kg body weight of contrast agent (Dotarem, Guerbet, France) was administered. Pulmonary blood flow (PBF) was calculated for both lung sides by placing 6 cylindrical regions of interest (ROI), apical, middle and basal, in the ventral and the dorsal lung, respectively. Peak signal to noise ratio (PSNR) was calculated.

#### RESULTS

#### CONCLUSION

In 2-year old children after CDH repair ipsilateral lung perfusion is significantly reduced. Higher temporal resolution and increased voxel size show a gain of PSNR and significantly decrease the underestimation of PBF. Protocol B should therefore be preferred, as a 2 mm<sup>3</sup> isotropic voxel resolution is sufficient to detect side-differences of lung perfusion.

#### CLINICAL RELEVANCE/APPLICATION

In the long-term follow up of children after CDH, MR-perfusion imaging can help to quantify lung impairment without ionizing radiation. A temporal resolution of 1.5 sec is advisable.

### **VSPD31-08 • Translational Experience in the Treatment of Duchenne Muscular Dystrophy (DMD) by Intra-arterial Transplantation of Mesoangioblasts (MABs): From a Toxicity Study in 10 Beagle Dogs to the First, Phase-1 Study in 3 Dystrophic Children**

**Massimo Venturini** MD (Presenter) ; **Giulio Cossu** ; **Letterio S Politi** MD ; **Michele Colombo** ; **Giulia Agostini** ; **Alessandro Del Maschio** MD

#### PURPOSE

Literature lacks of complete, single-center translational studies. DMD, a genetic syndrome characterized by progressive absence of dystrophin protein, causes progressive muscle degeneration, paralysis and death. Corticosteroids are not effective, while novel therapies (gene/stem cells) are on work. Our aim was to assess MABs intra-arterial infusion in Beagle dogs and, subsequently, in 3 dystrophic children, at escalating dose, to preliminarily assess the safety.

#### METHOD AND MATERIALS

Every 3 weeks, 10 dogs, under immunosuppressive treatment (cyclosporine-A), were submitted to 4 intra-arterial infusions each (2 in one lower limb, 2 in aorta), of either MABs (n=6) or placebo (n=4). Dogs were sacrificed to assess toxicity after 251 days. One year later, after the approval on behalf of the institutional ethical committee and obtaining written informed consent from the children's parents, every 2 months 3 DMD children (mean age=10 years) under immunosuppressive treatment (tacrolimus) were submitted to 4 allogeneic MABs intra-arterial infusions each (2 in one lower limb, 2 multidistrict) using a 4-Fr introducer/catheter. Efficacy was assessed every 2 months by quantitative strength measurements (Kin-Com-test) and thighs/legs fibro-fatty degeneration/quantification (MRI), and after 8 months by gastrocnemius biopsies.

#### RESULTS

No mortality related to MABs in Beagle dogs was recorded. The 12 intra-arterial MABs infusions were regularly performed with no peri-procedural complications, except for one successfully treated vasospasm. The only relevant complication was 1 focal thalamic ischemia of 1-cm (MRI) that occurred 5 hours after the fourth infusion, after sporadic atrial fibrillation (ECG) (Atrial-fibrillation-related-thrombosis? Late vasospasm?), without consequences. Relative stabilization/decrease in disease progression was observed. At MRI, a stabilization of fibro-fatty degeneration was more evident in the child treated at an earlier disease stage.

#### CONCLUSION

Our translational experience about MABs intra-arterial transplantation in DMD, showed no signs of toxicity in beagle dogs and a relative safe and partial effective in dystrophic children, with encouraging future perspectives.

#### CLINICAL RELEVANCE/APPLICATION

In DMD, a major MABs intra-arterial concentration, transplanted exclusively in the lower limbs, at an early disease stage, could determine an improvement of dystrophin restoration and clinical impact.

### **VSPD31-09 • Coronary Artery Imaging in Children**

**Cynthia K Rigsby** MD (Presenter)

#### LEARNING OBJECTIVES

1) To provide an overview of the imaging modalities used to image coronary arteries in children. 2) To show examples of anomalies of coronary artery origin, course, and termination. 3) To illustrate coronary artery anomalies associated with congenital heart disease. 4) To demonstrate coronary artery findings in Kawasaki disease.

#### ABSTRACT

Coronary artery anomalies can be classified as anomalies of origin and course, anomalies of coronary termination, coronary anatomy with congenital heart disease and acquired coronary abnormalities. Normal coronary artery anatomy and an imaging focused discussion of each of the different type of coronary abnormalities will be presented.

### **VSPD31-10 • Correlation of CT and MR findings with Surgery for Anomalous Aortic Origin of Coronary Arteries (AAOCA)**

#### PURPOSE

Anomalous aortic origin of the coronary artery (AAOCA) is commonly evaluated with magnetic resonance imaging (MRI) or computed tomography (CT) prior to surgery. Imaging targets include ostial location and morphology, intramurality, and presence of proximal stenosis. Precise description of the AAOCA morphology is important for surgical planning. Our objective is to correlate CT and or MRI with surgical findings in this high-risk population.

#### METHOD AND MATERIALS

IRB approval was obtained for our retrospective study. We identified all patients with AAOCA who were operated at our institution from 2003-2013. Patients who had no imaging available for review were excluded. Imaging was reviewed by a pediatric radiologist with 13 years of experience in cardiac imaging who was blinded to the results of the surgeries. Studies were assessed for the type of AAOCA, location and morphology of the anomalous ostium, right-left ostial relationship, and presence and length of intramural course. Surgical findings were reviewed for the same variables. The imaging interpretations were compared to the surgical data for concordance.

#### RESULTS

The patient population consisted of 16 patients (M:F = 10:6; age: 10 years  $\pm$  5), with 8 CT and 10 MR exams. 2 patients had both MRI and CT. CT was more accurate than MRI for all imaging targets (Table). MRI accurately predicted the type of coronary artery anomaly (90%) and ostial location (80%), but fared poorly in predicting type of R-L ostial relationship (60%), ostial morphology (10%) and intramurality (30%). Apart from its high accuracy for imaging targets, CT also provided virtual angioscopic views of the ostia that simulated surgical exposure.

#### CONCLUSION

CT is more accurate than MRI for characterization of critical imaging targets of AAOCA.

#### CLINICAL RELEVANCE/APPLICATION

CT is more accurate than MRI in defining ostial morphology, ostial relationship and intramural course and should be the imaging method of choice for AAOCA.

### VSPD31-11 • Compression of the Left Anterior Descending Artery during Percutaneous Pulmonary Valve Replacement: The Protective Role of Epicardial Fat?

Ladonna J Malone MD (Presenter) ; Uyen Truong ; Brian Fonseca ; Thomas Fagan MD ; Lorna Browne MD, FRCR

#### PURPOSE

The advent of percutaneous pulmonary valve replacement (PVR), providing a nonsurgical approach to the management of severe pulmonary regurgitation in patients with right ventricle to pulmonary artery (RV-PA) conduits, has transformed treatment of patients with repaired congenital heart disease. Extrinsic compression of the left anterior descending artery (LAD) during percutaneous PVR is a rare but potentially catastrophic complication, necessitating preoperative selective coronary angiogram with test balloon inflation to assess risk. If LAD occlusion is demonstrated, the percutaneous PVR is aborted. Cardiac MRI (CMR) is the gold standard in measuring RV size and optimal timing of PVR. Although LAD anatomy is well delineated on CMR, the minimum separation between the RV-PA conduit and LAD that would prevent LAD compression is unknown.

#### METHOD AND MATERIALS

16 patients underwent CMR prior to percutaneous PVR. Prior to PVR, 2 patients demonstrated extrinsic compression of the LAD during test balloon inflation while the other 14 did not. CMRs in both groups were retrospectively reviewed and the following data recorded in each: i) shortest distance between LAD and RV- PA conduit, ii) presence of circumferential epicardial fat surrounding the LAD, iii) thickness of conduit calcification, iv) proximal LAD course and v) relative position of the great vessels. Mean distance and minimum distance between LAD and RV-PA conduit were calculated in all patients and parameters in both patient groups compared.

#### RESULTS

In patients without extrinsic LAD compression, the mean distance from LAD to RV-PA conduit was 6.8 mm. The minimum distance was 1.6 mm. All these patients demonstrated a circumferential cuff of epicardial fat between the LAD and RV-PA conduit. Both patients with LAD compression had no measurable distance (0 mm) between the conduit wall and LAD, and a circumferential cuff of epicardial fat was absent. There was no significant difference in conduit calcification thickness between the two groups.

#### CONCLUSION

A circumferential cuff of epicardial fat between the LAD and RV-PA conduit decreases risk of extrinsic LAD compression during percutaneous PVR.

#### CLINICAL RELEVANCE/APPLICATION

The absence of a circumferential cuff of epicardial fat between the LAD and RV-PA conduit on a pre PVR CMR should raise concern for potential LAD compression during percutaneous PVR.

### VSPD31-12 • Cardiovascular CT in Neonates and Infants: Comparison of Effective Radiation Dose between Target-mode Prospective EKG-gated Volumetric CT Using 320 Detector Scanner and Ungated CT Using 64-slice Scanner

Siddharth P Jadhav MD (Presenter) ; Prakash M Masand MD ; Rajesh Krishnamurthy MD \*

#### PURPOSE

The target mode of prospective EKG gating with the volumetric 320 detector scanner provides cardiac pulsation-related motion compensation for cardiovascular imaging without increasing radiation exposure when compared to ungated volumetric studies. The objective of this study is to compare target mode volumetric imaging (320) to ungated 64 slice imaging (64) for cardiovascular studies in neonates and infants for image quality, diagnostic efficacy and radiation exposure.

#### METHOD AND MATERIALS

Following IRB approval, a retrospective evaluation of our experience with CTA for cardiovascular indications in neonates and infants aged 0-6 months was performed. 29 patients who underwent ungated imaging with 64 slice scanner from 2010-2012, and 22 patients who underwent volumetric imaging with the target protocol on the 320 detector scanner in 2012-2013 were included. Parameters collected included clinical history, indication for CT, qualitative assessment of image noise and pulsation related blurring, diagnostic efficacy, and radiation dose parameters (CTDI and DLP). Comparison was made to catheterization data and surgical reports for diagnostic accuracy.

#### RESULTS

The distribution of clinical indications was comparable between the 64 and 320 groups, and included status of branch pulmonary arteries in Tetralogy of Fallot, evaluation of aortopulmonary collaterals or ductal dependent pulmonary flow in pulmonary atresia, anomalous pulmonary venous return, pulmonary vein stenosis, coarctation, heterotaxy, and vascular mediated airway compromise. All studies were diagnostic for the main clinical indication. Average DLP for target 320 studies was 11.6, with average effective dose of 0.75 mSv using conversion tables from ICRP publication 103. Average DLP for 64 slice studies was 63.88, with average effective dose of 4.31 mSv. The 320 studies resulted in higher image quality related to less pulsation artifact, with visualization of coronary origins in all but one case.

#### CONCLUSION

Volumetric imaging with the target mode offers several advantages over previous generation scanners for cardiovascular indications in infants, including a 82% reduction in effective dose, ability to perform free-breathing studies, and improved image quality.

#### CLINICAL RELEVANCE/APPLICATION

Volumetric imaging with target-mode of EKG gating offers improved image quality and reduced radiation dose when compared to 64 slice

CT for cardiovascular imaging in neonates and infants.

### **VSPD31-13 • Radiation Dose and Image Quality Comparison of Three Scan Schemes in Retrospective ECG-gated Coronary CT Angiography for Pediatric Patients**

**Zhiming Liu MD (Presenter) ; Yong Li Cao ; Yun Peng MD**

#### **PURPOSE**

Retrospective ECG-gated coronary CT angiography (CCTA) is often used in children because of their higher heart rates. In this study, we assessed the image quality and radiation dose of three scan schemes in order to select an optimal retrospective CCTA technique for maximum dose reduction.

#### **METHOD AND MATERIALS**

60 consecutive patients (ages: 2months - 13years) were randomly assigned to three groups (20 in each group) for retrospectively ECG-gated CCTA with different tube current (mA) selection schemes. The tube voltage was 80kV, gantry rotation speed was 0.35s and helical pitches were between 0.16 and 0.20 based on patient heart rates for all groups. Group A used a fixed 350mA, group B used ECG modulated mA (350mA for 40-80% cardiac phases and 70mA for other phases), and group C also applied patient-dependent mA selection scheme for ECG modulation. The patient-dependent mA selection method was based on the CT value measurement in the scout view for individual patients. Image quality was assessed and image noise and CTDI value were measured for the three groups, and statistically compared with SPSS13.0.

#### **RESULTS**

Image noises and their standard deviations were  $25.5 \pm 4.3$  HU,  $25.0 \pm 4.8$  HU and  $24.8 \pm 1.2$  HU, respectively, with no difference among the three groups ( $p > 0.05$ ). Group C had much less deviation in image noise than groups A and B. There were no statistical difference between image quality scores among the three groups ( $4.3 \pm 0.4$ ,  $4.4 \pm 0.3$  and  $4.5 \pm 0.4$ , all  $p > 0.05$ ). The effective doses were 4.39mSv, 3.23mSv and 2.34mSv for groups A, B and C, respectively. Dose reductions of 26% and 47% were achieved for groups B and C, respectively, compared with group A with the use of a fixed mA. Group C with the patient-dependent mA for ECG modulation had the lowest effective dose.

#### **CONCLUSION**

Patient-dependent tube current scheme in retrospective CCTA for pediatric patients allows us to achieve a desired and consistent image quality across patient population, with the lowest radiation dose to patients.

#### **CLINICAL RELEVANCE/APPLICATION**

Low kVp and patient-dependent mA in retrospective CCTA for pediatric patients allows us to achieve a consistent image quality across patient population, with the lowest radiation dose to patients.

### **VSPD31-14 • Head Tracked Stereoscopic Pre-surgical Evaluation of Major Aortopulmonary Collateral Arteries in the Newborns**

**Frandics P Chan MD, PhD (Presenter) \* ; Sergio Aguirre \* ; Holly Bauser-Heaton MD, PhD ; Frank Hanley MD ; Stanton B Perry MD**

#### **PURPOSE**

Children born with pulmonary atresia (PA) with major aortopulmonary collateral arteries (MAPCA) undergo early surgery to reconstruct their central pulmonary arteries. This surgery, unifocalization, requires precise mapping of all native vessels supplying the lungs and this is currently accomplished by catheter angiography (CA), with supplemental 3D information from CTA. As each patient has his unique vascular anatomy, visual comprehension can be extremely challenging. A recently developed head tracked stereoscopic system, True 3D, helps user manipulate and inspect holographic objects in free space. We test the hypotheses that interpretation of CTA in MAPCA cases using True 3D is faster than and as accurate as traditional tomographic readout.

#### **METHOD AND MATERIALS**

With IRB approval, newborns less than 10-days old diagnosed with PA and MAPCA, who had CA and CTA of the chest within 2 weeks, were identified between 2007 and 2011. The CA images were evaluated by an experienced cardiologist for the origins and destinations of each native pulmonary artery and MAPCA to the lung segments. The CTA images were similarly scored by a cardiac radiologist using traditional tomographic readout and True 3D in two sessions separated by 4 weeks. Using CA as the reference standard, sensitivity, specificity, accuracy, these two approaches were calculated. Interpretation times were compared using paired Student's t-test.

#### **RESULTS**

9 newborns (mean weight 3.2kg) produced 25 traceable MAPCAs in addition to native pulmonary arteries. Using an 18-segments lung model, 774 distinct vessel-segment combinations were compared. The sensitivity, specificity, and accuracy of tomographic readout are 81%, 93% and 91% respectively. For True 3D, they are 90%, 91% and 91% respectively. The average time for interpretation is significantly shorter with True 3D, 13 +/- 4 min, than with tomographic readout, 22 +/- 7 min ( $P = 0.0004$ ).

#### **CONCLUSION**

This preliminary study demonstrates that head tracked stereoscopic interpretation of complex, minute pulmonary vessels in the newborn is as accurate as traditional readout. The interpretation time is significantly faster with True 3D, and this is likely due to enhanced visual cognition using the stereoscopic approach.

#### **CLINICAL RELEVANCE/APPLICATION**

Advanced digital stereoscopy enhances visual cognition of complex anatomic relationship and is recommended for the evaluation of congenital anomalies of the pulmonary vasculature.

### **VSPD31-15 • Determining the Normal Aorta Size in Infants and Children**

**S. Bruce Greenberg MD ; Shilpa Hegde MD (Presenter) ; Shelly Lensing**

#### **PURPOSE**

No adequate standards for determining the normal range of effective diameters of the aorta or iliac arteries in children using CT or MRI exist. Our purpose is to establish normal standards for the effective diameter of the aorta at multiple levels and of the iliac artery origins.

#### **METHOD AND MATERIALS**

Chest, abdomen and pelvis computed tomography examinations with intravenous contrast performed in children without cardiovascular disease provided the data sets. Body surface area (BSA) was calculated from patient height and weight for each patient. Children age ranged from 0 to 20 years (mean 9.5 years, sd 5.7). Body surface area ranged from 0.2 to 2.5 meter<sup>2</sup> (mean 1.23 meter<sup>2</sup>, sd 0.59). Chest measurements were performed on 88 children and abdomen measurements on 110 children. Double-oblique 1 mm reconstructions were used to measure aorta and iliac artery effective diameter at multiple locations by two pediatric radiologists. Pearson correlation and linear regression compared the body surface area and effective diameter measurements.

#### **RESULTS**

The results are summarized in the table. Very strong correlation between BSA and effective diameter were present at all measured levels of the aorta and the iliac arteries. The derived linear regression equations and beta standard error are included in the table. **Aorta or iliac artery level Pearson correlation Effective diameter (mm) Beta S.E.** aorta annulus 0.94 10 + (7.8) BSA 0.30 sinus of Valsalva 0.93 11.8 + (9.5) BSA 0.41 STJ 0.90 8.9 + (8.2) BSA 0.43 Ascending aorta 0.91 9.1 + (8.6) BSA 0.43 Aorta arch 0.93 6.8 + (8.2) BSA 0.35 Isthmus 0.94 6.5 + (7.1) BSA 0.29 Prox desc aorta 0.93 6.5 + (6.6) BSA 0.29 Aorta at diaphragm 0.93 6.2 + (5.2) BSA 0.24 Superior to celiac axis 0.92 5.8 + (5.2) BSA 0.22 Renal artery level 0.91 4.2 + (5.0) BSA 0.22 Distal abdominal aorta 0.91 4.0 + (4.6) BSA 0.21 Right iliac artery 0.88 2.8 + (3.2) BSA 0.17 Left iliac artery 0.89 2.9 + (3.1) BSA 0.16

#### CONCLUSION

The expected effective diameter for children of any expected body surface area can be calculated from the equations at 8 levels in the chest and three levels in the abdomen. The common iliac artery effective diameters can also be calculated.

#### CLINICAL RELEVANCE/APPLICATION

The linear regression analysis equations allow radiologists to quantitatively determine if the aorta is hypoplastic or aneurysmal in children rather than rely on subjective impression.

### VSPD31-16 • Imaging of Adolescents and Young Adults with Congenital Heart Disease

**Lorna Browne MD, FRCR (Presenter)**

#### LEARNING OBJECTIVES

1) Describe the relevant complex cardiac anatomy encountered in CHD adolescents and young adults, many of whom have undergone prior surgical repairs. 2) Describe the most likely lesions encountered in CHD adolescents and young adults. 3) Discuss some common surgical repairs and encountered complications. 4) Determine appropriate MR protocols for evaluating congenital heart disease according to the anatomic, pathologic, and hemodynamic characteristics of the defect and type of previous surgical repair. 5) Discuss the main clinical questions that are specifically posed in individual cases of pre and post operative CHD in adolescents and young adults.

## Vascular/Interventional - Tuesday Posters and Exhibits (12:15pm - 12:45pm)

Tuesday, 12:15 PM - 12:45 PM • Lakeside Learning Center

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**LL-VIS-TUA • AMA PRA Category 1 Credit™:0.5**

**Host**

**Albert A Nemcek, MD \***

### LL-VIS-TU1A • Percutaneous Image-guided Biopsy of Subsequent Lesions in Patients with Known Primary Malignancy: A Second Primary or Just a Metastasis?

**Laura E Gonzalez Lozada MD (Presenter) ; Eunice A Lara Garcia MD ; Carlos E Rojas Marin MD ; Edgar J Rosero Garcia MD ; Francisco Molina MD ; Oscar Arrieta**

#### PURPOSE

To evaluate and justify the need of performing a percutaneous image-guided biopsy of new lesions in patients with known primary cancer, determining the actual risk of being a second malignancy, unrelated to the first.

#### METHOD AND MATERIALS

A retrospective descriptive study using data from the imaging guided biopsies register from 2011-2012. Eighty patients presented subsequent appearance of indetermined lesions and underwent percutaneous image-guided biopsy. The histopathologic result were obtained and compared with the primary malignancy.

#### RESULTS

From the 80 patients included, 83.7% were positive for recurrent metastatic disease and 15% were positive for second primary cancer. Among the patients that presented a secondary primary tumor 66% had history of breast cancer, being gastric cancer the most common secondary malignancy. None of the patients were negative for malignancy. The most common primary cancer was breast cancer followed by cervical cancer. Frequently subsequent lesions sites were lung, mediastinum and ovaries.

#### CONCLUSION

Image guide percutaneous biopsy of subsequent lesions is justified on the basis of the risk of being a second primary tumor, instead of assuming to be secondary to the known primary tumor.

#### CLINICAL RELEVANCE/APPLICATION

Considering the risk and distinguishing whether new lesions represents a metastasis or a second cancer is important in terms for treatment and prognosis.

### LL-VIS-TU2A • The Combined Effect of Hypertension and Type-2 Diabetes Mellitus on Aortic Stiffness and Brachial Endothelial Dysfunction: An Integrated Study with 3.0T MRI

**Yan Shan (Presenter) ; Jiang Lin MD, PhD ; Pengju Xu ; Mengsu Zeng MD, PhD**

#### PURPOSE

The purpose of this study was to investigate the combined effect of hypertension and type-2 diabetes mellitus (DM2) on aortic stiffness and endothelial dysfunction by using an integrated 3.0 T MRI approach.

#### METHOD AND MATERIALS

A total of 31 non-hypertensive DM2 patients (mean age 55.4±8.5 years; 19 male, 12 female) and 31 hypertensive DM2 patients (mean age 58.3±6.1 years; 18 male, 13 female) underwent noninvasive 3.0 T MRI. Aortic distensibility (AD), aortic arch pulse-wave velocity (PWV) and brachial artery flow-mediated dilation (FMD) were assessed. Independent-Samples t-test and the Mann-Whitney U test were used to compare variables between groups as appropriate, while the chi-squared test was used for categorical variables. Pearson correlation analysis was performed to determine the relationship between measured parameters and to analyse the association between measured parameters and blood pressure. Univariable and multiple linear regression was used to determine the independent predictors of the measured parameters.

#### RESULTS

Compared with the non-hypertensive patients, the hypertensive patient showed lower AD at multiple levels (ascending aorta(AA):  $2.07 \pm 0.98 \times 10^{-3}$  mm Hg<sup>-1</sup> vs.  $3.21 \pm 1.70 \times 10^{-3}$  mm Hg<sup>-1</sup>, p-3 mm Hg<sup>-1</sup> vs.  $3.58 \pm 1.47 \times 10^{-3}$  mm Hg<sup>-1</sup>, p-3 mm Hg<sup>-1</sup> vs.  $4.27 \pm 1.75 \times 10^{-3}$  mm Hg<sup>-1</sup>, p

#### CONCLUSION

Hypertension has a contributive effect on aortic stiffness and endothelial dysfunction in DM2 patients. Direct quantification of both aortic stiffness and endothelial dysfunction using one-stop high-resolution MRI may help stratify cardiovascular risks in DM2 patients.

#### CLINICAL RELEVANCE/APPLICATION

Our results suggested that high-resolution MRI may help stratify cardiovascular risks in DM2 patient with direct quantification of both aortic stiffness and endothelial dysfunction.

### LL-VIS-TU3A • Percutaneous Catheter Drainage versus Needle Aspiration for Pyogenic Liver Abscess: A Meta Analysis

**Zhihui Chang BMedSc, MMed (Presenter) ; Zhaoyu Liu ; Zaiming Lu MD ; Qiyong Guo MD**

#### PURPOSE

To assess the effectiveness of Percutaneous catheter drainage(PCD) versus needle aspiration for patients with pyogenic liver abscess. This will be determined by the effects on treatment success rate, mortality rate and total hospital stay.

#### METHOD AND MATERIALS

MEDLINE, EMBASE, Cochrane library and some other databases, from January 1966 to March 2013, were searched for initial studies. We planned to include data from randomized controlled trials(RCTs) comparing the effectiveness of PCD and needle aspiration in the treatment of pyogenic liver abscess. Two authors independently extracted the data and assessed trial quality. Trialists were contacted to obtain missing information.

#### RESULTS

Two randomised clinical trials were eligible for inclusion in this review. Both trials compared PCD versus needle aspiration for pyogenic liver abscess. The trials included a total of 124 patients. There was no statistically significant difference between the two groups for treatment success rate (RR 1.14, 95% CI 0.98 to 1.32).The total hospital stay was about three days shorter (weighted mean difference (WMD), random effects -3 days, 95% CI -3.9 to -2.3) in the needle aspiration group compared with the PCD group. There was no mortality in both of the trials.

#### CONCLUSION

No significant differences were observed in treatment success rate and mortality rate between PCD and needle aspiration. Needle aspiration is associated with a significantly shorter hospital stay compared with the PCD. However, this cannot be recommended routinely based on the limited available evidence. More randomised clinical trials are needed to address these issues.

#### CLINICAL RELEVANCE/APPLICATION

Needle aspiration is probably as effective as percutaneous catheter drainage for the treatment of pyogenic liver abscess.

### **LL-VIS-TU4A • ECG Gated Thoracic Computed Tomography Angiography with Individualized Contrast Protocol: Effects on Radiation Dose and Image Quality**

**Charbel Saade MS (Presenter) ; Ali A Haydar MD, FRCR ; Fadi M El-Merhi MD ; Mukbil H Hourani MD**

#### PURPOSE

To investigate a reduced contrast protocol and its effects on radiation dose and image quality during gated thoracic CTA.

#### METHOD AND MATERIALS

Gated thoracic CTA was performed in 100 patients with acute aortic syndrome using a 64 channel computed tomography scanner and a dual barrel contrast injector. Patients were subjected in equal numbers to one of two contrast regimens. Patient age and gender were equally distributed across both groups. Regimen A, the department's standard protocol, consisted of a caudocranial scan direction with 120 mL of contrast intravenously injected at a flow rate of 4.5 mL/s; Regimen B involved a caudocranial scan direction and a novel contrast formula based on measured patient cardiovascular dynamics, using 50 mL of saline at 4.5 mL/s. The mean cross-sectional opacity of nine anatomical segments within the thoracic aorta and two within thoracic veins were measured for each patient and arteriovenous contrast ratio (AVCR) calculated. Regimens were compared using Mann-Whitney U non-parametric statistics. Receiver operating characteristic (ROC) analysis and visual grading characteristic (VGC) was performed.

#### RESULTS

Mean vessel opacification in the segments of the ascending aorta, transverse, and descending aorta were up to 18% higher (p

#### CONCLUSION

Caudocranial scan direction, reduced contrast volume, and injection timing based on vessel dynamics can significantly improve vessel opacification and visualisation, whilst reducing radiation dose.

#### CLINICAL RELEVANCE/APPLICATION

Matching contrast injection timing with vessel dynamics significantly improves vessel opacification, reduces contrast and radiation dose in the assessment of acute aortic syndrome.

### **LL-VIS-TU5A • Clinical Application of Lower Extremity Arterial CT Angiography Using a Low Concentration Contrast Agent (270 mg I/ml): A Preliminary Study**

**Xie Dexuan (Presenter) ; Zhang Jinling ; Xiao Xigang MD ; Jia Yulin MD**

#### PURPOSE

To investigate the feasibility of lower extremity arterial CT angiography with a low concentration contrast agent (270 mg I/ml).

#### METHOD AND MATERIALS

5 patients with lower extremity atherosclerosis for treatment in vascular surgery were selected undergo CTA on an HDCT(Discovery CT750 HD, GE, USA). 100 to 130 ml of the 270 mg I/ml concentration contrast agent was injected intravenously with the flow rate of 3.5~4 ml/s, followed by 40 ml of saline. Scan started at 4s after the CT value in the popliteal artery reached the threshold of 100HU. Scanning parameters included 80kV, automatic tube current modulation, rotation time of 0.8s, pitch of 1.375:1. Images were reconstructed with 50%ASIR. A 3-point ranking scale was used to assess the image quality of the 21 anatomic segments with score of 3 for strong homogenous enhancement of all the lower arterial segments and no venous enhancement; 2 for the fading of the contrast enhancement of all arterial segments with no or weak venous enhancement of superficial or deep veins. 1 for the absent of contrast enhancement in some parts of the arterial segments, or strong venous enhancement of superficial or deep veins. A score of =2 was considered as diagnostically acceptable. The vascular enhancement was assessed quantitatively by measuring the CT value in the regions of interest (ROIs) positioned within the vessel lumen.

#### RESULTS

100 of the 105 lower extremity artery segments were scored =2 for the evaluable rate of 95.23%. The average CT values for the abdominal aorta, iliac artery, femoral artery, popliteal artery and tibial artery was 406±23HU, 413±37HU, 379±56HU, 342±49HU, 296±73HU respectively.

#### CONCLUSION

It is feasible to achieve good image quality for lower extremity arterial CTA using 270mg I/ml contrast agent in combination with 80kV low dose scanning.

#### CLINICAL RELEVANCE/APPLICATION

The image quality for lower extremity arterial CTA using 270mg I/ml contrast agent is as good as the high concentrations one. It may be applied as a routine protocol for patients with PAOD.

### **LL-VIE-TU6A • Percutaneous Radiologic Placement of Continuous Ambulatory Peritoneal Dialysis (CAPD) Catheters: 'How to Do It'**

**Young Ho Kwon (Presenter) ; Se Hwan Kwon MD ; Joo Hyeong Oh MD**

#### PURPOSE/AIM

To review the techniques of percutaneous radiologic placement of continuous ambulatory peritoneal dialysis (CAPD) catheters, potential complications, and management of complications associated with these catheters.

#### CONTENT ORGANIZATION

- a. Introduction and background of CAPD
- b. Type of CAPD catheters
- c. Preprocedure evaluation (Anatomy, Indications and Contraindications)

- d. Techniques of percutaneous radiologic placement of CAPD catheters
- e. Postprocedure management
- f. Complications and radiologic management

#### SUMMARY

This exhibit will review

- a. The general concept of percutaneous radiologic placement of CAPD catheter
- b. The technique of percutaneous radiologic placement of CAPD catheter
- c. The complication and management of CAPD catheter

### LL-VIE-TU7A • Sacroplasty: "A Remedy for Pains in the Butt"?

**Malay Bhatt** (Presenter) ; **Kalie Adler** BS, DO ; **Lisa A Strand** RN ; **Brandt C Wible** MD \*

#### PURPOSE/AIM

Sacral insufficiency fractures are often extremely painful and debilitating for patients, limiting ambulation and impairing quality-of-life during the recovery period. Sacroplasty, which involves injection of polymethylmethacrylate cement into these sacral fractures, has been used to decrease pain in these patients along with shortening the recovery period. The purpose of this exhibit is to educate our colleagues about this interventional technique and the pain relief our patients have experienced with this procedure.

#### CONTENT ORGANIZATION

#### SUMMARY

The major teaching points of the exhibit are: 1. Difficulty of pain control in sacral insufficiency fractures 2. Educate colleagues on sacroplasty role in pain relief and improving patient outcomes 3. Share results of pain assessments completed on our patients after sacroplasty

## Vascular/Interventional - Tuesday Posters and Exhibits (12:45pm - 1:15pm)

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**LL-VIS-TUB • AMA PRA Category 1 Credit™:0.5**

### LL-VIS-TU1B • Stop-flow Foam Sclerotherapy (SFFS) of Symptomatic High Flow Female Varicocele

**Roberto Gandini** MD, PhD ; **Daniel Konda** (Presenter) ; **Valerio Da Ros** ; **Daniele Morosetti** MD ; **Sergio Abrignani** ; **Marcello Chiocchi** MD ; **Giovanni Simonetti** MD

#### PURPOSE

To assess the efficacy of Stop-Flow Foam Sclerotherapy (SFFS) in high flow pelvic varicocele using 3% sodium-tetradecyl-sulphate (STS) foam.

#### METHOD AND MATERIALS

A retrospective study was conducted in 26 patients (mean age: 37.3 years; range: 23-46) with pelvic congestion syndrome (PCS) with high outflow collaterals treated by SFFS between June 2005 and June 2011 at our Department. Full approval and waiver of informed consent for our study was obtained by our institutional review board. PCS was diagnosed by physical and transvaginal color-Doppler US, while high outflow venous collaterals were detected at selective ovarian venography. According to the type of varicocele (non cross-pelvic, cross-pelvic, the type of outflow (low- or high outflow) and their drainage (ovarian vein etc.), we created a new phlebographic classification of pelvic varicoceles. SFFS was performed by injection of 3% STS foam into the pelvic varices while performing balloon-occlusion of the major venous vessels to which the high outflow venous collaterals were tributary. Follow-up was performed at 1, 3, 6 and 12 months by physical and transvaginal color-Doppler US examination and by a questionnaire-based assessment of pain.

#### RESULTS

The technical success rate was 100%. After the injection of 3% STS foam, all patients presented a colic-like pain with spontaneous resolution after 5 minutes. Mean fluoroscopy time was  $17.0 \pm 3.49$  minutes. During follow-up, no recurrences of PCS were detected. A significant improvement of symptoms (Student's t test P

#### CONCLUSION

SFFS is a safe and effective procedure. Differently from other techniques, SFFS aims at the direct sclerotisation of pelvic varices rather than at the occlusion of outflow vessels. The procedure allows precise identification of all outflow vessels and, by temporary balloon-occlusion of the major venous vessels to which they are tributary, enables the stagnation of STS foam within the varices leading to their complete sclerotisation. SFFS does not require the positioning of foreign bodies (e.g. coils, plugs) and requires the administration of only small amounts of sclerosing agent. SFFS should be considered as an alternative to other endovascular and surgical options.

#### CLINICAL RELEVANCE/APPLICATION

This minimally invasive procedure is performed under local anaesthesia in a day hospital setting and is associated to a significant reduction of symptoms and low recurrence rates.

### LL-VIS-TU2B • Analysis of Percutaneous Transluminal Forceps Biopsy in 243 Patients Suspected of Having Malignant Biliary Obstruction and Predictive Factors for False Negative Diagnosis

**Younggyung Shin** (Presenter) ; **Gyoo Sik Jung** MD ; **Hee Kang** MD

#### PURPOSE

To evaluate diagnostic yields of percutaneous transluminal forceps biopsy in patients suspected of having a malignant biliary obstruction and evaluate predictive factors for false negative diagnosis.

#### METHOD AND MATERIALS

Two hundred forty three consecutive patients (151 men and 92 women; mean age, 61 years) with obstructive jaundice underwent transluminal forceps biopsy during or after percutaneous transhepatic biliary drainage. The lesions involved the common bile duct (n = 97), common hepatic duct (n = 60), hilum (n = 47), ampullary segment of the common bile duct (n = 29), right or left intrahepatic bile duct (n = 10). In each patient, three to five specimens (mean, 3.4 specimens) were taken from the lesion with 5.4-F biopsy forceps. The final diagnosis for each patient was confirmed with pathologic findings at surgery, additional histocytologic data, or clinical and radiologic follow-up. Multivariate logistic regression analysis was used to identify risk factors associated with false negative diagnosis.

#### RESULTS

177 of 243 biopsies resulted in correct diagnoses of malignancy. 17 biopsy diagnoses proved to be true-negative. There were 49 false-negative diagnoses and no false-positive diagnoses. The diagnostic performance of transluminal forceps biopsy in malignant biliary obstructions was as follows: sensitivity, 77.4%; specificity, 100%; and accuracy, 79%. Ampullary segment of common bile duct (odds ratio 4.355 95% CI 1.651-11.490, p=0.003) and non-mucosal tumor (odds ratio 2.386 95% CI 1.216-4.585, p=0.011) were the significant risk factor for false negative diagnosis. No major complications related to the biopsy procedures occurred.

#### CONCLUSION

Percutaneous transluminal forceps biopsy provides relatively high accuracy in the diagnosis of malignant biliary obstructions. The

predictive factors for false negative biopsy were biopsy site and tumor origin.

#### CLINICAL RELEVANCE/APPLICATION

Percutaneous transluminal forceps biopsy provides high accuracy in the diagnosis of malignant biliary obstructions.

### **LL-VIS-TU3B • Immediate and Late Outcomes of Bronchial and Systemic Artery Embolization for Palliative Treatment of Non-small-Cell Lung Cancer Patients with Hemoptysis**

**Masahiro Tanabe MD (Presenter) ; Takeshi Fujita MD ; Kazuko Moritani ; Naofumi Matsunaga MD, PhD ; Tsuneo Matsumoto MD**

#### PURPOSE

The aim of this study was to evaluate immediate outcomes, late outcomes, and safety of bronchial and systemic artery embolization (BAE) for palliative treatment in a group of patients with advanced non-small-cell lung cancer (NSCLC) with hemoptysis.

#### METHOD AND MATERIALS

Between March 2009 and November 2012, BAE using gelatin sponge particles was performed in 28 consecutive patients with NSCLC. Sixteen patients had adenocarcinoma and 12 had squamous cell carcinoma. Three patients were classified as clinical stage IIB, five were Stage IIIA, 14 were Stage IIIB, and six were Stage IV, respectively. Hemoptysis was defined as follows: acute massive bleeding greater than 300 mL within 24 h (n = 8), moderate bleeding of 100-300 mL within 24 h (n=12), and slight bleeding less than 100 mL within 24 h (n=8). A retrospective analysis of technical, immediate and late success rates was performed. Complications were also evaluated.

#### RESULTS

The technical success rate was 96%. Immediate clinical success within 24 h after BAE was achieved in 22 (81%) of 27 patients who underwent embolization. Hemoptysis was observed in five of 27 patients after BAE. A small amount of hemoptysis recurred within 14 days of embolization in two patients. Both immediate and late clinical success rates were achieved in 20 of 27 patients (74%). There were no major complications requiring further management, and eight (30%) minor complications occurred.

#### CONCLUSION

BAE with gelatin sponge particles can provide good management of hemoptysis as a palliative treatment in patients with advanced NSCLC.

#### CLINICAL RELEVANCE/APPLICATION

BAE with gelatin sponge particles is a safe and effective palliative treatment for hemoptysis in patients with advanced non-small-cell lung cancer for maintenance of quality of life.

### **LL-VIS-TU4B • Renal Cryoablation: A New Paradigm for Nearly any Tumor Location**

**Hussein D Aoun MD (Presenter) ; Peter J Littrup MD \* ; Barbara A Adam MSN ; Evan N Fletcher MS, BA ; Mark J Krycia BS**

#### PURPOSE

To assess technical feasibility, efficacy and complication rates of CT guided percutaneous renal mass cryoablation in a large series on long term follow up.

#### METHOD AND MATERIALS

CT and/or CT-US fluoroscopic-guided percutaneous cryoablations were performed in 247 procedures on 262 tumors (210 RCC, 45 metastasis, 6 oncocytomas and 1 angiomyolipoma) in 214 patients noting tumor size and location. Thirty-seven patients had multiple renal tumors ablated. Follow-up CT or MRI was utilized to assess efficacy and evaluate for local recurrences or new multicentric tumors. Hydrodissection with normal saline/ contrast (60:1) solution was performed to protect adjacent vital structures such as bowel, ureter or pancreas. Complications followed the grading system of the National Institutes of Health, Common Terminology of Complications and Adverse Events (CTCAE 4.0).

#### RESULTS

All the procedures were performed under conscious sedation and were virtually painless during and after the procedure. Average tumor and ablation size was 3cm and 5cm, respectively, with the largest 10.4cm. Hydrodissection was performed in 73 procedures. Major complication (only grade 3) rate attributable to the procedure was 2.4% (6/247). Of the major complications, 3 (3/5) were related to hemorrhage requiring transfusion (Grade 3). A ureteral stricture prior to ureteral stent placement for central tumors and bowel injury prior to protective hydrodissection techniques were observed early on in our experience. Median follow-up was 1.8 years with 72 patients having > 3 year follow-up and 36 patients having > 5 year follow-up. Local recurrence rate was 2% (6/262), with 4 technical failures and 2 tract recurrences. Of the local recurrences, 4 were re-ablated (2 tract and 2 technical) without residual disease on follow-up for a secondary efficacy of 99%.

#### CONCLUSION

Renal cryoablation has established low complication and local recurrence rates which do not appear to be significantly affected by tumor size or central location. CT guided percutaneous cryotherapy is a low cost and low morbidity alternative for patients with complex renal tumors.

#### CLINICAL RELEVANCE/APPLICATION

The rising cost of health care mandates consideration of renal cryoablation as a cost effective treatment option, justified by comparable low recurrence and complication rates for any renal location.

### **LL-VIS-TU5B • Mid-term Outcomes of Type II Endoleak Embolization**

**Roy Y Yang MD (Presenter) ; Kongteng Tan FRCR ; Robert Becroft MD ; Jeffrey D Jaskolka MD**

#### PURPOSE

Type II endoleaks (T2EL) are common complications following EVAR. Persistent T2EL are potentially associated with late aneurysm rupture. Although embolization procedures are frequently used to treat persistent T2EL, there is a paucity of literature on its outcomes. This study aims to evaluate the effectiveness of embolization of T2EL and whether the embolization agent, approach to embolization, or endoleak configuration has an impact on its efficacy.

#### METHOD AND MATERIALS

A retrospective review of patients who underwent EVAR and subsequent T2EL embolization between 2003 and 2012 was performed. Embolization was performed via direct sac puncture or a transarterial approach with the goal of obliterating both the endoleak sac and feeding vessels. Embolization agents used include cyanoacrylate glue only (43%), glue and coils (31%), coils only (18%), and other agents (8%). Aneurysm volume was measured before and after embolization. Technical success, freedom from sac expansion and the incidence of recurrent T2EL were documented. Comparisons were made between the outcomes using different embolization agents, approach to embolization, and T2EL configurations.

#### RESULTS

A total of 29 patients (median age 76 years) underwent 42 embolization procedures. The median duration from EVAR to embolization was 16 months (95% CI 10-24 months), and the median follow-up was 11 months (95% CI 7-22 months). Immediate technical success of embolization was 91%. Freedom from aneurysm sac expansion was achieved in 96%, and freedom from T2EL (no enhancement of the aneurysm sac) was accomplished in 71%. There were no ruptured aneurysms during the follow-up period. No statistically significant difference was found in the outcomes between different embolic agents, the approach for embolization or the configuration of the endoleak.



#### CONCLUSION

Embolization of T2EL with cyanoacrylate glue is effective for the prevention of aneurysm sac growth in mid-term follow-up. The results are similar regardless of the embolization approach, the addition of coils or the T2EL configuration. Further studies are needed to determine the long-term outcomes in this group of patients.

#### CLINICAL RELEVANCE/APPLICATION

Persistent T2EL are associated with serious adverse outcomes, thus evaluation of the efficacy of existing treatments is needed to optimize outcome in this group of patients.

### LL-VIE-TU6B • Nuts and Bolts of Microwave Ablation

**Meghan G Lubner MD (Presenter) ; Timothy J Ziemlewicz MD ; J. Louis Hinshaw MD \* ; Fred T Lee MD \* ; Christopher L Brace PhD \* ; Marci Center**

#### PURPOSE/AIM

- Review advantages/limitations of microwave ablation (MWA).
- Discuss applications of gas cooled MWA and available antennas.
- Use case-based review to illustrate patient selection, antenna placement, intraprocedural imaging, technical efficacy and complications of microwave ablation in the lung, liver, kidney, adrenal and retroperitoneum.

#### CONTENT ORGANIZATION

- Introduction
- Potential advantages and limitations of MWA
- Review of available antennas: advantages/limitations, applications.
- Multi-organ (liver, kidney, lung, retroperitoneum) clinical case based pictorial review illustrating patient selection, intraprocedural monitoring, technical efficacy, complications, follow up.
- Summary

#### SUMMARY

- Use of MWA enables rapid generation of very high temperatures, which can lead to decreased treatment time and decreased susceptibility to heat sink effects and high tissue resistance.
- Gas cooled MWA allows for treatment at high powers with a relatively small gauge antenna.
- MWA can be readily and effectively applied in the lung, liver, kidney, retroperitoneum.
- A conventional triaxial microwave antenna is able to generate relatively large, long ablation zones for treatment of larger tumors, whereas a modified triaxial antenna can produce a short, round ablation zone for treatment of tumors adjacent to vulnerable structures.

### LL-VIE-TU7B • Renal Denervation- What the Interventional Radiologist Needs to Know

**Ken Courtney (Presenter) ; Umer Salati MD ; Hong Kuan Kok MBBCh, MRCPI ; Davinia Ryan MBBCh, MRCPI ; Pradeep Govender ; William C Torreggiani MBBCh**

#### PURPOSE/AIM

The goal of this exhibit is to review the key radiological findings required prior to renal denervation as well as highlighting findings that contraindicate or potentially complicate successful renal denervation

#### CONTENT ORGANIZATION

Cases undergoing CT angiography prior to renal denervation will be presented. Renal denervation is an endovascular procedure generally carried out by either interventional radiologists or interventional cardiologists and its success is largely determined by the ability to screen and select the correct patients on CT angiography. In this exhibit, we select cases and demonstrate the key findings that require specific assessment such as renal artery size, uniformity and branching pattern. Examples of contraindications such as early secondary renal artery take off as well as asymmetrical tapering which are a contraindication to renal denervation are demonstrated.

#### SUMMARY

CT angiography prior to renal denervation is becoming a more common examination which will undoubtedly grow rapidly in the coming years. In this abstract we show the key radiological features which require assessment by the reporting radiologist.

### LL-VIE1302-TUB • The Use of Contrast-enhanced Ultrasound (CEUS) in Vascular Diseases

**Sasan Partovi BS \* ; Markus Aschwanden MD ; Fabian Rengier MD (Presenter) ; Deniz Bilecen MD, PhD ; Daniel Staub MD**

#### PURPOSE/AIM

Contrast-enhanced ultrasound (CEUS) is a novel imaging technique enabling patient studies at the bedside without any radiation exposure. The purpose of this educational exhibit is to demonstrate potential applications of contrast-enhanced ultrasound of vascular diseases.

#### CONTENT ORGANIZATION

- Introduction in contrast-enhanced ultrasound:
  - Technical considerations including equipment
  - Available and approved contrast agents for patient studies
- CEUS in carotid artery diseases:
  - Carotid atherosclerotic diseases and intraplaque neovascularization
- CEUS in abdominal aortic diseases:
  - Abdominal aneurysms
- c. Follow-up after catheter based endovascular aortic repair (EVAR)
- d. Chronic periaortitis
- CEUS in renal vascular diseases:
  - Renal infarction
  - Renal vein thrombosis
- CEUS in the skeletal muscle:
  - Quantitative CEUS for skeletal muscle microperfusion

#### SUMMARY

CEUS is a promising and evolving imaging technique. It enables the superior visualization of the microvasculature and microvasculature in different vascular disorders. These both features make CEUS an attractive approach for diagnosis and treatment monitoring of vascular diseases.

### LL-VIE1292-TUB • Prostate Artery Embolization: 'Shrinking Prostate Size...Not Sexual Drive'

**Krishna K Das MD ; Megha Nayyar ; Rahul Nayyar MD (Presenter)**

#### PURPOSE/AIM

Half of all men over the age of 60 will develop an enlarged prostate. 80% of men will experience benign prostatic hyperplasia (BPH) symptoms by the age of 80, but only 25% of men will be receiving BPH rx. Interventional radiology has been at the forefront of creating innovations in medicine, and prostatic artery embolization (PAE) is a novel therapy for patients suffering from BPH. We will review 15 journal articles discussing PAE and will summarize our findings to educate radiologists about a potential alternative rx for BPH. We will review the physiology and current medical/surgical rx for BPH and introduce the technique, indications, and complications of PAE.

## CONTENT ORGANIZATION

1 Prostate and Vascular Anatomy 2 Natural Hx of BPH 3 Dx of BPH 4 Rx Options 5 PAE (Hx, Technique, Complications and economics) 6 Chart summarizing our PUBMED literature review: # patients in each study, prostate size pre/post PAE, follow-up time, number of meds prior to PAE, complications, International Prostate Symptom score (pre and post PAE), potential advantages 7 Take home messages.

## SUMMARY

PAE is a novel therapy for patients suffering from BPH and currently, it is not well known to the public. Our purpose, in this educational exhibit, is to review the current literature and summarize the data in hopes of increasing awareness of this potentially game changing intervention.

## Vascular/Interventional (Aortic Imaging and Intervention)

Tuesday, 03:00 PM - 04:00 PM • E352

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SSJ26 • AMA PRA Category 1 Credit™:1 • ARRT Category A+ Credit:1

### Moderator

Elizabeth M Hecht, MD

### Moderator

Graham J Robinson, MBBCh \*

## SSJ26-01 • Electromagnetically Navigated in situ Fenestration of Aortic Stent Grafts: In-vitro Experiments and Pilot Animal Study

Hong-Sik Na MD (Presenter); Philipp Bruners MD; Peter Isfort MD; Andreas H Mahnken MD\*; Thomas Schmitz-Rode MD; Johannes Jansing DIPLENG; Christoph Wilkmann DIPLENG; Sabine Osterhues DIPLENG\*; Andreas Besting DIPLENG\*; Catherine Disselhorst-Klug PhD; Matias De La Fuente; Christiane K Kuhl MD\*; Tobias Penzkofer MD\*

### PURPOSE

To evaluate the feasibility of electromagnetically navigated in-situ fenestration of aortic stent grafts to revascularize renal arteries in EVAR using a phantom and swine model.

### METHOD AND MATERIALS

The proposed electromagnetic tracking system is operated by a custom-made navigation software working with a steerable EMT-guided catheter (8F) and a custom-made navigated guidewire (0.035) and being equipped with a gating algorithm to correct for breathing motion.

In the phantom model of an abdominal aorta with a stent graft in place fenestration was performed 40 times on each side with 20 approaches from each iliac artery. Catheterization times, number of attempts and quality of fenestration were assessed and analyzed. Quality was measured on a scale from 1 to 3, judged by the distance from the ostial center.

In 3 domestic swine a high porosity stent graft was placed in the abdominal aorta covering the two renal ostia after previous cone-beam CTA. Using the pre-procedural dataset, both renal arteries were reperfused by fenestrating the stent graft and deploying covered stents at the ostia. Successful reperfusion was documented by cone-beam CTA.

### RESULTS

In the phantom model average catheterization time was  $88.6 \pm 79.8$ s (18-474 s) with  $1.48 \pm 0.9$  attempts. Mean quality of the fenestration was  $2.0 \pm 0.7$ .

In the in vivo setting reperfusion was successfully performed in 5 renal arteries. In one case a stent strut was placed in front of the right ostium, so fenestration was possible only after introducing a Roch-Uchida needle. In the successful procedures, fenestration time was  $8.4 \pm 9.2$  min (catheter introduction to successful fenestration), stent placement time (catheter introduction to securing the branch with stent) was  $32.0 \pm 27.1$  min and average total stent-placement (aortic stent graft placement to placement renal stent) was  $93.2 \pm 51.9$  min. Problems delaying stent placement were attributable to the prototypical nature of the material (e.g. uncoated navigated guidewires, malfunctioning navigation coils).

### CONCLUSION

Although the overall procedure times are currently not within acceptable ranges for renal ischemia time, the completion rates and short fenestration times warrant further development of the proposed procedure.

### CLINICAL RELEVANCE/APPLICATION

Though EVAR is a valuable alternative to surgery nowadays it is still not suitable for emergency cases especially when side branches are involved. Our approach may allow EVAR even in those cases.

## SSJ26-02 • Abdominal Aortic Aneurysm Follow-up after Endovascular Repair by Non-invasive Vascular Elastography: Feasibility in a Canine Model

Elie Salloum MSc, BEng (Presenter); Antony Bertrand-Grenier; Sophie Lerouge; Claude Kauffmann PhD; Guy Cloutier PhD; Gilles P Soulez MD\*

### PURPOSE

Non-invasive vascular elastography (NIVE) is a new ultrasonic technique enabling the measurement of tissue deformation. We aim to apply and optimize elastography of abdominal aortic aneurysm (AAA) after endovascular aneurysm repair (EVAR) with stent-graft (SG) in a canine model to detect endoleaks and characterize thrombus organization.

### METHOD AND MATERIALS

SGs were implanted in a first group of 3 dogs with an aneurysm created in iliac arteries (6 aneurysms) and in a second group of 3 dogs in abdominal aorta. Type I endoleak was created in 6 iliac and 1 aortic aneurysms and type II in two aortic aneurysms. DUS (SuperSonic Imaging) and elastography examinations (Sonix RP, Ultrasonix) were performed at baseline, 1 week, 1 month, 3 month (first group) and 6 month (second group) follow-up. Angiography, CT-scan and histology were also performed at sacrifice. Ultrasonic raw radio frequency data were acquired on longitudinal and three axial planes (proximal, mid and distal part of the aneurysm) in order to generate time-varying strain images. Elastograms of zone of interest were computed using the Lagrangian Speckle Model Estimator (LSME). Area of endoleak, liquid thrombus (non-organized) and solid thrombus (organized) were identified and segmented by comparing the results of CT scan and histology. Strain values in area with endoleak, liquid and solid thrombus were compared.

### RESULTS

Five iliac and one aortic aneurysms had type I endoleaks. A type II endoleak was observed in two aortic aneurysms whereas one iliac aneurysm was sealed. Maximal axial strain values in endoleak, liquid and solid thrombus areas were respectively estimated at  $0.73 \pm 0.14\%$ ,  $0.22 \pm 0.035\%$ ,  $0.11 \pm 0.035\%$ . Strain values were significantly different between endoleak and liquid or solid thrombus areas ( $p = 5,136E-09$ ) and between solid and liquid thrombus areas ( $p = 0.00063$ ). All endoleak areas were clearly identified on elastography examinations using axial or shear strain parameters.

### CONCLUSION

The results show that NIVE is capable of detecting endoleak and characterize thrombus organization. Further development is needed to enable real time elastograms optimized for AAA follow-up after EVAR.

### CLINICAL RELEVANCE/APPLICATION

NIVE is a new technique that could reduce the cost and the exposition to ionizing radiation and contrast agents of follow up of AAA after EVAR. It also has a potential to evaluate thrombus organization

### **SSJ26-03 • Abdominal Aortic Aneurysm Follow-up by Dynamic Elastography after Endovascular Repair**

**Antony Bertrand-Grenier** (Presenter) ; **Elie Salloum** MSc, BEng ; **Sophie Lerouge** ; **Claude Kauffmann** PhD ; **Guy Cloutier** PhD ; **Gilles P Soulez** MD \*

#### **PURPOSE**

Supersonic Shear Wave Imaging (SSWI) measure the tissue elasticity in real-time. Our goal is to characterize the mechanical properties of abdominal aortic aneurysm (AAA) after endovascular aneurysm repair (EVAR) in a canine model (endoleaks, thrombus, walls) and correlate results with CT-Scan, Doppler Ultrasound (DUS) and pathologic findings.

#### **METHOD AND MATERIALS**

Stent Grafts (SGs) were implanted in 2 groups of dogs after creation of aortic or iliac aneurysms. The first group of 3 dogs (6 iliac arteries) had creation of type I endoleak and the second group of 3 dogs (3 aortic arteries) had creation of type I or type II endoleaks. DUS and elastography examinations (SSWI) were performed at implantation, 1 week, 1 month, 3 months (groups 1 and 2) and 6 months (group 2). Angiography, CT-scan and histology were also performed at sacrifice to evaluate the presence, the size and the type of endoleak and characterize aneurysm thrombus organization. Areas of endoleak, liquid thrombus (non-organized) and solid thrombus (organized) were identified and segmented by comparing histology to others technics. Elasticity moduli values in area with endoleak, liquid thrombus and solid thrombus were compared on longitudinal and three axial planes (proximal, mid and distal part of the aneurysm).

#### **RESULTS**

Five iliac and one aortic aneurysms had type I endoleaks and one iliac and two aortic aneurysms had type II endoleaks. Elasticity moduli of  $0.20 \pm 0.30$  kPa has been found in endoleak regions,  $63,40 \pm 66.28$  kPa in solid thrombus and  $2.97 \pm 1.96$  kPa liquid thrombus. Elasticity moduli values were significantly different between endoleak and solid thrombus areas ( $p = 0.0002$ ), endoleak and liquid thrombus areas ( $p = 0.0009$ ) and liquid thrombus and solid thrombus areas ( $p = 0.0003$ ). All endoleak areas were clearly identified and significantly different of solid thrombus areas. Dynamic elastography detected endoleaks in which DUS failed ( $n = 3$ ) and detected liquid thrombus (\*possibility associated with type V endoleak).

#### **CONCLUSION**

The results show that SSWI is able to detect endoleaks and characterize thrombus organization. The next objective is to evaluate in a phase II clinical study the feasibility and efficacy this approach.

#### **CLINICAL RELEVANCE/APPLICATION**

SSWI has the potential to evaluate thrombus organization, detect endoleaks and possibly endotension, reducing the cost, the exposition to radiation and contrast agents of follow up of AAA post-EVAR.

### **SSJ26-04 • Acute Limited Intimal Tears of the Aorta Diagnosed with ECG-gated CT Angiography: A 4-Year Single Center Experience**

**Anne S Chin** MD (Presenter) ; **D. Craig Miller** ; **Gerry Berry** ; **Dominik Fleischmann** MD \*

#### **PURPOSE**

Limited intimal tears (LIT) of the aorta presenting as acute aortic syndrome (AAS) are notoriously difficult to diagnose prospectively, reported to elude all cross-sectional imaging techniques. Although this entity has been included in the AHA classification of aortic dissection (class 3), this entity is thought to be rare and remains largely unknown to radiologists. We have observed this lesion at our institution on ECG-gated CT angiograms prospectively with concordant surgical/pathologic confirmation. The aim of this research is to evaluate the ability of state-of-the-art CT angiography to detect subtle limited aortic tears.

#### **METHOD AND MATERIALS**

All CTAs from Jan 1, 2009 to Dec 31, 2012 in patients presenting to our institution for AAS were retrospectively reviewed. LITs were diagnosed on CTA according to AHA and Svensson's original surgical description as subtle aortic wall contour bulges, without frank dissection. The presence and extent of associated intramural hematoma (IMH), and any other lesion descriptors were also noted. Various post-processing techniques were also performed in an attempt to increase lesion conspicuity and diagnostic confidence. Exam review was performed by two cardiovascular radiologists with 8 and 20 years experience in CV imaging. The number of missed cases were noted.

#### **RESULTS**

196 patients were diagnosed with AAS between Jan 2009-Dec 2012. The incidence of LIT was 8.1% (16 LITs, 115 classic dissection, 49 IMH, 11 penetrating atherosclerotic ulcer, and 5 rupturing aortic aneurysm). Of the 16 acute LITs, 14 were type A (ascending aorta involvement), and 2 were type B (one arch, one descending aorta). Of the nine patients who underwent urgent surgical repair, there was 100% concordance with CTA diagnosis. All type-A lesions were diagnosed prospectively, and only one type B LIT was missed on initial review.

#### **CONCLUSION**

Accurately and consistent detection of limited aortic tears is possible with ECG-gated CTA, although awareness of this lesion and meticulous review of the datasets is requisite; additional post-processing increases lesion conspicuity. To the best of our knowledge, this is a first report of the ability of CTA to detect LITs as well as the first to identify type B LIT lesions.

#### **CLINICAL RELEVANCE/APPLICATION**

Timely detection of acute limited intimal tears is critical for patient management, and can be accurately performed with ECG-gated CTA.

### **SSJ26-05 • Study of Relation between 320 Multidetector CT Renal Perfusion and the Size, Number and Position of Intimal Entries of Aortic Dissection Patients**

**Dongting Liu** (Presenter) ; **Zhaoqi Zhang** ; **Jiayi Liu** ; **Zhanming Fan**

#### **PURPOSE**

To investigate the characteristic of renal perfusion in aortic dissection patients using 320 multidetector CT and to assess its clinical value.

#### **METHOD AND MATERIALS**

#### **RESULTS**

#### **CONCLUSION**

The size, number and position of intimal entries can influence renal perfusion of patients with aortic dissection.

#### **CLINICAL RELEVANCE/APPLICATION**

MDCT is convenient to assess renal perfusion in aortic dissection patients. Perfusion imaging is helpful to make adequate preparations before the operation. It has important clinical significance.

### **SSJ26-06 • CT Assessment of Pattern and Presence of Intimal Defect in Aortic Intramural Hematoma**

**Clement Proust** (Presenter) ; **Jean Laurent Lamboley** ; **Loic Bousset** MD ; **Philippe C Douek** MD, PhD ; **Didier Revel** MD \*

## PURPOSE

In patients presenting with an acute aortic intramural hematoma (IMH) the detection of an associated intimal defect is important for patient treatment and prognosis. The purpose of this study was to investigate the prevalence of intimal rupture detected by multidetector computed tomography (MDCT) in patients with IMH.

## METHOD AND MATERIALS

## RESULTS

An intimal defect was found in 30 patients (81% of the patients). ULP was the most frequent pattern (15 cases, 50%). Intimal tear was found in 13 (43,3%) patients. ULP was more frequent in IMH involving the descending than the ascending aorta (71,4% vs 31,25%, p0.05).

## CONCLUSION

MDCT showed an intimal defect in up to 80% of the patients presenting with an acute IMH with a pattern depending on aortic IMH location.

## CLINICAL RELEVANCE/APPLICATION

In patients presenting with an acute IMH, MDCT allows to detect different pattern of intimal defect.

## Vascular/Interventional (CTA: Dose and Contrast Reduction)

Tuesday, 03:00 PM - 04:00 PM • N230

QA IR CT VA

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SSJ27 • AMA PRA Category 1 Credit™:1 • ARRT Category A+ Credit:1

### Moderator

**Dominik Fleischmann**, MD \*

### Moderator

**Geoffrey D Rubin**, MD \*

## SSJ27-01 • The Combination of Spectral CT Imaging and Low Concentration of Contrast Media (Iodixanol 270mgI/ml) Used in Abdominal CTA

**Dandan Shao** (Presenter); **Xuexue Wang**; **Ying Yu**; **Xu Xu**; **Lun Lu**; **Ping Yang**; **Yongbo Yang**; **Xingan Long**; **Dong Chen**; **Na Gao**; **Hong-Yan Cheng**

## PURPOSE

To evaluate the image quality and diagnostic value of using spectral CT imaging and iodixanol 270mgI/ml in abdominal CTA.

## METHOD AND MATERIALS

Thirty eight patients (BMI=25) with hepatic tumors, all of which intended to take surgical operation in our hospital, underwent bi-phase hepatic CT scan (Discovery CT750 HD, GE Healthcare). This study was approved by our institutional ethics committee. Half patients underwent spectral imaging and the other half underwent conventional CT scan. By GSI viewer software, optimal keV images were obtained directly. The CTA scan was triggered by SmartPrep software at the threshold of 100HU. Two CTA protocols (group A: n=19, 80/140kVp fast switching, 60%FBP+40%ASiR, injection volume of 1.2ml/kg, injection speed of 3.5ml/s, iodixanol 270mgI/ml; group B: n=19, 120 kVp, FBP, injection volume of 1.2ml/kg, injection speed of 3.5ml/s, IOHEXOL 350mgI/ml) were compared. The image quality parameters [the density of vessels, more distal branches; CT value, contrast-to-noise ratio (CNR) and signal-to-noise ratio (SNR) for common hepatic artery, proper hepatic artery and gastroduodenal artery] and radiation dose [the volume CT dose index (CTDI<sub>vol</sub>), the effective dose (ED)] were evaluated. Use 5-points scale to evaluate the image quality by 2 experienced radiologists individually and blinded (5 for the best, 1 for the worst, =3 for acceptable image quality).

## RESULTS

There was no statistical difference for subjective scores, mean SNR and mean CNR in the abdominal arteries between the two groups (4.05±0.52, 34.54±5.33, 23.06±4.52 for group A and 4.11±0.46, 33.64±4.89, 23.89±3.85 for group B, respectively), (p>0.05). Higher mean CT values were obtained in group B (284.11±37.81HU) than in group A (242.41 ±50.86HU), (p<sub>vol</sub> and ED for group A (15.89mGy and 0.24mSv) were significantly lower than those in group B (28.25mGy and 0.42mSv), (both p

## CONCLUSION

The use of low concentration of contrast media (iodixanol 270mgI/ml) combined with spectral CT imaging in abdominal CTA provided both Iodine dose and radiation dose reduction with similar image quality in comparison with the conventional protocol, for individuals with BMI=25.

## CLINICAL RELEVANCE/APPLICATION

The use of low iodine dose scan with spectral CT imaging decreased the patient's **renal toxicity** and **radiation injury** in CT imaging.

## SSJ27-02 • Injecting Contrast Media with Reduced Iodine Concentration at Higher Speed Results in Improved and Prolonged Arterial Enhancement in CT Angiography

**Toon Van Cauteren** MSc (Presenter); **Gert Van Gompel** PhD; **Nico Buls** DSc, PhD\*; **Koenraad H Nieboer** MD\*; **Inneke Willekens** MD; **Guy Verfaillie** PhD, MD; **Daniel Jacobs Tulleneers Thevissen** MD; **Johan De Mey**\*

## PURPOSE

To assess the impact of contrast media concentration on the height and length of arterial enhancement at constant iodine dose delivery rate (IDR) and total iodine dose (TID).

## METHOD AND MATERIALS

## RESULTS

Iodine concentration had a significant effect: the injection of lower concentrations at higher speed was associated with increased enhancement. Compared to 370 mg I/ml, all concentrations equal and below to 270 mg I/ml resulted in both a broader and higher arterial peak (all p values < 0.02).  $t_{>200HU}$  increased from 7.3 ± 4.0 s at 370 mg I/ml up to 15.8 ± 4.0 s at 120 mg I/ml, whereas CT<sub>max</sub> increased from 237 ± 33 HU to 271 ± 20 HU, respectively. Despite higher injection speed, only a marginal increase in injection pressure was observed for lower iodine concentrations due to their reduced viscosity.

## CONCLUSION

Despite constant IDR and TID, injecting a reduced contrast media concentration at higher speed results in a higher arterial peak enhancement and improved time window above 200 HU compared to the administration of a high contrast media concentration at lower speed.

## CLINICAL RELEVANCE/APPLICATION

At equal iodine burden, reduced contrast media concentration improves image quality and relaxes the timing of the acquisition in CT angiography studies.

## SSJ27-03 • Image Quality of Whole Aortic Angiography with Low Contrast Flow Rate and Dual-energy CT Non-linear Blending Technique

Jie Liu (Presenter) ; Jianbo Gao MD

### PURPOSE

To investigate the image quality of thoracoabdominal aortic angiography with a low contrast medium flow rate and DECT non-linear blending technique

### METHOD AND MATERIALS

Twenty patients with suspected aortic dissection were referred to whole aortic angiography. All patients underwent DECT angiography on a 128-slice dual-source CT with 64 \* 0.6 mm collimation, pitch 1.2, 80/Sn140 kVp tube potential. The contrast medium was adapted by patient weight (0.5 ml 370 mgI/ml contrast per kg of body weight) and the flow rate was calculated by the contrast volume divided by the sum of delay and scan duration. The resulting high and low kVp images were transferred to a commercial non-linear blending software package to optimize the image contrast and noise. The linear mixed image was used as reference image which was considered as simulated 120 kVp image. The region-of-interest was placed on ascending aorta (AA), descending aorta (DA) and bifurcation (AB). The noise, signal-to-noise ratio (SNR) and CT attenuation were recorded. The ROI was also placed on the muscle to calculate contrast-to-noise ratio (CNR)

### RESULTS

The patient weight was 72.5 ± 12.6 kg. The contrast volume was 36.5 ± 6.3 ml. The flow rate was 3.2 ± 0.4 ml/s. The CT attenuation was significant higher in optimal contrast than simulated 120 kVp group (AA: 358.4 ± 35.9 vs. 276.7 ± 34.9 HU, p < 0.001; DA: 325.8 ± 41.1 vs. 258.1 ± 31.2 HU, p < 0.001; 350.7 ± 44.3 vs. 271.5 ± 29.5 HU, p < 0.001). The noise of optimal contrast was significant higher than the simulated 120 kVp images in the aorta, but not on the muscles. The SNR was significantly different between two groups. The CNR of optimal contrast was significantly higher than simulated 120 kVp images (AA: 12.4 ± 1.8 vs. 7.0 ± 1.5, p < 0.001; DA: 11.1 ± 2.1 vs. 6.5 ± 1.5, p < 0.001; AB: 12.0 ± 2.0 vs. 6.8 ± 1.5, p < 0.001). The volume CT dose index and dose-length-product were 7.7 ± 1.6 mGy and 526.2 ± 125.7 mGy\*cm.

### CONCLUSION

DECT non-linear blending technique can improve the image quality of whole aortic angiography and permit a low contrast medium volume and flow rate injection protocol.

### CLINICAL RELEVANCE/APPLICATION

DECT permitted low contrast medium volume and flow rate which improve the patient care and maintain diagnostic image quality

## SSJ27-04 • Validation of a Low Dose Simulation Method for Evaluation of Sub-mSv Computed Tomography

Daniela Muenzel MD (Presenter) ; Thomas Koehler PhD \* ; Kevin M Brown MS \* ; Stanislav Zabic PhD \* ; Alexander A Fingerle MD ; Simone Waldt MD ; Edgar Bendik ; Tina Zahel ; Ernst J Rummeny MD ; Martin Dobritz MD ; Peter B Noel PhD

### PURPOSE

Evaluation of a new software tool for generation of simulated low-dose computed tomography (CT) images from an original higher dose scan.

### METHOD AND MATERIALS

Original contrast-enhanced and non-enhanced CT examinations (120 kVp; 100 mAs, 80 mAs, 60 mAs, 40 mAs, 20 mAs, and 10 mAs) of a swine were acquired. Simulations of CT images with a lower radiation exposure (range 10-80 mAs) were calculated using a low-dose simulation algorithm that simulates accurately both photon noise and electronic noise that would be present in a scan at lower dose. Simulated non-enhanced images were compared to the original non-enhanced CT data of the same radiation dose level regarding density values and image noise. Four radiologists assessed the visual appearance of the simulated contrast-enhanced CT data.

### RESULTS

Image characteristics of simulated low-dose scans were similar to the original acquisitions. Mean overall discrepancy of image noise and CT values between original and simulated CT images was 0.2 % (range -0.6 % to 0.8 %) and -0.3 % (range -2.1 % to 0.8 %), respectively, p > 0.05. Subjective observer evaluation of image appearance showed no visually detectable difference.

### CONCLUSION

Simulated low dose images showed excellent agreement with the original scan data concerning image noise, CT density values, and subjective assessment of the visual appearance of the simulated images.

### CLINICAL RELEVANCE/APPLICATION

An authentic low-dose simulation from actual CT examinations opens up important opportunity with regard to staff education, protocol optimization and introduction of new reconstruction techniques.

## SSJ27-05 • Reduced Iodine Dose Single Source Dual-energy CT Angiography of Abdomen for Assessment of Aorto-Iliac Diseases: Is This the Killer Application for Dual-energy CT?

Mukta D Agrawal MBBS, MD (Presenter) \* ; Surabhi Bajpai MBBS, DMRD ; George R Oliveira MD ; Sanjeeva P Kalva MD \* ; Jorge M Fuentes MD ; Koichi Hayano MD ; Yasir Andrabi MD, MPH ; Dushyant V Sahani MD

### PURPOSE

To investigate the performance of ssDE-CTA using reduce iodine dose for abdominal angiography in comparison to currently applied iodine dose conventional single energy CTA (SE-CTA) and to determine the energy level (keV) that provide optimal imaging for vascular and extravascular evaluation.

### METHOD AND MATERIALS

In a IRB approved ongoing clinical trial, 64 consecutive patients with AAA and prior SE-CTA exam using standard dose of iodine were enrolled. Their follow up CTA exam was undertaken on ssDECT (GE Discovery CT750 HD) with reduced iodine dose (21-24gms instead of 33-55gms). Patients received iso-osmolar iodinated CM (Iodixinol, GE) of 270 mgI/mL (group A, n=32) or 320 mgI/mL (group B, n=32) concentration. The arterial phase DECT images were processed to generate virtual monochromatic images (VMC) of various energies (40 to 140 keV at an increment of 5 keV). Two-experienced radiologist independently evaluated VMC image sets for subjective image quality and noise. Readers also determined the diagnostic keV range and the optimal keV for vascular and extravascular assessments. The contrast to noise ratio (CNR) was calculated on VMC images at various energies and SE-CTA images. A paired student t-test was used to determine statistical significance.

### RESULTS

All DE-CTA exams were considered diagnostic with an IQ score 4.2. Both readers observed a broad range of diagnostic keV images from 40 to 75; and 40-45 keV images were considered best for vascular assessment, whereas 60-65 keV images were rated best for both vascular and extra-vascular assessment. In comparison to SE-CTA images, VMC images (40 - 60 keV) provided significantly higher intravascular attenuation (200-20%) and CNR (40-20%) at 28% less iodine dose (p

### CONCLUSION

ssDE-CTA of abdomen at 28% less iodine dose provides a broad range of diagnostic keV, with 40-45 keV considered best for vascular evaluation and 60-65 keV for both vascular and extra-vascular assessment. This broad diagnostic keV range provides high latitude for image post processing.

#### CLINICAL RELEVANCE/APPLICATION

ssDECT enables substantial reduction in the iodine dose for CTA exam while yielding 200-20% higher intravascular enhancement thereby providing an opportunity to lower renal risks in older patients.

### SSJ27-06 • Whole-body 64-detector CT Angiography with Low-tube-Voltage (80 kVp) and Low-concentration (240 mg/mL) Contrast Material to Reduce Radiation Dose and Iodine Load

**Masayuki Kanematsu** MD ; **Satoshi Goshima** MD, PhD ; **Toshiharu Miyoshi** RT ; **Hiroshi Kondo** MD ; **Haruo Watanabe** MD ; **Yukichi Tanahashi** MD (Presenter) ; **Yoshifumi Noda** MD ; **Kyongtae T Bae** MD, PhD \* ; **Nobuyuki Kawai** MD

#### PURPOSE

To prospectively evaluate contrast enhancement, vascular depiction, image quality, and radiation dose of low-tube-voltage whole-body computed tomographic angiograms (CTAs) with low-concentration iodinated contrast material (CM).

#### METHOD AND MATERIALS

This study was approved by our institutional review board and all patients provided informed consent. Whole-body CTAs were obtained in 109 patients (body weight range, 37-100 kg; mean, 61.2 kg) with a 64-detector CT (Discovery CT750 HD; GE Healthcare) using adaptive statistical iterative reconstruction algorithm (ASiR; GE Healthcare). Patients were randomized into three groups: CTA with 240 mg/mL CM at 80 kVp (240-80 group), 300 mg/mL at 80 kVp (300-80 group), and 370 mg/mL at 120 kVp (370-120 group). CM was intravenously injected at 4 mL/sec and bolus tracking was used in all patients. Signal-to-noise ratio (SNR), arterial depiction, image quality, and radiation dose were assessed separately for the thorax, abdomen, and pelvis. A figure of merit (FOM) was computed to normalize the SNR, estimated effective dose, and iodine weight administered, using the following equation:  $FOM = SNR / \text{effective dose} / \text{iodine weight}$ .

#### RESULTS

Mean iodine weight administered was 21.6, 26.8, and 34.0 g, respectively, for 240-80, 300-80, and 370-120 groups ( $P < .05$ ). Mean vascular enhancement in the thoracic aorta, abdominal aorta, and iliac arteries ranged 508-521, 546-593, and 435-442 HU with 240-80, 300-80, and 370-120 groups, respectively ( $P < .05$ ). The arterial depiction and image quality were comparable between 240-80 and 370-120 groups and were greater with 300-80 group than with the other two groups in selected arteries ( $P < .05$ ). Mean effective dose was higher with 370-120 group (2.8-5.4 mSv) than with 240-80 group (2.3-4.3 mSv) for the abdomen and pelvis ( $P < .05$ ). Mean FOMs with 240-80 group (7.8-15.3) were greater for the abdomen ( $P < .05$ ) and tended to be greater for the thorax and pelvis than those with 370-120 group (4.8-9.2).

#### CONCLUSION

Use of 240 mg/mL CM at 80 kVp seems appropriate for a routine whole-body CTA and beneficial to the reduction of iodine load and radiation dose, whereas the use of 300 mg/mL CM may marginally improve the delineation of selected small arteries.

#### CLINICAL RELEVANCE/APPLICATION

Whole-body CTA with 240 mg/mL CM and 80-kVp tube voltage may replace conventional CTA with 350-400 mg/mL CM at 120-kVp tube voltage, contributing to a reduction of iodine load and radiation dose.

## Vascular Doppler (An Interactive Session)

Tuesday, 04:30 PM - 06:00 PM • E353B

US VA

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**RC410** • AMA PRA Category 1 Credit™:1.5 • ARRT Category A+ Credit:1.5

### RC410A • Challenges in Carotid Doppler

**Edward G Grant** MD (Presenter) \*

#### LEARNING OBJECTIVES

1) Understand the various forms of extracranial pathology affecting the arteries serving the brain and their diagnostic appearance/criteria as seen by the ultrasound examination. 2) Be familiar with the indications for a cerebrovascular examination and its relationship to correlative imaging. 3) Know the criteria set forth by the Society of Radiologists in Ultrasound Consensus Conference for internal carotid artery stenosis and their rationale.

### RC410B • Vertebral Artery Ultrasound: A Gateway to the Great Vessels

**Mindy M Horrow** MD (Presenter) \*

#### LEARNING OBJECTIVES

1) Describe normal anatomy and spectral Doppler of the vertebral arteries. 2) Describe the spectrum of Doppler findings of the subclavian steal phenomenon: pre, partial and complete steal. 3) Detect proximal disease in the innominate vessels and aorta using vertebral artery waveforms in combination with carotid waveforms.

#### ABSTRACT

### RC410C • Ultrasound Evaluation of the Upper and Lower Extremity Veins

**Leslie M Scouff** MD (Presenter) \*

#### LEARNING OBJECTIVES

1) Describe the US criteria for diagnosis of DVT in the upper and lower extremities. 2) Discuss common pitfalls in US evaluation of DVT. 3) Discuss current controversies in the US evaluation of DVT such as: acute vs chronic (residual) DVT; use of the D-dimer assay; should the calf veins be evaluated; is it appropriate to do unilateral exams. 4) Describe the role of US in identifying other causes of extremity pain and swelling.

#### ABSTRACT

This lecture will describe the technique and diagnostic criteria for the US diagnosis of DVT in the upper and lower extremities. Common pitfalls in sonographic assessment of DVT will be described as well as current clinical questions in US evaluation of patients suspected of harboring DVT such as: what is the importance of pre-test probability?, what is the role of the D-dimer assay?, how to differentiate acute from chronic DVT?, and should the calf veins be routinely examined? In addition, the US appearance of other causes of extremity pain and swelling will be described as US has been shown to be useful in making alternative diagnoses, which are often important for patient management, in up to 10% of cases.

## Advanced Vascular Imaging Techniques and Applications

Tuesday, 04:30 PM - 06:00 PM • S502AB

MR VA

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**RC412** • AMA PRA Category 1 Credit™:1.5 • ARRT Category A+ Credit:1.5

## RC412A • MRI of Chronic Mesenteric Ischemia

**Frandics P Chan MD, PhD (Presenter) \***

### LEARNING OBJECTIVES

1) To review the natural history and treatment outcome for mesenteric ischemia. 2) To distinguish the imaging work ups for acute versus chronic mesenteric ischemia. 3) To learn how to image the abnormal physiologic responses of chronic mesenteric ischemia.

### ABSTRACT

Mesenteric ischemia is the result of inadequate perfusion and oxygen delivery to the small intestine caused by vascular obstructions. Acute mesenteric ischemia (AMI) brought on by the abrupt occlusion of the superior mesenteric artery is a medical emergency. Mortality rate of AMI has been reported as high as 80%. Prompt CT angiography of the abdomen is the diagnostic imaging of choice. In contrast, chronic mesenteric ischemia (CMI) is the result of gradual obstructions of multiple splanchnic arteries. 90% of cases are caused by advanced atherosclerotic. Clinical diagnosis is difficult because symptoms are often vague and nonspecific. The classic clinical triad of gradual weight loss, fear of large meal, and post-prandial bowel angina may be absent. The gradual nature of the arterial obstruction promotes development of collateral arteries. The finding of an occluded splanchnic artery on angiography is not necessarily diagnostic of CMI. In difficult cases, a physiologic test that can demonstrate the sequelae of bowel ischemia would be helpful. Different imaging protocols have been proposed to detect changes in blood flow and oxygen saturation in the mesenteric circulation after a meal challenge. We will review some of these protocols and their abnormal physiologic responses indicative of CMI.

## RC412B • Renovascular MRI

**Henrik J Michaely MD (Presenter) \***

### LEARNING OBJECTIVES

1) To familiarize the audience with multi-parametric MRI of the kidneys including: MRA, MR-perfusion measurements, DWI, DTI and BOLD imaging. 2) To point out the physical basics of functional MRI of the kidneys. 3) To present clinical applications of functional MRI of the kidneys.

### ABSTRACT

Due to its complementary information to standard morphologic imaging functional renal magnetic resonance imaging is a rapid growing field of radiology. This refresher course provides a comprehensive overview of state-of-the-art functional renal imaging techniques including renal magnetic resonance angiography (high-yield information on improving your clinical practice), first pass renal perfusion for assessment of renal function (how to and clinical applications), blood-oxygen level dependant imaging of the kidneys and diffusion-weighted imaging of the kidneys including diffusion-tensor imaging of the kidneys. Basic technical concepts for all sequences will be laid out and will be illustrated by current clinical examples. Future applications of functional renal imaging are presented which also include iron-enhanced MRI.

## RC412C • Pre and Post Reconstructive Surgery Vascular Imaging

**Frank J Rybicki MD, PhD (Presenter) \***

### LEARNING OBJECTIVES

1) To understand the principles of vascular imaging in organ transplantation and reconstructive/ restorative surgery. 2) To learn common angiography protocols for vascular mapping and surgical planning. 3) To review image post-processing that renders findings optimal for communication with the comprehensive patient care team. 4) To review the most recent imaging results in pre- and post organ transplantation and reconstructive/ restorative surgery.

### ABSTRACT

Complex transplantation and restorative surgery, such as full face transplantation, is a unique model for studying vascular adaptation and the interaction between donor's and recipient's vascularized tissue. There are important consequences for surgical planning, and to date there is no published data on the mechanisms of vascular reorganization after these complex procedures. Data will be presented that hold potential to better our understanding of the biology after complex restorations, and these data have important implications on graft survival and rejection. This refresher course lecture will provide an overview of these complex processes from the perspective of vascular imaging, and the lecture will illustrate the arterial and venous adaptation to this unique environment. As the number and complexity of these procedures increases on a global scale, this initial evaluation is designed to serve as a template for future studies that will positively impact surgical outcomes and patient care.

## RC412D • Functional Vascular Imaging in Athletes

**Richard L Hallett MD (Presenter)**

### LEARNING OBJECTIVES

1) Identify anatomic and functional lesions that predispose to vascular entrapment and fibrotic syndromes in athletes. 2) Describe methods to assess vascular entrapment and fibrotic syndromes in athletes using dynamic, functionally challenged CTA and MRA. 3) Describe the imaging findings for diagnosis and follow-up of affected athletes.

### ABSTRACT

While exercise is a mainstay in preventing and treating atherosclerotic peripheral vascular disease, some vascular disorders manifest primarily in athletes. Both recreational and competitive athletes are at risk for development of non-atherosclerotic vascular diseases. These disease entities range from iliac endofibrosis in cyclists, popliteal entrapment syndrome in running sports, and thoracic inlet / outlet syndromes in overhead athletes. Recently, computed tomography angiography (CTA) and magnetic resonance angiography (MRA) have become valuable diagnostic options for many vascular diseases that can occur in the athlete. Optimum imaging in these disorders requires the ability to tailor the exam protocol to the specific disease entity and vascular territory in question. By combining rapid CT image acquisition with functional, physiologic provocative maneuvers, diagnostic information can be maximized. Newer blood-pool MR contrast agents also allow functional assessment without ionizing radiation exposure. This session will review the pathophysiology, risk factors, diagnosis, and classification of vascular diseases seen in the athlete. Logical protocol development utilizing (when necessary) provocative maneuvers will be reviewed. Interpretation strategies for interacting with these resulting large, dynamic datasets will also be reviewed.

## Non-Atherosclerotic Vascular Diseases (An Interactive Session)

**Wednesday, 08:30 AM - 10:00 AM • E353B**

VA

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**RC512 • AMA PRA Category 1 Credit™:1.5 • ARRT Category A+ Credit:1.5**

## RC512A • Vasculitis

**Phillip M Young MD (Presenter)**

### LEARNING OBJECTIVES

1) To review clinical and imaging manifestations of vasculitis. 2) To discuss imaging protocols for assessment of vasculitis.

**RC512B • Genetic Disorders****Elliot K Fishman MD (Presenter) \***

## ABSTRACT

The rapid developments in CT angiography have provided unparalleled capabilities for evaluation of the vascular tree in studies that combine rapid data acquisition, isotropic data and 3 dimensional mapping. At the same time an ever increasing domain of knowledge is developing around a range of vascular pathologies including Marfans Syndrome, Loeys Dietz Syndrome and Ehlers Danlos Syndrome to name a few entities where knowledge is expanding at break neck speed. In this presentation I will review many of the key imaging findings of a range of genetic vascular pathologies and define the unique findings of specific entities. The role of imaging in lesion detection, monitoring and guiding therapy is addressed. The role of the radiologist as part of the Vascular team is discussed as well. Finally specific protocols including how to optimize dose is addressed.

**RC512C • Vascular Malformations****Klaus D Hagspiel MD (Presenter) \***

## LEARNING OBJECTIVES

1) To review the classification of vascular malformations and tumors and their clinical and MRI features. 2) To review appropriate MR imaging protocols for the assessment and treatment follow up of these lesions.

## ABSTRACT

Vascular malformations and tumors comprise a wide, heterogeneous spectrum of lesions that often represent a diagnostic and therapeutic challenge. Frequent use of an inaccurate nomenclature has led to considerable confusion. Since the treatment strategy depends on the type of vascular anomaly, correct diagnosis and classification are crucial. Magnetic resonance (MR) imaging is the most valuable modality for classification of vascular anomalies because it accurately demonstrates their extension and their anatomic relationship to adjacent structures. This presentation will review the clinical and MR imaging features that aid in diagnosis of vascular anomalies and their proper classification. MR imaging protocols suitable for comprehensive assessment of vascular anomalies including functional analysis of the involved vessels will be discussed.

**Women and Cardiovascular Disease (In Conjunction with the American Association for Women Radiologists)****Wednesday, 08:30 AM - 10:00 AM • S104A****CT VA CA**[Back to Top](#)**RC516 • AMA PRA Category 1 Credit™:1.5 • ARRT Category A+ Credit:1.5****Moderator****Yoshimi Anzai, MD****RC516A • The Utility of Coronary CTA for the Evaluation of Coronary Artery Disease****Jill E Jacobs MD (Presenter)**

## LEARNING OBJECTIVES

1) To understand the benefits and limitations of coronary CTA for the assessment of coronary artery disease.

**RC516B • Cardiac CT Perfusion for Coronary Artery Disease****U. Joseph Schoepf MD (Presenter) \***

## LEARNING OBJECTIVES

1) To describe the various image acquisition protocols that are available for measuring myocardial perfusion with CT. 2) To recognize findings of normal and pathologic myocardial perfusion patterns at CT. 3) To discuss specific advantages of CT based assessment of myocardial perfusion in women. 4) To identify potential future clinical applications involving CT myocardial perfusion imaging.

**RC516C • Cardiac MR for Myocardial Infarction****Gisela C Mueller MD (Presenter) \***

## LEARNING OBJECTIVES

1) To understand technique, imaging findings, and clinical application of MR for myocardial infarct.

## ABSTRACT

1) To describe the MR technique for myocardial infarct  
2) To discuss segmental anatomy, MR appearances, and appropriate reporting of myocardial infarction  
3) To discuss differential diagnoses of myocardial infarct on MR images and diagnostic pitfalls  
4) To discuss clinical indications, alternative diagnostic methods, and impact on patient management of MR for myocardial infarction

**Cardiac Radiology Series: Transcatheter Aortic Valve Replacement (TAVR)****Wednesday, 08:30 AM - 12:00 PM • S502AB****IR VA CA**[Back to Top](#)**VSCA41 • AMA PRA Category 1 Credit™:3.75 • ARRT Category A+ Credit:4****Moderator****Dominik Fleischmann, MD \*****Moderator****Jonathan A Leipsic, MD \*****VSCA41-01 • The Emerging Role of TAVR****James Min MD (Presenter) \***

## LEARNING OBJECTIVES

1) To understand the use of cardiac CT in the setting of transcatheter aortic valve replacement.

**VSCA41-02 • CT-angiography Based Evaluation of the Aortic Valve Annulus for Prosthesis Sizing in Transcatheter Aortic Valve Implantation (TAVI) - Predictive Value and Optimal Thresholds for Major Anatomic Parameters**



#### PURPOSE

To evaluate the predictive value of CT-measurements of the aortic annulus for prosthesis sizing in transcatheter aortic valve implantation (TAVI) and to calculate optimal cutoff values for the selection of the small, medium and large valve size for two manufacturers.

#### METHOD AND MATERIALS

In 351 TAVI-patients, optimal prosthesis size was determined during TAVI by inflation of a balloon catheter at the aortic annulus. The Corevalve Valve System (Medtronic; CV) and the Edward Sapien XT valve (Edwards Life Sciences; ES) were used in 235 and 116 patients, respectively. All patients had undergone CT-angiography of the bodytrunc prior to TAVI. Using the CT datasets, the length of the long and short axis as well as circumference and area of the aortic annulus were measured by two experienced observers. A 10-fold nested cross-validation approach was used to estimate the predictive power of different anatomical parameters for the prosthesis size ultimately implanted and to define optimal cut-off points.

#### RESULTS

There was excellent interobserver agreement (ICC's > 0.85), so average values were used for further analysis. Differences between patients who underwent implantation of the small, medium or large prosthesis were significant for all evaluated aortic root parameters and both manufactures (p<0.05)

#### CONCLUSION

CT-based aortic root measurements permit good prediction of the prosthesis size considered optimal during TAVI. Applying the proposed parameter ranges, prosthesis size would have been chosen correctly in 87% of cases. Inclusion of the degree of calcification and/or the dimensions of the sinus of Valsalva into our model might further increase its predictive potential.

#### CLINICAL RELEVANCE/APPLICATION

The proposed cutoff-values for major anatomic parameters of the aortic annulus can serve as a guide for non-invasive prosthesis sizing for the most widely used TAVI prosthesis models

### **VSCA41-03 • C-arm CT has Higher Interobserver Variability Compared to Multidetector CT (MDCT) for Transcatheter Aortic Valve Implantation/Replacement (TAVI/R) Planning**

**Suhny Abbara MD (Presenter) \* ; Lorenzo Azzalini ; Umesh C Sharma MD, DPhil ; Ignacio Inglessis ; Igor F Palacios ; Brian B Ghoshhajra MD**

#### PURPOSE

Accurate characterization of the aortic annulus and root is critical for guidance of prosthesis diameter choice in TAVI/R planning, and to accurately deploy the valve, and is usually performed by transesophageal echocardiography or MDCT. The same C-arm used for fluoroscopy during the procedure may also be utilized to acquire 3-D datasets that are similar to MDCT. However, this C-arm CT (CACT) is not currently used to perform measurements of the aortic root to guide the procedure. We aim to evaluate the interobserver variability of CACT aortic root measurements, as compared to MDCT.

#### METHOD AND MATERIALS

CACT and MDCT were performed in 20 patients. Multiplanar reconstructions were performed to determine aortic annulus area, circumference and diameters, sinus of Valsalva diameters and height, leaflet length, distance of the coronary ostia to annulus plane, sinotubular junction, ascending aortic diameters, and predicted perpendicular projection to annulus plane (Figure 1). Each parameter was determined by two independent blinded cardiac imagers. Interobserver variability for CACT- and MDCT-derived measurements was determined using the intraclass correlation coefficient (ICC).

#### RESULTS

No significant interobserver variability was found for all variables derived from MDCT (ICC 0.45 to 0.93). However, there was significant disagreement for the following measurements derived from CACT: aortic annulus short and long axis diameters, area and circumference (ICC

#### CONCLUSION

No significant interobserver variability was found with MDCT. Although, good agreement was found for the measurements above the aortic annulus with CACT, the measurements of the aortic annulus demonstrate greater variability compared to MDCT, possibly due to absence of contrast within the left ventricular outflow tract. Therefore sizing of TAVI/R valves may not reliably be performed based on CACT measurements alone.

#### CLINICAL RELEVANCE/APPLICATION

CACT provides MDCT-like images, but measurements of aortic annulus are not reliable. Sizing of TAVI/R valves therefore continues to require MDCT or echocardiography.

### **VSCA41-04 • Assessment of the Aortic Annulus with TransEsophageal Echocardiography, Multidetector Computed Tomography and Magnetic Resonance to Direct Surgical Sizing: Can We Rely on Imaging?**

**Leonardo Capitolo MD (Presenter) ; Marco Gatti MD ; Claudio Maria Berzovini ; Riccardo Faletti ; Stefano Salizzoni ; Paolo Fonio ; Mauro Rinaldi ; Giovanni Gandini MD**

#### PURPOSE

Precise sizing of the aortic annulus is crucial in order to properly select type and size prosthesis to avoid complication during TAVI procedures. We Evaluate aortic annulus sizing performed by TransEsophageal Echocardiography (TEE), MultiDetector Computed Tomography (MDCT) and Magnetic Resonance (MR) and compares the results to direct intra-operative sizing.

#### METHOD AND MATERIALS

#### RESULTS

All imaging techniques yield results in satisfactory agreement with one another and with the Hegar (R=0.70 for TEE; R=0.81 for MDCT and R=0.81 for MR), even if with different behaviors: MDCT and TEE suffer from overestimation for smaller diameters changing into underestimation for larger ones; MR overestimate over the whole diameter range. The measurements within ±2 mm around the Hegar sizing result in 71% for TEE, 76% for MR and 80% for MDCT.

#### CONCLUSION

MDCT and MR seem to be more accurate in annulus measurements, with different advantages and drawbacks, than TEE.

#### CLINICAL RELEVANCE/APPLICATION

The imaging and the assessment of virtual tube could accurately size the aortic annulus in order to properly select the most appropriate valve size for transcatheter aortic valve implantation (TAVI)

### **VSCA41-05 • Functional Anatomy and Measurements of the Aortic Root**

**Jonathan A Leipsic MD (Presenter) \***

#### LEARNING OBJECTIVES

1) Discuss the most reproducible and accurate methods for annular assessment with CT with a focus on the dynamic changes throughout the cardiac cycle. 2) Provide a deeper understanding of proposed annular sizing strategies with MDCT with focus on recently published multicenter trial data. 3) Discuss the role of MDCT to identify potential adverse root features to help reduce the risk of annular injury.

## VSCA41-06 • Intentional Computed Tomography-based Oversizing in Balloon-expandable Transcatheter Aortic Valve Replacement - Incidence of Paravalvular Regurgitation and Post-deployment Geometry

Philipp Blanke MD (Presenter) ; Eva Maria Spira ; Gregor Pache MD ; Mathias F Langer MD, PhD

### PURPOSE

To evaluate the incidence of paravalvular regurgitation and post-deployment geometry of intentional computed tomography (CT)-based oversizing of Transcatheter Heart Valves (THV) in Transcatheter Aortic Valve Replacement (TAVR) using pre- and post-deployment dual-source CT.

### METHOD AND MATERIALS

115 patients with severe aortic stenosis (mean age  $81 \pm 7$  years, mean aortic valve area  $0.68 \pm 0.18 \text{ cm}^2$ ) underwent retrospectively gated dual source CT for THV sizing prior to TAVR. Aortic annulus dimensions were quantified by means of planimetry and area-derived diameter calculation ( $D = 2 \times \sqrt{\text{area}/\pi}$ ) at the level of the basal attachment points of the aortic cusps during systole. THV selection was CT-diameter-based (EdwardSAPIEN XT 23mm THV for D 25mm). Post-deployment CT was performed in 95 patients. Stent-expansion was assessed planimetrically at the inlet, outlet and level of the native annulus. Relative oversizing and relative changes in annulus dimensions were calculated.

### RESULTS

Average pre-deployment annulus diameter was  $24.1 \pm 1.8 \text{ mm}$ , average post-deployment diameter was  $23.9 \pm 1.5 \text{ mm}$  ( $p = \text{n.s.}$ ). Average relative change in annulus diameter was  $-0.5 \pm 3.6\%$ . Mean relative oversizing was  $9.1 \pm 4.7\%$ . Mean diameter at the THV outlet was significantly larger than at the THV inlet ( $24.3 \pm 1.8 \text{ mm}$  vs.  $23.8 \pm 1.7 \text{ mm}$ ,  $p$

### CONCLUSION

Intentional oversizing of the THV based on an area-derived annulus diameter in CT and an adapted incremental sizing scheme appears safe and is associated with a lower incidence of relevant paravalvular regurgitation, as compared to published landmark trial with echocardiography-based THV-sizing

### CLINICAL RELEVANCE/APPLICATION

Planimetric assessment of the aortic annulus by CT allows for intentional prosthesis oversizing in transcatheter aortic valve replacement to reduce the occurrence of paravalvular regurgitation.

## VSCA41-07 • CT Angiography for Aortic Root Measurements in TAVR Patients: Comparison of High-pitch Dual-source CT Image Acquisition versus Retrospective ECG-Gating

Felix G Meinel MD (Presenter) ; U. Joseph Schoepf MD \* ; Carlo Nicola De Cecco MD ; Aleksander Krazinski ; Maximilian F Reiser MD ; Lucas L Geyer MD \* ; Daniel H Steinberg MD

### PURPOSE

To compare the diagnostic value and robustness of high-pitch dual-source CT angiography versus retrospectively ECG-gated data acquisition for aortic root measurement during pre-procedural planning of transcatheter aortic valve replacement (TAVR).

### METHOD AND MATERIALS

With IRB approval and in HIPAA compliance, data of 20 patients ( $77.5 \pm 12.8$  years, 11 male, heart rate  $69.4 \pm 15.5 \text{ bpm}$ ) considered for TAVR were retrospectively analyzed. All patients had undergone both retrospectively ECG-gated cardiac CT (scan 1) as well as high-pitch dual-source CT angiography (scan 2) of the aorta. Scan 2 targeted the end-systolic phase at 35% of the RR-cycle. A BMI-based contrast medium (CM) injection protocol was used with 70-144mL volume, injected at 3.0-5.5mL/s. For consistency, both scans were reconstructed with a section thickness of 1.5mm with 0.7mm increment. Image quality (IQ) was subjectively assessed. Aortic annulus dimensions were measured as area-derived diameters. Based on effective diameter, agreement for prosthesis selection between the high-pitch image acquisition (DFLASH) was compared with standard reconstructions at 30%-80% ( $D_{30}$ - $D_{80}$ ) of the RR-cycle.

### RESULTS

All patient studies had at least 150 HU CM attenuation at the level of the aortic root. In scan group 1, aortic annulus measurements could be successfully performed in all patients. Scan 2 resulted in 7 studies with non-diagnostic IQ. Patients with non-diagnostic IQ had a significantly higher body-mass index ( $38.5 \pm 10.1 \text{ kg/m}^2$  versus  $27.4 \pm 4.2 \text{ kg/m}^2$ ,  $p$ FLASH  $24.1 \pm 2.0 \text{ mm}$ ,  $D_{30}$   $24.6 \pm 2.2 \text{ mm}$ ,  $D_{40}$   $24.2 \pm 2.1 \text{ mm}$ ,  $D_{50}$   $24.1 \pm 2.2 \text{ mm}$ ,  $D_{60}$   $23.9 \pm 1.99 \text{ mm}$ ,  $D_{70}$   $23.8 \pm 1.98 \text{ mm}$ ,  $D_{80}$   $24.2 \pm 2.3 \text{ mm}$ . In patients with diagnostic IQ, the highest agreement in prosthesis sizing was found in 11 of 13 patients by  $D_{30}$  ( $\kappa = 0.65$ ) and 13 of 13 patients by  $D_{70}$  ( $\kappa = 1.00$ ) compared with DFLASH.

### CONCLUSION

For TAVR planning, the use of high-pitch dual-source CT angiography is feasible in the majority of patients. However, retrospectively ECG-gated cardiac CT should be considered in problematic scenarios, such as obese patients or cardiac arrhythmia.

### CLINICAL RELEVANCE/APPLICATION

High-pitch dual-source CTA requires appropriate patient selection for reliable measurements of the aortic annulus in TAVR patients compared with the more robust retrospectively ECG-gated approach.

## VSCA41-08 • Accuracy of Aortic Root Annulus Assessment with Cardiac Magnetic Resonance in Patients referred for Transcatheter Aortic Valve Implantation: A Comparison with Multi-detector Computed Tomography

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

### PURPOSE

Cardiac magnetic resonance (CMR) has distinct advantages over 2D echocardiography such as exceptional spatial resolution and does not need administration of contrast agents, provides similar 3D multi-slice images of the aortic root, so that it may be a valid alternative to MDCT. The aim of this study is to compare the accuracy of CMR evaluation of AoA as compared to MDCT in patients referred for TAVI.

### METHOD AND MATERIALS

50 patients were studied with a 1.5-T scanner (Discovery MR450, GE Healthcare, Milwaukee, WI). Steady-state free precession cine acquisitions were acquired with following parameters: echo time 1.57 ms, repetition time 46 ms, slice thickness 8 mm, field of view  $350 \text{ mm} \times 263 \text{ mm}$ , and pixel size  $1.4 \text{ mm} \times 2.2 \text{ mm}$ . Two long-axis view of the aortic root and ascending aorta were obtained. Thus, serial short-axis cines orthogonal to the AoA (3-mm thickness with 1.5-mm overlapping) were imaged. The following parameters were assessed with CMR and compared with those obtained with MDCT: AoA maximum diameter (AoA-Dmax), minimum diameter (AoA-Dmin), and area (AoA-A), length of the left coronary, right coronary, and non-coronary aortic leaflets, degree (grades 1 to 4) of aortic leaflet calcification and distance between AoA and coronary artery ostia.

### RESULTS

AoA-Dmax, AoA-Dmin and AoA-A were  $26.45 \pm 2.83 \text{ mm}$ ,  $20.17 \pm 2.20 \text{ mm}$ ,  $444.88 \pm 84.61 \text{ mm}^2$  and  $26.45 \pm 2.76 \text{ mm}$ ,  $20.59 \pm 2.35 \text{ mm}$  and  $449.78 \pm 86.22 \text{ mm}^2$  by MDCT and CMR, respectively. The length of left coronary, right coronary, and non-coronary leaflets were  $14.02 \pm 2.27 \text{ mm}$ ,  $13.33 \pm 2.33 \text{ mm}$ ,  $13.39 \pm 1.97 \text{ mm}$ , and  $13.95 \pm 2.18 \text{ mm}$ ,  $13.30 \pm 2.14 \text{ mm}$ ,  $13.46 \pm 1.80 \text{ mm}$  by MDCT and CMR, respectively, while the scores of aortic leaflet calcifications were  $3.4 \pm 0.7$  vs.  $2.97 \pm 0.77$ . Finally, the distance between AoA and left main and right coronary artery ostia was  $16.21 \pm 3.07 \text{ mm}$ ,  $16.02 \pm 4.29 \text{ mm}$  and  $16.14 \pm 2.83 \text{ mm}$ ,  $16.14 \pm 4.36 \text{ mm}$  by MDCT and CMR, respectively. There was close agreement between CMR and MDCT measurements, whereas aortic leaflet calcifications were underestimated by CMR.

### CONCLUSION

Aortic root assessment with CMR including AoA size, aortic leaflet length and coronary artery ostia height is accurate in comparison to MDCT.

CLINICAL RELEVANCE/APPLICATION  
CMR may be a valid imaging alternative in patients unsuitable for MDCT.

### VSCA41-09 • Access Vessel Assessment

**Dominik Fleischmann MD (Presenter) \***

#### LEARNING OBJECTIVES

1) Review the possible percutaneous access sites for patients undergoing TAVR: femoral, transapical, transaortic, subclavian/axillary. 2) Explain the techniques for accurate vessel visualization, diameter measurements and curvature assessment. 3) Present the current recommendations for minimum access vessel diameters with clinical examples.

#### ABSTRACT

Treatment planning for TAVR requires meticulous assessment of access vessels to assure safe device delivery. A high-quality CTA dataset with 0.6-1.25mm section thickness is a prerequisite for accurate vessel visualization and measurement. While transverse source images provide a reasonably good 'first look', most patients require dedicated postprocessing with curved planar reformations and orthogonal images through the access vessels to determine the minimal vessel diameter, to assess for the presence of calcifications, and display the degree of tortuosity. The minimum arterial diameter necessary for TAVR depends on the valve type and size, as well as on the outer diameter of the delivery system. The outer diameter of the delivery system should not exceed 1.05 times the inner arterial diameter. If heavy calcifications are present, particularly circumferential or horse-shoe shaped, the delivery system should be smaller. If peripheral arterial access is inadequate, a direct transaortic route can be chosen through a mini-sternotomy, or right mini-thoracotomy (2nd interspace). It is important to exclude heavy calcifications at a potential aortic access site (e.g. plaque of porcelain aorta), and to determine the distance between the aortic access and the valve plane to assure enough length for device delivery. Transapical access can be gained through a left lateral mini-thoracotomy (5th or 6th interspace).

### VSCA41-10 • Low Volume, Low Iodine Concentration Contrast Medium Protocol for Comprehensive CT Planning of Transcatheter Aortic Valve Replacement

**Aleksander Krazinski ; Philipp Blanke MD ; U. Joseph Schoepf MD \* ; Justin R Silverman ; Carlo Nicola De Cecco MD ; Lucas L Geyer MD (Presenter) \* ; Fabian Bamberg MD, MPH \* ; Daniel H Steinberg MD**

#### PURPOSE

To investigate the feasibility of a dual-source CT angiography (CTA) protocol with a low volume of low iodine concentration contrast medium (CM) for comprehensive planning of transcatheter aortic valve replacement (TAVR) in a patient group with a high prevalence of chronic renal failure and atrial fibrillation.

#### METHOD AND MATERIALS

44 patients, considered for TAVR, underwent retrospectively ECG-gated CTA of the heart, immediately followed by high-pitch CTA of the femoro-ilio-aortic access route using two different injection protocols of low iodine concentration (320mgI/mL) iodixanol: group A, iodine delivery rate (IDR)-based (target, 1.28gI/s), CM volume 60mL, flow rate 4.0mL/s; group B, BMI-based (routine protocol), CM volume range 70-144mL, flow rate range 3.0-5.5mL/s. All injections were followed by a 50mL saline chaser. Aortic root complex and iliofemoral dimensions were measured. Mean arterial attenuation, signal-to-noise ratio (SNR), and contrast-to-noise ratio (CNR) were calculated. Subjective image quality was assessed at the level of the aortic root complex and the aortoiliac vasculature.

#### RESULTS

Gender distribution (12 female, 8 male,  $p=0.226$ ), age ( $82.1\pm 9.8$  years,  $80.0\pm 11.5$  years,  $p=0.520$ ), body mass index ( $26.8\pm 4.1\text{kg/m}^2$ ,  $29.1\pm 4.7\text{kg/m}^2$ ,  $p=0.098$ ), and heart rate ( $69.3\pm 10.3\text{bpm}$ ,  $70.0\pm 14.5\text{bpm}$ ,  $p=0.849$ ) showed no significant differences between groups. Aortic root complex and iliofemoral dimensions could be analyzed in all cases. Mean attenuation at the level of the aortic root ( $272.5\pm 100.3\text{HU}$ ,  $318.9\pm 67.3\text{HU}$ ,  $p=0.097$ ), the aorta ( $214.7\pm 70.0\text{HU}$ ,  $251.2\pm 82.4\text{HU}$ ,  $p=0.140$ ), and the iliofemoral access route ( $264.1\pm 87.2$ ,  $287.7\pm 64.9$ ,  $p=0.337$ ) was non-significantly lower in group A. SNR and CNR were non-significantly higher in group B. Qualitative assessment of image quality did not result in significant differences.

#### CONCLUSION

The performance of a combined CTA protocol consisting of a retrospectively ECG-gated cardiac CTA immediately followed by a high-pitch scan of the femoro-ilio-aortic access route is feasible. With this approach, the amount of CM can be considerably reduced by using a single low volume CM bolus without substantial loss of image quality in fragile, multimorbid patients who are considered for the TAVR procedure.

#### CLINICAL RELEVANCE/APPLICATION

This comprehensive protocol facilitates the use of a low volume, low iodine concentration CM protocol, which is essential in this patient group who often presents with significant comorbidities.

### VSCA41-11 • Influence of Left Ventricular Geometry and Body-surface Area on Aortic Annulus Dimensions in Patients prior to Transcatheter Aortic Valve Implantation - Assessment by Computed Tomography

**Philipp Blanke MD (Presenter) ; Eva Maria Spira ; Tobias Baumann MD ; Gregor Pache MD ; Mathias F Langer MD, PhD**

#### PURPOSE

To investigate the influence of left ventricular geometry, left ventricular function, body surface area (BSA), and gender on aortic annulus dimensions by computed tomography (CT) in patients with severe aortic stenosis.

#### METHOD AND MATERIALS

ECG-gated cardiac dual-source CT data of 289 consecutive patients with severe aortic stenosis (mean age  $81\pm 7$  years, 121 males, mean aortic valve area  $0.68\pm 0.18\text{cm}^2$ ) was included. Aortic annulus dimensions were quantified by means of planimetry and area-derived diameter calculation ( $D = 2 \times \sqrt{\text{area}/\pi}$ ) at the level of the basal attachment points of the aortic cusps during systole. End-diastolic left ventricular volume (LVEDV), left ventricular ejection fraction (LVEF) and left ventricular myocardial mass (LVM) were assessed by multiphasic cine image reconstructions. Pearson correlation analysis and a step-wise multi-linear regression model were performed.

#### RESULTS

Mean aortic annulus diameter was  $24.4\pm 2.4\text{mm}$ , mean LVEF  $59.1\pm 16.1\%$ , mean LVEDV  $145.6\pm 51.5\text{ml}$ , mean LVM  $181.8\pm 54.2\text{g}$ , and mean BSA  $1.8\pm 0.2\text{m}^2$ . A positive and significant correlation ( $p$

#### CONCLUSION

In patients with aortic stenosis, aortic annulus dimensions are influenced by gender, BSA and left ventricular geometry. A larger end-diastolic left ventricular volume, as present in left ventricular dilation, is associated with a larger annulus diameter.

#### CLINICAL RELEVANCE/APPLICATION

In patients undergoing transcatheter aortic valve replacement, aortic annulus dimensions are critical for prosthesis sizing. This study aids in understanding predictors of annulus dimension.

### VSCA41-12 • Anatomical and Procedural Features Associated with Annular Injury in Balloon Expandable Transcatheter Aortic Valve Replacement

**Jonathan A Leipsic MD (Presenter) \* ; Marco Barbanti MD ; Philipp Blanke MD ; Gudrun Feuchtner MD \* ; David Wood MD, FRCP \* ; James Min MD \* ; John Webb MD, FRCP \***

## PURPOSE

Aortic root rupture is a major concern with balloon expandable TAVR. We sought to identify predictors of aortic root rupture during balloon-expandable TAVR using MDCT.

## METHOD AND MATERIALS

Thirty seven consecutive patients with left ventricular outflow tract (LVOT)/annular rupture complicating balloon expandable TAVR were collected from 17 centers and 10 countries. Analysis was performed on an historical cohort of 150 consecutive TAVR patients without aortic root rupture who underwent pre-procedure MDCT at St Paul's Hospital, Vancouver, to identify a comparable group. Matched case-control analysis was conducted where random 1 to 1 matching datasets were constructed on confounders which include gender, baseline aortic valve area, baseline mean transaortic gradient and annular area on CT. Conditional logistic regression was used on the matched data to assess study variables' association with root rupture. MDCT assessment included short and long axis diameters and cross sectional area of the sinotubular junction, annulus and LVOT, as well as the presence, location, and extent of LVOT calcification.

## RESULTS

Mean age was 82.4±8.5 years and 74% of patients were females. There were no significant differences between the two groups in any preoperative clinical and echocardiographic variables. Aortic root rupture was identified in 20 patients and periaortic hematoma in 11. Patients with root rupture had a higher degree of LVOT calcification quantified by Agatston score (181.2±211.0 vs. 22.5±37.6, p

## CONCLUSION

This study demonstrates that LVOT calcification and aggressive annular area oversizing are associated with an increased risk of aortic root rupture during TAVR with balloon-expandable prostheses. Larger studies are warranted to confirm these findings.

## CLINICAL RELEVANCE/APPLICATION

We have identified an important anatomical factor and two procedural variables strongly associated with annular rupture which will allow for a deeper understanding of this important complication.

## VSCA41-13 • Complications and Incidental Findings

**Gudrun Feuchtner MD (Presenter) \***

### LEARNING OBJECTIVES

1) To learn which imaging features are associated with complications related to TAVI procedure. 2) To understand morphology of aortic valve, annulus, calcifications and implications for procedure success. 3) To learn which incidental findings have impact on pre-procedural patient management and intraoperative complications.

### ABSTRACT

Transcatheter aortic valve implantation (TAVI) is a modern innovative minimal invasive approach to treat patients with severe aortic stenosis effectively. Imaging plays a key role to ensure procedure success and to avoid complications. During this course, imaging features associated with complications will be discussed: 1) Major vascular complications occur at 15%. This rate can be cut when selecting patients carefully taking into account high-risk features on CT. 2) Aortic annular calcification are related to intraoperative complications, and high-risk characteristics will be shown. 3) Incidental findings having impact on patients' management will be identified.

## VSCA41-14 • The Impact of Post-implant SAPIEN XT Geometry on Conduction Disturbances, Hemodynamic Performance and Paravalvular Regurgitation

**Cameron J Hague MD (Presenter) ; Jonathan A Leipsic MD \* ; John Webb MD, FRCPC \* ; Stefan Toggweiler ; Melanie Freeman ; Ronald Binder ; David Wood MD, FRCPC \* ; Marco Barbanti MD ; Donya A Al-Hassan MD**

### PURPOSE

To examine the relationship between post valve placement geometry and position of a percutaneously placed Edwards Sapien XT balloon expandable aortic valve and the presence of prosthetic valve dysfunction and post-implant conduction abnormalities.

### METHOD AND MATERIALS

89 consecutive patients with symptomatic aortic stenosis undergoing transcatheter aortic valve replacement (TAVR) with a balloon expandable Sapien XT valve had pre and post valve assessments with multidetector computed tomography (MDCT), transthoracic echocardiography (TTE) and pre and post procedure 12 lead ECG. MDCT measures included valve circularity, percent expansion, inflow/outflow valve areas, and implantation height. Chart review assessed for placement of a permanent pacemaker (PPM) in subjects post TAVR. Statistical analyses were performed using SPSS statistics software. A p-value below 0.05 was considered significant. IRB approval was obtained for this study. All subjects provided consent.

### RESULTS

89 patients (age 82±8 years, 54 male, 35 female) undergoing TAVR with an Edwards Sapien XT THV were analyzed. Analysis of post implant MDCTs demonstrate average THV stent frame placement as follows: outflow 0.3mm +/- 2.6mm below the left main ostium, and inflow (inferior aspect of stent) was 3.6 +/- 2.2mm below the aortic annulus (basal insertion of the native aortic leaflets). Paravalvular regurgitation (PAR) as assessed by TTE was absent in 24.7%, mild in 67.4%, moderate in 5.6% and moderate to severe in 2.2%. As assessed by MDCT stent frame inflow area in relation to the native annular area, and the difference of the stent frame long-axis diameter to native annulus long axis diameter were the only measured parameters predictive of PAR (p=0.03 and p=0.023 respectively). 5.1% of subjects required a new PPM following TAVR. The MDCT derived THV inflow level to annular distance was the strongest predictor of PPM placement post TAVR. (3.5 +/- 2.0mm versus 7.1 +/- 2.5mm, p=0.001).

### CONCLUSION

MDCT measures of THV implantation depth and relationship of inflow stent area to native annulus area are strong predictors of new onset conduction disturbances/PPM placement and PAR respectively, both important causes of morbidity and mortality post TAVR.

### CLINICAL RELEVANCE/APPLICATION

MDCT measures of implantation depth and stent inflow area versus native annular area provide important predictors of complications TAVR (PPM placement and PAR respectively).

## VSCA41-15 • Contrast Induced Nephropathy after Contrast Enhanced Computed Tomography prior to Transcatheter Aortic Valve Implantation

**Vera S Schneider BS (Presenter) ; Florian Schwarz MD ; David Jochheim MD ; Christian Kupatt MD, PhD ; Maximilian F Reiser MD ; Hans-Christoph R Becker MD ; Philipp Lange MD ; Julinda Mehilli MD ; Frederik F Strobl MD**

### PURPOSE

Contrast induced nephropathy (CIN) is a common complication after contrast enhanced computed tomography (CT). Particularly, patients with aortic valve stenosis (AS) are at increased risk for CIN due to their high prevalence of chronic kidney disease. The aim of this analysis is to determine the rate of CIN in patients with AS following contrast enhanced CT scans prior to transcatheter aortic valve implantation (TAVI).

### METHOD AND MATERIALS

### RESULTS

Rates for CIN in patients with GFR under 30, 30 to 60 and over 60 ml/min, were 13.6 %, 10.9 %, 6.8 %, respectively. Average contrast volume in patients who developed CIN was 101 ml vs. 92 ml in those who did not (p < 0.05), supporting a strong relation between the development of CIN and the volume of contrast administered.

#### CONCLUSION

The incidence of CIN in high risk patients with AS undergoing contrast enhanced CT depends on the baseline GFR. We found a close relation between the amount of administered contrast media and the development of CIN.

#### CLINICAL RELEVANCE/APPLICATION

Low dose contrast protocols for CT angiography may help reduce the risk of CIN particularly in high risk patients with AS in whom baseline renal function frequently is impaired.

### **VSCA41-16 • Fusion of Cardiac Computed Tomography Angiography and 18F-Fluorodesoxyglucose Positron Emission Tomography for the Detection of Prosthetic Heart Valve Endocarditis**

**Wilco Tanis** (Presenter) ; **Asbjorn Scholtens** MD ; **Jesse Habets** MD ; **Renee B Van Den Brink** MD, PhD ; **Lex Van Herwerden** \* ; **Steven Chamuleau** MD, PhD ; **Ricardo P Budde** MD, PhD

#### PURPOSE

In prosthetic heart valve (PHV) endocarditis transthoracic and transesophageal echocardiography (TTE and TEE) may fail to recognize vegetations and peri-annular extensions, which is an indication for urgent surgery. Moreover, abnormal peri-annular anatomy after PHV implantation is not uncommon and differentiation between active or absent inflammation is difficult. The purpose of this study is to investigate the additional value of imaging with fused Computed Tomography Angiography (CTA) and 18F Fluorodesoxyglucose Positron Emission Tomography including low dose CT (FDG-PET/CT) providing high resolution anatomical and functional information.

#### METHOD AND MATERIALS

In our hospital PHV patients suspected for endocarditis undergo additional CTA and sometimes also FDG-PET/CT imaging when TTE and TEE are inconclusive. All PHV patients that underwent FDG-PET/CT were selected from the hospital database and assigned as cases or controls. Surgical inspection was the reference standard for cases.

#### RESULTS

Twelve PHV endocarditis cases and six normal functioning PHV controls were identified, which all underwent TTE, TEE, CTA and FDG-PET/CT. On surgical inspection 11/12 cases had peri-annular extension and 4/12 had a vegetation. CTA alone detected all vegetations but missed one peri-annular extension. FDG-PET/CT alone missed all vegetations, however all peri-annular extensions were detected correctly. Combined FDG-PET/CT and CTA detected all peri-annular extensions and vegetations correctly. Controls were all free of significant FDG uptake. SUV ratios around the PHV ring were significantly (p

#### CONCLUSION

Fused FDG-PET and CTA imaging is a promising tool to correctly diagnose PHV endocarditis in patients with an inconclusive echocardiography. SUV ratios may be of additional help for correct detection of peri-annular extensions.

#### CLINICAL RELEVANCE/APPLICATION

PHV endocarditis sometimes remains difficult to diagnose with echocardiography due to acoustic shadowing of mechanical valves. In those cases hybrid imaging with CTA and FDG-PET/CT may guide treatment.

### **VSCA41-17 • Characteristics of Aortic Valvular Function and Ascending Aorta Dimensions According to Bicuspid Aortic Valve Morphology Using Dual-source Computed Tomography**

**Tae Hyung Kim** (Presenter) ; **Sung Min Ko** ; **Meong Gun Song** ; **Hweung Gon Hwang** ; **Jung Ah Park**

#### PURPOSE

The bicuspid aortic valve (BAV) is associated with aortic valve dysfunction and ascending aorta dilatation. The relationship between BAV morphology and ascending aorta dimensions remains unclear. We sought to characterize the aortic valve function and the ascending aorta dimensions according to valve morphology using dual-source computed tomography (DSCT).

#### METHOD AND MATERIALS

Two hundred nine BAV patients who underwent DSCT and transthoracic echocardiography were retrospectively included. BAV was classified into type I (anterior-posterior orientation of cusps or raphe) and type II (lateral orientation of cusps or raphe), and divided into raphe + (presence of raphe) and raphe - (absence of raphe) using DSCT.

#### RESULTS

Type I was present in 129 patients (61.7%) and raphe + in 120 (57.4%) patients. BAV type I and II was more commonly in patients with raphe + (84%) and raphe - (69%), respectively. Aortic regurgitation was more common in patients with type I (45%) and raphe + (53%), and aortic stenosis in patients with type II (46%) and raphe - (56%). Type I patients had a larger aortic annulus and smaller tubular portion of ascending aorta (29.9±4.7 mm and 41.7±7.3 mm, respectively) compared to type II patients (26.7±3.5 mm and 44.3±8.3 mm, respectively), P

#### CONCLUSION

BAV morphology is helpful in predicting the type of aortic valve dysfunction and the location of ascending aorta dilatation

#### CLINICAL RELEVANCE/APPLICATION

BAV morphology is helpful in predicting the type of aortic valve dysfunction and the location of ascending aorta dilatation.

## **Interventional Radiology Series: Embolotherapy**

**Wednesday, 08:30 AM - 12:00 PM • E352**



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**VSIR41 • AMA PRA Category 1 Credit™:3.25 • ARRT Category A+ Credit:4**

#### **Moderator**

**Jafar Golzarian**, MD

#### LEARNING OBJECTIVES

1) Describe recent evidence concerning the use of embolization for symptomatic prostatic hypertrophy. 2) Explain the use of liquid embolic agents. 3) Describe treatment of complex visceral aneurysms using embolization. 4) Describe two obstetrical or gynecologic emergencies requiring embolization. 5) List two techniques to prevent non-target embolization.

### **VSIR41-01 • Non-Target Embolization: How To Prevent or Minimize?**

**Christoph A Binkert** MD (Presenter) \*

#### LEARNING OBJECTIVES

1) To learn about functional anatomy and flow changes during embolization. 2) To learn about the appropriate use of different materials. 3) To learn about technical tricks to minimize non-target embolization.

### **VSIR41-02 • Liquid Embolic Agents**

**Robert A Morgan** MD (Presenter) \*

#### LEARNING OBJECTIVES

1) To learn about the indications, properties and techniques for the use of the different embolic agents.

#### ABSTRACT

### VSIR41-03 • Incidence and Clinical Management of Ruptured and Incidentally Diagnosed Visceral Aneurysms

**Sebastian Schotten** MD (Presenter) ; **Evelyn Dappa** ; **Roman Kloeckner** MD ; **Jens Schneider** ; **Christoph Dueber** MD ; **Michael B Pitton** MD

#### PURPOSE

Visceral arterial aneurysms (VAA) are a rare entity with a prevalence between 0.1 – 2% and have a high risk for rupture with mortality rates between 20-75%. We therefore reviewed and analyzed the institutional data base for diagnosis and management of VAA over a period of 10 years.

#### METHOD AND MATERIALS

An automatic analysis of the institutional database using the word "aneurysm" resulted in identification of 12.588 reports (CT, MRI, and Angiography). 239 of these patients could be identified suffering from VAA (mean age 65 years ± 12.5 years). VAA were analyzed with respect to location, size, true aneurysm or false aneurysms after surgery/intervention, rupture status, management, and clinical follow-up.

#### RESULTS

Diagnosis included VAA of the splenic artery (n=81), celiac trunk (n=46), renal artery (n=42), hepatic artery (n=37), superior mesenteric artery (n=15), gastroduodenal artery (n=10) and others (8). The overall size of the aneurysms was 17.8 ± 10.2mm; min. 4 mm, max. 112 mm). 44 VAA were rated as false aneurysms (18%), 25 of them after surgery and 11 after percutaneous interventions like biopsies or drainages. 58 of 239 cases were treated with transarterial intervention (n=47) or surgery (n=11). Interventions included embolization with coils (n=35) or glue (n=4), implantations of covered stents (n=4), and combinations of these (n=4). 40 patients were diagnosed at rupture and were treated on an emergency basis (hemoglobin 8.6±1.7mg/dl). There was no significant difference in size between ruptured and non-ruptured VAA (15.2 ± 8.4mm vs. 16.3 ± 10.1mm). The 30-day mortality in ruptured cases was 8.3% (12 of 36) after interventional treatment compared to 25% after surgery (1 of 4). No fatality occurred after interventional treatment of non-ruptured aneurysms (n=11). The conservatively treated patients presented a 30-day mortality of 6.1% (11 of 181).

#### CONCLUSION

The clinical impact of accidentally diagnosed VAA still remains unclear. However, symptomatic or ruptured VAA might be associated with a high mortality rate. There was no difference in size in ruptured and non-ruptured aneurysms. Interventional treatment seems to offer a beneficial approach in emergency cases compared to surgery.

#### CLINICAL RELEVANCE/APPLICATION

False aneurysms seem to have a considerably higher risk of rupture and should be promptly treated irrespective of the diameter.

### VSIR41-04 • Complex Visceral Aneurysms

**Michael D Darcy** MD (Presenter) \*

#### LEARNING OBJECTIVES

View learning objectives under main course title.

### VSIR41-05 • A Comparison of the Results of Arterial Embolization for Bleeding and Non-bleeding Gastroduodenal Ulcers

**Denis Krause** MD (Presenter) ; **Louis Estivalet** ; **Pierre Thouant** ; **Violaine Capitan** ; **Jean P Cercueil** MD ; **Romarc Loffroy**

#### PURPOSE

Although some authors have advocated the practice of arterial embolization for angiographically negative acute hemorrhage from gastroduodenal ulcers, this technique remains controversial. The goal of our study was to compare the results of arterial embolization for bleeding (BU) and non-bleeding (NBU) gastroduodenal ulcers.

#### METHOD AND MATERIALS

Transcatheter embolization was performed in 57 patients (39 men, 18 women, mean age 69.8 years) who experienced acute bleeding from gastroduodenal ulcers. At the time of embolization active contrast extravasation was seen in 36 of 57 patients, while in the remaining 21 patients embolization was based on endoscopic findings. Patient demographics, clinical success, need for re-intervention secondary to re-bleeding, and 30-day complication and mortality rates were reviewed and compared between the two groups by using statistical analyses.

#### RESULTS

In the BU group, the gastroduodenal artery (GDA) was embolized in 31 patients (86.1%), the left gastric artery (LGA) in three patients (8.3%), and the left gastroepiploic artery (LGEA) in two patients (5.6%). In the NBU group, the GDA was embolized in 18 patients (85.7%), and the LGA in three patients (14.3%). Clinical success (61.9 vs. 75.0%, P = 0.30), need for re-intervention (38.1 vs. 27.8%, P = 0.42), and 30-day complication (9.5 vs. 5.6%, P = 0.57), and mortality (28.6 vs. 25%, P = 0.77) rates were not statistically different between the two groups. Embolization in patients in NBU group did not have impact on clinical success (Odds Ratio, 0.54; 95%CI, 0.17–1.72; P = 0.30).

#### CONCLUSION

Arterial embolization in patients with angiographically NBU is as safe and effective as embolization in patients with BU.

#### CLINICAL RELEVANCE/APPLICATION

The practice of empiric arterial embolization for angiographically negative acute hemorrhage from gastroduodenal ulcers should be systematically used as it is efficient.

### VSIR41-06 • Embolization of Obstetrical and Gynecologic Emergencies

**Sue E Hanks** MD (Presenter)

#### LEARNING OBJECTIVES

1) Identify appropriate patients for transcatheter embolization following gynecologic or obstetric procedures. 2) Choose effective embolic agents to treat hemorrhage from gynecologic malignancies. 3) Define angiographic approach to identification of hemorrhage from gynecologic and obstetric emergencies.

### VSIR41-07 • Medium and Long Term Outcome of Prostatic Arterial Embolization to Treat Benign Prostatic Hyperplasia

**Joao M Pisco** MD (Presenter) ; **Hugo A Rio Tinto** MD \* ; **Tiago Bilhim** MD \* ; **Lucia C Fernandes** MD ; **Jose A Pereira** MD ; **Luis C Pinheiro** ; **Antonio Oliveira** ; **Marisa Duarte** MD

#### PURPOSE

To evaluate the medium and long term outcome of prostatic arterial embolization (PAE) to treat lower urinary tract symptoms associated with benign prostatic hyperplasia (BPH).

#### METHOD AND MATERIALS

Two hundred forty patients (age range, 62 – 82 years; mean age, 74.1 y) with BPH and moderate to severe lower urinary tract

symptoms after failure of medical treatment underwent PAE between March 2009 and March 2012. Patients were followed between 1 and 4 years after PAE (mean 18 months). International Prostate Symptom Score (IPSS), quality of life improved (QoL), international Index of Erectile Function (IIEF), peak urinary flow (Qmax), prostate-specific antigen (PSA), prostate volume were evaluated every 6 months. Technical success is defined as embolization of at least one prostatic artery. Clinical success is considered when there is a reduction of the IPSS at least 25% of the total score and = 15, a reduction of the QoL at least 1 point of the total or = 3 and no need of medical or any other treatment.

#### RESULTS

There were 4 technical failures. From the 236 evaluated patients there were 39 (16.5%) short term clinical failure up to 1 year. Therefore there are 197 evaluated at medium term between 1 and 3 years. From this group of patients evaluated at medium term there were 17 clinical failures. The cumulative rate at 3 years was 23.7%. There are 17 patients followed at long term between 3 and 4 years, with 2 clinical failures. The cumulative rate at 4 years is 75.4%.

There was a major complication a small area of bladder wall base ischemia. Surgery was required to treat that ischemia.

#### CONCLUSION

PAE is safe procedure with low morbidity as well as good short, medium and long term results.

#### CLINICAL RELEVANCE/APPLICATION

Prostatic Artery Embolization can have a future place in urologic guidelines and it is important to report technical and clinical outcomes.

### **VSIR41-09 • Prostate Embolization**

**Jafar Golzarian MD (Presenter)**

#### LEARNING OBJECTIVES

View learning objectives under main course title.

### **VSIR41-10 • Coil Embolization of the Splenic Artery: Impact on Splenic Volume and Factors Contributing to Volume Preservation**

**Stephen R Preece MD (Presenter) ; Paul V Suhocki MD ; John Yoo ; Tony P Smith MD ; Charles Y Kim MD \***

#### PURPOSE

Splenic artery embolization can be performed as an alternative to splenectomy in the setting of splenic injury or splenic artery pathology. However, the impact on splenic function is not well understood. The purpose of this study is to determine the impact of coil embolization of the splenic artery on splenic volume based pre- and post-embolization CT imaging as well as hemofiltration function.

#### METHOD AND MATERIALS

Splenic artery embolization was performed on 148 consecutive patients over an 8 year period for various indications in this IRB approved retrospective study. Sixty patients (36 males, mean age 49 years) had contrast-enhanced CT before and after coil embolization of the splenic artery. The mean time between embolization and last follow up CT was 355 days. Pre and post-embolization splenic volumes were calculated with volume rendering software. The presence of Howell-Jolly bodies was ascertained on lab tests.

#### RESULTS

Splenic artery embolization resulted in a mean decrease in splenic volume by 15% (range -88% to +158%). Splenic volumes on CT scans performed within 30 days of embolization did not change significantly after embolization but after 30 days the mean percentage reduction was 21% (p=0.004). Embolization of the distal splenic artery resulted in a 30% splenic volume reduction (p=0.003) whereas splenic volumes did not change significantly after proximal embolization. Both traumatic and nontraumatic indications resulted in similar degree of volume loss, although pre-embolization splenic volumes were significantly smaller in trauma patients (p=0.029), and more trauma patients underwent distal embolization (p=0.005). Multivariate analysis revealed that only coil location significantly impacted splenic volume reduction. Three patients transiently had Howell-Jolly bodies after embolization. No patients required repeat embolization or splenectomy.

#### CONCLUSION

Coil embolization of the main splenic artery results in only a modest degree of splenic volume loss with retention of hemofiltration function. These findings support the growing body of literature that some degree of splenic function is maintained after splenic artery embolization.

#### CLINICAL RELEVANCE/APPLICATION

Splenic artery embolization for trauma and splenic artery pathology is likely preferable to splenectomy when feasible considering that at least some degree of splenic function is retained.

### **VSIR41-11 • Prostatic Arterial Embolization as an Alternative Treatment for Patients with Benign Prostatic Hyperplasia for Patients with Benign Prostatic Hyperplasia and Acute Urinary Retention with Bladder Catheter**

**Lucia C Fernandes MD (Presenter) ; Joao M Pisco MD ; Luis C Pinheiro ; Tiago Bilhim MD \* ; Hugo A Rio Tinto MD \* ; Marisa Duarte MD ; Jose A Pereira MD ; Antonio Oliveira**

#### PURPOSE

To Access the results of prostatic arterial embolization (PAE) for patients with benign prostatic hyperplasia (BPH) and acute urinary retention (AUR) with bladder catheter.

#### METHOD AND MATERIALS

Fifty-three patients aged 48 to 82 years with BPH, AUR and bladder catheter underwent PAE. Prostate volume and Prostatic Specific Antigen (PSA) were evaluated before PAE. The prostate volume ranged between 44cc and 210cc (mean 95cc). Twenty-six patients had prostates larger than 100cc. PVA particles sized 100µm and 200µm were used as embolic material. International prostate symptom score (IPSS), Quality of life (QoL), International Index Erectile Function (IIEF), uroflowmetry, (Qmax - peak urinary flow and PVR - post voiding residual volume), Prostatic Specific Antigen (PSA) and prostate volume, were assessed after successful removal of bladder catheter, at 1, 3, 6 and every 6 months thereafter to access the clinical outcome. Patients were evaluated between 3 and 48 months (mean 15 months). It was considered clinical success if the patient could urinate easily after removal of the prostate catheter, the IPSS lower than to 15 and the QoL reduced at least 1 point and no need of medical treatment or any other treatment.

#### RESULTS

All patients were treated as outpatients. There was one technical failure (1.9%) and one patient was lost to follow-up. There was short-term clinical success at 3 months in 45/51 (88.2%). There were 46 (11.8%) patients which bladder catheter could not be removed and were considered short term clinical failures and PAE was repeated. In 4 of them the bladder catheter could be removed, therefore the secondary clinical success was shown in 49/51 (95.1%) patients. The 2 patients which catheter could not be removed were treated by TURP and open prostatectomy, respectively. At 18 months there were 4/51 (7.8%) mid-term clinical failures. Three of them were successfully treated with repeated PAE. The third was treated by open prostatectomy. In 5 patients controlled at long term between 3 and 4 years there was not any recurrence. There was not any major complication.

#### CONCLUSION

PAE in patients with BPH and AUR with bladder catheter is a safe procedure with successful removal of the bladder catheter and good short mid and long-term results.

#### CLINICAL RELEVANCE/APPLICATION

Applying a new technique (PAE) in patients with BPH and AUR and with bladder catheter

LEARNING OBJECTIVES

View learning objectives under main course title.

**VSIR41-13 • Wrap Up and Discussion**

LEARNING OBJECTIVES

View learning objectives under main course title.

**Vascular/Interventional (Venous Access/Women's Intervention)**

**Wednesday, 10:30 AM - 12:00 PM • E353A**

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**IR** **VA** **OB** **GU**

**SSK23 • AMA PRA Category 1 Credit™:1.5 • ARRT Category A+ Credit:1.5**

**Moderator**

**Bart L Dolmatch**, MD \*

**Moderator**

**Anne C Roberts**, MD \*

**SSK23-01 • Central Venous Access: Evolving Roles of Radiology and Other Specialties Nationally over Two Decades**

**Richard Duszak** MD (Presenter) ; **Nadia Husain** ; **Daniel D Picus** MD ; **Danny Hughes** PhD ; **Baogang Xu** PhD

PURPOSE

To evaluate national trends in central venous access (CVA) procedures over two decades with regard to changing specialty group roles and places of service.

METHOD AND MATERIALS

Aggregated claims data for temporary central venous catheter (CVC) and long-term central venous access device (CVAD) procedures were extracted from Medicare Physician Supplier Procedure Summary master files from 1992 through 2011. CVC and CVAD procedure volumes by specialty group and place of service were studied.

RESULTS

Between 1992 and 2011, temporary and long-term CVA placement procedures increased from 638,703 to 808,071 (+27%) and 76,444 to 316,042 (+313%), respectively. For temporary CVCs, radiology (0.4% in 1992 to 32.6% in 2011) now exceeds anesthesiology (37.0% to 22.0%) and surgery (30.4% to 11.7%) as the dominant provider group. Surgery continues to dominate in placement and explantation of long-term CVADs (80.7% to 50.4% and 81.6% to 47.7%, respectively), but radiology's share has grown enormously (0.7% to 37.6% and 0.2% to 28.6%). Although volumes remain small (

CONCLUSION

Over the last two decades, CVA procedures on Medicare beneficiaries have increased considerably. Radiology is now the dominant overall provider.

CLINICAL RELEVANCE/APPLICATION

As venous access procedures have increased dramatically in Medicare beneficiaries over the last two decades, radiology's relative contributions to these important services has expanded dramatically

**SSK23-02 • Mechanical Failure with a Radiologically Placed Totally Implantable Central Venous Arm Port System**

**Jasmin D Busch** MD (Presenter) ; **Catherine T Mahler** ; **Christian R Habermann** MD ; **Andreas Koops** MD ; **Gerhard B Adam** MD ; **Harald Ittrich** MD

PURPOSE

To evaluate the frequency of mechanical failures, in particular catheter line rupture and fragment embolization, related to a radiographically controlled and brachially placed totally implantable central venous arm port system (TCVAP) used for mid- to long-term vascular access.

METHOD AND MATERIALS

A retrospective audit of our Centricity Radiology Information System (GE Healthcare, Braunschweig, Germany) was performed from 2006 until April 2013 to determine the number of Cook Vital-Port Mini Titanium (Cook Medical Inc., Limerick/Ireland) implanted between January 1, 2006, and June 30, 2011 and the frequency of device-related complications (mechanical failure, rupture and fragment embolization) until demise or explantation.

RESULTS

CONCLUSION

With the Cook Vital-Port Mini Titanium implanted at the upper arm we observed in 2.3% a partially or complete catheter line fracture associated with a high incidence of fragment embolization. The high rate of clinically unapparent catheter line fractures demands special attention of TCVAP users to recognize malfunctions. Despite from the risk of extravasation in patients under chemotherapy, in particular, fragment embolization puts the patients at risk for further severe complications.

CLINICAL RELEVANCE/APPLICATION

TCVAP are a proper tool for vascular access. However, due to the accumulation of material failure further investigation are warranted to determine the cause of material failure.

**SSK23-03 • Characteristics of an Infectious Complication on Implantable Venous-access Port**

**Jisue Shim** ; **Tae Seok Seo** MD, PhD ; **In-Ho Cha** MD, PhD ; **Myung Gyu Song** MD (Presenter) ; **Eun-Young Kang** MD ; **Hwan Seok Yong** MD ; **Chang Hee Lee** MD

PURPOSE

The purpose of this study is to assess the demographic and bacteriologic characteristics and risk factors of implantable venous-access port (IVAP)-associated infection.

METHOD AND MATERIALS

Between August 2003 and November 2011, we placed 1,747 ports in interventional radiology suites. A total of 144 and 1,603 ports were placed in patients with hematologic malignancy and with solid tumor, respectively. We removed 45 ports to treat port-related infection, from 37 patients with systemic febrile symptom and 8 patients with signs of local infection. We evaluated the incidence of port-related infection, demographic factors, bacteriologic data, and patients' progress by review of medical record. Univariate analyses (chi-square test and Fisher's exact test) and multivariate logistic regression analyses were used to determine the risk factors for complications.



## RESULTS

Overall, 45 (2.58%) out of 1,747 ports were removed for infectious symptom, with an incidence rate of 0.075 events/1,000 catheter-days. The incidence rate of port-related infection was higher in hematologic disease patient than in solid organ tumor patient ( $p=0.03$ ). The infection rate was higher in inpatients intervention than outpatients ( $p=0.02$ ). Hematologic malignancy was the only significant risk factor of IVAP-related infection (OR 0.304, 95% confidence interval 0.144-0.643,  $p=0.02$ ). Microorganisms were isolated from 30 (66.7%) blood samples. Causative organisms were *Staphylococcus* species ( $n=13$ ), *Candida* species ( $n=9$ ), Non-tuberculosis *Mycobacterium* ( $n=2$ ), *Escherichia coli* ( $n=1$ ), *Acinetobacter baumannii* ( $n=2$ ), *Klebsiella pneumoniae* ( $n=2$ ), *Rhodotorula mucilaginosa* ( $n=1$ ) and *Enterococcus faecium* ( $n=1$ ). Additionally, catheter tip culture studies were positive in nine cases and isolated microorganisms were same as blood culture studies. Wound culture in localized infection revealed no organisms in all cases.

## CONCLUSION

The incidence of IVAP-related infection was significantly higher in hematologic malignancy patient and when intervention was done after admission. The common causative organisms were *Staphylococcus* and *Candida* species. The explanation of devices seems to be helpful for treatment of local and systemic infection suspiciously related with IVAPs.

## CLINICAL RELEVANCE/APPLICATION

The knowledge of the characteristics of IVAP-related infection may be helpful to manage infected port.

### **SSK23-04 • Patients' Perceptions of Peripherally Inserted Central Catheter for Cancer Treatment: A Comparative Single-institution Prospective Analysis**

**Francois-Xavier Arnaud MD (Presenter) ; Christophe Teriitehau ; Gabrielle Weber-Donat ; Denis Metivier ; Caroline Bouzad ; Julien Potet MD \***

## PURPOSE

To prospectively assess the perceptions of cancer patients of having a PICC and to compare these perceptions with those of non-cancer patients.

## METHOD AND MATERIALS

Patients' perceptions were registered on three occasions (T1, right after PICC placement; T2: 1 week after placement and T3: three weeks after placement), with the use of two specific questionnaires. Questionnaire I contained 17 items covering five domains (anxiety, information, pain, procedure duration and discomfort), whereas questionnaire II was made up of 17 items covering 6 domains (pain, information, restrictions in daily activities, anxiety, discomfort and overall satisfaction) Results were analyzed considering the cancer group and then compared to the non-cancer group using Pearson chi-squared or Fisher's exact tests and Student T-tests. Regression tests were performed to study the association between different factors and the procedure-related pain at T1 or the global satisfaction at T2 and T3.

## RESULTS

150 PICCs were implanted in 125 consecutive patients (78 patients in the cancer group and 47 in the non-cancer group). Pain level was low (2.5, 95% CI 2.0-2.9) in cancer patients at T1 and decreased at the end of the procedure (0.5, 95% CI 0.2-0.7). 96.2% of cancer patients found that the pain was equal or lower than expected before the procedure. Disturbing factors were venous puncture (24.4% of patients), local anesthesia (23.1%) and lying position on the angiography table (20.5%) in cancer patients. Pain levels at exit-site at T2 and T3 were low but significantly higher in the cancer group than in the non-cancer group (T2: 0.9 vs 0.4,  $p=0.05$  and T3 : 0.8 vs 0.2,  $p=0.01$ ). At T2, global satisfaction was 5.4 times worse in painful patients ( $p=0.02$ ). Cancer patients stated that the PICC interfered when taking a shower (48.1% of patients at T2), but not for basic activities. They mostly feared that PICC might be a source of infection (46.3% vs 18.2% in non-cancer patients,  $p=0.008$ ). No factor of disturbance, discomfort or fear was associated with a worse global satisfaction.

## CONCLUSION

PICC placement and port during hospitalization were well accepted by cancer patients. Physicians should focus on exit-site pain treatment in cancer patients for a better satisfaction.

## CLINICAL RELEVANCE/APPLICATION

PICC placement was well tolerated and PICC device were a well-accepted method of delivering chemotherapy and supportive agents in the daily life of cancer patients.

### **SSK23-05 • Preliminary Study on the Safety and Efficacy of Ultrasound Guided High-intensity Focused Ultrasound (USgHIFU) Treatment of Symptomatic Uterine Fibroids Using High Sonication Energy Protocol**

**H. Y. J Leung (Presenter) ; Simon C Yu MD ; Ka Lok Lee MBChB ; Mabel M Tong MBBCh ; Helen Hoi Lun Chau ; Eva Chun Wai Cheung ; Alyssa Sze Wai Wong ; Anil T Ahuja MD**

## PURPOSE

To assess the safety and efficacy of ultrasound guided high-intensity focused ultrasound (USgHIFU) treatment of symptomatic uterine fibroids using high sonication energy protocol.

## METHOD AND MATERIALS

This was a prospective on going phase one study. Protocol was approved by institutional review board and informed consent were obtained. A total of 20 patients with 22 symptomatic fibroids were included in the study and were treated with US-guided HIFU ablation. The fibroids were ablated using dot mode under power output of 800 -1500W for 1500 - 2000 sonication pulses at each spot. The primary endpoints were peri-procedural complications. The secondary endpoints were clinical symptomatic improvement and radiological evidence of treatment response including degree of fibroid infarction and volume shrinkage at 3 months after treatment. The symptoms studied include pain, menorrhagia, and fibroid related urinary symptoms and these were assessed by pain score, pictorial chart score, Urogenital Distress Inventory (UDI -6) and Incontinence Impact Questionnaire (IIQ-7). The degree of fibroid infarction was assessed by dynamic contrast 3T MRI and was reflected by non-perfused ratio (NPR) calculated as non-perfused volume as a percentage of the total fibroid volume.

## RESULTS

Nineteen patients tolerated the treatment well and were treated on an outpatient basis. One patient who received treatment for a fibroid located

## CONCLUSION

This prospective study suggests that USgHIFU may be safe and effective in treating symptomatic uterine fibroids in carefully selected patient group. Uterine fibroids which are located

## CLINICAL RELEVANCE/APPLICATION

USgHIFU ablation using high sonication energy protocol may be safe and effective in treating symptomatic uterine fibroids in carefully selected patient group.

### **SSK23-06 • Non-invasive In Vivo Estimation of Uterine Fibroid Thermal Conductivity in Magnetic Resonance Imaging Guided High Intensity Focused Ultrasound (MR-HIFU) Therapy**

**Jiming Zhang \* ; John H Fischer MD ; Pei-Herng Hor PhD ; Raja Muthupillai PhD (Presenter) \***

## PURPOSE

To estimate *in vivo* thermal conductivity of uterine fibroid tissue from the spatio-temporal evolution of temperature during MR guided focused ultrasound surgery (MR-HIFU) in women.

## METHOD AND MATERIALS

All MR-HIFU was performed at 1.5 T using a commercial MR-HIFU platform (Sonalleve, Philips Healthcare) with a 256Ch spherical shell HIFU transducer (1.2-1.4 MHz), and an integrated receiver coil. The temperature evolution after 13 volumetric sonications in three

women was recorded in real-time using a multi-shot echo planar imaging technique described previously<sup>1</sup>. All subjects provided written informed consent as per IRB guidelines.

**Estimation of thermal conductivity:** Thermal conductivity is calculated based on Pennes's bio-heat transfer equation. The spatio-temporal temperature evolution following heating is modeled by a Gaussian distribution<sup>2</sup>. If,  $S_{xy}$  and  $S_z$  and represent the standard deviation of the spatio-temporal temperature spread in the in-plane/through-plane monitoring slices, then the rate of change of over time yields thermal diffusivity  $D$  and thermal conductivity  $k^2$ .

## RESULTS

A total of 13 cells with diameters of 4mm (n=3), 8mm (n=7), and 12mm (n=3) were used to treat uterine fibroids. The mean temperature elevated from 37°C to  $64.8 \pm 1.4^\circ\text{C}$ , resulting in an average 240 EM dose volume of  $1.8 \pm 1.3 \text{ cm}^3$  across cells. From the recorded spatial-temporal temperature profiles, the thermal conductivity(k) was estimated to be  $0.5 \pm 0.06 \text{ W}/(\text{m}\cdot\text{K})$ .

## CONCLUSION

The results from our study show that it is possible to estimate thermal conductivity of human uterine fibroid tissue *in-vivo* from spatio-temporal evolution of temperature during volumetric MR-HIFU. *In-vivo* uterine fibroid thermal conductivities across different cell sizes were within 13% of the mean, indicating close agreement, and is roughly similar to reported thermal conductivities of skeletal muscle. 1. Kohler, et al. Med. Phys., 36(8), 3521-35, 2009 2. Zhang, et al. JMRI, 37(4), 950-7, 2012

## CLINICAL RELEVANCE/APPLICATION

1. Effectiveness of tissue ablation during MR-HIFU *in vivo* is influenced by tissue thermal properties such as thermal conductivity which can be estimated from spatio-temporal evolution of temperature.

## **SSK23-07 • MRgFUS Treatment of Uterine Fibroids: Evaluation of Fibroid Volume, Perfused Volume (PV) and Clinical Scores Modifications at 6-month and 12-month Follow Up**

**Marta Vaiani MD (Presenter) ; Irene Invernizzi MD ; Paola Enrica Colombo ; Fabio Zucconi MPH ; Angelo Vanzulli MD ; Cristiana Ticca MD**

## PURPOSE

to assess the correlation between fibroid volume, perfused volume (PV) and clinical scores modifications at 6-month (6-m) and 12-month (12-m) follow up evaluation, in 28 patients with 32 fibroids treated with Magnetic Resonance guided Focused Ultrasound Surgery (MRgFUS)

## METHOD AND MATERIALS

32 symptomatic uterine fibroids in 28 women (age 35-54 y-o) underwent MRgFUS treatment between September 2010 and January 2012 using the ExAblate 2000 system (InSightec). Before treatment T2weighted multiplanar MR images were obtained to measure uterine fibroids volume. Immediately after treatment T1weighted contrast-enhanced fat-sat multiplanar MR images were used to measure the Non-Perfused Volume (NPV) and to define PV subtracting NPV from fibroid volume. Similar images obtained  $6 \pm 1$  months and  $12 \pm 2$  months after treatment were used to determine fibroid volume and PV modifications. The Symptom Severity Score (SSS) and Quality of Life Score (QOLS) were examined before treatment and at 6-m and 12-m. Quantitative and qualitative relations between fibroid volume, PV and clinical scores modification at baseline, 6-m and 12-m were measured (analysis of variance, Spearman correlation)

## RESULTS

Fibroid volume significantly decreased from  $140 \pm 126 \text{ cm}^3$  to  $102 \pm 107 \text{ cm}^3$  (6-m) and  $100 \pm 103 \text{ cm}^3$  (12-m) (p The average post-treatment PV ratio (p-tPV ratio, considered as post-treatment PV divided by initial volume) was  $29 \pm 17\%$  and PV significantly increased between baseline and 12-m from  $44 \pm 56 \text{ cm}^3$  to  $74 \pm 88 \text{ cm}^3$  (p

## CONCLUSION

MRgFUS treatment of uterine fibroids determines significant fibroid shrinkage and clinical improvement already after 6-m, and results are still important even after 12-m. The significant PV increase between post-treatment and 12-m is not correlated with p-tPV ratio and does not affect the clinical improvement of patients

## CLINICAL RELEVANCE/APPLICATION

MRgFUS is a non-invasive, safe and effective treatment for uterine fibroids; the PV significant increase between post-treatment and 12-m does not affect the important clinical improvement of patients

## **SSK23-08 • The Apparent Diffusion Coefficient (ADC) Value of the Uterine Adenomyosis for the Prediction of the Potential Response to Uterine Artery Embolization (UAE)**

**Yaewon Park (Presenter) ; Dae Chul Jung ; Man Deuk Kim MD**

## PURPOSE

To determine the utility of the apparent diffusion coefficient (ADC) value for the prediction of the potential response to uterine artery embolization (UAE) for symptomatic adenomyosis.

## METHOD AND MATERIALS

Our study included twenty-three patients who underwent diffusion weighted (DW) MRI before UAE between June 2011 and November 2012. All patients underwent 3 months follow-up MRI after UAE. The embolic agent used was polyvinyl alcohol(PVA) particle. A quantitative measurement of the ADC was performed for each adenomyosis. Complete response was defined as more than 90% of non-perfusion area of adenomyosis following UAE at 3 months follow-up MRI. Incomplete response was defined as less than 90% of non-perfusion area at follow-up MRI. ADC value was compared between patients that achieved complete response and incomplete response after UAE via analysis. Statistical analysis was performed to evaluate the diagnostic performance of the predictor for differentiated the complete from the incomplete response.

## RESULTS

Of the twenty-three patients, seventeen showed complete response and six showed incomplete response. The ADC ranged from  $0.8413 \pm 1.2440 \times 10^{-3} \text{ mm}^2/\text{s}$  (mean  $1.0745 \pm 0.1122$ ). The mean ADC of the complete response group was  $1.0449 \pm 0.1063$  and  $1.1585 \pm 0.0881$  in the incomplete response group (p value = 0.029). Using a threshold of lesser than  $1.1475 \times 10^{-3} \text{ mm}^2$ , the sensitivity and specificity of the ADC for the prediction of success after UAE were 83.3% and 82.4%, respectively.

## CONCLUSION

The ADC of uterine adenomyosis can be utilized as a predictor for successful response of UAE in adenomyosis.

## CLINICAL RELEVANCE/APPLICATION

The ADC of uterine adenomyosis is a potential predictor for complete response of UAE in symptomatic adenomyosis.

## **SSK23-09 • Embolization of Symptomatic Post-abortion Uterine Arteriovenous Malformations**

**Helene Vernhet-Kovacsik MD, PhD ; Valerie Monnin-Bares ; Hamid Zarqane (Presenter) ; Sebastien Bommart MD**

## PURPOSE

To assess immediate and mid-term clinical outcome of hyperselective embolization of symptomatic post-abortion uterine arterio-venous malformations (AVM).

## METHOD AND MATERIALS

Since January 2009, 13 consecutive women with acquired symptomatic (bleeding) intra-uterine post-abortion arteriovenous malformation were referred in our institution. Women with AV malformation persisting 10 weeks after abortion, as demonstrated by MR angiography

and/or US doppler were referred for embolization. MRI was performed before and after embolization (1 month). Technical success, immediate and mid-term (6-36 months) clinical outcome (recurrent bleeding, myometrial necrosis or infection) and imaging follow-up (myometrial thickness and enhancement after injection of gadolinium, presence of residual AVM) were recorded.

#### RESULTS

At 10 weeks after abortion, 11/13 women had persistent AV malformation. Hyper-selective embolization using Onyx (n=9), particles (n=2) was performed during 1 (n=6), 2 (n=2) up to 3 (n=3) sessions. Complete technical success was reached in 9/11 cases. The MAV could not be completely occluded in 2 cases (arterial ovarian supply, uterine supply). Bleeding was stopped in all cases and recurrent spotting at 3 months was noted in 2 cases (cases with technical failure). No uterine necrosis nor infection was present at mid-term follow-up. At MRI, a persistent active AVM was present in 2 cases, myometrial thickness was decreased at the site of the embolized AVM in 2 cases and normal enhancement of the entire uterine wall was present in 10/11 cases.

#### CONCLUSION

Hyperselective embolization of post-abortion uterine AVM is safe and immediately efficient but clinical mid-term outcome closely depends on technical success of embolization

#### CLINICAL RELEVANCE/APPLICATION

Hyperselective embolization of post-abortion uterine AVM is safe and efficient when complete.

### Vascular/Interventional - Wednesday Posters and Exhibits (12:15pm - 12:45pm)

#### Wednesday, 12:15 PM - 12:45 PM • Lakeside Learning Center

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**LL-VIS-WEA** • AMA PRA Category 1 Credit™:0.5

Host  
**Ranjith Vellody**, MD

#### **LL-VIS-WE1A • Manual Compression for Puncture Site Hemostasis after Percutaneous Treatment of Abdominal Aortic Aneurysm Using a Low Profile Device: A Single Center Experience**

**Costantino Del Giudice** MD (Presenter) ; **Roberto Gandini** MD, PhD ; **Carlo Andrea Reale** ; **Giorgio Loreni** ; **Erald Vasili** ; **Giovanni Simonetti** MD

#### PURPOSE

To assess feasibility and efficacy of percutaneous endovascular abdominal aortic aneurysm (AAA) repair using Ovation Trivascular stent-graft with hemostasis at the puncture site through manual compression.

#### METHOD AND MATERIALS

A prospective study was conducted on 27 consecutive patients (26 males and 1 females; mean age: 73,5±5,2), with AAA treated between December 2010 and May 2012 using the Ovation stent-graft system with an entirely percutaneous approach. The mean AAA diameter was 56.1±7.6mm. Manual compression was performed to obtain postprocedural hemostasis

#### RESULTS

The stent-graft was successfully implanted in all patients using an entirely percutaneous approach. Two patient (7.4%) presented a type II endoleak after stent-graft implantation with a spontaneous resolution in one case and treated with coil embolization in the other one. Manual hemostasis was achieved in all cases without complications. No surgical conversions were required. During follow-up, no aneurysm-related deaths were recorded. Through 24 months, each AAA shrunk by at least 5 mm and no device-related events were observed on imaging.

#### CONCLUSION

The Ovation stent-graft allows safe and effective treatment of AAAs with hemostasis of the puncture site by manual compression.

#### CLINICAL RELEVANCE/APPLICATION

This approach may allow abdominal aortic treatment without need of a surgical access and percutaneous closure device, reducing access related complications

#### **LL-VIS-WE2A • Frequency of Growing Splenic Artery Aneurysms Detected by Multidetector Row CT Angiography in Patients with Chronic Liver Diseases**

**Takaharu Tsuda** MD, PhD (Presenter) ; **Hiroaki Tanaka** MD ; **Megumi Takechi** MD ; **Gen Koiwahara** ; **Teruhito Mochizuki** MD

#### PURPOSE

#### METHOD AND MATERIALS

#### RESULTS

Eight growing SAAs were found in seven patients. Every growing SAA was saccular and more than 10mm in diameter. Thus, 47% (8/17) of SAAs more than 10 mm in diameter showed growth. On the other hand, none of SAAs less than 10 mm in diameter showed growth. Four of seven patients with multiple SAAs had growing SAA. Every patient having growing SAA was liver cirrhosis. There was a single patient which needed coil embolization therapy in this study because of fast growing.

#### CONCLUSION

47% of SAA more than 10 mm in diameter showed growth in patients with liver cirrhosis. Specifically, patients with multiple SAAs were likely to have growing SAA. However, frequency of fast-growing SAA which needed therapy was relatively low.

#### CLINICAL RELEVANCE/APPLICATION

(dealing with CT angiography); In patients with chronic liver diseases, most of growing SAAs are more than 10 mm in diameter and patients with multiple SAAs may be high risk for growing SAA.

#### **LL-VIS-WE3A • Core Biopsies of Renal Masses: An Accurate Tool for Managing all That Is Indeterminate**

**Andrea Veltri** MD (Presenter) \* ; **Irene Garetto** MD ; **Carlo Gazzera** ; **Enrico Bollito** ; **Donatella Pacchioni** MD ; **Alessandro Volpe** MD ; **Mauro Papotti** MD

#### PURPOSE

The wider utilization of cross-sectional imaging has increased the detection of indeterminate cystic and solid enhancing renal masses (RM). Despite an accurate pre-operative radiological study, surgical extirpation still results in at least 20% of benignancy. Literature suggests that renal biopsy can be accurate and significantly impacting on clinical choices. Our aim is to evaluate the safety, accuracy and usefulness of image-guided core biopsy (CB) in the management of RM.

#### METHOD AND MATERIALS

In 258 consecutive patients (171 male; 16-88 y, m 65), 268 RM (10-160 mm, m 33; 19 cystic, 236 solid, 13 mixed) underwent CB (265 US-guided, 2 CT-guided, 1 US+CT guided), by coaxial technique (18G tru-cut needle inserted in a 17G styleted cannula).

Major and minor complications (according to SIR criteria) were recorded.

The result of 50 CB was not assessable, due to patients lost at follow-up.

Of the remaining 218 RM, 101 underwent ablative treatments, so a gold standard diagnosis was not available. Therefore, accuracy was calculated on 117 CB, verified on the basis of histology after surgical resection (76), response to medical therapy (7) or outcome at imaging follow-up (3-104 months, n 35) (34: 25 benign and 9 malignant selected for active surveillance).

## RESULTS

No major complications occurred (namely, no seedings). 10 minor complications (7 small perirenal hematomas, 1 macrohematuria not requiring transfusion, 1 self-resolving intercostal arteriovenous fistula and 1 hematoma in the abdominal wall) were managed on an out-patient basis.

Among the 218 assessable CB, the pathological diagnoses were 167 malignant (160 RCC, 4 NHL, 3 met) and 51 benign (38 renal cell tumors, including 28 oncocytoma and 7 AML).

According to the above gold standard criteria, TP were 75/117, FN 7, TN 35, FP 0. Sensitivity, specificity and diagnostic accuracy were 91.4%, 100% and 94%, respectively. PPV was 100%, NPV 83.3%. 142/218 RM (65.1%) were managed other than surgically.

## CONCLUSION

CB is safe and accurate. We contribute to the growing number of series that are demonstrating the usefulness of CB in the clinical management of RM.

## CLINICAL RELEVANCE/APPLICATION

Since low specificity or pitfalls of imaging can affect characterization of RM, causing unnecessary surgical resections, CB should be considered in the clinical management of all indeterminate lesions

### **LL-VIS-WE4A • Non-invasive Prediction of Hepatic Transplant Portal Vein Stenosis - Experience at a Single High Volume Transplant Center**

**Marie A Vasher MD (Presenter) ; Danny R Lababidi MD ; Kamal Massis MD ; Bruce R Zwiebel MD ; Dana M Poletto MD ; Haydy Rojas RN ; Yougui Wu PhD**

## PURPOSE

We sought to compare Doppler ultrasound findings to transhepatic catheter portal venogram findings of hepatic transplant main portal vein stenoses, and to determine which Doppler ultrasound criteria are often the best non-invasive measures for diagnosing portal vein stenosis.

## METHOD AND MATERIALS

32 post-hepatic transplant transhepatic catheter portal venograms following initial Doppler ultrasound were performed at our institution on 30 patients from November 1, 2004 to May 31, 2012 due to clinical, biochemical, Doppler ultrasound, CT and/or MRI abnormalities. Doppler ultrasounds and catheter portal venograms were retrospectively reviewed. Doppler ultrasound criteria of main portal vein peak velocity, velocity step-up ratio, and change in velocity across the anastomosis were correlated with catheter portal venogram. Narrowing of the main portal vein of at least 50% on portal venogram was considered stenotic. 54 randomly chosen patients without suspicion of hepatic transplant portal anastomotic stenoses were assigned to our control group. Patients who underwent catheter portal venogram without findings of portal vein stenosis were also assigned to our control group.

## RESULTS

## CONCLUSION

## CLINICAL RELEVANCE/APPLICATION

Applying the Doppler ultrasound criteria yielded in our study will result in selecting the most appropriate hepatic transplant patients with main portal vein stenosis for catheter portal venogram.

### **LL-VIE-WE6A • High Resolution Imaging with High Frequency Intravascular Ultrasound Improves Sensitivity in Cancer Staging when Vascular Encasement or Mass Effect is Suspected on Dynamic Computed Tomography: Special Cases in Hepatobiliary and Pancreatic Cancer**

**Cristian Coroian MD, MBA (Presenter) ; Brian A Bianco DO, MBA ; Wilbur B Bowne MD ; Alexander E Trebelev MD**

## PURPOSE

To present the emerging technique of high resolution intravascular ultrasound (IVUS) evaluation of arterial invasion by cancer. We demonstrate the ability to interrogate the three layers of the hepatic, superior mesenteric, splenic, and gastroduodenal arteries (including adventitia, media, and intima) with sub-millimeter resolution. By using IVUS, we more accurately stage hepatobiliary and pancreatic cancer in patients where dynamic computed tomography (CT) demonstrates cancer encasement or mass effect on an artery.

## METHOD AND MATERIALS

A 6 Fr sheath is used to gain access and navigate a wire into the target vessel. The IVUS probe is then advanced while recording Chroma flow gray scale images through the arterial segment of interest. Start and end scan location is determined by fluoroscopic roadmap. Patients with pancreatic cancer and hepatobiliary cancer are selected. As part of cancer staging, dynamic CT imaging is performed. In patients where the tumor mass encases or causes mass effect on the hepatic artery, superior mesenteric artery, splenic artery, or gastroduodenal artery, high frequency IVUS is performed (as described above) to evaluate invasion of the vascular adventitia, media, and intima. Pathological findings are correlated with IVUS images. Traditional methods of indirectly suggesting invasion by assessing vascular encasement or mass effect of a tumor on a vessel by dynamic CT are compared with IVUS results to determine sensitivity and specificity. Dynamic CT curved reformatted images are then correlated with IVUS images to determine exact location and integrity of the artery layers. The sub-millimeter spacial resolution of IVUS allows for grayscale anatomic identification and accurate determination of tumor invasion.

## RESULTS

We present cases of cholangiocarcinoma and pancreatic cancer showcasing the accuracy of IVUS in resolving dynamic CT suspected vascular invasion with the highest spatial resolution. 100% accuracy is attained with no periprocedural complication.

## CONCLUSION

High frequency IVUS is technically feasible in the splanchnic arteries. IVUS is an emerging technique in the staging of cancer, and in our experience, provides 100% accuracy in determining arterial vascular invasion.

## CLINICAL RELEVANCE/APPLICATION

High frequency IVUS is an emerging technique in staging of cholangiocarcinoma and pancreatic cancer, and in our experience, provides 100% accuracy in determining arterial vascular invasion.

### **LL-VIE-WE7A • Radiation Safety in the Interventional Radiology Suite**

**Prasad S Dalvie MD (Presenter) ; Narendra B Gutta MBBS, MD ; Orhan S Ozkan MD ; John C McDermott MD**

## PURPOSE/AIM

To review radiation risks to healthcare workers and patients during interventional procedures and demonstrate tips and techniques for reducing radiation exposure.

## CONTENT ORGANIZATION

A. Radiation Physics & concept of ALARA B. Side effects of radiation (stochastic & deterministic) C. Radiation monitoring and

documentation D. Standard precautions during IR procedures E. Guide to DSA settings and features (knobology) F. Special precautions (pregnancy, pediatric patients, large patient & complex procedures)

#### SUMMARY

This exhibit will review - a. Physics relevant to fluoroscopic and DSA procedures b. Radiation risks from interventional procedures c. Radiation monitoring and documentation d. Standard and special procedures to reduce radiation exposure

### **LL-VIE1293-WEA • Nonvascular Uses of Liquid Embolic Agents: Therapy for Biliary Leaks, Ureteral Leaks, Lymphatic Leaks, and Enterocutaneous Fistulas**

**Karen Alderfer MD (Presenter) ; Ramon Ter-Oganesyan MD ; Michael D Katz MD ; Ilya Lekht MD ; M. Victoria Marx MD ; Sue E Hanks MD**

#### PURPOSE/AIM

1. Overview of available liquid embolic agents and their conventional vascular uses. 2. Discussion of possible nonvascular uses. 3. Review of cases from our institution where liquid embolic agents have been utilized in nontraditional ways.

#### CONTENT ORGANIZATION

Liquid embolic agents  
Review of currently available types of liquid embolic agents and traditional vascular uses Discussion of nonvascular uses of liquid embolic agents  
Hepatobiliary  
Genitourinary  
Gastrointestinal  
Lymphatic Case discussion and imaging review  
Detailed review of cases from our institution where liquid embolic agents have been used in non-vascular organ systems

#### SUMMARY

NBCA glue (N- butyl cyanoacrylate) and Onyx Liquid Embolic System (ethylene vinyl alcohol and DMSO (dimethyl sulfoxide)) have been used as vascular embolic agents in various parts of the body to arrest hemorrhage and shut down arteriovenous malformations. In our institution, the utility of these liquid embolic agents has been extended to nonvascular uses as well. In this presentation, we review several cases from our institution where liquid embolic agents have been utilized to achieve therapeutic success in biliary leaks, ureteral leaks, lymphatic leaks, and enterocutaneous fistulas.

### **LL-VIE1303-WEA • Diagnosis and Endovascular Management of High Flow Peripheral Arterio-venous Malformations (AVMs)**

**Anil K Pillai MD (Presenter) ; Jed A Hummel MD ; Sanjeeva P Kalva MD \* ; Seth Toomay MD ; Mark Reddick ; Nancy K Rollins MD ; Kenrick Lam BS**

#### PURPOSE/AIM

#### CONTENT ORGANIZATION

This presentation will include classification, imaging features on CT/MRI and catheter angiography, anatomical and flow considerations in the selection of the embolic materials, the technical aspects and a brief review of literature eliciting the success rates of such therapy. The role of various embolic materials including alcohol, 3% sotradecol, n-butyl cyanoacrylate, ethylene vinyl copolymer, coils and vascular plug devices will be illustrated.

#### SUMMARY

The high flow AVM are often associated with serious symptoms. The endovascular management of vascular malformations is gaining acceptance as the primary treatment. The viewer will gain a better understanding of classification, indications and contraindications for endovascular therapy, technical considerations, different embolic materials and complications following endovascular therapy of high flow peripheral

## **Vascular/Interventional - Wednesday Posters and Exhibits (12:45pm - 1:15pm)**

**Wednesday, 12:45 PM - 01:15 PM • Lakeside Learning Center**



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**LL-VIS-WEB • AMA PRA Category 1 Credit™:0.5**

### **LL-VIS-WE1B • Multidetector CT or MR Angiography before Endovascular Peripheral Arterial Intervention?**

**Vittorio Semeraro MD (Presenter) ; Alessandro Cina MD ; Carmine Di Stasi MD ; Riccardo Marano MD ; Roberto Iezzi MD ; Lorenzo Bonomo MD ; Luigi Natale MD**

#### PURPOSE

Multidetector CT angiography (MDCTA) and MR angiography (MRA) are described as accurate techniques for the assessment of significant stenoses and obstructions and for selecting patients with peripheral arterial disease for surgical and endovascular treatment. Until now no studies have compared MDCTA and MRA in the same population regarding the evaluation of peripheral arteries. Aside from known contraindication to MDCTA and MRA no evidence-based indications are available for patients suitable for both techniques. Purpose of this study was to compare MDCTA and MRA in selecting patients for peripheral endovascular intervention

#### METHOD AND MATERIALS

We compared MDCTA (16 slices scanner) and MRA (1.5 T scanner; 3D gadolinium-enhanced three station bolus chase acquisition plus time resolved acquisition on calves and feet) in 35 patients (Fontaine II-IV) candidates to endovascular treatment to stratify patients according to the TASCII score and to a run-off severity score. We evaluated also the accuracy of techniques to identify the degree of involvement of each arterial segment. Selective angiography performed during the treatment was employed as standard of reference

#### RESULTS

330 segments and 35 limbs were available for comparative evaluation. MDCTA and MRA resulted both accurate to classify patients according to TASC score in aorto-iliac (accuracy 0.92 for MDCTA and MRA) and femoro-popliteal (MDCTA 0.94 MRA 0.90) districts. MDCTA was founded to be more accurate to stratify infrapopliteal districts according to the runoff severity score (0.96 vs 0.9) and to assess the impairment of runoff arteries (0.94 vs 0.88) at per-segment analysis. MDCTA showed a higher diagnostic reliability than MRA and a lower examination time

#### CONCLUSION

Our result could suggest MDCTA technique could be the preferred procedure when clinical history or duplex sonographic evaluation are indicative of severe impairment of the infrapopliteal district

CLINICAL RELEVANCE/APPLICATION  
Comparison between Angio CT and Angio MR to evaluate lower limbs.

### **LL-VIS-WE2B • Clinical Value of Lower Extremity Arterial Imaging Using 80 kVp and Automatic Tube Current Modulation Technique Compared with Traditional 120kVp Scan**

**Ying Guo MD (Presenter) ; Dapeng Shi MD ; Ying Hui Ge MD, PhD**

#### **PURPOSE**

The purpose of this study was to evaluate the image quality and radiation dose of lower extremity arterial imaging using 80kVp with automatic tube current modulation technique compared with traditional 120 kVp scan.

#### **METHOD AND MATERIALS**

60 consecutive outpatients with lower extremity occlusive disease performed 64-slices CT scan were randomly divided into 2 groups. The first group (group1, n=30) used standard 120kVp with automatic tube current modulation(NI=10), and the second (group2, n=30) used 80kVp with automatic tube current modulation(NI=10). We selected the observing levels at pelvic, knee, calf and foot levels for noise measurement and image quality assessment with a 3-point scale. Paired analysis was performed on radiation dose, image quality, and image noise using t-test.

#### **RESULTS**

#### **CONCLUSION**

Using low kVp with automatic tube current modulation for lower extremity arterial scanning can reduce radiation dose by13.42% compared with 120kVp and artery signal intensity can be increased by 53.55% at the foot level.

#### **CLINICAL RELEVANCE/APPLICATION**

Radiation dose can be reduced and lower extremity arterial image can be improved by scan with optimized scan protocol of 80kVp.

### **LL-VIS-WE3B • Detailed CTA Study of 60 Superficial Femoral Artery Occlusions: Can Morphological Quantitative Analysis Lead to a New Classification?**

**Mickael Ohana MD, MSc (Presenter) ; Soraya El Ghannudi-Abdo MD ; Elie Girsowicz ; Nabil Chakfe MD, PhD ; Catherine Roy MD**

#### **PURPOSE**

TASC II actual classification of superficial femoral artery (SFA) occlusions is limited to length and calcifications analysis on 2D angiograms. State-of-the-art computed tomography angiography (CTA) provides much more information than traditional invasive angiography: detailed quantitative morphological analysis of CTA could be the basis of a refined classification.

#### **METHOD AND MATERIALS**

46 patients (65% men, 68yo  $\pm$  11,6) totalizing 60 SFA occlusions were retrospectively included. Presence of a SFA occlusion was the only inclusion criterion.

For each pathological artery, curved multiplanar reconstructions following the occluded SFA course were used to measure the total length and the mean diameter of the occluded segment. Color-coded map provided an accurate estimation of calcifications volume among the occluded segment.

#### **RESULTS**

SFA occlusion was complete in 39% of cases.

Mean occluded segment length was 219mm  $\pm$ 107 (14-530mm); mean occluded segment diameter was 6.1mm  $\pm$ 1.6 (3.4-10mm); mean calcifications volume in the occluded segment was 1265mm<sup>3</sup>  $\pm$ 1893 (0-8815mm<sup>3</sup>), corresponding to a percentage of 17.4%  $\pm$ 20 (0-88.7%).

Defining a cutoff between small or preserved caliber at 5mm and between low or heavily calcified occlusions at 4% allowed the distinction of 4 groups: heavily calcified occlusions of normal caliber (56%), low calcified occlusions of preserved caliber (19%), low calcified occlusions of small caliber (15%) and heavily calcified occlusions of small caliber (10%). Proportions of these 4 groups were roughly the same regardless of TASC II classification.

#### **CONCLUSION**

TASC II classification is inadequate for SFA occlusions: quantitative CTA analysis with measurement of mean occluded diameter and percentage of calcifications can refine it. This could be particularly useful in the management of TASC II type D lesions, as new endovascular revascularization techniques are arising, and this CTA-based morphological classification could provide support in choosing between them.

#### **CLINICAL RELEVANCE/APPLICATION**

Not all SFA occlusions are the same: this morphological CTA study points out TASC II classification weaknesses and could be the basis of a more precise patient management.

### **LL-VIS-WE4B • Evaluation of Patients after Sclerotherapy for Venous Malformation Using MRI**

**Sebastien Bommart MD (Presenter) ; Helene Vernhet-Kovacsik MD, PhD ; Valerie Monnin-Bares ; Hamid Zargane**

#### **PURPOSE**

To define which MRI data correlate best with the clinical outcome of patients after sclerotherapy for peripheral venous malformations.

#### **METHOD AND MATERIALS**

DESIGN: Retrospective analysis of a serie of consecutive cases. SETTING: Series of cases in a French medical center. SAMPLE: thirty five patients during 76 sessions were treated with Aetoxysclerol 3% mixed with contrast media and air as a foam with a ratio 60/10/30: from January 2010 to December2012. All patients had MRI before and one month after completion of the treatment. MRI protocol includes STIR weighted sequences and T1 weighted sequences with fat saturation before and after injection of gadolinium. METHODS: we reviewed the MRI examinations obtained before and after treatment completion. Data studied on each examination were: size of the malformation on the STIR sequence (3 largest diameters) and % of enhancement on T1 sequences. A correlation was searched for between MRI data and clinical result. MAIN OUTCOME MEASURES: Data studied on MRI examination were: size of the malformation on the STIR sequence (3 largest diameters) and % of enhancement on T1 sequences Side effects;; clinical result was scored from 0 (lack of improvement) to 5 complete improvement.

#### **RESULTS**

Clinical results were scored 0 (n=1) 2 (n=2) 3 (n=18) and 4 (n=12). MRI: decrease of the largest diameter was 75% (n=11). All patients with a decrease of enhancement >75% had a clinical score at 4 .

#### **CONCLUSION**

The percentage of decrease of enhancement on T1 fat sat sequence is reflects the best the clinical outcome after sclerotherapy for venous malformations.

#### **CLINICAL RELEVANCE/APPLICATION**

MRI evaluation of venous malformation after sclerotherapy should include T1 weighted sequences with fat saturation before and after injection of gadolinium.

## **LL-VIS-WE5B • Removal of the Grid during Routine Biliary Interventional Procedures Performed in a Flat Panel Interventional Suite: Preliminary Data on Image Quality and Patient Radiation Exposure**

**Kelvin Cortis MD, MRCS, FRCR (Presenter) ; Roberto Miraglia MD ; Luigi Maruzzelli MD ; Roberta Gerasia ; Corrado Tafaro ; Angelo Luca MD**

### **PURPOSE**

To determine whether grid removal during routine biliary interventional procedures performed in a flat panel interventional suite results in adequate image quality and in a significant reduction of the patient radiation exposure.

### **METHOD AND MATERIALS**

Routine biliary interventional procedures were defined as those in which absence of fine image detail during fluoroscopy carries no procedural impact including change of internal-external biliary drains (BCC) or balloon dilatation of biliary anastomosis (bilioplasty). 10 consecutive patients were enrolled, 8 had a BCC and 2 bilioplasty. The study population consisted of 8 adults with an average Body Surface Area (BSA) of 1.64, and 2 children with an average BSA of 0.49. All patients had a previous procedure in which the grid was used. Constant object-to-detector and source-to-image distance were maintained in each patient during the grid/no-grid procedures. The same fluoroscopy protocol was used for all examinations. The dose area product (DAP given in cGy.cm<sup>2</sup>) and procedure fluoroscopy time (given in seconds) were recorded for each procedure. DAP was normalized per unit of fluoroscopy time (nDAP, cGy.cm<sup>2</sup>/s). In order to quantify the change in nDAP, the nDAP of the procedure done without the grill was divided by that done with the grill for each patient, and the change in dose expressed as a percentage.

### **RESULTS**

In all procedures image quality was considered adequate by two different interventional radiologists and all procedures were successfully completed without significant changes in fluoroscopy time between the two groups (p=0.37). In every procedure without the grid nDAP was inferior as compared to the nDAP in procedures performed using the grid. The mean reduction in dose was 32.3%±21.1% (p=0.01).

### **CONCLUSION**

Our preliminary data shows that removal of the grid in routine biliary procedures is feasible and results in a significant reduction of patient radiation exposure. Larger studies with more procedures are warranted to confirm this data.

### **CLINICAL RELEVANCE/APPLICATION**

Most routine biliary procedures can be performed without a grid with reduction in radiation exposure. This seems of particular relevance since most of these patients require frequent re-intervention.

## **LL-VIE-WE6B • Hemoptysis in Hereditary Hemorrhagic Telangiectasia (HHT): A Single Symptom, Many Mechanisms**

**Jacques Sellier MD (Presenter) ; Mostafa El Hajjam MD ; Stephen Binsse MD ; Sophie Chagnon ; Pascal Lacombe**

### **PURPOSE**

In HHT patients, hemoptysis in non-embolized patients is often due to ruptured pulmonary arterio-venous malformations (PAVM). In treated patients, the source of bleeding can originate from more complex mechanisms implying a careful study of the PAVM vascular supply. We illustrate those mechanisms and the way we treat them.

### **METHOD AND MATERIALS**

During a 12-year period, 970 patients with HHT were evaluated at our center. 425 patients had PAVMs and 246 were embolized. Five percent of all patients presented hemoptysis. Patients with hemoptysis were prospectively investigated clinically in association with bronchial endoscopy, computed tomography and/or angiography. All imaging data were collected and reported to a potential cause. Each cause and its management are illustrated by case reports.

### **RESULTS**

In patients with PAVM, hemoptysis was mostly due to parenchymal rupture of the malformation. Immediate embolization of the culprit PAVM was mandatory. In previously embolized patients, bleeding could originate from already embolized malformations. In this case, three different mechanisms of hemoptysis were encountered, that could occur concomitantly: - recanalization of a previously embolized artery mainly due to insufficient packing of coils, - reperfusion of the PAVM by growth of pulmonary-to-PAVM anastomoses, - and development of systemic supplies to the embolized area. Treatment of recanalized artery is based on packing complementary coils. Symptomatic large pulmonary-to-PAVM anastomoses can be embolized with coil. Systemic supply needs other strategies of embolization to prevent any embolic complication because of direct connections between systemic arteries and PAVM. Finally, hemoptysis could be related to pulmonary hypertension or its life-threatening complication: rupture of pulmonary artery aneurisms.

### **CONCLUSION**

Hemoptysis in HHT patients is a monomorphic presentation of polymorphic conditions that implies a careful strategy before interventional treatment.

### **CLINICAL RELEVANCE/APPLICATION**

Hemoptysis is a potential life-threatening manifestation of HHT requiring emergency embolization. Identifying mechanism guides the therapeutic strategy.

## **LL-VIE-WE7B • Minimally Invasive Imaging Guided Procedures for Pain Control or Relief in Oncological Patients: What Can We Do?**

**Mauricio R Moura MD, MD (Presenter) ; Eduardo Garcia ; Eduardo P Anastacio ; Felipe D Barbosa MD ; Marcos R Menezes MD ; Publio C Viana MD**

### **PURPOSE/AIM**

Pain control is an important tool in managing oncologic patients and have equal importance to the actual treatment of the disease. The main objective of this study is to share with Radiologists, Interventional especially, our experience in minimally invasive image-guided procedures focused on therapeutic control of pain.

### **CONTENT ORGANIZATION**

We selected didactic and illustrative cases performed in ICESP (Cancer Institute of the State of São Paulo) of the following procedures: Celiac plexus neurolysis; thermal ablation of secondary bone lesions using Focused Ultrasound (FUS) guided by Magnetic Resonance Imaging (HIFU-MRI), Radiofrequency and Cryoablation associated with vertebroplasty; Infiltration of nerve roots guided by CT. Treated patients had pain that was unresponsive to other therapies and often presenting collateral effects.

### **SUMMARY**

Interventional Radiology is a fundamental resource among the multidisciplinary involving therapies for pain control. Beside established procedures such as neurolysis of celiac plexus, Root Infiltration, percutaneous vertebroplasty, thermal ablation of bone primary or secondary lesions ( with RFA or Cryoablation); novel therapeutic approaches, such as thermal ablation HIFU-MRI are gaining space in daily practice with a promising future.

## **Vascular/Interventional (Vascular Ultrasound)**

**Wednesday, 03:00 PM - 04:00 PM • E450B**

**Moderator**  
**Christoph A Binkert**, MD \*  
**Moderator**  
**Robert A Morgan**, MD \*

### SSM24-01 • Contrast-enhanced Ultrasound Evaluation of Peripheral Microcirculation in Critical Limb ischemia Patients Undergoing Endovascular Revascularization

**Costantino Del Giudice** MD (Presenter) ; **Fabrizio Chegai** MD ; **Roberto Gandini** MD, PhD ; **Antonio Orlacchio** MD ; **Giovanni Simonetti** MD

#### PURPOSE

To evaluate peripheral microcirculation assessed with contrast-enhanced ultrasound (CEUS) in patients with critical limb ischemia undergoing endovascular recanalization in comparison to percutaneous oximetry

#### METHOD AND MATERIALS

The study population comprised 14 diabetic patients (9 male, age  $76 \pm 7.5$  years old) with critical limb ischemia. Transcutaneous oxygen (TCPO<sub>2</sub>) and carbon dioxide (TcPCO<sub>2</sub>) tension was evaluated in the perilesional area. A ultrasound Doppler of the artery directly feeding the ischemic angiosome was performed to confirm the presence of peripheral arteriopathy disease and to evaluate the peak systolic velocity (PSV) and the end diastolic velocity (EDV). Microvascular blood flow in the ischemic angiosome was evaluated with CEUS. The same parameters were evaluated in the contralateral healthy foot as control.

#### RESULTS

Time- to-peak (TTP) and mean tissue transit time (TTT) were significantly prolonged and derived intensity peak (dIP) was significantly lower in the ischemic foot than the healthy contralateral (TTP  $48.76 \pm 9.38$  s vs.  $32.12 \pm 6.8$  s,  $p=0.011$ , A/Ttt  $6.81 \pm 4.52$  s vs.  $3.25 \pm 3.27$  s,  $p=0.02$  and dIP  $4.8 \pm 2.3$  db vs.  $8.6 \pm 3.1$  ). A significantly good correlation between transcutaneous parameters and CEUS parameters was observed.

#### CONCLUSION

Peripheral microcirculation may be evaluated with CEUS. TTP, TTT and dIP may be an alternative to percutaneous oximetry parameters to evaluate peripheral microcirculation in critical limb ischemia

#### CLINICAL RELEVANCE/APPLICATION

Percutaneous oximetry may fails to evaluate peripheral microcirculation. CEUS; may be an useful alternative; in order to assess the degree of critical limb ischemia before endovascular revascularization

### SSM24-02 • Measurement of Peripheral Muscle Microperfusion (PMP) and Macroperfusion in an Animal Peripheral Artery Disease (PAD) Model Using Contrast-enhanced Ultrasound (CEUS) and Doppler Flow (DF) Measurement

**Claas P Naehle** MD (Presenter) \* ; **Verena A Steinberg** ; **Gottfried Mommertz** ; **Dominik Krause** ; **Hans H Schild** MD

#### PURPOSE

Non-invasive assessment of PMP could improve management of PAD patients and allow for evaluation of new therapies. However, currently only very limited data using outdated/discontinued CEUS technology for assessment of PMP exists.

#### METHOD AND MATERIALS

In a porcine animal model, PMP of the lower extremity was quantified using CEUS replenishment kinetics (mean transit time (mTT) and wash-in rate (WiR)) of the biceps femoris during i.v. steady-state infusion of an ultrasound contrast agent (INN-sulphur hexafluoride). In addition, macroperfusion was measured at the common femoral artery using a DF probe. PMP and DF measurements were performed bilaterally at rest and under vasodilatation by adenosine stress (infusion rate  $70 \mu\text{g/kg}$  body weight/min.) after unilateral creation of a moderate external iliac artery stenosis (mean gradient  $14.4 \pm 5.4$  mmHg).

#### RESULTS

In all 10 pigs all measurements could be performed. During adenosine stress and after stenosis creation, PMP decreased significantly compared to baseline measurements (rest vs. adenosine stress: mTT:  $7.8 \pm 3.3$  s vs.  $21.2 \pm 18.4$  s;  $p < 0.05$  - WiR:  $58.4 \pm 38.1$  arbitrary units (AU) vs.  $26.2 \pm 15.7$  AU;  $p < 0.05$  - DF:  $122.3 \pm 31.4$  ml/s vs.  $83.6 \pm 28.1$  ml/s;  $p < 0.05$  | no stenosis vs. stenosis: mTT:  $8.1 \pm 3.1$  s vs.  $29.2 \pm 18.0$  s;  $p < 0.05$  - WiR:  $53.0 \pm 22.7$  AU vs.  $13.6 \pm 8.5$  AU;  $p < 0.05$  - DF:  $120.3 \pm 19.5$  ml/s vs.  $65.9 \pm 40.0$  ml/s;  $p < 0.05$ ). After stenosis creation, adenosine stress lead to a further decrease of PMP, but had no effect on macroperfusion (stenosis rest vs. stenosis adenosine stress: mTT:  $29.2 \pm 18.0$  s vs.  $56.3 \pm 38.7$  s;  $p < 0.05$  - WiR:  $13.6 \pm 8.5$  AU vs.  $6.0 \pm 4.1$  AU;  $p < 0.05$  - DF:  $65.9 \pm 40.0$  vs.  $62.2 \pm 33.2$ ,  $p < 0.05$ ).

#### CONCLUSION

In a porcine PAD model, CEUS for assessment of PMP is feasible. In addition, using mTT and WiR for quantification of PMP appears to be more sensitive compared to DF measurements.

#### CLINICAL RELEVANCE/APPLICATION

Measurement of PMP using CEUS may prove to be a useful tool in diagnosis of PAD and for evaluation of new therapies.

### SSM24-03 • Non-invasive Prediction of Hepatic Transplant Portal Vein Stenosis - Experience at a Single High Volume Transplant Center

**Marie A Vasher** MD (Presenter) ; **Danny R Lababidi** MD ; **Kamal Massis** MD ; **Bruce R Zwiebel** MD ; **Dana M Poletto** MD ; **Haydy Rojas** RN ; **Yougui Wu** PhD

#### PURPOSE

We sought to compare Doppler ultrasound findings to transhepatic catheter portal venogram findings of hepatic transplant main portal vein stenoses, and to determine which Doppler ultrasound criteria are often the best non-invasive measures for diagnosing portal vein stenosis.

#### METHOD AND MATERIALS

32 post-hepatic transplant transhepatic catheter portal venograms following initial Doppler ultrasound were performed at our institution on 30 patients from November 1, 2004 to May 31, 2012 due to clinical, biochemical, Doppler ultrasound, CT and/or MRI abnormalities. Doppler ultrasounds and catheter portal venograms were retrospectively reviewed. Doppler ultrasound criteria of main portal vein peak velocity, velocity step-up ratio, and change in velocity across the anastomosis were correlated with catheter portal venogram. Narrowing of the main portal vein of at least 50% on portal venogram was considered stenotic. 54 randomly chosen patients without suspicion of hepatic transplant portal anastomotic stenoses were assigned to our control group. Patients who underwent catheter portal venogram without findings of portal vein stenosis were also assigned to our control group.

#### RESULTS

#### CONCLUSION

#### CLINICAL RELEVANCE/APPLICATION

Applying the Doppler ultrasound criteria yielded in our study will result in selecting the most appropriate hepatic transplant patients with main portal vein stenosis for catheter portal venogram.



## **SSM24-04 • Stenosis Index Is a Specific Secondary Screening Test for Patients with Suspected Transplant Hepatic Arterial Stenosis**

**Sherwin S Chan** MD, PhD (Presenter) \* ; **Thomas X Le** MD ; **Michael F McNeely** MD ; **Manjiri K Dighe** MD ; **Theodore J Dubinsky** MD

### **PURPOSE**

Stenosis Index (SI) is a novel angle-independent quantitative measure that is computed using Fourier analysis of the spectral Doppler waveform. We evaluate the utility of stenosis index (SI) as a secondary measure after resistive index (RI) to increase the accuracy of diagnosing transplant hepatic artery stenosis using Doppler ultrasound (US).

### **METHOD AND MATERIALS**

An institutional anonymized retrospective case-control study was performed. Patients who underwent US for suspected post-transplant hepatic artery stenosis and abdominal angiography within 30 days at a large academic center in 2006-2010 were included. Patients who had no imaging of the transplanted artery on their angiography and patients who did not have complete ultrasound evaluation of their hepatic arteries were excluded. These Spectral Doppler images were imported into MATLAB and SI was calculated for each artery in each patient by obtaining a ratio of the power in high frequency bands to fundamental frequency. Student t-test and receiver operator characteristic (ROC) analyses were used to characterize the performance of SI, with ROC analysis providing the optimal SI threshold for detecting clinically relevant stenoses.

### **RESULTS**

63 patients (20 with clinically relevant stenoses) met the inclusion and exclusion criteria. The mean + standard deviation SI of the right and left hepatic arteries for stenotic arteries was 1.04 + 0.22 and normal transplant arteries was 1.18 + 0.19. The mean SI of these two groups were significantly different ( $p=0.01$ ). In these patients, area under the ROC curve (AUC) was 0.71 for SI and a cutoff value of SI < 0.95, gave a specificity of 95% and sensitivity of 40%. In comparison, RI AUC = 0.6 and RI < 0.6 had a specificity of 20% and sensitivity of 93% for significant transplant hepatic artery stenosis.

### **CONCLUSION**

In a subset of patients whom appeared suspicious enough on ultrasound to warrant angiography, SI is an excellent screening test for transplant hepatic artery stenosis.

### **CLINICAL RELEVANCE/APPLICATION**

Stenosis Index is an excellent secondary confirmatory test for transplant hepatic artery stenosis and its use can reduce the number of equivocal and false positive cases who proceed to invasive workup

## **SSM24-05 • Should Ultrasound Be Used as Prophylactic Screening for Venous Thromboembolism in High Risk Patients with Malignancy?**

**Katherine A Kaproth-Joslin** MD, PhD (Presenter) ; **Charles Francis** MD ; **Susan K Hobbs** MD, PhD ; **Alok Khorana** ; **Deborah J Rubens** MD

### **PURPOSE**

Using the previously described clinical risk score for venous thromboembolism (VTE) (Khorana et al, Blood 2008) to identify high risk patients, this study evaluates the utility of screening for thrombosis in a prospective cohort of initially asymptomatic cancer patients initiating outpatient chemotherapy.

### **METHOD AND MATERIALS**

Asymptomatic cancer patients initiating a new chemotherapy regimen and found to be high-risk for VTE based on a predictive risk model (score =3) were enrolled on an ongoing prospective cohort study with informed consent. Patients were evaluated with a baseline and an every 4 ( $\pm$  1) week serial US study for up to 16 weeks. Additionally, CT scans obtained for restaging purposes were also evaluated for VTE.

### **RESULTS**

Of the 35 high-risk patients enrolled, 8 (23%) were found to have VTE, 5 patients w/ DVT alone (14%), 1 w/ PE alone (3%) and 2 (6%) w/ both. 32 patients underwent a baseline US and 3 asymptomatic DVTs were identified (9%), w/ 1 patient also having an asymptomatic PE detected on staging CT. Subsequent US were performed in 23 patients at week 4 (0DVT), 21 patients at week 8 (0DVT) and 18 patients at week 12 (1 DVT, 6%). An additional 2 patients developed symptomatic DVT between screens. Restaging CT scans identified an asymptomatic PE in a patient at week 6 and an asymptomatic PE in a patient at week 9. Of the patients w/ isolated DVT, 2 had isolated unilateral calf clot, 2 had unilateral calf and thigh clot, and 1 had unilateral upper extremity clot.

### **CONCLUSION**

In this prospective observational study, 23% of cancer outpatients deemed high-risk for VTE developed clot at a rate much higher than found in both normal and acutely ill hospitalized populations (0.5 and 6% respectively). This study confirms the validity of the previously described risk score developed by Khorana et al and makes this model highly predictive of identifying patients at risk for VTE. In addition, these findings suggest that screening US for asymptomatic clot should be considered in high-risk patients based on this risk score. This study highlights the importance of VTE screening in the calf, w/ 50% of patients w/ VTE having calf clot and 25% having isolated unilateral calf clot, indicating that this region should be included in the assessment of DVT.

### **CLINICAL RELEVANCE/APPLICATION**

Screening ultrasonography for asymptomatic thrombosis should be considered in high-risk patients based on this risk score with the goal of reducing the morbidity and mortality associated with VTE.

## **SSM24-06 • A Comparison between Contrast-enhanced Ultrasound (CEUS) and Multi-slice Computer-tomography (MS-CT) in Detecting and Classifying Endoleaks in the Follow-up after EVAR**

**Dirk-Andre Clevert** MD (Presenter) \* ; **Verena Guertler** ; **Wieland H Sommer** MD ; **Georgios Meimarakis** ; **Maximilian F Reiser** MD

### **PURPOSE**

To compare Contrast-Enhanced-Ultrasound (CEUS) and Multislice-Computed-Tomography (MS-CT) angiography in detecting and classifying endoleaks in the follow-up of patients following Endovascular-Aortic-Aneurysm-Repair (EVAR).

### **METHOD AND MATERIALS**

In this retrospective study a cohort of 171 patients with both CEUS and MS-CT follow-up examinations after EVAR were included. In total 489 CEUS and 421 MS-CT examinations were assessed during the follow-up. B-scan, color Doppler and CEUS were performed in all patients. MS-CT was performed with a 16- up to 128-slice-scanner.

### **RESULTS**

Regarding our inclusion and exclusion criteria we obtained 200 contemporary examination pairs out of the 132 patients of our cohort. MS-CT was used as the preferred examination in determining the presence of an endoleak. The true positive rate for the detection of endoleaks with CEUS was 42% (84/200), the false positive rate was 4% (8/200), the true negative rate was 52% (105/200), and the false negative rate was 2% (3/200). The sensitivity of CEUS was therefore 97%, and the specificity was 93%. McNemar's test value was 0.227 and kappa coefficient was 0.889.

### **CONCLUSION**

CEUS appears to be as good as MS-CT in the detection of endoleaks in the follow-up after EVAR, with the added advantages of no radiation dose and no nephrotoxicity of the contrast agents. A switch of the preferred examination from MS-CT to CEUS should be considered.

CLINICAL RELEVANCE/APPLICATION

CEUS appears to be as good as MS-CT in the detection of endoleaks in the follow-up after EVAR, with the added advantages of no radiation dose and no nephrotoxicity of the contrast agents.

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**Abdominal Vasculature: Ultrasound and Doppler**

**Thursday, 08:30 AM - 10:00 AM • S103CD**

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**RC610** • AMA PRA Category 1 Credit™:1.5 • ARRT Category A+ Credit:1.5

**RC610A • Liver Doppler**

**Kathryn A Robinson** MD (Presenter)

LEARNING OBJECTIVES

1) Identify normal hepatic hemodynamics. 2) Identify hemodynamic alterations in portal hypertension. 3) Identify portal and hepatic vein thrombosis. 4) Identify normal sonographic and Doppler findings as well as complications of Transjugular Intrahepatic Portosystemic Shunt (TIPS).

ABSTRACT

**RC610B • Contrast Ultrasound in the Abdomen**

**Hans-Peter Weskott** MD (Presenter) \*

LEARNING OBJECTIVES

1) Understanding the indications of contrast enhanced ultrasound (CEUS) in different abdominal organs. 2) Learning about the importance of the three contrast phases and how CEUS performs in detecting and characterizing focal liver lesions. 3) Learning the potential value as well as the limitations of CEUS in renal disorders. 4) Learning how CEUS performs in diseases of other solid organs including the intestine and major abdominal vessels.

ABSTRACT

Liver: In patients with favorable scanning conditions CEUS is at least as sensitive as contrast enhanced CT (CECT) in detecting malignant liver lesions. Due to a high temporal resolution, even a short hyper-enhancement of a few seconds can reliably be detected, thus improving the characterization of focal liver lesions. A majority of malignant lesions can therefore be characterized as iso- or hyper-enhancing. During the arterial phase the tumor's vessel architecture and direction of contrast filling is important for characterizing a lesions character. Due to a high spatial resolution, novel contrast imaging techniques allow detection of washed out lesions down to 3mm in size. CEUS characterizes focal liver lesions with a much higher diagnostic confidence than conventional US and is comparable to CT and MRI. CEUS also improves intraoperative tumor detection and characterization. Using time intensity analysis a change in contrast enhancement and kinetics helps in estimating tumor response to chemotherapy. CEUS is also used to monitor local ablation therapy and is a useful imaging tool to detect early tumor recurrence. Gallbladder: CEUS can be used to better visualize ulceration, perforation, and tumors of its wall. Pancreas: CEUS can be used to reliably image necrosis in acute pancreatitis. It helps to differentiate neuroendocrine tumors from ductal adenocarcinoma. Kidney: CEUS adds great value in detecting and characterizing complicated cysts and is believed to be more accurate than CECT. However, its value in differentiating solid renal tumors is limited. Parenchymal changes due to infectious diseases can be diagnosed by using CEUS. It is highly sensitive in detecting organ infarctions as well. Intestine: CEUS is of great value in characterizing inflammatory diseases and especially in imaging complications. CEUS improves visualization of abdominal vascular disorders

**RC610C • Aorta and Its Branches**

**Mary C Frates** MD (Presenter)

LEARNING OBJECTIVES

1) Understand the gray scale and Doppler techniques useful for evaluating the aorta and its branches. 2) Recognize the presence of vascular stenosis, aneurysm and malformations. 3) Understand the challenges in the sonographic evaluation of aortic stent grafts.

ABSTRACT

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**Vascular Lesions in Children: Diagnostic Dilemmas and Treatment Options**

**Thursday, 08:30 AM - 10:00 AM • S102AB**

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**RC613** • AMA PRA Category 1 Credit™:1.5 • ARRT Category A+ Credit:1.5

**RC613A • Hemangiomas and Vascular Syndromes**

**Patricia E Burrows** MD (Presenter) \*

LEARNING OBJECTIVES

1) Participants will become familiar with the current classification of vascular anomalies, including subtypes of hemangioma and vascular overgrowth syndromes. 2) They will be familiar with imaging findings associated with different subtypes of hemangiomas, simple vascular malformations and vascular overgrowth syndromes. 3) They will be able to prescribe appropriate imaging studies, based on the clinical findings.

## ABSTRACT

This presentation will review a classification of vascular anomalies and associated imaging findings. Hemangiomas are proliferative tumors of infancy. Infantile hemangioma (glut1 positive) is the most common and consists of a soft tissue mass composed of capillaries with dilated feeding and draining vessels. Congenital hemangiomas (glut1 negative) (RICH and NICH) are fully formed at birth and behave differently from infantile hemangiomas. Imaging may also be different. Vascular malformations are usually composed of channels without a soft tissue mass. Combined malformations are the exception, as they are often associated with soft tissue overgrowth. Venous malformations are classified as focal, multifocal or diffuse types. Familial forms include blue rubber bleb nevus syndrome, glomuvenous malformation and cutaneomucosal venous malformations. Sporadic and cutaneomucosal venous malformations are caused by TIE2 mutations. Venous malformations are hyperintense on T2 weighted images and usually show slow and partial enhancement. Lymphatic malformations can be cystic [macrocytic, microcystic] or composed of dysfunctional channels. These generally appear hyperintense on T2 weighted imaging and do not enhance. AVM and AV fistula appear as dilated channels, usually within normal or hypertrophied tissue. Angiography shows early venous drainage. Angioarchitecture varies. Associated mutations include ALK1, endoglin, SMAD4, RASA-1, PTEN. Combined malformations can be associated with low flow or fast flow channels and often have associated soft tissue overgrowth. Syndromic forms include Klippel-Trenaunay syndrome (CLVM), CLOVES syndrome, CM macrocephaly syndrome, and PTEN hamartoma syndrome. These patients require careful and extensive imaging to identify the vascular anomalies present, limb length discrepancy and soft tissue anomalies. In summary, vascular anomalies vary in their extent and severity of symptoms. Ultrasonography is useful to determine flow characterist

### RC613B • Treatment of High-Flow Lesions - Manage or Cure?

**David M Hovsepien MD (Presenter) \***

#### LEARNING OBJECTIVES

1) Participants will learn about treatment planning for arteriovenous malformation, about challenging cases that require multiple approaches in staged procedures, and possible complications from IR intervention.

#### ABSTRACT

### RC613C • Low-flow Lesions-Basic and Advanced Treatment Options

**Leah E Braswell MD (Presenter)**

#### LEARNING OBJECTIVES

Participants will learn about needle sclerotherapy techniques for venous malformation and drain sclerotherapy techniques for macrocystic lymphatic malformation. Complimentary treatment techniques, peri-procedural management, and long term follow-up will be discussed.

## Emergency Body MRI: Vascular Emergencies, Abdominal Emergencies and the Pregnant Patient (How-to Workshop)

Thursday, 08:30 AM - 10:00 AM • E261

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**RC651 • AMA PRA Category 1 Credit™:1.5 • ARRT Category A+ Credit:1.5**

**Christine O Menias, MD**

**Constantine A Raptis, MD**

**Vamsi R Narra, MD,FRCR \***

#### LEARNING OBJECTIVES

1) Review the role of MRI as a primary diagnostic modality for evaluation of acute abdominal and pelvic pathologies. 2) Describe the various clinical scenarios as it pertains to vascular emergencies, abdominal emergencies and the evaluation of an acute abdomen in a pregnant patient. 3) Case examples of pertinent entities of Acute abdomen on MRI will be reviewed.

#### ABSTRACT

Magnetic resonance imaging (MRI) is now more readily available in the emergency room setting and is becoming the primary modality used to diagnose acute abdominal pathologies in situations where there may be relative contraindications to computed tomography (CT). A review by MRI of various acute abdomen conditions is presented. The future directions of MRI in evaluating patients with abdominal emergencies are also briefly discussed.

Review the MRI features of Acute Hepatic and Biliary entities such as Cholelithiasis, cholecystitis, cholangitis, Hepatic abscess and Mirizzi syndrome MRI features of acute pancreatitis and complications such as necrotizing, hemorrhagic and pseudoaneurysm

Review the MRI imaging features of acute Genitourinary entities such as renal abscess, pyelonephrosis and obstructing ureteral stone Acute Gyn entities include MRI imaging of PID, ovarian torsion, hematocolpos, and ruptured hemorrhagic cyst Review the Acute gastrointestinal disorders on MRI such as SBO, mesenteric arterial and venous ischemia Crohns, colitis, and Peptic ulcer disease

## Vascular Imaging Series: CT Angiography-New Techniques and Their Application

Thursday, 08:30 AM - 12:00 PM • S502AB

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**V5VA51 • AMA PRA Category 1 Credit™:3.25 • ARRT Category A+ Credit:4**

#### Moderator

**Dominik Fleischmann, MD \***

#### LEARNING OBJECTIVES

1) To describe and illustrate new techniques for CT angiography. 2) To show present and future clinical applications of these methods.

### V5VA51-01 • Iterative Reconstruction for CTA

**Sandra S Halliburton PhD (Presenter) \***

#### LEARNING OBJECTIVES

1) Understand the basic principles of iterative reconstruction for CT. 2) Describe commercially available iterative reconstruction techniques. 3) Review the advantages and disadvantages of iterative reconstruction. 4) Discuss the incorporation of iterative reconstruction algorithms into clinical protocols for CT angiography.

#### ABSTRACT

### V5VA51-02 • Model-based Iterative Image Reconstruction (MBIR) in CT Angiography of the Chest - A Dose Finding Cadaver Study

**Stefan Wirth MD (Presenter) \* ; Fabian Mueck ; Zsuzsanna Deak MD ; Sonja Kirchhoff MD ; Oliver Peschel ; Maximilian F Reiser MD ; Michael K Scherr MD**

#### PURPOSE

To compare image quality (IQ) of 64-row CT angiography of the chest, respectively acquired at varying dose levels and reconstructed

with model based iterative reconstruction (MBIR), to standard baseline examinations at full dose and using adaptive statistical iterative image reconstruction (ASIR).

#### METHOD AND MATERIALS

8 male and 3 female cadavers were included (79±18.5kg; 72.5±17.2y/o; BMI 26.3±5.1). Following injection of contrast media (Angiofil-Macro: Arterial=800ml; Venous=1200ml; Virtangio, Fumedica, Muri; Switzerland) a full-dose baseline reference (FBR) was acquired (CT HD750; GE Healthcare, Waukesha, IL) using a standard-of-care protocol (0.625mm helical, 0.984 pitch, 120kV, 10-400mA modulation, noise index NI=39 VS=0.625; NI = allowed procentual level of noise in a water phantom in virtual slices of varying thickness (VS) in mm; raw data were reconstructed in soft tissue kernel using ASIR 50%). These baseline raw data were also reconstructed with MBIR (D0). Additionally, each cadaver was scanned with varying dose levels D1-D5 by changing NI and VS (D1: NI=35, VS=2.5; D2: NI=70, VS=0.625; D3: NI=35, VS=5; D4: NI=70, VS=2.5; D5: NI=70, VS=5; all reconstructed with MBIR). Except for NI, VS and MBIR, all other parameters were identical to the FBR, all series reformatted in 3mm axial, coronal and sagittal slices. Two radiologists, blinded to the dose level, independently compared IQ for CT angiography of D0-D5 to the full-dose FBR (IQ: -2:diagnostically inferior, -1:inferior, 0:equal, +1:superior, +2:diagnostically superior; respectively). For statistical analysis ICC and Wilcoxon test were used.

#### RESULTS

Mean values were (CTDIvol in mGy: D0 = 10.4±0.9, D1 = 7.4±2.6, D2 = 6.6±2.5, D3 = 4.3±1.8, D4 = 2.1±0.9, D5 = 1.1±0.5); (IQ: D0 = +1.0±0.3, D1 = +0.9±0.3, D2 = +0.7±0.3, D3 = +0.5±0.3, D4 = +0.2±0.3, D5 = -0.5±0.6). All values were significant different from one another; p

#### CONCLUSION

Data reconstruction with MBIR instead of ASIR allows for significant dose reduction of 80% in CT angiography of the chest without impairment of the image quality, resulting in a calculated mean effective dose of 0.94±0.66 mSv.

#### CLINICAL RELEVANCE/APPLICATION

For standard CT angiography, MBIR allows for diagnostic imaging of the chest below 1mSv without loss of image quality (overall, vessel wall, thrombus material, calcifications).

### **VSVSA51-03 • Evaluation of Diagnostic Quality and Image Adequacy of Low Dose CT Angiography with Model Based Iterative Reconstruction in Follow Up of Endovascular Aortic Aneurysm Repair**

**Neil Hansen MD (Presenter) ; Ravi K Kaza MD ; Katherine E Maturen MD ; Peter S Liu MD ; Joel F Platt MD**

#### PURPOSE

To evaluate the image quality and overall adequacy of low dose Computed Tomographic Angiography (LD-CTA) with model based iterative reconstruction (MBIR) in patients evaluated following endovascular aortic aneurysm repair (EVAR) in comparison to standard dose CTA (SD-CTA) with Adaptive Statistical Iterative Reconstruction (ASIR).

#### METHOD AND MATERIALS

30 patients who had LD-CTA with MBIR and a prior SD-CTA with ASIR following EVAR were included. Two radiologists independently evaluated 60 CTAs in a random blinded fashion. Image quality for evaluation of stent configuration, stent lumen, aneurysm outline, vessel outline, and overall vascular and solid organ imaging adequacy were graded on a scale of 1 to 5 (1=poor, 2=acceptable, 3=good, 4=very good, 5=excellent). Maximal aneurysm sac diameter was measured, and the presence or absence of an endoleak was recorded. Image noise and contrast to noise ratio (CNR) were measured for all CTs. Scanner generated CT dose index (CTDI vol) and Dose Length Product (DLP) were recorded for the arterial and delayed phases.

#### RESULTS

Mean qualitative image score for LD-CTA averaged in the good to very good range in all categories. There was no significant difference between LD-CTA and SD-CTA in evaluation of stent lumen (4.1 vs. 3.9; p = .077). There was a significantly (p < .0001) higher score for the SD-CTA in the following categories: stent configuration (4.5 vs. 3.6), aneurysm outline (4.8 vs. 3.8), vessel outline (4.7 vs. 3.3), overall vascular adequacy (4.6 vs. 4.1), and overall solid organ imaging adequacy (4.6 vs. 3.3). Interobserver evaluation for endoleak detection was good for both groups, but higher for the LD-CTA (kappa = .92 vs .77). There was no significant difference in the mean aneurysm diameter between the two readers on LD-CTA and SD-CTA. The effective radiation dose for the LD-CTA was significantly (p < .0001) lower than SD-CTA during both the arterial (4.4 vs 16.2 mSv) and the venous (2.4 vs 6.7mSv) phases. As compared to SD-CTA with ASIR, the measured image noise was significantly lower (14.7 vs. 19.3; p < .001) and CNR was higher (25.6 vs. 17.1; p < .001) on the LD-CTA.

#### CONCLUSION

In patients being followed up after EVAR, low dose CTA with MBIR produces diagnostically acceptable image quality with significant radiation dose reduction.

#### CLINICAL RELEVANCE/APPLICATION

Low dose CTA with MBIR after EVAR produces diagnostic image quality with significant patient radiation dose reduction.

### **VSVSA51-04 • CT Angiography of the Chest and Abdomen: Image Quality, Interobserver Variability, and Diagnostic Accuracy for Iterative versus Filtered Back Projection Reconstruction**

**Elizabeth George MBBS (Presenter) ; Kanako K Kumamaru MD, PhD ; Pamela M Deaver MD ; Katherine Mullen MD ; Sachin S Saboo FRCR, MD ; Frank J Rybicki MD, PhD \* ; Kurt Schultz RT \* ; Ashish R Khandelwal MD ; Michael L Steigner MD \* ; Dimitris Mitsouras PhD**

#### PURPOSE

To test the hypothesis that CT angiography (CTA) images reconstructed with iterative method (AIDR3D) have superior image quality, lower interobserver variability in anatomical measurements, and higher diagnostic accuracy when compared to the same raw data reconstructed with filtered back projection (FBP).

#### METHOD AND MATERIALS

All 157 clinical chest and abdominal CTA (Table) acquisitions (320x0.5 mm CT) over 5 months (6/12-10/12) were performed at a reduced radiation dose (compared to standard at our institution) and the raw data was reconstructed with both AIDR3D and FBP. Quality of arterial phase images was assessed by two independent readers (4-point scale) for both reconstructions. For 1/3 of patients (n=53, randomly chosen), signal-to-noise ratio (SNR) and contrast-to-noise ratio (CNR) was measured at the artery of interest. For renal donors (n=10), kidney size and renal artery length were measured by two readers for both reconstructions, and interobserver variability determined. For coronary CTA with reference standard catheter angiography (n=15), degree of coronary stenosis and level of confidence (3-point scale) in assessment was determined by two readers for both reconstructions, interobserver agreement and diagnostic accuracy was assessed.

#### RESULTS

Image quality score had good interobserver agreement (weighted  $\kappa=0.67$ ) and was higher (p

#### CONCLUSION

Reduced radiation exposure CTA images reconstructed with AIDR3D have higher objective and subjective image quality when compared to FBP, with a tendency towards lower interobserver variability among the CTA clinical indications tested.

#### CLINICAL RELEVANCE/APPLICATION

AIDR3D reconstruction for CTA acquisitions can reduce radiation dose with high image quality, supporting its routine use.

### **VSVSA51-05 • Dual-Energy and Low kVp CTA**

**Sachio Kuribayashi MD (Presenter) \***

#### LEARNING OBJECTIVES

1) Understand the basic principles and technical basics of dual energy CTA. 2) Describe two components of dual energy imaging including material decomposition and virtual monochromatic spectral imaging. 3) Review the experimental studies and discuss the potential clinical application to vascular systems.

### **V5VA51-06 • Reduced Radiation Dose and Improved Diagnostic Image Quality at Cardiovascular CT Angiography by Automated, Individualized X-ray Tube Voltage Selection: Intra-individual Comparisons**

**Aleksander Krazinski** (Presenter) ; **U. Joseph Schoepf MD \*** ; **Justin R Silverman** ; **Christian Canstein \*** ; **Robin Brothers RT** ; **Lucas L Geyer MD \*** ; **Felix G Meinel MD**

#### PURPOSE

To evaluate radiation dose and image quality at cardiovascular CT angiography (CTA) with an automated x-ray tube voltage adjustment application by intra-individual comparison in patients undergoing CTA of the heart or aorta.

#### METHOD AND MATERIALS

The study was IRB approved and HIPAA compliant. We retrospectively analyzed paired studies in 64 patients (35 male, 60±16 years), who had undergone two 2<sup>nd</sup> generation dual-source CTA acquisitions of the heart or aorta before and after the implementation of an automated x-ray tube voltage adjustment application. Each study pair consisted of a baseline scan (scan1) where tube voltage was operator selected based on the patient's body mass index and a follow up scan (scan2) where tube voltage was automatically selected based on the anatomical attenuation of the topogram (scout) acquisition. Other parameters were kept identical between the two scans: 2x64x0.6mm collimation; 320mAs modulated reference tube current-time product. Subjective image quality (IQ) was rated and objective IQ was measured by mean arterial attenuation, image noise, signal-to-noise ratio (SNR) and contrast-to-noise ratio (CNR). To adjust for differences in radiation exposure, a figure of merit (FOM) was calculated. Effective radiation dose equivalents were compared. All values are given as mean±standard deviation (SD) and were tested for significance using the Wilcoxon signed-rank test.

#### RESULTS

All studies were considered diagnostic. A different kV level between scan1 and scan2 was automatically selected in 18 patients (28%). Overall subjective IQ (3.30±0.87, 3.56±0.85, p=0.02), SNR (14.6±5.93, 16.65±5.90, p=0.005), CNR (12.13±5.34, 14.08±5.30, p=0.007), and FOM (20.9±24.3, 44.0±44.7, p

#### CONCLUSION

Patient specific protocol adjustment by automated x-ray tube voltage selection can operator-independently optimize cardiovascular CTA image acquisition parameters with improved objective and subjective image quality.

#### CLINICAL RELEVANCE/APPLICATION

At cardiovascular CTA, patient specific protocol adjustment by automated voltage selection offers significant radiation reduction across an identical patient population while image quality is enhanced

### **V5VA51-07 • Utility of Iodine Extracted Images from Single Source Dual-energy CTA to Evaluate the Success of Endovascular Repair of Abdominal Aortic Aneurysm**

**Mukta D Agrawal MBBS, MD** (Presenter) \* ; **Sanjeeva P Kalva MD \*** ; **George R Oliveira MD** ; **Jorge M Fuentes MD** ; **Yasir Andrabi MD, MPH** ; **Koichi Hayano MD** ; **Dushyant V Sahani MD**

#### PURPOSE

To investigate if the iodine-extracted (IE) images from DE-CTA can enable confident assessment of stent patency and endoleak following endovascular repair of abdominal aortic aneurysm (EVAR).

#### METHOD AND MATERIALS

In this IRB approved prospective study, 51 consecutive patients with EVAR had follow-up CTA exam using ssDECT (GE discovery CT750 HD). The arterial (25-30 sec) and delayed phase (60 sec) DECT datasets were processed to create material density iodine extracted images (IE) and virtual monochromatic (VMC) images at 50 and 70 keV. Three-experienced radiologist independently evaluated only the IE images to assess stent patency and endoleak detection. The diagnostic evaluation based on combined unenhanced, multiphase enhanced and processed VMC images served as the reference standard for comparison of performance and interpretation time. Number of endoleak detected on IE images were compared to that detected on all other images.

#### RESULTS

All readers made their interpretations in 51 cases using IE except in 4 cases for R1 and 2 cases for R2, review of other image datasets was demanded but their interpretations remained unchanged. 15 endoleaks were confidently detected on IE images by all readers including those in 4 patients with Onyx embolization for type 2 endoleaks. Although arterial phase IE images detected all 15 leaks, in 3 patients delayed phase IE images were helpful. Average time spent per case was 5.34 minutes for IE images alone in comparison to 21.30 minutes for the entire processed DECT dataset.

#### CONCLUSION

Review of ssDE-CTA rendered IE images alone can enable confident assessment of stent patency and endoleak detection in patients with EVAR.

#### CLINICAL RELEVANCE/APPLICATION

ssDECT benefit vascular imaging but has introduced workflow challenge to process and interpret multiple dataset. IE combine the unique features to efficiently yield pertinent information for EVAR exam

### **V5VA51-08 • Implications for Contrast Medium Delivery**

**Hans-Christoph R Becker MD** (Presenter)

#### LEARNING OBJECTIVES

1) Understand the basic principles and technical basics of dual energy CTA. 2) Describe two components of dual energy imaging including material decomposition and virtual monochromatic spectral imaging. 3) Review the experimental studies and discuss the potential clinical application to vascular systems.

### **V5VA51-09 • Utility of Dual Energy Spectral CT for Reducing Contrast Medium Dose in Abdominal CT Angiography: Initial Clinical Experience**

**Xin Lei** (Presenter) ; **Yang Xiaotang** ; **Gao Jinfang** ; **Zhao Zhikai** ; **Chang Chao** ; **Fan Lin**

#### PURPOSE

To investigate the utility of dual energy spectral CT (DEsCT) for reducing contrast medium in abdominal CT angiography.

#### METHOD AND MATERIALS

This prospective study was approved by the institutional review board with patient informed consent. 22 consecutive patients (BMI>=24, 13men, 9 women; mean age, 45.4±12.6 years) with suspected abdominal occupied lesions underwent either conventional CTA with 120kVp and iodixanol (Visipaque, 270mg/ml) (n=12) or spectral CTA with iohexol (Omnipaque, 350mg/ml) (n=10). The injection rate and amount for two groups were 3.5 ml/s and 1ml/kg. Images of both groups had 0.625mm slice thickness. Monochromatic images (40-140keV) were generated from the spectral CTA, and from which an optimal energy level was selected for obtaining the best contrast-noise-ratio (CNR) for the abdominal aorta at the renal artery level relative to the erector spine muscle. The CT value and noise of the abdominal aorta and muscle at the optimal monochromatic image set of spectral CTA group and at conventional CTA group were

measured. Two radiologists assessed all images with 5-points scale. CTDIvol was recorded. Data were analyzed using student T-test.

## RESULTS

### CONCLUSION

With 29% contrast medium reduce and similar radiation dose, spectral CTA provided better image quality than conventional CTA.

### CLINICAL RELEVANCE/APPLICATION

Low-keV monochromatic CTA should be an optional choice for patients who have underlying renal function impairment.

## **VSPA51-10 • CT Venography with Dual Energy CT: Dose Reduction of Contrast Material with Low Tube Voltage**

**Shintaro Ichikawa** MD (Presenter) ; **Utaroh Motosugi** MD ; **Masato Imaizumi** ; **Katsuhiko Sano** MD ; **Hiroyuki Morisaka** MD ; **Tomoaki Ichikawa** MD, PhD \*

### PURPOSE

To assess whether dose of contrast material can be reduced in CT venography with low tube voltage (80 kVp) CT.

### METHOD AND MATERIALS

This prospective study included 63 patients. They were randomly divided into 3 groups that were administered different doses of contrast material (600, 500, and 400 mg I/kg). We used an area-detector CT scanner (Aquilion ONE; Toshiba Medical Systems, Japan) and iopamiroI (Iopamiron®; Bayer Yakuhin, Ltd., Japan). All patients underwent dual energy CT at 80 and 135 kVp. Conventional image (120kVp) was made from them and 80 and 120 kVp were compared. We measured the average CT value of 4 regions of interests, namely, the left and right femoral and popliteal veins, and a value of =80 HU was considered sufficient contrast for detecting deep vein thrombosis (Goodman, et al. Radiology 2005). Two radiologists evaluated the contrast of veins and muscles with a 3-point confidence scale, and scores within =5 points of the total score were considered adequate.

### RESULTS

The mean CT value of images taken at 80 kVp was significantly higher than that taken at 120 kVp (600 mg I/kg, 150.1 ± 19.9 HU vs. 121.8 ± 14.2 HU; 500 mg I/kg, 134.4 ± 19.4 HU vs. 108.7 ± 14.3 HU; and 400 mg I/kg, 115.9 ± 15.8 HU vs. 91.6 ± 12.2 HU, respectively). The mean CT value was lowest for the image at 120 kVp after administration of 400 mg I/kg of contrast material. The proportion of patients with scores over 80 HU of 400 mg I/kg and at 120 kVp (15/21 [71.4%]) was significantly lower than that of the control group (600 mg I/kg at 120 kVp; 21/21 [100%]). The proportion of patients with scores 5 points higher than the total score of 400 mg I/kg of contrast material and at 120 kVp (12/21 [57.1%]) was significantly lower than that of the control group (600 mg I/kg at 120 kVp; 20/21 [95.2%]). There was no significant difference between the images obtained after administration of 400 mg I/kg of contrast material at 80 kVp and the control images (600 mg I/kg at 120 kVp). Moreover, in this study, the use of 80 kVp rather than 120 kVp showed a 30% reduction in radiation exposure (CTDI VOL [10.4 vs. 14.9 mGy], respectively).

### CONCLUSION

By using low tube voltage (80 kVp), the dose of contrast material can be reduced to at least 400 mg I/kg, while keeping sufficient contrast to diagnose deep venous thrombosis.

### CLINICAL RELEVANCE/APPLICATION

This study showed that low tube voltage (80 kVp) CT can help reduce the dose of contrast material and radiation exposure.

## **VSPA51-11 • Feasibility of Low kV Settings CT-angiography with Ultra Low Contrast Medium Volume for the Assessment of Thoracic and Abdominal Aorta Disease**

**Cammillo R Talei Franzesi** (Presenter) ; **Davide Ippolito** MD ; **Pietro A Bonaffini** MD ; **Davide Fior** MD ; **Orazio Minutolo** MD ; **Sandro Sironi** MD

### PURPOSE

To evaluate the image quality, the diagnostic performance and the radiation dose exposure of low-kV CT angiography (CTA) protocol (100 kV) with ultra low-contrast medium volume (40 mL) in the assessment of thoracic and abdominal aorta disease.

### METHOD AND MATERIALS

From July 2011 to February 2013, 76 patients (28 women; mean age 65.4 years; range, 35-83 years; BMI

### RESULTS

In all the CT studies we could correctly visualize and evaluate main branches of thoracic and abdominal aorta. No significant difference of density measurements was achieved between the low-kV protocol (mean attenuation value of thoracic aorta 304HU, abdominal aorta 343HU and renal arteries 331HU) and the control group (mean value of thoracic aorta 320HU, abdominal aorta 339HU and renal arteries 303HU). The radiation dose exposure was significantly lower (p

### CONCLUSION

Low-kV protocol provides a diagnostic performance comparable to standard protocol, decreasing significantly the radiation dose exposure (particularly in the abdomen) and with a significant reduction of contrast material volume.

### CLINICAL RELEVANCE/APPLICATION

Low-kV and low-contrast volume CT-angiography provides a significant reduction of radiation exposure, maintaining good image quality, also allowing evaluation of patients with renal dysfunction.

## **VSPA51-12 • A Novel CT-based Calcium Scoring System of the Lower Extremity Arteries: Impact on Luminal Assessment with CT Angiography**

**Stacey Schriber** (Presenter) ; **Waleska M Pabon-Ramos** MD ; **Holly L Nichols** BS ; **Mark L Lessne** MD ; **Charles Y Kim** MD \*

### PURPOSE

Calcification of the lower extremity arteries can hinder luminal visualization on CT angiography. However, not all types and degrees of calcification are problematic. The purpose of this project is to utilize a novel calcium scoring system to correlate calcification characteristics with luminal visibility and diagnostic accuracy.

### METHOD AND MATERIALS

The study population consisted of 99 legs in 57 patients (31 male, mean age 65 years) that underwent both CT and conventional angiography of the lower extremities within 3 months of each other. The arteries of each leg were divided into 9 segments. A single axial image was chosen from the CTA in each arterial segment for evaluation. The degree of stenosis (

### RESULTS

371 of 514 arterial segments analyzed had some degree of calcification. Both calcium morphology and circumference scores demonstrated a strong inverse correlation with diagnostic confidence for the infrainguinal arteries but moderate in the iliac arteries (p

### CONCLUSION

The proposed calcification scoring system based on calcium morphology and circumference correlated well with diagnostic confidence and accuracy of luminal assessment on CTA.

### CLINICAL RELEVANCE/APPLICATION

Characterization of the calcium morphology and circumference on CTA can provide a method for quantifying the diagnostic accuracy of interpretation of luminal patency and stenosis

## **VSPA51-14 • Post Processing, Workflow and Interpretation**

LEARNING OBJECTIVES

1) To illustrate steps in image post-processing for the interpretation of CTA images. 2) To highlight elements that can be used to optimize workflow for multiplanar reformatted images, maximum intensity projections, and three-dimensional volumes.

ABSTRACT

**Neuroradiology (Cerebrovascular Imaging)**

Thursday, 10:30 AM - 12:00 PM • N229

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MR VA NR

**SSQ15** • AMA PRA Category 1 Credit™:1.5 • ARRT Category A+ Credit:1.5

Moderator

Howard A Rowley, MD \*

Moderator

Paul M Ruggieri, MD \*

**SSQ15-01 • Physiologic Variability in Internal Jugular Venous Caliber: A Retrospective Review**

Karen Buch MD (Presenter); Raymond Groller; Rohini N Nadgir MD; Akifumi Fujita MD; Osamu Sakai MD, PhD \*

PURPOSE

Chronic cerebrospinal vascular insufficiency (CCSVI) is a proposed condition described as intra-luminal stenosis of the internal jugular (IJV) resulting in impeded venous flow from the brain and has been linked to pathologies such as multiple sclerosis (MS). However, calculations of IJV stenosis are vague and typically described in veins with at least a 50% reduction in luminal caliber. The purpose of this study is to assess normal anatomic and physiologic caliber changes of the IJV over its course.

METHOD AND MATERIALS

Following IRB approval, 500 consecutive neck CT angiograms from January-July 2012 were retrospectively reviewed. Images were helically acquired at 1.25mm slice thickness on 64-detector row CT scanners. IJV surface areas were calculated at the jugular foramen, C1-C7 levels, and jugular angles bilaterally. Electronic medical records were reviewed for clinical parameters including age, gender, neurologic history including MS, neck mass, and neck surgery/dissection. Severely motion limited studies, subjects with limited clinical data, history of radical neck dissections, and known IJV occlusions were excluded. Statistical analysis was performed using a t-test.

RESULTS

383 patients were included (202 females, 181 males), ranging in age from 2-89 years (mean 47.3 years). Mean area was 66 mm<sup>2</sup> at the jugular foramen, 56.9 mm<sup>2</sup> at C1, 66 mm<sup>2</sup> at C2, 80 mm<sup>2</sup> at C3, 96 mm<sup>2</sup> at C4, 126 mm<sup>2</sup> at C5, 164 mm<sup>2</sup> at C6, 176 mm<sup>2</sup> at C7, and 128 mm<sup>2</sup> at the jugular angle. Degree of IJV narrowing was calculated at each vertebral body level using the IJV area at C7 as the denominator: 63% at the jugular foramen, 68% at C1, 62% at C2, 55% at C3, 45% at C4, 28% at C5, and 7% at C6. Statistically significant differences were observed between mean IJV areas at the C1-C5 levels compared to C7 level (p

CONCLUSION

The IJV demonstrates marked variability in its course in the neck, with areas of narrowing greater than 50% in cervical and skull base regions. Given the normal physiologic variation in the caliber of this vessel, diagnosis and treatment of stenosis should proceed with caution.

CLINICAL RELEVANCE/APPLICATION

Given the marked normal physiologic variation in the caliber of the IJV, diagnosis and treatment of stenosis should proceed with caution.

**SSQ15-02 • Arterial Remodeling of Intracranial Atherosclerosis: Detection and Characterization Using 3D High Resolution Black Blood MRI**

Ye Qiao (Presenter); Jarunee Intrapromkul MD; Zeeshan Anwar; Li Liu; Bruce A Wasserman MD

PURPOSE

To determine the ability and extent of intracranial arteries to accommodate plaque formation by outward (positive) remodeling using 3D high resolution black blood MRI (BBMRI).

METHOD AND MATERIALS

Thirty-one patients (22 male; mean age 57.6±12.2 years) with cerebrovascular ischemic events underwent 3D time-of-flight MRA and contrast-enhanced BBMRI examinations for intracranial atherosclerotic disease at 3T. The 3D BBMRI sequence was acquired using a volumetric isotropic TSE acquisition with the following parameters: TR/TE, 2000ms/38ms; TSE factor, 56 echoes; acquired resolution, 0.4x0.4x0.4 mm<sup>3</sup>; scan time, 7.5 minutes. Each identified plaque was classified based on location (i.e., posterior vs. anterior circulation). Lumen area (LA), outer wall area (OWA), and wall area (WA) at the most stenotic site and reference site were measured. Normalized wall index (NWI) was calculated as WA divided by OWA. Arterial remodeling index (RI) was calculated as OWA at the lesion site divided by OWA at the reference site, after adjusted for vessel tapering. Arterial remodeling was categorized as: positive if RI >1.05, intermediate if 0.95 =RI =1.05, and negative if RI

RESULTS

One hundred and five plaques were identified in 31 patients, with multiple plaques seen in 23 patients. Forty-two were detected in the posterior circulation (basilar,19; PCA, 6; and vertebral,17), and 63 in the anterior circulation (ACA, 9; ICA, 34 and MCA, 20). Compared with anterior circulation plaques, posterior circulation plaques had larger NWI (i.e., plaque burden) (posterior vs anterior: 0.77±0.20 vs. 0.68±0.16, p=0.035), greater RI (posterior vs anterior: 1.22±0.56 vs. 1.04±0.27, p=0.042), and more frequently exhibited positive remodeling (posterior vs anterior: 50% vs.39%). Reliability for wall morphology measurements was excellent (ICCs ranged from 0.95 to 0.98).

CONCLUSION

Arterial remodeling of intracranial atherosclerosis appears to be geographic. Compared with anterior circulation arteries, posterior circulation arteries appear to have a greater capacity to remodel in response to plaque formation.

CLINICAL RELEVANCE/APPLICATION

These findings yield important information necessary for the interpretation of angiographic images, as posterior circulation plaques are probably underestimated by angiography.

**SSQ15-03 • An MRI Pulse Sequence for Whole-brain Bolus Tracking at High Frame Rates: RAZER (RADial kZ-blipped 3D GRE-EPI for Whole-brain Perfusion)**

Sumeeth V Jonathan MS (Presenter); Parmede Vakil PhD; Yong Jeong; Rajiv G Menon PhD; Sameer A Ansari MD, PhD; Timothy J Carroll PhD

PURPOSE

To measure cerebral perfusion, bolus tracking with DSC-MRI demands rapidly acquired T<sub>2</sub>\*-weighted MR images. Current implementations of DSC-MRI are constrained by a temporal resolution of no more than 2 s (0.5 FPS) to adequately characterize a contrast agent bolus, with tradeoffs in SNR and spatial resolution. We introduce RAZER, a pulse sequence that obtains whole-brain

DSC-MRI perfusion measurements at 6.2 FPS and 1.7 mm isotropic voxel resolution.

#### METHOD AND MATERIALS

**Sequence design:** RAZER uses in-plane radial sampling and through-plane 3D GRE-EPI Cartesian sampling to produce a cylindrical 3D  $k$ -space. Consecutive frames are acquired in 10.3 s (0.09 FPS) for bolus tracking, but dynamic bolus information is recovered at 0.16 s per frame (6.2 FPS) prior to perfusion analysis using sliding window view-sharing in  $k$ -space.

**Subjects:** 1 patient with angiographically-confirmed Moyamoya disease.

**Image acquisition:** In vivo bolus tracking was performed using RAZER and a typical 2D GRE-EPI pulse sequence (voxel size =  $1.7 \times 1.7 \times 5.0 \text{ mm}^3$ ) as a reference standard. RAZER scan parameters: second injection, TE/TR = 36/81 ms, flip angle =  $45^\circ$ , slices = 76, voxel size =  $1.7 \times 1.7 \times 1.7 \text{ mm}^3$ , repetitions = 12, 3.0 T Tim Trio. Images were acquired with a single-dose injection of 0.1 mmol/kg Gd-DTPA at 4 mL/s. Both acquisitions were automatically processed online to produce parametric maps of relative cerebral blood flow (rCBF), relative cerebral blood volume (rCBV), and mean transit time (MTT).

#### RESULTS

Figure 1 compares coronal, sagittal, and axial perfusion maps in RAZER (a) and the 2D GRE-EPI reference (b) with angiographic assessment (c) consistent with Moyamoya disease. Increased coverage in RAZER allows for fine resolution of the perfusion metrics in the through-plane direction while the reference is blurred. There is strong agreement in perfusion metrics using Bland-Altman correlation ( $r^2 = 0.91$ , mean bias in MTT measurements =  $-0.01 \pm 0.89 \text{ sec}$ ). Perfusion maps were coregistered prior to correlation using SPM.

#### CONCLUSION

RAZER obtains whole-brain perfusion measurements with good reference standard agreement. Sliding window view-sharing in  $k$ -space permits the use of a large temporal resolution for DSC-MRI without sacrifices in SNR and spatial resolution.

#### CLINICAL RELEVANCE/APPLICATION

RAZER is recommended for whole-brain MR perfusion study of central nervous system tumors, stroke, cerebrovascular occlusive disease, and Alzheimer's.

### SSQ15-04 • In-Vivo Visualization of the PICA Perfusion Territories with Super-selective Pseudo-continuous Arterial Spin Labeling MRI

**Nolan Hartkamp ; Laurens J De Cocker MD (Presenter) ; Michael Helle \* ; Matthias Van Osch ; Jaap Kappelle ; Reinoud P Bokkers MD, PhD ; Jeroen Hendrikse MD**

#### PURPOSE

To develop the first technique to visualize the cerebellar perfusion territories in-vivo.

#### METHOD AND MATERIALS

The perfusion territories of the vertebral arteries (VAs) were examined in 14 healthy subjects with four super-selective p-CASL MRI sequences (with labeling of both internal carotid arteries and both VAs). The following arterial perfusion territories in the cerebellum were distinguished: (1) territory exclusively fed by one vertebral artery (VA), namely the PICA territory in subjects with normal anatomy; (2) territory exclusively fed by the contralateral VA (contralateral PICA territory); (3) territory fed by both VAs after mixing in the basilar artery (bilateral AICA and SCA territories). The territorial perfusion maps were superimposed on anatomical T1WI and the PICA territories were manually outlined on the T1WI. The perfusion territories were also correlated with the arterial anatomy of the vertebrobasilar system using time-of-flight MR angiography.

#### RESULTS

The vast majority of PICA perfusion territories could be identified. In 10 out of 14 subjects, both PICA perfusion territories could be distinguished. One subject had a missing VA, and one subject had a missing or hypoplastic PICA on one side. Two subjects did not have a discernible PICA territory on one side, either secondary to tiny anastomoses between the PICA and AICA, or either secondary to insufficient mixing of blood in the basilar artery.

#### CONCLUSION

We postulate that a selective labeling of each vertebral artery (VA) allows distinguishing the cerebellar territories that are exclusively fed by one VA (PICA in subjects with normal vascular anatomy) from those territories supplied by the basilar artery (AICA and SCA).

#### CLINICAL RELEVANCE/APPLICATION

The ability to link a cerebellar infarct with a particular perfusion territory may yield information on infarct pathogenesis and may refine treatment planning.

### SSQ15-05 • 4D Flow MRI Indicates Changes in Intracranial Hemodynamics in Arteries Supplying Arteriovenous Malformations

**Amir R Honarmand MD (Presenter) ; Biraj M Patel MD ; Can Wu ; Susanne Schnell ; Pegah Entezari MD ; Parmede Vakili PhD ; Michael C Hurley MBBCh ; Bernard Bendok MD ; Ali Shaibani MD ; Timothy J Carroll PhD ; Michael Markl PhD ; Sameer A Ansari MD, PhD**

#### PURPOSE

To evaluate peak velocity (PV) and net flow (NF) in arteries supplying intracranial arteriovenous malformations (AVMs) using 4D flow MRI.

#### METHOD AND MATERIALS

With IRB approval, baseline 4D flow MRI was performed at 1.5T or 3T MR systems for a prospective study. Flow quantification was performed using ECG gated three-directional velocity encoding with full 3D coverage of the AVM nidus, feeding and draining vessels, and contralateral equivalent normal arteries. 4D flow MRI was acquired in an axial oblique 3D volume using flip angle of  $15^\circ$ , VENC: 100 cm/s, spatial resolution =  $(1.2-1.6)^3 \text{ mm}^3$ , and temporal resolution: 44 ms. Data analysis included 3D visualization of the velocity data and flow quantification using time integrated 3D pathlines positioned orthogonal to the vessel by a commercially available software (Enight, CEI, Inc. Apex, NC). AVM Spetzler-Martin (SM) grade and nidus volume ( $\frac{1}{6} \cdot X \cdot Y \cdot Z$  dimensions) were obtained. Paired sample t test, one-way ANOVA, univariable, and stepwise multiple regression analysis were performed to build predictive models.

#### RESULTS

Ten patients (7M/3F) with mean age of 40.7 (10-66) years were studied. Hemodynamic parameters of 17 arteries (5 ICAs, 9 MCAs, 2 PCAs, and 1 ACA) supplying the AVM nidus, normal contralateral equivalent arteries, and corresponding sinus draining the AVM were quantified. PV and NF were significantly higher in AVM arterial feeders (AFs) compared with normal contralateral equivalent arteries (EA) (mean: 0.96 Vs. 0.66 m/s,  $P=0.001$ ; 5.2 Vs. 3.0 ml/cycle,  $P=0.004$ , respectively). No significant difference was observed between AFs  $\diamond$  PV, NF, and sinus PV based on AVM SM classification. ( $P=0.08$ ,  $P=0.1$ ,  $P=0.4$ , respectively). Stepwise multiple regression and univariable models identified nidus volume and EA  $\diamond$  PV to be positively correlated with PV in AFs ( $P=0.01$ ,  $r=0.6$ ;  $P=0.003$ ,  $r=0.7$ , respectively). NF was the significant factor for predicting PV in EAs ( $P=0.001$ ,  $R=0.7$ ). Positive direct correlation was observed between AFs  $\diamond$  PV and sinus PV ( $P=0.01$ ,  $R=0.6$ ).

#### CONCLUSION

4D flow MRI is feasible for monitoring of cerebral AVM hemodynamic parameters and illustrates subtle, but distinct hemodynamic changes in arterial feeders compared to a normal equivalent arteries.

#### CLINICAL RELEVANCE/APPLICATION

These findings may have implications in novel characterization schemes for risk stratification based on quantitative flow analysis.

### SSQ15-06 • Diagnosis of Carotid Artery Dissection with CT: Does the Contrast Material Really Help?

**Luca Saba MD (Presenter) ; Eytan Raz MD ; Mario Piga ; Roberto Montisci MD ; Eugenio A Genovese MD**



#### PURPOSE

The purpose of this work was to evaluate if the use of contrast material in the MDCTA study of carotid artery dissection (CAD) modify the diagnostic performance

#### METHOD AND MATERIALS

One hundred patients (61 men, 39 women; mean age, 51 years; range, 25 - 78 years) 40 with and 60 without CAD, that underwent MDCTA for suspected CAD formed the study cohort. In this study patients from three different groups were included (patients with MR confirmation of CAD, n = 40; patients with MR confirmation of CAD absence, n = 20; patients that underwent MDCTA of carotid arteries for atherosclerosis analysis, n = 40). Three blinded observers with different level of expertise analyzed the randomized basal scan and after 3 months the observers evaluated the same datasets by using basal scans (BS) and after administration of contrast material (CM). Statistical analysis included Receiver Operating Characteristics (ROC) curve analysis and the Cohen weighted test.

#### RESULTS

The ROC curve analysis showed that for the 3 observers the use of BS versus BS and CM produced an improvement of the diagnostic confidence with AUC values from 0,894 to 0,926 (p value = 0.91) ; from 0,856 to 0,879 (p value = 0.365); and from 0,819 to 0,982 (p value = 0.01). The Cohen kappa analysis showed no significant difference in concordance with the use of BS versus BS and CM. The prevalence of uncertain findings was in 16%, 20.5% and 33% in the BS and 15%, 17.5% and 29% in BS and CM for observer 1, 2 and 3 respectively.

#### CONCLUSION

Results of our study suggest that the use of BS instead the classic BS and CM determines a small reduction in the diagnostic confidence of the readers, that is statistically significant in the only the junior one. Therefore the use of the only BS in the suspect of CAD may help in reducing cost and risk related to the administration of contrast material.

#### CLINICAL RELEVANCE/APPLICATION

Results of our study suggest that the use of the only basal in the suspect of CAD can be used and this approach may help in reducing cost and risk related to the administration of contrast material.

### **SSQ15-07 • Carotid Artery Stenosis: Comparison of 3D Time-of-Flight MR Angiography and Contrast-enhanced MR Angiography at 3.0T**

**Ivan Platzek MD (Presenter) ; Dominik A Sieron MD ; Philipp Wiggermann ; Michael Laniado MD**

#### PURPOSE

To compare 3D time-of-flight MR angiography (TOF MRA) and contrast-enhanced MR angiography (CEMRA) for quantification of carotid artery stenosis at 3.0T.

#### METHOD AND MATERIALS

Twenty-three patients (5 f, 18 m; mean age 61 y, age range 45-78 y) with external carotid artery stenosis detected with Doppler ultrasonography were examined on a 3.0T MR system. The MR examination included both 3D TOF MRA and CEMRA of the carotid arteries. MR images were evaluated independently by two radiologists. Stenosis evaluation was based on a four-point scale: 0 = normal, 1 = mild stenosis, less than 50%; 2 = moderate stenosis, 50-69%, 3 = severe stenosis, more than 70% but less than full occlusion, 4 = occlusion). TOF MRA and CEMRA were evaluated separately, with a four-week time interval between evaluation sessions. While evaluating TOF MRA, the readers were blinded for CEMRA images and vice versa. Furthermore, the readers were blinded for other imaging or clinical data. In cases of interrater differences concerning the same MR angiography type, stenosis grade was determined by the readers in consensus. Stenosis grades determined by TOF and CEMRA were compared using the Wilcoxon test. Cohens Kappa was used to evaluate interrater reliability.

#### RESULTS

#### CONCLUSION

At 3.0T, 3D TOF MRA should not be used as replacement for contrast-enhanced MRA of the carotid arteries, as it results in significantly higher stenosis grades, and may lead to inadequate therapy.

#### CLINICAL RELEVANCE/APPLICATION

The current results imply that TOF MRA at 3.0T should not be used as a replacement for CEMRA, which itself is well validated by comparison with digital subtraction angiography in previous studies.

### **SSQ15-08 • Intraplaque Hemorrhage on Routine 3D-Time-of-Flight MR Angiography Is Strongly Associated with Symptomatic Status in Carotid Artery Stenosis**

**Hediyeh Baradaran MD (Presenter) ; Hooman Kamel MD ; Atul Mangla MD ; Ankur Pandya PhD, MPH ; Allison Dunning ; Vito Fodera MD ; Pina C Sanelli MD ; Ajay Gupta MD**

#### PURPOSE

Intraplaque hemorrhage (IPH) in carotid artery atherosclerosis is strongly associated with previous and future stroke. Carotid plaque imaging has previously relied on high-resolution imaging using dedicated surface coils or MRI sequences not routinely obtained to measure stenosis. Recent reports suggest 3D-time-of-flight (TOF) imaging can accurately predict IPH compared to histopathology. We investigated the association between IPH determined on routinely acquired, 3D-TOF MRA neck images and prior stroke or TIA in patients with high-grade carotid stenosis.

#### METHOD AND MATERIALS

Subjects were screened after review of consecutive MRA neck exams performed from 8/2009 through 8/2012. Patients were included if they had high-grade carotid artery stenosis (70-99%) on non-contrast 3D-TOF MRA and documentation of prior stroke/TIA and vascular risk factors. IPH was determined by a validated technique assessing carotid plaque signal 50% more hyperintense than adjacent muscle. Assessments were made by two independent, blinded neuroradiologists with a third used as a tie-breaker. Clinical data was determined by consensus of two stroke neurologists. Statistical analysis was performed using univariate and multivariate logistic regression analysis with adjustment of statistically significant covariate risk factors.

#### RESULTS

After reviewing 4895 consecutive neck MRAs, 51 subjects with 53 carotid arteries met inclusion criteria. Vascular risk factors were not significantly different between groups. IPH was present in 24 carotid arteries. Of patients with IPH-positive exams, 15 had prior events (10 strokes, 5 TIAs). Of those with negative exams, 4 had prior events (3 strokes, 1 TIA). In the univariate logistic regression analysis, the OR of the association of IPH to any prior ischemic event was 14.5 (95% CI 3.6-57.6) and the age- and sex-adjusted OR was 14.2 (95% CI 3.3-60.5). The association was preserved across magnet field strengths.

#### CONCLUSION

Our study demonstrates a strong association between ischemic events and IPH as determined on widely available, standard, large field-of-view neck coils using a 4-minute MRA sequence which is commonly used for screening exams.

#### CLINICAL RELEVANCE/APPLICATION

With prospective validation of our findings, regular reporting of IPH on neck MRA studies can be used as a risk stratification tool to complement measures of luminal diameter stenosis.

### **SSQ15-09 • CTA vs. 3T Black-Blood MRI for Identification of Symptomatic Carotid Plaques: A Comparative Study**

**Jochen M Grimm MD** (Presenter) ; **Andreas Schindler** ; **Florian Schwarz MD** ; **Clemens C Cyran MD \*** ; **Martin Dichgans MD** ; **Tobias Saam MD \*** ; **Tobias Freilinger** ; **Maximilian F Reiser MD** ; **Konstantin Nikolaou MD \*** ; **Fabian Bamberg MD, MPH \*** ; **Chun Yuan PhD \***

#### PURPOSE

The purpose of this prospective comparative study was to evaluate CT angiography (CTA) and black-blood 3T-MRI (bb-MRI) regarding their respective ability to identify symptomatic carotid plaques.

#### METHOD AND MATERIALS

20 patients with unilateral symptomatic carotid disease who underwent extensive clinical workup at our stroke unit to exclude other causes of ischemic stroke underwent standard CTA and bb-MRI with TOF, pre- and post-contrast fsT1w-, fsT2w- and fsPDw- sequences within 7 days of symptom onset. Both symptomatic and contralateral asymptomatic sides were evaluated. By bb-MRI, plaque morphology and composition and prevalence of complicated type VI lesions (AHA-LT6) with haemorrhage, thrombus and/or ruptured fibrous cap were evaluated. By CTA, plaque type (soft, mixed, hard), plaque density in HU and presence of ulceration and thrombus were evaluated. Sensitivity (SE), specificity (SP), positive and negative predictive value (PPV, NPV) were calculated using a two-by-two table.

#### RESULTS

For identifying the symptomatic side AHA-LT6 was the best bb-MRI variable and presence of plaque ulceration was the best CTA variable, resulting in a SE, SP, PPV and NPV of 80%, 80%, 80% and 80% for AHA-LT6 as assessed by bb-MRI, 40%, 95%, 65% and 71% for plaque ulceration as assessed by CTA. The SE, SP, PPV and NPV for the combination of AHA-LT6 as determined by bb-MRI and ulceration as determined by CTA was 85%, 75%, 77% and 83%, respectively.

#### CONCLUSION

Bb-MRI delivered a better sensitivity, NPV and PPV compared to CTA at identifying the symptomatic side, while CTA offered an excellent specificity at the cost of low sensitivity and moderate PPV and NPV. Results were only slightly improved over bb-MRI when combining both techniques.

#### CLINICAL RELEVANCE/APPLICATION

This study shows that bb-MRI is better suited to detect symptomatic carotid plaques than CTA. A combination of both techniques is only marginally superior to bb-MRI alone.

## Vascular/Interventional (Radioembolization)

Thursday, 10:30 AM - 12:00 PM • N227



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**SSQ21** • AMA PRA Category 1 Credit™:1.5 • ARRT Category A+ Credit:1.5

#### Moderator

**Hyun S Kim**, MD

#### Moderator

**Charles T Burke**, MD

**SSQ21-01 • Prospective Randomized Comparison of Selective Internal Radiation Therapy (SIRT) versus Transarterial Chemoembolisation (TACE) for the Treatment of Hepatocellular Carcinoma (HCC)**

**Roman Kloeckner MD** (Presenter) ; **Waltraud Eichhorn** ; **Gerd Otto MD** ; **Marcus A Worns** ; **Christoph Dueber MD** ; **Michael B Pitton MD**

#### PURPOSE

To prospectively compare SIRT and Drug Eluting Bead-TACE (DEB-TACE) for the treatment of intermediate stage HCC.

#### METHOD AND MATERIALS

From 04/2010 to 04/2013, a total 24 patients with histology proven irresectable intermediate stage N0, M0 HCCs were randomized to receive SIRT or DEB-TACE. Randomization was stratified according to tumor load < or =25%. SIRT was performed in a bilobar approach and could be repeated once for each lobe in case of recurrence. TACE was repeated every 6 weeks until either no viable tumor tissue was detected by MRI or if contraindications prohibited further treatment. Follow-up was carried out by MRI in 3 month intervals.

#### RESULTS

Each group consisted of 12 patients. Demographic data were not considerably different between both groups (SIRT: 8 male / 4 female, mean age 72 ± 7 years; TACE: 10 male / 2 female, mean age 71 ± 9 years). 1 patient in each group had an initial tumor load =25%. Mean follow up period in the SIRT group was 394 ± 311 days compared to 385 ± 292 days. Overall median survival was 592 days. There was no significant difference in median survival between both groups (p=0.81). 7 SIRT patients died (5x liver failure, 1x deterioration of general condition and 1x subacute liver/kidney failure after surgical therapy of a pseudoaneurysm of the common femoral artery). 6 TACE patients died (3x tumor progress, 1x liver failure, 1x bleeding of esophageal varices, 1x deterioration of general condition after coronary bypass surgery).

#### CONCLUSION

No significant difference was found in median survival between SIRT and TACE in intermediate stage HCC-patients. The lower rate of tumor progression in the SIRT group was nullified by a greater incidence of liver failure.

#### CLINICAL RELEVANCE/APPLICATION

This is the first prospective randomized study comparing SIRT and TACE for the treatment of HCC. Further studies with a greater number of patients are essential.

**SSQ21-02 • PET/MRI of Hepatic 90Y Microsphere Uptake: Correlation of Angiographic and Radiologic Findings with Microsphere Deposition**

**Kathryn J Fowler MD** (Presenter) \* ; **Nael E Saad MBChC \*** ; **Akash Sharma MD** ; **Christina K Speirs MD, PhD** ; **Jeffrey R Olsen MD \*** ; **Jose Garcia-Ramirez** ; **Richard Laforest PhD** ; **Ananya Benegal** ; **Parag Parikh MD \***

#### PURPOSE

Y90 radioembolization provides preferential delivery of radioactive microspheres allowing higher doses delivered over a limited range. Pre-embolization work-up with angiography +/- coil embolization, and Tc-99m MAA SPECT is done to assess suitability. Despite importance of optimal technique, there is limited literature on imaging the biodistribution of microsphere delivery. The purpose of this prospective study was to evaluate the post-radioembolization distribution of particles with PET/MR (Siemens Biograph, Erlangen, Germany).

#### METHOD AND MATERIALS

PET/MRI was performed within 48 hours (range 3.5-24 hours) of radioembolization for 4 patients with HCC and 7 patients with metastases (5 colorectal, 1 anal squamous cell carcinoma, and 1 neuroendocrine). Microsphere type included resin (n=8) and glass (n=3) with delivery to the right (n=8), left (n=2), and proper hepatic artery (n=1). Biodistribution was qualitatively assessed as discrete within the tumor, ill-defined, and assigned as whole liver, lobar or sectional distribution. Comparison with pre-treatment angiography, Tc-99m MAA, and gadoteric acid enhanced MRI with diffusion weighted imaging was performed to analyze distribution, non-target delivery, and tumoral coverage.

## RESULTS

PET/MRI demonstrated intrahepatic Y90 microsphere distribution in all patients following radioembolization (n= 11). PET biodistribution localized to tumor for 9 patients. Peripheral uptake was observed in metastatic lesions, correlating with enhancement and diffusion restriction. Uptake in HCC was more uniform and was observed within tumor thrombus as well. Heterogeneous distribution within a treatment region was observed in 2 cases of colorectal cancer metastases, which correlated with differential perfusion on pre-treatment workup.

## CONCLUSION

PET/MRI allows localization of 90Y microsphere biodistribution following radioembolization. The pattern of distribution correlates with pre-treatment angiography, Tc-99m MAA SPECT, enhancement and diffusion imaging. Future work will focus on correlating biodistribution of particles with tumor response and outcomes with possible validation of 90Y PET/MRI as an indicator of adequate tumor coverage and early predictor of treatment response/failure potentiating adaptive treatment regimens.

## CLINICAL RELEVANCE/APPLICATION

PET/MR imaging of Y90 distribution provides confirmation of delivery to the expected region, tumor coverage, and validation of pre-treatment planning results.

### SSQ21-03 • Yttrium-90 Radioembolization for Neuroendocrine Tumor Liver Metastases

**Katherine Y Fan** BS (Presenter) ; **Aaron T Wild** BA ; **Vivek Gowdra Halappa** MD ; **Rachit Kumar** MD ; **Susannah Yovino** MD ; **Timothy Pawlik** MD \* ; **David O Cosgrove** MBBCh, FRCR \* ; **Ihab R Kamel** MD, PhD \* ; **Joseph M Herman** MD, MSc ; **Jean-Francois H Geschwind** MD \*

## PURPOSE

Surgical resection remains the only curative option for neuroendocrine tumor liver metastases (NETLM). However, 90% of patients have unresectable disease. Limited data currently exists for yttrium-90 (Y-90) radioembolization, an emerging treatment option for unresectable NETLM. This study evaluates the efficacy, tolerability, and prognostic factors of Y-90 radioembolization in NETLM patients.

## METHOD AND MATERIALS

Thirty-eight patients underwent glass-based Y-90 radioembolization for NETLM at a single institution between April 2004 and February 2012. Patients were assessed radiographically (using magnetic resonance imaging), serologically, and clinically at 1 month and then every 3 months post-treatment for tumor response, toxicity, and survival outcomes.

## RESULTS

Median length of follow-up was 17 months (IQR, 9-37). Median survival was 29 months. On imaging follow-up, 3 patients (9%) had a complete response (CR) to treatment, 6 (17%) had a partial response (PR), 21 (60%) had stable disease (SD), and 5 (14%) developed progressive disease (PD). Multivariate analysis with backward elimination revealed 2 factors to be independently associated with good tumor response (CR/PR): histological subtype (p=0.037) and hepatic tumor burden (p=0.038). Inferior overall survival (OS) was observed in patients requiring more than one Y-90 treatment (HR 7.384, p=0.003) and in patients with = 1 ECOG performance status (HR 3.539, p=0.04) on multivariate proportional hazards regression models for OS. Development of grade 3 serologic toxicities was observed in only 2 patients (one with elevated bilirubin, the other elevated alkaline phosphatase) after treatment. Grade 3 non-serologic toxicities experienced included abdominal pain (11%), fatigue (11%), nausea/vomiting (5%), ascites (5%), dyspnea (3%), diarrhea (3%), and peripheral edema (3%).

## CONCLUSION

Our institutional experience demonstrates Y-90 radioembolization to be an efficacious, safe, and tolerable treatment for NETLM.

## CLINICAL RELEVANCE/APPLICATION

Y-90 radioembolization can safely and effectively target liver metastases from neuroendocrine tumors and is recommended for patients with unresectable liver metastases.

### SSQ21-04 • Intratumoral Vascular Shunting: The Missing Link between Circulating Tumor Cells and Metastasis?

**Amy R Deipolyi** MD, PhD (Presenter) ; **Patrick D Sutphin** MD, PhD ; **Siddharth Govindan** MD ; **Suvranu Ganguli** MD \* ; **Rahmi Oklu** MD, PhD

## PURPOSE

Colorectal carcinoma is a leading cause of cancer mortality mostly due to metastasis. It is unclear how large circulating tumor cells (CTCs) shed from the tumor traverse capillary beds to establish distant lesions. Intratumoral vascular shunting, however, may provide a conduit for CTCs to access distant sites. To determine whether intratumoral shunting is associated with metastasis, we assessed how tumor shunting related to the presence of disseminated disease and to clinical outcome.

## METHOD AND MATERIALS

61 colorectal cancer patients with liver metastases (30 F, 31 M; mean age 63 yr) were evaluated for selective internal radiation therapy (SIRT) from 5/07 to 8/12. Following transcatheter injection of radioactive particles (99mTc-MAA), lung shunt fractions (LSF) were calculated reflecting the amount of intratumoral shunting of MAA particles, which can measure up to 150 microns. Medical records were reviewed for other metastases and the size of liver lesions before and after SIRT, the time between SIRT and disease progression, and patient survival after SIRT. Liver tumor size was estimated using the largest dimension of the largest lesion. The relationship of LSF and estimated tumor size to outcomes was assessed using linear regression and student's t test.

## RESULTS

Patients with lung metastases at the time of SIRT had significantly higher LSF (mean 9.2%) than patients without lung metastases (mean 6.1%) (p

## CONCLUSION

LSF may be a more robust marker of metastatic potential than tumor size. Increased LSF due to vascular shunting within liver metastasis is an indicator of distant lesions and is associated with more rapid disease progression after SIRT. Intratumoral shunting may provide a conduit for CTCs to access more remote organs, bypassing filtration by liver parenchyma and may be an important factor in metastatic potential of colorectal cancer.

## CLINICAL RELEVANCE/APPLICATION

Vascular shunting in liver metastases from colorectal cancer is a robust indicator of more distant metastases and future disease progression, and may be a more useful clinical marker than tumor size.

### SSQ21-06 • Boosted Selective Internal Radiation Therapy (B-SIRT) Using 90Y-loaded Glass Microspheres Induces Prolonged Overall Survival for PVT Patients

**Etienne Garin** MD (Presenter) \* ; **Laurence Lenoir** ; **Julien Edeline** ; **Eveline Boucher** ; **Yan Rolland** MD, PhD \*

## PURPOSE

Evaluation of the response rate and survival of hepatocellular carcinoma PVT patients treated with Therasphere using the boost concept.

## METHOD AND MATERIALS

Therasphere was administered in 40 PVT hepatocellular carcinoma patients (main= 11, lobar = 23, segmental= 6). MAA SPECT/CT quantitative analysis was used for the calculation of the tumour dose (TD), the healthy injected liver dose (HLD) and the injected liver dose (LD). Response was evaluated at 3 months using EASL criteria. OS was evaluated using Kaplan and Meyer tests.

## RESULTS

Mean 90Y-loaded microspheres injected activity was  $3.1 \pm 1.5$  GBq. Mean LD was  $143 \pm 49$  Gy. Median TD was 316 Gy for responding lesions versus 133 Gy for non responding lesion ( $p = 0.205$  Gy with a LD  $> 150$  Gy and a HLD 205 Gy. OS was 12m [3-8] for patients with main PVT versus 21.5m [12-28.7] for patients segmental or lobar PVT (ns). Finally OS was 23.2m for patients with a TD  $> 205$  Gy and a good PVT targeting ( $n = 34$ ).

## CONCLUSION

Boosted selective internal radiation therapy using 90Y-loaded glass microspheres induces prolonged overall survival for PVT patients without increasing liver toxicity.

## CLINICAL RELEVANCE/APPLICATION

Boost selective internal radiation therapy using 90Y loaded glass microsphere allows a fully customized oncological therapy for PVT patients inducing prolonged survival.

### SSQ21-07 • Sorafenib versus Y90-radioembolization in Cirrhotic Patients with Hepatocellular Carcinoma (HCC): Cohort and Nested Control-case Study with Propensity Analysis

**Alberta Cappelli MD (Presenter) ; Cristina Mosconi ; Annagiulia Gramenzi ; Sara Marinelli ; Alessandro Granito ; Virginia Erroi ; Silvia Fiumana ; Mauro Bernardi ; Luigi Bolondi ; Franco Trevisani ; Rita Golfieri MD**

## PURPOSE

Sorafenib and Transarterial Y90-radioembolization (TARE) are treatments currently available for advanced (BCLC stage C) HCC not amenable or resistant to curative options and transarterial chemoembolization (TACE). No study comparing the outcome of these patients (pts) is yet available. We performed a case-control, retrospective study to compare the survival in both groups comparing the two treatments after patients' matching for the independent prognostic factors.

## METHOD AND MATERIALS

## RESULTS

67 Sorafenib pts and 63 TARE pts were selected. The two groups did not significantly differ for gender, aetiology, previous HCC treatments, portal vein thrombosis, Child-Pugh class, MELD score, BCLC stage, alpha-fetoprotein levels, ascites, creatinine, platelet count. Median survival did not differ between Sorafenib (13.1 months; 95% CI: 3.1-23.2) and TARE (13.2; 6.1-20.2;  $P = 0.854$ ) and mortality rate at 1, 2 and 3 years was respectively 48%, 70% and 86% vs 48%, 73% and 80%. Propensity model matched 34 pts for independent non co-axial prognostic factors: PS, MELD, portal thrombosis, tumour gross pathology. Median survival was 13.1 months (1.3-25.0) for Sorafenib and 9.0 months (3.7-14.3) for TARE ( $P = 0.214$ ).

## CONCLUSION

In advanced HCC not otherwise treatable, Sorafenib provides, after adjustment for the confounding factors, a not statistically significant better survival than TARE.

## CLINICAL RELEVANCE/APPLICATION

In advanced HCC treated with Sorafenib or TARE, the propensity analysis demonstrates that median survival is better after Sorafenib but not statistically different (13.1 vs 9.0 months:  $p = 0.214$ ).

### SSQ21-08 • A New Model to Estimate Prognosis after Yttrium-90 Radioembolization in Patients with Hepatocellular Carcinoma

**Thomas C Lauenstein MD (Presenter) ; Judith Ertle ; Stefan P Mueller MD \* ; Andreas Bockisch ; Guido Gerken ; Joerg Schlaak**

## PURPOSE

A prognostic model to estimate the survival in hepatocellular carcinoma (HCC) patients treated with transarterial hepatic selective internal radiotherapy (SIRT) is not fully characterized. We aimed to establish a new scoring model including assessment of both tumor responses and therapy-induced systemic changes in HCC patients to predict survival at an early time point post-SIRT.

## METHOD AND MATERIALS

149 HCC patients treated with SIRT (TheraSphere, MS Nordion, Canada) were included into this study. CT images and biomarkers in blood tested at one month post-SIRT were analyzed and correlated with clinical outcome. Tumor responses were assessed by RECIST 1.1, mRECIST, and Choi criteria. Kaplan-Meier methods were used to estimate survival curves. Cox regression was used in uni- and multivariable survival analyses and in the establishment of a prognostic model.

## RESULTS

## CONCLUSION

A new model including imaging and non-imaging parameters may predict survival of HCC patients at an early time point after SIRT. In this model, Choi criteria should be applied rather than RECIST or mRECIST.

## CLINICAL RELEVANCE/APPLICATION

Efficacy of SIRT can be predicted one month after therapy.

## Vascular/Interventional - Thursday Posters and Exhibits (12:15pm - 12:45pm)

### Thursday, 12:15 PM - 12:45 PM • Lakeside Learning Center



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### LL-VIS-THA • AMA PRA Category 1 Credit™:0.5

Host

**Dmitry J Rabkin**, MD, PhD

### LL-VIS-TH1A • Effect of Hypoxia-Inducible Factor (HIF)-1 alpha Upgrade on Vasculogenic Mimicry (VM) and Angiogenesis in Rabbit VX2 Liver Tumors after Transcatheter Arterial Embolization (TAE)

**Jingfeng Zhang** PhD, MD (Presenter) ; **Bingying Lin** ; **Lingxiang Ruan** PhD, MD ; **Shunliang Xu**

## PURPOSE

TAE could result in more severe hypoxia, which activated HIF-1 $\alpha$  pathway and angiogenesis, and affected the effect of treatment. VM was found as a new model of tumor micro-circulation, which has a close relationship with the growth, development, invasion, metastasis and prognosis of hepatic carcinoma. This study was to verify the hypothesis that upgrading of HIF-1 $\alpha$  expression after TAE could lead to much more formation of both VM and angiogenesis in hepatic carcinoma. Therefore, our purpose was to investigate the expression of HIF-1 $\alpha$  and its relation to VM and angiogenesis in Rabbit VX2 liver tumors after TAE.

## METHOD AND MATERIALS

A total of twenty-four New Zealand White rabbits were successfully implanted with VX2 tumor in liver and divided into three group at random, such as Lipiodol-based TAE group ( $n = 8$ ), Polyvinyl alcohol (PVA)-based group ( $n = 8$ ) and Control group ( $n = 8$ ). Tumors in each group were received TAE with Lipiodol, PVA particles (diameter: 300 $\mu$ m -500 $\mu$ m) and Saline respectively after implanting for two

weeks. One, three and seven days after TAE, animals were humanely killed, and tumor samples were collected for immunohistochemical staining with HIF-1 $\alpha$  and double staining with CD34 and PAS. Expression level of HIF-1 $\alpha$  protein was evaluated, and VM density (VMD) and micro vascular density (MVD) was calculated.

## RESULTS

### CONCLUSION

Upgrading of HIF-1 $\alpha$  expression is associated with the increasing of VM and angiogenesis after TAE, which has made a new challenge to the interventional therapy of hepatic carcinoma. HIF-1 $\alpha$  might represent promising therapeutic targets for anti-microcirculation in combination with TAE against liver tumors.

### CLINICAL RELEVANCE/APPLICATION

HIF-1 $\alpha$  might represent promising therapeutic targets for anti-microcirculation in combination with TAE against liver tumors.

## **LL-VIS-TH2A • Therapeutic Effect of Intra-arterial Chemotherapy with DDP and 5-FU via Bilateral Uterine Arteries for Advanced Uterine Cervical Cancer**

**Kang Zhou MD (Presenter) ; Xiaoguang Li MD ; Zhengyu Jin MD**

### PURPOSE

To evaluate the response rate of patients with advanced uterine cervical cancer who were treated with neoadjuvant intra-arterial chemotherapy (NAIC) using a combination of DDP and 5-FU.

### METHOD AND MATERIALS

### RESULTS

54 patients received 1 course and 18 patients received 2 courses. The overall response rate was 77.78%. The response rates of patients with IB2, IIa and IIb cervical cancer were 92.86%, 83.33% and 62.50% (p

### CONCLUSION

NAIC using a combination of DDP and 5-FU via bilateral uterine artery can safely reduce the tumor volume of advanced cervical cancer, suppress the lymph node metastasis and parametrial infiltration. NAIC is effective for preoperative treatment of advanced cervical cancer with easier radical hysterectomy. NAIC is more effective to stage IB2 cervical cancer than stage IIa and IIb, and also to SCC than adenocarcinoma.

### CLINICAL RELEVANCE/APPLICATION

NAIC is effective for preoperative treatment of advanced cervical cancer

## **LL-VIE-TH5A • Thoracic Tumor Ablation: Review of Anatomic Considerations and Adjunctive Techniques**

**Bradley B Pua MD (Presenter) \* ; Adam D Talenfeld MD ; David Li MD, PhD ; Ronald S Winokur MD ; David C Madoff MD**

### PURPOSE/AIM

Purpose:

- To review important anatomic considerations when performing thermal ablation in the thorax.
- To provide a detailed pictorial of neurovascular anatomy and describe clinical findings if these sites are injured during thermal ablation.
- To describe adjunctive techniques to avoid injury to these structures.

### CONTENT ORGANIZATION

- Pictorial review utilizing CT images and figures to describe the anatomic course of important neurovascular structures.
- Content will be organized by each neurovascular structure: with a figure of its anatomy, the CT correlate, then a description of its course and treatment if injured. An associated case is presented if applicable.
- A section will discuss adjunctive techniques to avoid these complications.

### SUMMARY

Teaching points:

- To be able to describe and identify areas corresponding to important neurovascular structures in the thorax such as the phrenic nerve, vagus nerve, internal mammary vessels and course of the intercostal neurovascular bundle in varying ages.
- To be able to describe and treat complications associated with inadvertent injury to these structures.
- The viewer should be able to describe adjunctive techniques such as creation of an artificial pneumothorax or infusion of a saline/fluid buffer to protect these structures from thermal injury.

## **LL-VIE-TH6A • Inject or Reject: Today's Role of the Sinogram**

**Ann Packard MD ; Chad J Fleming MD ; Stephanie K Carlson MD \* ; Claire E Bender MD (Presenter)**

### PURPOSE/AIM

There is controversy as to the value of the sinogram in the management of patients with percutaneously or surgically placed drainage catheters. At our institution, our Interventional Radiology division performed 2532 sinograms in 2012. The purpose of this exhibit is to share our experience and describe its value to our patients.

### CONTENT ORGANIZATION

1. Introduction of exam basics
2. Indications/contraindications
3. Techniques/equipment
4. Patient management guidelines for optimal care
5. Specific management schemes for

a) abscesses, b) lymphoceles, c) high-output fistulae, d) low-output fistulae

### SUMMARY

Careful dedicated performance and evaluation of the sinogram can optimize patient care.

## **LL-VIE1286-THA • Comprehensive Techniques of Difficult IVC Filter Removals and Value of Preretrieval Imaging**

**Luke J Higgins MD (Presenter) ; Camila G Zamboni MD ; Kelvin K Hong MD \* ; Mark L Lessne MD**

### PURPOSE/AIM

To present our experience and review the recent literature regarding techniques and clinical considerations for difficult IVC filter removals. To describe the benefit of preretrieval imaging for procedural planning.

### CONTENT ORGANIZATION

1. .... Introduction 2. .... Review types of retrievable IVC filters 3. .... Preretrieval imaging Provide specific imaging examples of difficult filter retrievals and how the use of preretrieval imaging optimizes procedural planning. 4. .... "IVC filter retrieval techniques" Advanced IVC filter retrieval techniques will be described with specific imaging examples. Periprocedural considerations, including intraprocedural anticoagulation and typical "tools of the trade" will be reviewed. 6. .... "Complications of IVC filter retrieval" Both common and infrequent complications of IVC filter retrieval will be illustrated; techniques of complication management will be detailed.

#### SUMMARY

Both the diagnostic and interventional radiologist must be well versed in the imaging and management of IVC filters. This presentation will review the preprocedural, intraprocedural and complicating factors of difficult IVC filter removals.

### Vascular/Interventional - Thursday Posters and Exhibits (12:45pm - 1:15pm)

Thursday, 12:45 PM - 01:15 PM • Lakeside Learning Center



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**LL-VIS-THB** • AMA PRA Category 1 Credit™:0.5

#### **LL-VIS-TH1B • Looking beyond International Normalized Ratio (INR) in Liver Interventions**

**Archana T Laroia MD (Presenter) ; Sandeep T Laroia MD**

##### PURPOSE

INR remains a much used laboratory parameter to evaluate bleeding diathesis in patients with liver disease. Based on elevated INR value, the patient is often treated with either Vitamin K or fresh frozen plasma (FFP), especially if the patient has to undergo a guided invasive intervention like liver biopsy or TIPS procedure. However clinically significant bleeding from the intervention site remains rare. FFP infusions remain a routine clinical practice despite the potential for significant adverse effects as well as significant resource utilization. A more reliable test is Thromboelastography (TEG), which is evaluated against INR.

##### METHOD AND MATERIALS

Thirty one patients with liver disease induced bleeding diathesis (defined as INR > 1.5) were studied. TEG was obtained and patients' clinical course was followed. Various parameters of TEG test as well as other anticoagulant protein levels were studied where available.

##### RESULTS

Twenty two (73%) of the patients with elevated INR had TEG parameters within normal limits. These patients also maintained normal hemostasis during their clinical course. Remaining nine (27%) patients had abnormal INR as well as abnormal TEG parameters. Three (33%) of these patients showed evidence of clinically significant bleeding.

##### CONCLUSION

Measuring TEG parameters is a better way to assess hemostasis in patients with liver injury rather than relying solely upon INR. INR is a measure of procoagulants only where as TEG is more comprehensive as it measures both the procoagulant and anticoagulant proteins. This change in Interventional Radiology practice would not only avoid potential harm from aggressive FFP infusions but also be cost effective.

##### CLINICAL RELEVANCE/APPLICATION

Using Thromboelastography (TEG) instead of INR alone in Interventional Radiology practice would not only avoid potential harm from aggressive measures like FFP infusions, but also be cost effective.

#### **LL-VIS-TH2B • MR Image Characteristics during and after Cryoablation of Uterine Fibroids**

**Tadashi Shimizu MD (Presenter) ; Noriko Nishioka MD ; Daisuke Abo MD ; Yusuke Sakuhara MD**

##### PURPOSE

To demonstrate characteristics of MR images of uterine fibroids during and after cryoablation .

##### METHOD AND MATERIALS

Symptomatic uterine fibroids were ablated percutaneously using a MR compatible high-pressure argon-based cryoablation system under open MR imaging guidance. Follow up T1-weighted, T2-weighted and Gd-DTPA enhanced T1-weighted MR images were taken over at one day, two week, and six week intervals in 6 patients and in 4 weeks in one patient.

##### RESULTS

Eight fibroids in 7 patients were treated. Six fibroids were intramural and two were submucosal. The maximum diameters of the fibroids ranged from 3.4 to 9.5 cm and the mean was 7.4 cm. The maximum diameters of the frozen area ranged from 4.8 to 8.5 cm and the mean was 6.6 cm. The average freezing time was 18.9 min. In five patients of intramural fibroids, the non-contrast enhanced areas in Gd-DTPA enhanced T1-weighted images after cryoablation were larger than the frozen area. In two cases of submucosal fibroids, normal myometrium around the fibroids were frozen and the signal intensity of the MR images returned to normal in six weeks.

##### CONCLUSION

MR images after cryoablation indicate the necrotic area is larger than the frozen area in the uterine fibroid and we can expect spontaneous recovery of normal myometrium in the frozen area.

##### CLINICAL RELEVANCE/APPLICATION

MR images show ablation zone in the uterine fibroid is larger than frozen area after cryoablation and signal intensity of frozen normal structure of the uterus recovers in 6 weeks.

#### **LL-VIS-TH3B • Comparing a Volumetric Post-processing Analysis Technique to Orthogonal Measurement of Ascending Thoracic Aortic Aneurysms Using ECG-gated CTA**

**Arvin R Akhavan BA (Presenter) ; Audrey Sigmund ; Matthew A Stratton ; Pegah Entezari MD ; Jeremy D Collins MD \* ; James C Carr MD \***

##### PURPOSE

Are ascending thoracic aortic aneurysm (TAA) volumetric measurements with a novel volumetric method strongly correlated to, more sensitive than, and more reproducible than conventional orthogonal measurements?

##### METHOD AND MATERIALS

ECG-gated CT angiography of subjects between 18 and 89 years old who were diagnosed with TAA and who had undergone at least two ECG-gated CTAs of the thoracic aorta at Northwestern Memorial Hospital as a standard of care were used for this study. Exclusion criteria included a history of known aortic dissection, non-diagnostic imaging studies, or a history of cardiac surgery or surgery on the aorta or aortic valve between or before two serial scans. Orthogonal diameter measurements were taken from CTA image reports. Volumetric measurements were obtained from the same CTA scans using a semi-automated Vitrea software.

##### RESULTS

Volumetric and orthogonal measurements were successfully obtained from 108 CTA imaging studies. The Pearson product-moment correlation coefficient demonstrated a Pearson r of 0.823 and 0.856 between maximum orthogonal and volumetric measurements in both

the aortic sinus and the ascending aorta, respectively. Based on the paired t-test, both orthogonal and volumetric measurements demonstrated significant changes in aneurysm size to a confidence level of at least 95%. The comparison of inter-observer and intra-observer agreement showed high intra- and inter-observer reliability over both volumetric and orthogonal measurements. Intra-observer correlation coefficients for volume measurements ranged from 0.98 to 0.99 for measurements taken at different levels of the aorta, compared to 0.97-0.98 for diameter measurements at the same levels. Inter-observer correlation coefficients ranged from 0.94-0.98 for volumes and 0.92-0.97 for diameters.

#### CONCLUSION

Volumetric analysis of ascending TAA is highly correlated to the conventional two-dimensional method, there seems to be no significant difference in sensitivity between the two methods, and both methods demonstrated strong measurement reproducibility. From this research, the time-intensive volumetric analysis does not add a significant benefit over orthogonal analysis.

#### CLINICAL RELEVANCE/APPLICATION

The results of this study suggest that volumetric analysis does not provide a significant advantage over the less time intensive, conventional orthogonal method of ascending TAA measurement.

### **LL-VIS-TH4B • Development and Evaluation of a MR-compatible Guidewire with a Diameter of 0.018◆?: Preliminary Results**

**Robin Bruhn** (Presenter) ; **Miriam Ariens** ; **Christian Wasiak \*** ; **Paul Borm \*** ; **Matthias Von Walter \*** ; **Christiane K Kuhl MD \*** ; **Nils A Kraemer**

#### PURPOSE

In spite of many challenges, MRI guided vascular interventions may offer advantages because they may allow the depiction of not only the target vessel, but also the surrounding anatomy of the target organ. For all types of vascular procedures, a guidewire is needed to navigate the catheter to the target vessel. In trans-arterial tumor therapies, small vessels need to be selectively engaged with microcatheters. Purpose of this research was to evaluate a new 0.018◆ MR-compatible guidewire (GW) in an in-vitro phantom.

#### METHOD AND MATERIALS

We developed a MR-compatible GW consisting of a non-ferromagnetic fibre glass core and two surrounding layers of agamid fibre. Using the micropullwinding technique, stiffness and flexibility of the GW can be varied individually along the shaft. Iron oxide nanoparticles in 3 different concentrations (M1, M2, M3) applied along the tip at distances of 1 cm are used for visualization in MRI. A hydrophilic coating assures gliding of the GW (sliding friction coefficient Two different gradient echo sequences with a temporal resolution of 0.30 sec and 0.78 sec, respectively, were used to visualize navigation of this GW in an in-vitro vessel phantom with and without flow simulation. Visibility of the GW was assessed by measuring marker susceptibility artefacts (a total of n=56) on the MR images. To evaluate clinical GW steerability, different phantom vessels were engaged under MR guidance.

#### RESULTS

On both real-time sequences the markers attached to the GW tip allowed precise visualization. The mean diameters of the marker susceptibility artefacts in pulse sequences acquired horizontal (X) and along B0 (Y) were 5.5/8.4mm (X/Y) (standard deviation (SD) 1.1/1.2mm) for M1; 7.5/9.3mm (SD 0.8/0.8mm) for M2 and 9.4/12.1mm (SD 1.0/1.2mm) for M3. Under MRI guidance, all target vessels of the phantom could be engaged successfully in adequate time.

#### CONCLUSION

The new micropullwinding technique offers the opportunity to build a thin (0.018◆) MR-compatible GW that appears to be useful for superselective vascular MR-guided interventions. Animal experiments are in preparation.

#### CLINICAL RELEVANCE/APPLICATION

With the new production technique an adjustable 0.018◆ GW for superselective endovascular MR-guided interventions may become feasible.

### **LL-VIE-TH5B • Cone-Beam Computed Tomography in the Interventional Radiology Suite: Technical Optimization and Clinical Application**

**Katherine Bruksch BA** (Presenter) ; **Laurence Donahue MD** ; **Ramona Gupta MD** ; **Robert K Ryu MD** ; **Robert J Lewandowski MD \***

#### PURPOSE/AIM

Cone-beam computed tomography (CBCT) offers improved spatial/contrast resolution over conventional digital subtraction angiography (DSA) and is being increasingly utilized by interventional radiologists (IRs) to provide intra-procedural information. This educational exhibit aims to provide a comprehensive analysis of the technical optimization and increasing clinical application of CBCT in the IR suite.

#### CONTENT ORGANIZATION

This exhibit will review technical aspects of CBCT, highlighting potential advantages/disadvantages of CBCT versus DSA and conventional CT-angiography. Tips for optimizing imaging/clinical applications of CBCT will also be presented. The exhibit will then provide a comprehensive clinical/pictorial review of current vascular and non-vascular applications of CBCT in the IR suite. A critical review of the published medical literature will support the clinical impact of CBCT.

#### SUMMARY

CBCT is being increasingly applied during IR procedures because it provides improved intra-procedural imaging, patient safety, and efficacy of minimally invasive procedures. This exhibit will feature clinical examples to demonstrate the utility of CBCT and review techniques to optimize its utilization.

### **LL-VIE-TH6B • Stop the Bleeding! A Review of Current Embolization Techniques and Materials**

**Jenanan Vairavamurthy MD** (Presenter) ; **Marcin K Kolber MD** ; **Adam R Zybulewski** ; **James E Silberzweig MD**

#### PURPOSE/AIM

1. To review the clinical indications and technique for percutaneous embolization 2. To educate the reader on the various agents used in embolization. 3. To review the embolization materials used in different clinical cases with an emphasis on why certain agents are used in specific clinical scenarios.

#### CONTENT ORGANIZATION

1. Review of percutaneous embolization. a. Clinical indications. b. Embolization techniques. c. Postembolization considerations. 2. Review of different embolization agents. a. Autologous clot. b. Absorbable bioprothetic material. c. Nonabsorbable particles. d. Coils. e. Detachable balloons. f. Sclerosant agents. g. Polymers. h. Amplatzer plug. 3. Case based review of which embolization agents are used for each indication. a. Trauma. b. Gastrointestinal hemorrhage. c. Hemoptysis. d. Uterine fibroid embolization. e. Prostatic artery embolization. f. Arteriovenous malformations. g. Hepatic neoplasm.

#### SUMMARY

Embolization therapy is a standard interventional procedure. Successful therapy is predicated on technical skills, knowing disease pathology, and an understanding of the various embolic agents used. A case based review of the different embolic agents presented in this education exhibit will allow the reader to have a deeper understanding of embolotherapy and be better prepared for successful treatment in emergent and non-emergent settings.

### **LL-VIE1294-THB • Intrnodal Lymphangiography for Thoracic Duct Embolization: A Pictorial Guide**

PURPOSE/AIM

To illustrate techniques and troubleshooting tips for performing successful intranodal lymphangiography associated with thoracic duct embolization. After reviewing the presentation, the reader should be able to do the following:

1. List the common indications for lymphangiography and thoracic duct embolization.
2. Describe the procedure for performing intranodal lymphangiography.
3. Describe the procedure for thoracic duct embolization.
4. List potential complications associated with intranodal lymphangiography and thoracic duct embolization.

CONTENT ORGANIZATION

I. Indications for intranodal lymphangiography and thoracic duct embolization II. Anatomy III. Techniques, Pitfalls, and Pearls A. Intranodal lymphangiography B. Thoracic duct embolization IV. Summary V. Conclusions

SUMMARY

This exhibit reviews indications and techniques for intranodal lymphangiography with thoracic duct embolization.

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**Peripheral Artery Disease (PAD)**

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**Thursday, 04:30 PM - 06:00 PM • S404CD**

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**RC712 • AMA PRA Category 1 Credit™:1.5 • ARRT Category A+ Credit:1.5**

**Moderator**

**Stephen T Kee**, MD

LEARNING OBJECTIVES

- 1) Discuss the basic pathology of peripheral artery disease.
- 2) Describe the risk factors associated with the development of peripheral artery disease.
- 3) Outline the benefits of providing a comprehensive clinical service in the management of PVD.
- 4) Discuss how to build a PVD practice.
- 5) Describe the basic techniques employed in the treatment of PVD.

ABSTRACT

**RC712A • Clinical Overview of PAD**

**Stephen T Kee** MD (Presenter)

LEARNING OBJECTIVES

View learning objectives under main course title.

**RC712B • Lower Extremity CTA**

**Richard L Hallett** MD (Presenter)

LEARNING OBJECTIVES

- 1) Describe techniques for patient selection, acquisition, reconstruction, and interpretation of lower extremity CTA.
- 2) Describe evidence-based results for lower extremity CTA, and expected impact on patient care.
- 3) Describe a coherent plan that integrates lower extremity CTA into cost-effective clinical care.

ABSTRACT

Peripheral arterial disease (PAD) is a common cause of morbidity and mortality in developed countries. Traditionally, imaging for risk stratification and therapeutic planning involved catheter angiography. In recent years, cross-sectional imaging by CTA and MRA has proven a robust technique for non-invasive PAD assessment. Given ubiquity of CT scanning technology, CTA is widely available. High resolution datasets can be acquired rapidly, which facilitates assessment of clinically labile or trauma patients. To be optimally effective, CTA techniques require particular attention to contrast medium and scan protocol. With appropriate protocol design, data acquisition requires limited operator dependence. The acquired 3D dataset is rich with information, but requires careful scrutiny by the interpreting physician. Volumetric review of these datasets produces the most accurate results. Extensive small vessel calcification remains a potential barrier to full assessment of pedal vessels by CTA. Recent published data validates the clinical effectiveness of CTA for diagnosis of PAD and for the direction of treatment planning. Ongoing research aims to exploit the newest generation of CT scanners to acquire additional information, including dual energy data, time-resolved information, and radiation dose savings.

**RC712C • Lower Extremity MRA**

**Harald Kramer** MD (Presenter)

LEARNING OBJECTIVES

- 1) Identify the appropriate technique for peripheral MRA depending on the available hardware and the clinical question and condition of the patient.
- 2) Differentiate between different contrast agents and their specific characteristics.
- 3) Chose between different contrast agent application schemes depending on the technique used and the clinical question.
- 4) Compare the pros and cons of contrast-enhanced and non contrast-enhanced techniques for peripheral MRA.

ABSTRACT

The prevalence of symptomatic peripheral artery disease (PAD) ranges around 3% in patients aged 40 and 6% at an age of 60 years. Additionally, the prevalence of asymptomatic PAD lies between 3% and 10% in the general population increasing to 15% to 20% in persons older than 70 years of age. However, these data still might underestimate the total prevalence of PAD since screening studies showed that between 10% and 50% of all patients with intermittent claudication (IC) never consult a doctor about their symptoms. These data prove the need for an accurate and reliable method for assessment of the peripheral vasculature. Digital subtraction angiography (DSA) still serves as the reference standard for all vascular imaging techniques. However, because of the absence of ionizing radiation, the use of non-nephrotoxic contrast agents or even non contrast-enhanced sequences and the large toolbox of available techniques for high-resolution static and dynamic imaging Magnetic Resonance Angiography (MRA) constitute an excellent non-invasive alternative. Different acquisition schemes and contrast agent application protocols as well as different types of data sampling for static, dynamic, contrast- and non contrast-enhanced imaging enable to tailor each exam to a specific question and patient respectively.

**RC712D • Endovascular Treatment of PAD**

**Stephen T Kee** MD (Presenter)

LEARNING OBJECTIVES

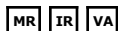
View learning objectives under main course title.

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**Vascular Imaging Series: MR Angiography-Principles and Technique Optimization**

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VSVA61 • AMA PRA Category 1 Credit™:3.25 • ARRT Category A+ Credit:4

**VSVA61-01 • Contrast-enhanced and Time-resolved MRA****Stefan G Ruehm MD (Presenter) \*****LEARNING OBJECTIVES**

1) Understand the general principles of contrast-enhanced and time-resolved MR Angiography. 2) Be familiar with sample clinical applications for time-resolved MR Angiography in several vascular beds. 3) Be aware of the major caveats in contrast enhanced MR Angiography at 1.5T and 3.0T and how to avoid them.

**VSVA61-02 • Whole Body Cardiovascular Magnetic Resonance Imaging in the Detection of Occult Disease in Diabetes Mellitus****Graeme Houston MD, FRCR \* ; Jonathan Weir-McCall MBBCh, FRCR (Presenter) ; Suzanne L Duce PhD ; Shona Matthew BSc, PhD \* ; Stephen Gandy ; Helen Colhoun ; Deirdre Cassidy ; Gill Reekie ; Jil J Belch ; Patricia Martin****PURPOSE**

The IMI-SUMMIT MRI study assessed whole body cardiovascular MR (WBCVMR) to provide surrogate markers of macrovascular disease in patients with diabetes mellitus. WBCVMR combines whole body contrast enhanced magnetic resonance angiography (WBCE-MRA) and cardiac MR(CMR) in a single examination. We compared WBCVMR in type 2 diabetic and non-diabetic patients, with and without symptomatic cardiovascular disease(CVD).

**METHOD AND MATERIALS**

156 subjects were divided into 4 groups: diabetics with (group 1, n=31) or without (group 2, n=55) CVD, and non-diabetics with (group 3, n=28) or without (group 4, n=29) CVD. WBCVMR was performed on 3T MRI (Siemens Trio, Erlangen, DE). WBCE-MRA was performed from skull vertex to feet following intravenous gadoterate meglumine (Dotarem, Guerbet, FR). The subtracted data were divided into 31 anatomical arterial segments. Each segment was scored according to degree of luminal narrowing: 0=normal, 1=

**RESULTS**

143 datasets were included, of which 87(60%) were male (13 excluded due to incomplete scan/inadequate image quality). The mean age was 63.9±8.1 years. Mean WBAS were 0.41+/-0.45 (group 1), 0.17+/-0.17 (group 2), 0.49+/-0.4 (group 3), and 0.15+/-0.18 (group 4). Mean LVM(g) were: 61.6 +/-9.7 (group 1), 55.6+/-10.5 (group 2), 60.4+/-10.6 (group 3), and 52.6+/-8.7 (group 4). WBAS correlated with LVM (r=0.41; p

**CONCLUSION**

WBCVMR offers a robust investigation for detecting and quantitating whole body atheroma burden. Extensive arterial disease and silent myocardial scarring can be visualised in asymptomatic diabetic patients.

**CLINICAL RELEVANCE/APPLICATION**

Type 2 diabetics have an elevated risk of cardiovascular events which can occur in apparently healthy patients. Screening with WBCVMR may identify those at increased risk of future events.

**VSVA61-03 • Feasibility Study of MR-tricks Sequence in Evaluation of the Dorsalis Pedis Artery and the First Dorsal Metatarsal Artery****Bo Sun (Presenter) ; Yue Dong ; Dianxiu Ning ; Qingwei Song BS, BEng ; Meiyu Sun****PURPOSE**

To study the feasibility of MR angiography of the dorsalis pedis artery and the first dorsal metatarsal artery ( FDMA) by three-dimensional time-resolved imaging of contrast kinetics (TRICKS) sequences.

**METHOD AND MATERIALS**

43 cases with suspected or known soft tissue diseases of the ankle and foot were examined retrospectively by conventional MR sequences and TRICKS sequence on GE signa 1.5T HD echospeed MRI . MIP reconstruction was done to evaluate the image quality of arterial branches on ADW4.4 workstation and the evaluated criteria was divided into 4 grades according to the visualization of dorsalis pedis artery( grade 1↯2), FDMA and toe web network(grade3↯4). FDMA was dissected and categorized according to its location(superficial, intramuscular, inframuscular, absent), diameter[large( > 1.5mm ) , medium( 1.0↯1.5mm ) , and small( second toe =Dfirst toe),main trunk type(Dsecond toe>Dfirst toe),fine small branch(Dsecond toe↯first toe)]

**RESULTS**

8 cases(18.6%,8/43)in grade 4, 22(51.16%,22/43)in grade 3,8(18.6%,8/43) in grade 2 and 5(11.62%,5/43) in grade 1. In the grade 1 group, the dorsalis pedis arteries of 2 cases were absent and images of the other 3 cases were not clear because of severe venous contamination.

The TRICKS images of 38 cases(arterial scales=2 point) showed location and diameter of FDMA ,and the TRICKS images of 30 cases(arterial scales=3 point) showed branching pattern at the toe web of FDMA:( 1)Location:superficial (8), intramuscular(22 cases), inframuscular (8 cases), absent(0 cases);(2)Diameter: large(2 cases) , medium(25 cases) , and small(11 cases);(3)Branching pattern at the toe web:ramifying type(11 cases),main trunk type(5 cases),fine small branch(14 cases).

**CONCLUSION**

MR angiography of the dorsalis pedis artery and FDMA was achievable with MR TRICKS sequences, and it was useful for clinical evaluation of FDMA.

**CLINICAL RELEVANCE/APPLICATION**

MR angiography of the dorsalis pedis artery and FDMA with MR TRICKS sequences is available in preoperative evaluation for rebuilding thumb and finger by dissociating toe transplant.

**VSVA61-04 • Renal MRA at 7T: How Much Gadolinium Do We Need?****Lale Umutlu MD (Presenter) \* ; Karsten J Beiderwellen MD ; Michael Forsting MD ; Mark E Ladd PhD ; Oliver Kraff MSc ; Thomas C Lauenstein MD****PURPOSE**

Renal impairment displays a relative contraindication to the application of Gadolinium- based contrast-agents. Hence, contrast dose reduction has become an important issue in the clinical setting. The aim of this trial was to determine whether contrast agent (CA) dose reduction to one-half and one-quarter of the standardized dosage allows for preserved image quality of renal MR angiography at 7T.

**METHOD AND MATERIALS**

12 healthy subjects underwent renal MR angiographic examinations on a 7T MR system (Magnetom 7T), utilizing a custom-built 8-channel RF body coil. Dynamic 3D FLASH data sets were obtained pre contrast and in arterial phase after the application of contrast agent. Examinations were performed at three different time points for injection of three dosages of CA (Gadobutrol, Bayer Healthcare): (1) 0.1 mmol/kg body weight (BW), (2) 0.05 mmol/kg BW and (3) 0.025 mmol/kg BW. Contrast ratios (CR) were measured pre and post contrast in the aorta and both renal arteries in correlation to adjacent psoas major muscle. Qualitative analysis with regard to delineation of the pre-contrast and post-contrast renal arterial vasculature was performed by two radiologists using a five-point-scale (5=excellent to 1= non diagnostic).

## RESULTS

Non-enhanced T1w MRI provided an inherently high signal intensity of vasculature, yielding a good overall pre-contrast arterial delineation (mean 3.65). The application of contrast agent showed improved vessel delineation in subjective ratings of qualitative analysis for all three dosages, yielding comparable results with only minor improvement associated to increased dosage (mean aorta: 0.025Gd 4.4; mean0.05Gd 4.6; mean0.1Gd mean 4.80). Accordingly, quantitative analysis of contrast ratios showed minor increase of mean values with increasing Gadolinium dosage (mean right renal artery: 0.025Gd 0.36; mean0.05Gd 0.38; mean0.1Gd mean 0.42).

## CONCLUSION

Our results demonstrate the successful facilitation of a significant dose reduction to one-quarter of the standardized dosage, while maintaining high image quality.

## CLINICAL RELEVANCE/APPLICATION

The facilitation of a significant dose reduction to one-quarter while maintaining high image quality, may be of high diagnostic value for MRA examinations in patients with renal impairment.

### **VSVA61-05 • MR Contrast Agents for Vascular Imaging**

**Tim Leiner MD, PhD (Presenter) \***

#### LEARNING OBJECTIVES

1) To understand the different classes of contrast agents available for vascular imaging as well as their strengths and weaknesses. 2) To understand both acute and delayed safety concerns associated with administration of MR contrast agents for vascular imaging. 3) To understand proper contrast agent dosing for vascular MR imaging. 4) To understand basic principles underlying successful contrast injection.

#### ABSTRACT

### **VSVA61-06 • Gadofosveset-enhanced MR Venography of the Lower Extremities for Evaluation of Venous Reflux Disease: Feasibility and Comparison of Perforator Vein Imaging with Duplex Ultrasound**

**Andrew R Lewis MD (Presenter) ; Daniele Marin MD ; Holly L Nichols BS ; Daniel Geersen ; Cynthia K Shortell MD ; Charles Y Kim MD \***

#### PURPOSE

Duplex ultrasound (U/S) is the gold standard for imaging of venous reflux disease. CT and direct MR venography (MRV) have shown promising results, but are limited in the degree and extent of superficial vein opacification. Gadofosveset, a blood-pool agent, is uniquely well suited for venous imaging. The purpose of this study is to assess the feasibility of MRV of the deep and superficial venous system and to determine its accuracy in detection of perforator veins.

#### METHOD AND MATERIALS

Retrospective review of our imaging database from 9/2010 to 9/2012 yielded 58 patients (40 females, mean age 54) who underwent MRV of the abdomen, pelvis, and lower extremities as well as dedicated U/S evaluation of venous reflux disease of one or both legs. Axial MRV images were acquired during the equilibrium phase, approximately 5 minutes after IV gadofosveset injection. The lower extremity deep, superficial, and perforator veins were divided into 11 segments for evaluation. Two radiologists independently rated the visualization score of each venous segment on a scale of 1-4 with 4 being highest. Signal and contrast-to-noise ratios were calculated for the venous segments. The detection of enlarged perforator veins was assessed and compared to sonography.

#### RESULTS

Analysis was performed on 80 legs that underwent both MRV and U/S. The mean visualization scores for all analyzed venous segments were excellent (3.8-3.9 on a scale of 1-4). The SNR/CNR values were 280/165 for the femoral vein, 230/144 for the above-knee GSV, 394/237 for the below-knee GSV, 303/177 for the small saphenous vein, and 385/240 for superficial varices. 100% of pathologic perforator veins identified on dedicated U/S were detected on MRV. Additional occult enlarged perforator veins were identified on MRV measuring up to 6mm in diameter.

#### CONCLUSION

MRV with gadofosveset allowed excellent visualization of varices, superficial, and perforator veins of the legs with a high SNR and CNR that was not previously possible with other contrast agents. The exceptional sensitivity for detection of perforator veins may enable improved treatment of venous reflux disease. Additional studies are warranted to correlate MRV findings with disease characterization and treatment outcomes.

#### CLINICAL RELEVANCE/APPLICATION

The excellent imaging quality of the entire venous system of the lower extremities with gadofosveset-enhanced MR venography may enable a new system for evaluation of venous reflux disease.

### **VSVA61-07 • MRA at 3T in Peripheral Arterial Occlusive Disease: Comparison of Gadoterate Meglumine - to Gadobutrol-MRA Using DSA as a Standard of Reference: A Randomized European Multicenter Trial**

**Christian Loewe MD (Presenter) \* ; Javier Arnaiz Garcia MD ; Denis Krause MD ; Luis Marti-Bonmati MD, PhD ; Manuela Aschauer MD ; Armando Tartaro MD ; Massimo Lombardi MD \* ; Marta Burrel MD, PhD ; Reynald Izzillo ; Michael M Lell MD \***

#### PURPOSE

To assess the diagnostic value of two contrast agents in CE-MRA at 3T in peripheral arterial occlusive disease (PAOD).

#### METHOD AND MATERIALS

189 patients were included in this double-blind trial. Patients randomly underwent peripheral CE-MRA with 0.1mmol/kg of either gadoterate meglumine (Dotarem) or gadobutrol (Gadavist). The primary endpoint was degree of agreement to DSA in stenosis detection and grading of both CE-MRA examinations. A non-inferiority analysis was performed based on two independent centralized readings. Secondary endpoints were specificity, sensitivity, positive/negative predictive values, diagnostic confidence, stenosis length, vessel diameter, signal-to-noise ratio and contrast-to-noise ratio. Safety and treatment recommendation were also recorded.

#### RESULTS

The non-inferiority was demonstrated for the primary endpoint. The sensitivity in the detection of significant stenosis for Reader 1 was 69.9% in gadoterate meglumine group compared to 71.0% in gadobutrol group (p=0.72), whereas the specificities were 85.0% and 85.2% (p=0.84), respectively. For Reader 2, sensitivities were 61.5% and 62.0% (p=0.77) and specificities were 91.4% and 91.2% (p=0.51). No difference in SNR and CNR was found between both groups (p = 0.72 and p=0.73), respectively as well as regarding the other secondary endpoints. There were no serious adverse events.

#### CONCLUSION

Contrast media with higher T1 relaxivity have been proposed to be advantageous as far as efficacy is concerned. However, the present study demonstrated the feasibility of PAOD evaluation at 3T and the lack of superiority of gadobutrol over gadoterate meglumine in terms of diagnostic accuracy despite the different Gd-concentrations and T1 relaxivities exhibited by the two contrast agents.

#### CLINICAL RELEVANCE/APPLICATION

Our study has demonstrated that there is no significant difference in terms of diagnostic accuracy when comparing Gd-DOTA-enhanced MRA and gadobutrol-enhanced MRA in an equimolar manner.

## **VSVA61-08 • Non-contrast MRA: TOF and SSFP Based Techniques**

**James C Carr MD (Presenter) \***

### **LEARNING OBJECTIVES**

1) Understand the technical issues underlying non contrast MRA based on TOF and SSFP. 2) Become familiar indications and guidelines for using non contrast MRA. 3) Illustrate applicability of non contrast MRA in a variety of relevant clinical scenarios.

## **VSVA61-09 • Comparison of Non-contrast Enhanced SSFP MRA with Gadolinium Enhanced MRA in the Evaluation of the Post-operative Ascending Aorta**

**Emily Pang MD (Presenter) ; Gregory P King MD ; Simin Jeddiyan MD ; Anna E Zavodni MD, MPH**

### **PURPOSE**

The objective of this study was to evaluate the comparability of non-contrast SSFP and gadolinium enhanced MRA sequences in the quantitative and qualitative assessment of the post-operative ascending aorta.

### **METHOD AND MATERIALS**

After obtaining Research Ethics Board approval, we conducted a single center retrospective review of the 59 consecutive patients sent for MRI follow-up post ascending aortic replacement surgery between 2007 and 2012. Our analysis included 51 patients (mean age 67 +/- 3 years) with both non-contrast SSFP and gadolinium enhanced MRA sequences (8 patients were excluded due to not having one or both sequences performed). The images were independently evaluated by two cardiovascular fellowship trained radiologists with at least 2 years of experience, who measured the diameter of the thoracic aorta at several points including the root, ascending aorta, arch and descending aorta, as well as assessed for qualitative abnormalities. The datasets were compared using paired T-test, Bland-Altman, and kappa coefficient analysis (statistical significance was determined using a Bonferroni correction for multiple comparisons). Intra and inter-observer variability was also determined.

### **RESULTS**

There was no statistically significant difference in measurements between non-contrast SSFP and gadolinium sequences, with the exception of the aortic annulus in patients who did not have valve replacement ( $p < 0.001$ ). We postulate that this finding was because the 3D gadolinium sequences allowed for measurements of the normally ovoid annulus in more than one dimension. Kappa analysis also demonstrated good agreement with regards to the quantitative observations. Inter and intra-observer variability was excellent (ICC  $>0.8$ ).

### **CONCLUSION**

Our results suggest that using an unenhanced SSFP MRA sequence is comparable to gadolinium enhanced MRA in the quantitative and qualitative evaluation of the post-operative ascending aorta. Adequate and accurate information is obtained from the non-contrast SSFP sequence such that intravenous gadolinium may be rendered unnecessary for surgical follow-up imaging, reducing the risk and inconvenience to the patient, as well as health care costs.

### **CLINICAL RELEVANCE/APPLICATION**

Using unenhanced SSFP MRA may be sufficient in the post-operative MR imaging follow up of ascending aorta replacements, omitting the risks and costs associated with IV gadolinium administration.

## **VSVA61-10 • Performance of Non-enhanced ECG-gated Quiescent-interval Single Shot MRA (QISS-MRA) at 3 Tesla. A Comparison with Contrast-enhanced MRA and DSA**

**Jan Hansmann MD (Presenter) ; John N Morelli MD ; Henrik J Michaely MD \* ; Thomas Riestler MD ; Johannes Budjan MD ; Stefan O Schoenberg MD, PhD \* ; Ulrike I Attenberger MD \***

### **PURPOSE**

To evaluate the diagnostic accuracy of a non-enhanced ECG-gated quiescent-interval single shot MR-Angiography (QISS-MRA) at 3T with contrast-enhanced MRA (CE-MRA) and digital subtraction angiography (DSA) serving as the standard of reference.

### **METHOD AND MATERIALS**

16 consecutive patients (9 male, 7 female, mean age  $70 \pm 12$  years) with peripheral arterial disease stages II-IV underwent a combined peripheral MRA protocol consisting of a large field-of-view QISS-MRA (acquisition time 18 min), continuous-table-movement MRA (acquisition time 62 sec), and an additional time-resolved MRA (acquisition time 96 sec) of the calves. DSA correlation was available in 8 patients. Image quality and degree of stenosis was assessed. Sensitivity and specificity of QISS-MRA was evaluated with CE-MRA and DSA serving as the standards of reference by two readers.

### **RESULTS**

328 total segments were assessed. Overall sensitivity and specificity were, respectively, 81.1% and 83.5% for QISS-MRA vs CE-MRA. Relative to DSA, sensitivity for QISS-MRA was high (100% versus 91.2% for CE-MRA) in the evaluated segments; however, specificity was substantially less than that of CE-MRA (76.5% vs 94.6%,  $p$  There was no significant difference in image quality between QISS-MRA and CE-MRA at the calf station ( $p=0.17$ ). For the vasculature of the pelvis and thigh QISS-MRA was rated significantly lower compared to CE-MRA ( $\bar{\kappa}$  interreader agreement was very good for both QISS-MRA and CE-MRA ( $\kappa=0.83$  and  $0.96$  respectively).

### **CONCLUSION**

Overall image quality and specificity of QISS-MRA at 3T are diminished relative to CE-MRA, potentially due to long acquisition times. However, when image quality is adequate, the high sensitivity of QISS-MRA may render it useful as a screening examination in patients with contraindications to gadolinium chelate administration.

### **CLINICAL RELEVANCE/APPLICATION**

Due to its high sensitivity at 3 Tesla, QISS might serve as screening tool to rule out significant stenoses in patients with impaired renal function.

## **VSVA61-11 • Performance of Unenhanced MRA Using Spatial Labeling with Multiple Inversion Pulses Sequence to Depict Transplant Renal Vascular Anatomy and Complications**

**Hao Tang (Presenter) ; Daoyu Hu MD, PhD ; Zi Wang**

### **PURPOSE**

To prospectively evaluate the performance of a new unenhanced magnetic resonance angiography (Unenhanced MRA) sequence, spatial labeling with multiple inversion pulses (SLEEK), to depict transplant renal vascular anatomy and complications in comparison to color doppler ultrasonography (CDUS), digital subtraction angiography (DSA) and intraoperative findings.

### **METHOD AND MATERIALS**

75 patients with renal transplant were examined with Unenhanced MRA using SLEEK and CDUS. DSA was performed in 14 patients. Surgery was performed for 7 patients. The ability to present transplant renal vascular anatomy and complications with SLEEK were evaluated by two experienced radiologists, and to correlate the results with CDUS, DSA and intraoperative findings.

### **RESULTS**

### **CONCLUSION**

Unenhanced MRA using SLEEK is a reliable diagnostic method for depicting transplant renal vascular anatomy and complications. It is relatively inexpensive and is not associated with renal complications. It can be as a good choice for screening renal vascular anatomy and

complications, especially in patients with renal insufficiency.

#### CLINICAL RELEVANCE/APPLICATION

Unenhanced MRA using SLEEK is a reliable diagnostic method for depicting transplant renal vascular anatomy and complications, especially in patients with renal insufficiency.

### **VSVA61-12 • Hemodynamic Outcome Following Aortic Root Replacement with or without Hemiarch Replacement Assessed by 4D Flow MRI**

**Edouard Semaan** (Presenter); **Michael Markl** PhD; **Chris Malaisrie** \*; **Alex Barker**; **Bradley D Allen** MD; **Zoran Stankovic** MD; **Patrick McCarthy**; **James C Carr** MD \*; **Jeremy D Collins** MD \*

#### PURPOSE

To evaluate aortic hemodynamics using 4D flow MRI following aortic root replacement (AR) or aortic root and hemiarch replacement (AR+HA), comparing to patients following non-mechanical aortic valve replacement (AVR) alone.

#### METHOD AND MATERIALS

IRB approval was obtained. 31 patients were recruited following open AVR (group 1: AR, n=16, 51±13 yrs; group 2: AR+HA, n=4, 60±10 yrs; group 3: AVR alone, n=11, 69±11 yrs). Aortic blood flow was measured using ECG and respiration synchronized 4D flow MRI (3-directional venc = 150cm/s, 2.0-2.8mm<sup>3</sup>, temp res 40-44msec) at 1.5 or 3T (Aera, Avanto, or Skyra, Siemens, Erlangen, GE) post-contrast administration. Data analysis included 3D blood flow visualization (EnSight, CEI, USA) based on time-resolved 3D pathlines and systolic 3D streamlines. Helical flow was assessed in the Ascending aorta (AAo), arch, and descending aorta on a 3-point Likert scale (360°). 3D pathlines qualitatively identified the existence of flow jets and the quadrant of flow impingement in the proximal, mid, and distal AAo. Flow uniformity was analyzed by quadrant dichotomizing systolic peak velocities at 1m/s. Peak systolic velocities and acceleration were quantified in 9 planes distributed throughout the thoracic aorta. Groups were compared using the student's t-test.

#### RESULTS

4D flow MRI revealed similar helical flow across groups (p>0.05). 72 % (8 of 11) of patients in group 3 demonstrated outflow jets impinging on the right anterior proximal aortic wall. Jet flow was seen in 52% (10 of 20) of patients in groups 1 and 2 and was preferentially directed towards the anterior wall. Flow profiles were asymmetric in 62%, 100%, and 72% of groups 1-3, respectively. There were significant differences between groups 1 and 2 compared to group 3 for peak acceleration and significant differences between groups 1 and 3 for peak velocities (p

#### CONCLUSION

4D flow MRI characterized flow in AVR patients. Our preliminary findings demonstrate elevated peak systolic velocities and acceleration in patients with aortic grafts compared to patients with AVR alone. Follow-up studies are warranted to investigate the influence of these findings on ventricular loading and patient outcome.

#### CLINICAL RELEVANCE/APPLICATION

4D flow MRI demonstrates increased aortic peak velocities and acceleration status-post aortic replacement with graft material, suggesting increased ventricular loading with altered aortic compliance.

### **VSVA61-13 • 3D Cine PC VIPR as a Sensitive Indicator of Post-prandial Hyperemia with an Added Value of Avoiding Vortex and Helical Flow Portions**

**Masataka Sugiyama** (Presenter); **Yasuo Takehara** MD; **Kevin M Johnson** \*; **Oliver Wieben** PhD; **Tetsuya Wakayama** PhD \*; **Hiroyuki Kabasawa**; **Shuhei Yamashita** MD; **Harumi Sakahara** MD; **Atsushi Nozaki**; **Naoki Oishi**

#### PURPOSE

3D cine PC with vastly undersampled isotropic projection steady-state free precession imaging (VIPR) is a recently developed MR method that can cover full spatial and temporal data of the blood flow velocity. The purpose of our study is two folds i.e., 1) to test if 3D PC VIPR can be used for dietary stress test in detecting the post-prandial hyperemia of the SMA, and 2) to assess the flow patterns within SMA with streamline analysis for finding out the optimum plane to measure correct blood flow.

#### METHOD AND MATERIALS

All studies were conducted on a 3.0T MR imager with phased array coil. Five healthy volunteers (23 to 53 y.o.) were enrolled. Under 8 hr fasting, 2D cine PC and 3D cine PC VIPR were repeated before and after the intake of 400 Kcal supplementary diet. The measuring planes for the 2D cine PC were placed at the proximal portion, mid curved portion and the distal straight portion of the main trunk of SMA. With 3D cine PC VIPR, retrospective measurements at the corresponding planes were performed and the values were compared.

#### RESULTS

#### CONCLUSION

Newly developed 3D cine PC VIPR can be used for dietary stressed SMA flow measurement with an added value of delineating the vortex and helical flow portions in the SMA where the measurement should be avoided.

#### CLINICAL RELEVANCE/APPLICATION

3D cine PC VIPR is feasible as a dietary stress test for non-obstructive mesenteric ischemia by detecting the post-prandial hyperemia. The beauty of the method is retrospective flow analysis.

### **VSVA61-14 • Non-contrast MRA: Phase-contrast MRA**

**Scott B Reeder** MD, PhD (Presenter)

#### LEARNING OBJECTIVES

1) Understand the underlying principles of phase velocity MRA. 2) Be familiar with the currently available methods for phase velocity MRA. 3) Be familiar with important applications and examples of phase velocity MRA. 4) Understand current limitations and pitfalls associated with phase velocity MRA.

### **ISP: Nuclear Medicine (Cardiovascular Imaging)**

**Friday, 10:30 AM - 12:00 PM • S505AB**



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**SST12 • AMA PRA Category 1 Credit™:1.5 • ARRT Category A+ Credit:1.5**

**Moderator**

**Akash Sharma**, MD

**Moderator**

**Pamela K Woodard**, MD \*

**SST12-01 • Nuclear Medicine Keynote Speaker: New Horizons in Cardiovascular Imaging with PET/MRI**

**Pamela K Woodard** MD (Presenter) \*

**SST12-03 • FDG-PET/CT: Do Contrast Enhanced CT for Attenuation Correction and Ultra-HD-PET Influence the SUV-values in Large Vessel Walls?**

**Ingo Janssen** (Presenter) ; **Inga Buchmann** ; **Florian M Vogt MD**

#### PURPOSE

To optimize large-vessel-imaging in FDG-PET/CT we evaluated, if contrast enhanced CT (ceCT) for attenuation correction (AC) in FDG-PET-CT and ultraHD-(high-definition-PET+ time of flight) (uHD) compared with iterative reconstruction (IR) may lead to differences in large-vessel-SUV.

#### METHOD AND MATERIALS

50 patients (pat), who underwent FDG-PET/CT in malignant-disease-staging, were included in this retrospective study. All pat were unsuspecting for large-vessel-vasculitis. 25 pat underwent FDG-PET-CT with ceCT for AC (group A; 100 ml Xenetix 300 i.v, delay 50 sec) and 25 pat FDG-PET-CT with non-contrast (nc) CT for AC (group B).  $242 \pm 15$  MBq FDG were applied i.v. PET-CT-scans with acquisition of uHD and IR data started  $82 \pm 19$  min p.i. (Biograph mCT, Siemens). SUVmax-values in identical localizations in the wall of ascending aorta, aortic arch and descending aorta were evaluated by VOI-analysis in all patients. Further a SUVmax/mediastinal-bloodpool (MB)-ratio and SUVmax/liver-bloodpool(LB)-ratio were calculated. MB was determined by drawing a VOI directly inside of the ascending aorta, LB by drawing a VOI in visually physiological liver-tissue. Mean SUVmax, mean MB-ratio and mean LB-ratio of both groups were compared in uHD and IR. Significance level was defined as  $p = 0.05$ .

#### RESULTS

Mean SUVmax-values in group A were significantly higher than in group B (uHD: p

#### CONCLUSION

CeCT for AC in FDG-PET/CT shows significant higher SUVmax-values in aortic wall and uHD demonstrates significant higher aortic-wall to background-contrasts. These results may significant influence the interpretation of large-vessel-vasculitis imaging in FDG-PET/CT.

#### CLINICAL RELEVANCE/APPLICATION

Further studies have to be performed, to evaluate the influence of ceCT for AC and uHD-PET on vasculitis-imaging in FDG-PET/CT.

### **SST12-04 • 11C-Choline PET/CT Evaluation of Atherosclerotic Disease**

**Ann Packard MD** (Presenter) ; **Geoffrey B Johnson MD, PhD** ; **Christopher H Hunt MD** ; **Mark A Nathan MD** ; **Patrick J Peller MD \***

#### PURPOSE

Choline is known to be a prominent constituent of atherosclerotic plaque. This study measures the 11C-Choline accumulation in the abdominal aorta compared to vessel wall calcification and conventional risk factors of atherosclerotic disease.

#### METHOD AND MATERIALS

The 11C-choline PET/CT database was searched retrospectively from 1999-2012 for patients with data related to atherosclerotic risk factors, including medications, laboratory data, and medical history with an accrual target of 100 patients. PET/CT scans were evaluated blinded to clinical information by a Nuclear Medicine physician with 25 years of PET/CT experience, for radiotracer activity and calcium quantification. The aorta was analyzed from the renal arteries to the bifurcation. Max SUV was obtained from an ROI placed around the aorta on axial imaging at the level of peak activity. Max SUV ratios of aorta to blood pool were calculated. Clinical atherosclerotic risk factors were correlated to 11C-choline max SUV/BP ratio. Basic statistical analysis included Students-T test and ANOVA.

#### RESULTS

All 11C-Choline PET/CTs were performed for prostate cancer recurrence. Of a cohort of 900 11C-choline PET/CTs, 104 patients with adequate clinical data were targeted, and of these, 94 had complete imaging, and had a mean age of 69.6 (SD 8.33 yrs, range 45-86) at the time of scan; 50 had prior or active smoking history, 38 were on statin therapy for hyperlipidemia, and 14 had prior cardiovascular events including MI or stroke. Patients with a prior cardiovascular event had a higher max SUV ratio ( $2.99 \pm 0.599$ , p

#### CONCLUSION

Patients with prior cardiovascular events and those on statin therapy had higher choline uptake within the abdominal aorta. No relationship was found between choline and calcium, or a difference in calcium score between groups stratified for cardiovascular risks.

#### CLINICAL RELEVANCE/APPLICATION

11C-Choline PET/CT may be useful in evaluating and identifying active atherosclerotic vascular disease in patients receiving PET/CTs for other reasons.

### **SST12-05 • Quantification of Myocardial Blood Flow and Coronary Flow Reserve with an Innovative Tc-99m Sestamibi Dynamic SPECT/CT Method: Validation with Coronary Angiography in a Pilot Study**

**Chung-Chieh Huang** (Presenter) ; **Fu-Chung Chen** ; **Po-Nien Hou** ; **Guang-Uei Hung** ; **Ran Klein \*** ; **Robert Dekemp PhD \*** ; **Wan-Chen Chen** ; **Bailing Hsu**

#### PURPOSE

Myocardial blood flow (MBF)/coronary flow reserve (CFR) quantification with positron emission tomography has demonstrated the incremental value in diagnosis and risk stratification of coronary artery disease (CAD) over perfusion alone images, but its widespread utilization is limited in areas without appropriate flow tracers. This study investigates the diagnostic value of a dynamic SPECT/CT (dSPECT) method as a potential utility for flow quantification.

#### METHOD AND MATERIALS

Fifteen patients who underwent clinically indicated dipyridamole-stress/rest Tc99m-sestamibi myocardial perfusion SPECT were enrolled to evaluate both perfusion and dSPECT MBF/CFR. Coronary angiography for all patients confirmed 9 CAD with =50% stenosis (5 one-vessel, 1 two-v, 3 three-v). In addition, 5 low-likelihood (LL) patients with normal perfusion were included to obtain the range of LL MBF/CFR. dSPECT images were quantitatively reconstructed and analyzed for MBF/CFR with 1-tissue/2-kinetic compartmental flow model, tracer extraction correction and rest heart rate/pressure product correction using FlowQuant program. Traditional perfusion images were interpreted visually with a 17-segment model to create summed stress scores (SSS). Receiver-operating characteristic (ROC) analysis was used to evaluate the diagnostic performance of stress MBF (SMBF), CFR and SSS in detecting CAD.

#### RESULTS

Global SMBF and CFR of CAD group ( $1.31 \pm 1.03$  ml/min/g and  $1.61 \pm 0.94$ ) were significantly lower than those of non-CAD ( $2.42 \pm 0.51$  ml/min/g,  $p=0.016$  and  $3.06 \pm 0.66$ ,  $p=0.0038$ ) and LL groups ( $2.81 \pm 0.38$  ml/min/g,  $p=0.0023$  and  $2.78 \pm 0.67$ ,  $p=0.02$ ). No significant difference was noted between non-CAD and LL groups for global SMBF and CFR ( $p=0.18$  and  $0.51$ ). For vessel-based CAD (prevalence: 16 of 45 vessels, 36%) detection, area under the ROC curve (AUC) for territorial SSS ( $0.548 \pm 0.091$ ) was significantly smaller than that of SMBF ( $0.812 \pm 0.063$ ,  $p=0.009$ ) or CFR ( $0.815 \pm 0.063$ ,  $p=0.011$ ).

#### CONCLUSION

Our preliminary results suggest that dSPECT is a simple and effective method for the quantitation of MBF and CFR that can enhance the accuracy for CAD diagnosis without adding extra radiation burden to patients.

#### CLINICAL RELEVANCE/APPLICATION

Traditional MPI likely underestimate the extent and severity of perfusion abnormality in multi-vessel CAD, dSPECT MBF/CFR quantitation is clinically feasible and can enhance the diagnostic performance

### **SST12-06 • A Comparative Analysis of Myocardial Perfusion on Gated SPECT vs Coronary Atherosclerosis and Coronary Calcium Score on 64-slice CT**

**Parul Mohan MBBS, MD** (Presenter) ; **Harsh Mahajan MD, MBBS** ; **Upendra Kaul MBBS, MD**

#### PURPOSE

. Currently both gated SPECT and multislice CT are available for functional imaging i.e. assessing the haemodynamic consequences of CAD and anatomical imaging i.e. visualizing the coronary artery tree respectively. The aim of the current study was to compare the results of 64-slice CT and gated SPECT on a regional basis (per vessel distribution territory) in patients with known or suspected CAD.

#### METHOD AND MATERIALS

One hundred and fifty patients underwent both gated SPECT for myocardial perfusion imaging and 64-slice CT for coronary calcium scoring and coronary angiography. The coronary calcium score was determined for each coronary artery. Coronary arteries on multislice CT angiography were classified as having no CAD, insignificant stenosis (0% luminal narrowing). Gated SPECT findings were classified as normal or abnormal (reversible or fixed defects) and were allocated to the territory of one of the various coronary arteries.

#### RESULTS

In coronary arteries with a calcium score of 10 or less, the corresponding myocardial perfusion was normal in 94 %. In coronary arteries with extensive calcifications (score > 400), the percentage of vascular territories with normal myocardial perfusion was lower, 52%. Similarly, in most of the normal coronary arteries on 64-slice CT angiography, the corresponding myocardial perfusion was normal on SPECT in >94%. In contrast, the percentage of normal SPECT findings was significantly lower in coronary arteries with obstructive lesions.

#### CONCLUSION

Although a relationship exists between the severity of CAD on multislice CT and myocardial perfusion abnormalities on SPECT, analysis on a regional basis showed only moderate agreement between observed atherosclerosis and abnormal perfusion. Accordingly, 64-slice CT and gated SPECT provide complementary rather than competitive information, and further studies should address how these two modalities can be integrated to optimize patient management.

#### CLINICAL RELEVANCE/APPLICATION

The comprehension of the data derived by the use of coronary angiography and cardiac radionuclide imaging is of paramount importance

### **SST12-07 • Inter-platform Reproducibility for Quantitative Assessment of Arterial [18F] Fluorodesoxyglucose (FDG) Uptake in Large Peripheral Vessels: A PET/CT Study**

**Birgit Langhans** (Presenter) ; **Axel Rominger** ; **Markus Hacker** ; **Peter Bartenstein** ; **Maximilian F Reiser MD** ; **Tobias Saam MD \***

#### PURPOSE

FDG-PET/CT is able to quantify arterial wall inflammation and is increasingly used in clinical trials to assess effects of new anti-atherosclerotic therapies. The objective of this study was to analyse inter-platform reproducibility of FDG uptake.

#### METHOD AND MATERIALS

20 cancer patients were examined by whole-body FDG-PET/CT on two different platforms (platform 1: GE Discovery 690; platform 2: Siemens Biograph 64) with a median time between the first and second scan of 3.6 [2.8, 5.0] months. The maximum standardized uptake value (SUV<sub>max</sub>), the mean venous blood-pool (SUV<sub>bp</sub>) and the target-to-background ratio (TBR=SUV<sub>max</sub>/SUV<sub>bp</sub>) were determined in the aortic arch, ascending, descending, and abdominal aorta and both iliac and carotid arteries.

#### RESULTS

Mean SUV<sub>max</sub>, averaged across all arterial territories were significantly higher on platform 1 compared to platform 2, with a mean difference of 0.25±0.31 (SUV<sub>max</sub>1: 2.86 vs. SUV<sub>max</sub>2: 2.61; p=0.002). However, mean TBR values did not differ significantly between the platforms (TBR1 2.25 vs. TBR2 2.10; p=0.2). When the vascular territories were assessed separately, SUV<sub>max</sub> was significantly higher on platform 1 in the aortic arch, ascending, descending and abdominal aorta. No significant differences in SUV values were found in iliac and carotid arteries. TBR values for the different vascular territories did not differ significantly, except for the aortic arch.

#### CONCLUSION

SUV<sub>max</sub> measurements differ significantly across different platforms, but not the TBR values. For serial assessment of vessel wall inflammation we therefore recommend to use the identical platform or alternatively to use TBR measurements instead of SUV measurements.

#### CLINICAL RELEVANCE/APPLICATION

Hybrid imaging by PET/CT is a promising technology for the localization of vulnerable plaques based on the uptake of various molecular imaging agents indicative of inflammatory processes.

### **SST12-08 • Optimizing 18F-FDG-PET Imaging of Vessel Wall Inflammation - The Impact of 18F-FDG Circulation Time, Dose, Uptake Parameters, and Fasting Blood Glucose Levels**

**Jan Bucerius** (Presenter) ; **Venkatesh Mani PhD** ; **Colin Moncrieff** ; **Josef Machac MD \*** ; **Valentin Fuster MD** ; **Michael E Farkouh** ; **Ahmed Tawakol MD \*** ; **James Rudd MD, PhD** ; **Zahi A Fayad PhD \***

#### PURPOSE

<sup>18</sup>F-fluorodeoxyglucose (FDG) positron emission tomography (PET) is increasingly used for imaging of vessel wall inflammation. However, limited data is available regarding the impact of methodological variables, i. e. patient's pre-scan fasting glucose, the FDG circulation time, the injected FDG dose, and of different FDG uptake parameters, in vascular FDG-PET imaging.

#### METHOD AND MATERIALS

195 patients underwent vascular FDG-PET/CT of the aorta and the carotids. Arterial standard uptake values (mean SUV<sub>max</sub>) as well as target-to-background-ratios (mean TBR<sub>max</sub>) and the FDG blood pool activity in the superior vein cava (SVC) and the jugular veins (JV) were quantified. Vascular FDG uptake classified according to tertiles of patient's pre-scan fasting glucose levels, the FDG circulation time, and the injected FDG dose was compared using ANOVA. Multivariate regression analyses were performed to identify the potential impact of all variables described on the arterial and blood pool FDG uptake.

#### RESULTS

Tertile analyses revealed FDG circulation times of about 2.5 h and pre-scan glucose levels of less than 7.0 mmol/l showing favorable relations between the arterial and blood pool FDG uptake. FDG circulation times showed negative associations with the aortic mean SUV<sub>max</sub> values as well as SVC- and JV FDG blood pool activity but a positive correlation with the aortic- and carotid mean TBR<sub>max</sub> values. Pre-scan glucose was negatively associated with aortic- and carotid mean TBR<sub>max</sub> and carotid mean SUV<sub>max</sub> values, but correlated positively with the SVC blood pool uptake. Injected FDG dose failed to show any significant association with the vascular FDG uptake.

#### CONCLUSION

FDG circulation times and pre-scan blood glucose levels significantly impact FDG uptake within the aortic and carotid wall and may bias the results of image interpretation in patients undergoing vascular FDG-PET/CT. FDG dose injected was less critical. Therefore, circulation times of about 2.5 h and pre-scan glucose levels less than 7.0 mmol/l should be preferred in this setting.

#### CLINICAL RELEVANCE/APPLICATION

Standardization of vascular FDG-PET/CT imaging methodology and protocols to non-invasively assess vascular inflammation.

### **SST12-09 • FDG PET CT To Evaluate Response of Cardiac And Extracardiac Sarcoidosis to Immunosuppressive Therapy**

**Kavitha Yaddanapudi DMRD, MBBS** (Presenter) ; **Donald R Neumann MD, PhD** ; **Culver Daniel** ; **Richard Brunken MD \***

#### PURPOSE

To evaluate the response to immunosuppressive therapy in patients with active cardiac and extra cardiac Sarcoidosis on serial FDG PET CT scans. To assess differences in response of cardiac and extra cardiac disease to immunosuppressive therapy.

#### METHOD AND MATERIALS

Retrospective evaluation of eighteen patients with biopsy proven Sarcoidosis who underwent serial FDG PET scans (twenty nine data sets) to assess disease activity in response to therapy. The interval between serial scans ranged between three and twelve months. Patients received immunosuppressive therapy including prednisone, methotrexate or both. The response of cardiac disease was categorized as progressive if there was increase in inflammation or scar, stable if no change was noted and response if decrease in disease activity was noted. The extracardiac disease was graded as response, resolution, stable and progressive disease.

#### RESULTS

The extracardiac disease showed resolution or partial response in 11 patients, progression in 3 patients, stable disease in 2 patients and negative scan in 2 patients. Cardiac disease showed response in 7 patients, progression in 5 patients and stable disease in 6 patients. In 7 patients extracardiac disease showed treatment response or resolution, whereas cardiac disease progressed or remained stable. In 3 patients who had progression of extracardiac disease, cardiac disease also progressed or remained stable. In all patients response to therapy of both cardiac and extracardiac disease correlated well with a self-perceived response to therapy.

#### CONCLUSION

Serial FDG PET CT scans are a good objective indicator of response to therapy and correlate well with clinical well-being in patients who respond to therapy. Cardiac disease is more resistant to treatment compared to extracardiac disease.

#### CLINICAL RELEVANCE/APPLICATION

Response to therapy is a very important guiding factor in optimizing dosage of toxic immunosuppressive agents in patients with Sarcoidosis and FDG PET CT is probably the most reliable tool available.

## Vascular/Interventional (MR Guidance/Topics of Interest)

Friday, 10:30 AM - 12:00 PM • E350



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**SST16** • AMA PRA Category 1 Credit™:1.5 • ARRT Category A+ Credit:1

#### Moderator

**Dmitry J Rabkin**, MD, PhD

#### Moderator

**Elizabeth M Hecht**, MD

### **SST16-01 • Utilization of the iPad for Patient Education during Informed Consent in Interventional Radiology: A Randomized Controlled Trial**

**Sahil V Mehta** MD (Presenter) ; **Lauren E Ferrara** MD ; **Seth J Berkowitz** ; **William C Lo** ; **Salomao Faintuch** MD \*

#### PURPOSE

To evaluate if interactive media presented on an iPad improves patient understanding and confidence during the informed consent process in interventional radiology.

#### METHOD AND MATERIALS

Patients were randomized into 4 groups. The control group (C) received an electronic consent form on the iPad. The second group was shown their radiology images (I) on an iPad. Dynamically displayed images were used to explain the patient's disease and planned intervention. The third group was shown interactive anatomic drawings (D) of their disease and planned intervention. The final group was shown a short video animation about the procedure to be performed (V). Patients completed a survey to rate their experience.

#### RESULTS

Fifty-six consecutive patients completed the study, 14 in each group. Procedures included venous access, nephrostomy, gastrostomy, fibroid and chemo embolization, tumor ablation, angiogram and biopsy. Use of the iPad was graded as significantly helpful to understand the reasoning for the procedure by 86% of patients in the imaging group (I), 79% in the drawing group (D) and 71% in the video group (V), compared to 43% of controls (p

#### CONCLUSION

Patients reacted positively to use of the iPad during informed consent, even when used as a simple replacement for a paper form. Nonetheless, clinical images and interactive drawings significantly improved patient understanding and confidence in the procedure to be performed. While videos were considered helpful, they were received less positively by patients, perhaps due to a reduction in interactivity with the provider. The iPad is a useful tool to help build a patient-physician relationship before an interventional procedure.

#### CLINICAL RELEVANCE/APPLICATION

The iPad can be very helpful during informed consent for interventional radiology procedures. It can significantly increase patient understanding, confidence and satisfaction.

### **SST16-02 • Radiology Milestones: A Multiyear Study of Resident Experience with Radiologic Procedures at a Large Academic Medical Center**

**Adam B Prater** MD (Presenter) ; **Bradley S Rostad** MD ; **Emily Ebert** BS ; **Rachel Kearns** BS ; **Thomas W Loehfelm** MD, PhD ; **Brent Little** MD ; **Christopher P Ho** MD ; **Mark E Mullins** MD, PhD

#### PURPOSE

The American College of Graduate Medical Education (ACGME) and the American Board of Radiology (ABR) initiated the Radiology Milestones Project in 2012 to create a framework for assessing the competency of radiology residents. An analysis of procedures performed by prior residents might help guide the assessment of procedural competency of current and future residents. Our study documented the most common types and numbers of procedures performed by radiology residents in a large academic center over a ten year period.

#### METHOD AND MATERIALS

Institutional review board approval was obtained. Resident procedure logs from graduating class years 2002 to 2012 were de-identified and organized into a secure electronic database. Summary statistics for each procedure type were calculated.

#### RESULTS

Resident procedure logs consisted of both paper and electronic forms, which varied in the number of resident participation and in the types and numbers of procedures documented. Over a ten year period, 110 residents recorded a total of 13,678 procedures consisting of 70 different procedure types. The most common recorded procedures were vascular catheter insertion, CT-Guided abdominal biopsies and drain placement, fluoroscopic Lumbar puncture, and ultrasound guided thoracentesis, paracentesis and thyroid biopsies. However, the numbers and types of procedures recorded for each resident varied considerably (mean 124 ± 75, max 331, min 15).

#### CONCLUSION

Although a wide variety of procedures are performed by residents during residency, resident procedural experience, as measured by procedure log data, varies significantly between residents even within the same program. This may be due to variability in resident procedure logging practices and procedures performed as data are manually entered by residents and are possibly underreported. Given

the future directions suggested by the Radiology Milestones Project, our findings highlight the need for national guidelines regarding procedure requirements, and a more accurate method of acquiring radiology procedure data.

#### CLINICAL RELEVANCE/APPLICATION

The future of graduate medical education is geared towards data-driven metrics that can accurately depict resident progress and competence.

### SST16-03 • Magnetically Assisted Remote Controlled Endovascular Catheter for Interventional MRI: In Vitro Navigation at 1.5T

**Aaron D Losey** MS (Presenter) ; **Prasheel Lillaney** ; **Alastair Martin** \* ; **Daniel L Cooke** MD ; **Mark W Wilson** MD ; **Maythem Saeed** DVM, PhD ; **Steven W Hetts** MD \*

#### PURPOSE

Using real-time MRI for interventional procedures affords a wealth of physiologic and structural information. The promise of endovascular MR guided procedures remains unrealized in part because of the lack of MR compatible catheters and guide wires. Innovative techniques for guiding a catheter in the magnetic field of the MR scanner have been proposed, but limited functionality has been described to date. This study evaluates navigation of a magnetically assisted remote controlled (MARC) catheter compared to guidance without magnetic assistance in vitro at 1.5T.

#### METHOD AND MATERIALS

#### RESULTS

#### CONCLUSION

We have developed and tested MARC catheters for endovascular navigation. At angles of 45 degrees or greater magnetic assistance was significantly faster than non-assisted guidance. The MARC catheter provides a novel opportunity to navigate effectively in interventional MRI environment. Preclinical in vivo studies are underway.

#### CLINICAL RELEVANCE/APPLICATION

Real-time MR guided catheter navigation with the MARC catheter could revolutionize minimally invasive procedures by advancing local treatment of stroke, cardiac arrhythmias and solid tumors.

### SST16-04 • Non-enhanced T1-weighted Imaging of the Visceral Arteries at 7 Tesla

**Anja Fischer** MD (Presenter) ; **Oliver Kraff** MSc ; **Stefan Maderwald** PhD, MSc ; **Karsten J Beiderwellen** MD ; **Thomas C Lauenstein** MD ; **Lale Umutlu** MD \*

#### PURPOSE

Aim of the study was to assess the feasibility of different non-contrast-enhanced T1-weighted (w) sequences for imaging of the visceral arteries of the upper abdomen at 7 Tesla.

#### METHOD AND MATERIALS

12 healthy volunteers were examined on a 7 T whole-body MR-system utilizing a custom-built 8-channel transmit/receive coil and radiofrequency shimming. The following non-enhanced sequences were acquired: (1) T1w 2D FLASH, (2) T1w 3D FLASH and (3) Time of flight (TOF)-MRA in transversal orientation. The following visceral arteries were evaluated (1) both common hepatic arteries, (2) coeliacal and splenic artery, (3) superior and (4) inferior mesenteric artery. For qualitative analysis, image quality and the presence of artifacts were assessed using a five-point scale (image quality: 5 = excellent vessel delineation to 1 = non-diagnostic; artifacts: 5 = no artifact to 1 = non-diagnostic). Contrast Ratios (CR = (Svessel-Sliver)/(Svessel+Sliver)) of the above named arteries in correlation to adjacent visceral tissue or psoas muscle were calculated for quantitative assessment. For statistical analysis, a Wilcoxon Rank Test was applied.

#### RESULTS

All three sequences provided a homogenous hyperintense delineation of the assessed visceral arteries. Qualitative image analysis showed a superiority of TOF MRA, providing best overall image quality (TOF 4.17, 2D FLASH 3.42, 3D FLASH 3.46) and highest mean values for image quality for all analyzed vessel segments. TOF MRA showed least impairment due to artifacts (overall artifacts TOF 4.08, 2D FLASH 3.50, 3D FLASH 3.46). Quantitative image analysis confirmed the superiority of the TOF sequence showing significant higher CR values for all visceral arteries due to an effective suppression of background signal (e.g. right hepatic artery TOF 4.25, 2D FLASH 3.54, 3D FLASH 3.33; p

#### CONCLUSION

Non-contrast-enhanced T1w imaging in general and, TOF MRA in particular, appear to be promising techniques for good quality assessment of visceral arteries without the need of contrast media at 7 Tesla.

#### CLINICAL RELEVANCE/APPLICATION

Non-enhanced MRA of visceral arteries at 7 T may bear the potential to be a good alternative to contrast-enhanced MRA, particularly for examination of patients with renal insufficiency.

### SST16-05 • MR Lymphangiography in Clinical Diagnostics of Focal Lesions of the Lymphatic Vessel System in Peripheral Lymphedema

**Frederik F Strobl** MD (Presenter) ; **Carolin Burgard** ; **Mayo Weiss** ; **Maximilian F Reiser** MD ; **Mike Notohamiprodjo**

#### PURPOSE

Lymphoceles or focal dermal backflow form part of focal lesions of the peripheral lymphatic system. Focal dermal backflow is a frequent drainage pattern in the imaging of primary and secondary lymphedema and stands for a diffuse leakage of the tracer into subcutaneous tissue. In addition to lymphoscintigraphy, the magnetic resonance (MR) lymphangiography provides a valuable morphological and anatomical gain in information. Patients with this aforementioned disease pattern can benefit from this kind of information in pre- and postsurgical diagnostic procedures. The purpose of this study was to compare findings of MR lymphangiography with those of lymphoscintigraphy in the assessment of focal lesions of the lymphatic vessel system in peripheral lymphedema.

#### METHOD AND MATERIALS

In this study, 44 consecutive patients with uni- or bilateral lymphedema and lymph vessel transplants of the lower extremities were included. MR lymphangiographies were performed with a 3.0-T fat-saturated three-dimensional gradient-echo MR after gadopentetate dimeglumine injection. Results of MR lymphangiography and lymphoscintigraphy were reviewed separately by a radiologist and a nuclear physician and concordance of the two techniques regarding existence, localization, distribution and confidence were examined.

#### RESULTS

With lymphoscintigraphy, which constituted the standard diagnostic procedure, focal lesions like lymphoceles or focal dermal backflow could be diagnosed in 23 patients. This result was confirmed by MR lymphangiography in 19 patients. Thus, there exists an excellent sensitivity of 83% and a specificity of 84% for MR lymphangiography. In addition, MR lymphangiography depicted auxiliary information about the anatomical constitution of lymph vessels or lymphoceles and showed a better differentiation between focal multiple or diffuse lesions.

#### CONCLUSION

Imaging findings of both techniques, the MR lymphangiography and the lymphoscintigraphy, showed an excellent correlation. Due to superior morphological and anatomical resolution, MR lymphangiography provides supplementary information for pre-surgical work-up in patients with focal lesions of the lymphatic vessel system in peripheral lymphedema.

#### CLINICAL RELEVANCE/APPLICATION



MR lymphangiography can provide 3D anatomical information without radiation exposure. Therefore it is a valuable alternative to lymphoscintigraphy in patients with peripheral lymphedema.

### **SST16-06 • Thermal versus Mechanical Disruption of Mice Melanoma due to MR Guided HIFU, a Feasibility Study**

**Martijn Hoogenboom** MSc (Presenter) ; **Martin J Van Amerongen** MSc ; **Iringo Kovacs** ; **Gosse Adema** ; **Arend Heerschap** PhD ; **Jurgen J Futterer** MD, PhD

#### **PURPOSE**

MR guided HIFU is an upcoming technique for non-invasive tumor treatment, however the differences in pathologic and immunologic effects by thermal or mechanical HIFU treatment is uncertain. The purpose of this feasibility study is to differentiate between mechanical and thermal MR guided HIFU ablation and to visualize the different pathologic and immunologic effects.

#### **METHOD AND MATERIALS**

Nine C57Bl/6n wild type mice were subcutaneously injected with B16F10 tumor cells at the right femur. After 9-10 days the tumor size was >8x8 mm. A 3MHz, 16 channel phased array HIFU system with an acoustic energy of 43-46W, was placed in a 7T animal MR scanner. An in-house made gelpad and degassed water was used for acoustic coupling.

The ablation process was visualized using MR guided thermometry (FLASH sequence, proton resonance frequency shift method: TR/TE=40/4ms, flip angle 25°, 5slices, 0.3mm inter-slice distance, voxel size 0.78x0.78x1.5mm<sup>3</sup>, 3.8s/dynamic, 0.5°C temperature accuracy).

Three different treatment strategies (3-6 spots) were applied in each tumor, 3 mice per strategy, respectively. First, continuous wave (CW) mode, 4 seconds ablation. Second, pulsed wave (PW) mode, 120shots of 20ms, pulse repetition frequency (PRF) of 4. Third, PW-mode, 500shots of 5ms, PRF 4. The mice are sacrificed 3 days after treatment, the tumor is removed for pathological evaluation, using HE-staining.

#### **RESULTS**

Temperatures of >35,

#### **CONCLUSION**

Thermal and mechanical HIFU treatment create different pathologic and immunologic responses, further research is necessary for quantification of these differences.

#### **CLINICAL RELEVANCE/APPLICATION**

Pathologic and immunologic effects due to HIFU are still uncertain, before testing on humans a mice set up is created for a good evaluation of these effects.

### **SST16-07 • MR-guided Focused Ultrasound Ablation of Pancreatic Cancer: A Totally Non-invasive Treatment for Pain Palliation and Tumor Control of Locally Advanced Lesions (Stage III)**

**Fulvio Zaccagna** MD (Presenter) ; **Alessandro Napoli** MD ; **Gaia Cartocci** ; **Gulia Brachetti** ; **Fabrizio Boni** ; **Vincenzo Noce** MD ; **Luca Bertaccini** ; **Maurizio Del Monte** ; **Carlo Catalano** MD

#### **PURPOSE**

To evaluate the feasibility of MR-guided focused ultrasound (MRgFUS) ablation for pain palliation and local tumor control in selected patients with unresectable primary pancreatic adenocarcinoma.

#### **METHOD AND MATERIALS**

6 patients with histologically proven unresectable pancreatic adenocarcinoma, who were clinically unable (n 4) or refused (n 2) to undergo chemo-radiation therapy, underwent MRgFUS treatment on a dedicated 3T unit featuring the ExAblate 2100 system (InSightec). All lesions were evaluated for device accessibility prior to treatment. MRgFUS procedures were performed in general anesthesia with constant breath control. Clinical assessment included evaluation of symptoms severity with visual analogue scale (VAS) before and after treatment. After treatment all patients underwent CHT with the same chemotherapy scheme. Imaging follow-up, including both CT and MR examinations, was performed immediately after treatment and at 3 and 6 months in order to evaluate the effects of MRgFUS on the targeted tumor and the absence of procedure-related complications.

#### **RESULTS**

#### **CONCLUSION**

Our preliminary clinical experience suggests that MRgFUS is a feasible and repeatable ablative technique in selected patients with unresectable and device-accessible pancreatic adenocarcinoma.

#### **CLINICAL RELEVANCE/APPLICATION**

MRgFUS treatment for locally advanced pancreatic tumor is a safe procedure and could be repeated without increase of adverse event risk.

### **SST16-08 • The Synergy of High-intensity Focused Ultrasound and Low-dose Generic Chemotherapeutic Virtually Eliminates Multi-drug Resistant Solid Tumor Cells**

**Howard Q Vo** MD, MS (Presenter) ; **Yoo-Shin Kim** PhD ; **Brian E O'Neill** PhD

#### **PURPOSE**

Despite medical advances, multidrug-resistant (MDR) cancers continue to challenge the patients. Their clinical prognoses may further be complicated by the need for additional surgical procedures and/or radiotherapy. In this study, we seek to evaluate a new strategy in which the synergy of high-intensity focused ultrasound (HIFU) and a single low dose of a generic chemotherapeutic is utilized to attack MDR solid tumor cells.

#### **METHOD AND MATERIALS**

This strategy is partly an outgrowth of an in-house Phase 4 clinical trial in which MRI-guided HIFU was used to treat uterine fibroids. The clinical procedure was adapted for the 3-day *in vitro* study during which human uterine sarcoma cell line (MES-SA/Dx5 (ATCC® CRL1977®)), known for resistance to multiple drugs such as Doxorubicin (Dox), was paradoxically treated with Dox.

Day 1: Each data sample consisted of ~20K cells grown inside a well of 8-well glass slides (Lab-Tek). The well was then filled with McCoy's media and incubated at 36 °C for 4h. Afterward each well was sealed and secured onto a fixture before being submerged in a warm degassed water bath. The targets for HIFU therapy are the center points of the 4 quadrants of each well's base. The constant HIFU parameters for each well were acoustic pressure 7MPa, RF 1Hz, focal-zone depth and 30 sec/sonication/center point while duty cycle (DC) ranged 0-60% between the wells. 2h after HIFU treatment, the wells were unsealed and incubated overnight.

Day 2: Cell media for each well was replaced with fresh media containing [Dox] 0-1 ug/mL prior to repeating the HIFU procedure from 24h earlier.

Day 3: After 24h of exposure to Dox, cell survivability study was performed to determine the contributions of HIFU-mediated necrosis and Dox-mediated apoptosis.

#### **RESULTS**

Cell survivability decreased by increasing [Dox] or DC. In the Dox-only group (DC 0%), average survivability was 93% for [Dox] 0.5 ug/mL while in the HIFU-only group ([Dox] 0 ug/mL), average survivability was 42% for DC 50%. In contrast, there was virtually no survivability of sarcoma cells for [Dox] 0.5 ug/mL and DC = 50%.

## CONCLUSION

The synergy of HIFU and low-dose Doxorubicin was successful in virtually eliminating MDR uterine sarcoma cells.

## CLINICAL RELEVANCE/APPLICATION

A combination of HIFU and a low-dose generic chemotherapeutic may be a promising alternative to existing treatments (regular-dose multidrug regimen, surgery or radiotherapy) against some MDR cancers.

## SST16-09 • Non-Vascular Interventional Procedures in an Urban General Hospital: Analysis of 2001-2010 with Comparison to the Previous Decade

**Peter F Hahn MD, PhD (Presenter) \* ; Alexander R Guimaraes MD, PhD \* ; Ronald S Arellano MD ; Peter R Mueller MD \* ; Debra A Gervais MD \***

## PURPOSE

Non-vascular image-guided procedures such as biopsy and fluid drainage are accepted medical care. Having previously reported an analysis of the 21324 cases in the 1991-2000 fiscal years, we undertook a comparative study of procedures performed by the same abdominal interventional group from October, 2000 through September, 2010.

## METHOD AND MATERIALS

With IRB approval a 20-year quality assurance database verified against the radiology information system was queried for procedure location (eg. pleura, liver, bowel, abdomen) and type (eg. biopsy, catheter insertion, transient drainage), demographics and trends. New hospital numbers assigned each year served to normalize for overall hospital activity.

## RESULTS

We performed 50195 IR procedures in 24309 distinct patients (M:F 12625:11684; average age 60), 940 procedures in under-20s and 571 in patients 90 or older. 15345, 4377 and 1754 patients had 1, 2 or 3 procedures; 470 had 10 or more. 27 supervising radiologists and 277 individuals participated as operators, double the previous decade. Biopsy (4.8% average yearly increase), abdominal drainage (7.3%), paracentesis (12.9%), tube manipulation (13.0%), suprapubic tube insertion (21.0%), and gastrostomy (44.6%) all increased strongly (p

## CONCLUSION

Referrals for non-vascular IR procedures have doubled over two decades, outpacing growth in new hospital patients and requiring increased resource allocation.

## CLINICAL RELEVANCE/APPLICATION

Since some specialized procedures like biliary and renal drainage have not increased proportionately, newly trained operators may have diminished experience with these more demanding cases.

## Disclosure Index

### A

**Abbara, S.** - Consultant, Perceptive Informatics, Inc Author with royalties, Reed Elsevier Author with royalties, Amirsys, Inc  
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**Aguirre, S.** - Founder, EchoPixel, Inc Shareholder, EchoPixel, Inc  
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**Awai, K.** - Research Grant, Toshiba Medical Systems Research Grant, Hitachi Medical Corporation Research Grant, Bayer AG Research Consultant, DAIICHI SANKYO Group Research Grant, Eisai Ltd

### B

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**Bax, J.** - Research funded, Eigen  
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**Brown, D. B.** - Consultant, Cook Group Incorporated Consultant, Biocompatibles International plc  
**Brown, K. M.** - Employee, Koninklijke Philips Electronics NV  
**Brunken, R.** - Research Grant, Bracco Group Research Grant, Astellas Group  
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**Burrows, P. E.** - Research Consultant, Pierre Fabre Laboratories

### C

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**Collins, J. D.** - Consultant, C. R. Bard, Inc  
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**Cosgrove, D. O.** - Research Consultant, SuperSonic Imagine Research Consultant, Bracco Group Speakers Bureau, Toshiba Corporation  
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**D**

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**E**

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**F**

**Faintuch, S.** - Consultant, Boston Scientific Corporation  
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**Forsberg, F.** - Equipment support, Toshiba Corporation Equipment support, Siemens AG Research collaboration, General Electric Company Research collaboration, Ultrasonix Medical Corporation Research collaboration, Toshiba Corporation Advisory Board, Siemens AG Advisory Board, Toshiba Corporation  
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**G**

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**Gebauer, B.** - Research Consultant, C. R. Bard, Inc Research Consultant, Sirtex Medical Ltd Research Grant, C. R. Bard, Inc Research Consultant, Perceptive Inc  
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**Gervais, D. A.** - Research Grant, Covidien AG  
**Geschwind, J. H.** - Consultant, Biocompatibles International plc Consultant, Bayer AG Consultant, Guerbet SA Consultant, Nordion, Inc Grant, Biocompatibles International plc Grant, F. Hoffmann-La Roche Ltd, Inc Grant, Bayer AG Grant, Koninklijke Philips Electronics NV Grant, Nordion, Inc Grant, ContextVision AB Grant, Celonova BioSciences, Inc Founder, PreScience Labs, LLC CEO, PreScience Labs, LLC  
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**Guo, W.** - Research Grant, Siemens AG

**H**

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**Hetts, S. W.** - Consultant, Silk Road Medical Inc Consultant, Medina Medical Inc Research Grant, Stryker Corporation Data Safety Monitoring Board, Stryker Corporation  
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**Hinshaw, J.** - Stockholder, NeuWave Medical, Inc Medical Advisory Board, NeuWave Medical, Inc Stockholder, Novelos Therapeutics, Inc  
**Hippe, D. S.** - Research Grant, Koninklijke Philips Electronics NV Research Grant, General Electric Company Research Grant, Koninklijke Philips Electronics NV  
**Ho, V. B.** - In-kind support, General Electric Company  
**Hong, K. K.** - Speaker, Boston Scientific Corporation Consultant, SureFire, LLC  
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**Houston, G.** - Director, Vascular Flow Technologies Ltd Shareholder, Vascular Flow Technologies Ltd Grant, Guerbet SA  
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**I**

**Ichikawa, T.** - Consultant, DAIICHI SANKYO Group

**J**

**Jacobson, J.** - Stockholder, Genelux Corporation  
**Johnson, K. M.** - Research support, General Electric Company

**K**

**Kagen, A. C.** - Speakers Bureau, Lantheus Medical Imaging, Inc Consultant, Lantheus Medical Imaging, Inc

**Kalva, S. P.** - Proctor, Sirtex Medical Ltd Consultant, Celonova Biosciences Inc  
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**Karellas, A.** - Institutional research collaboration, Koninklijke Philips Electronics NV Institutional research collaboration, Hologic, Inc  
**Kauczor, H.** - Research Grant, Boehringer Ingelheim GmbH Research Grant, Siemens AG Speakers Bureau, Boehringer Ingelheim GmbH Speakers Bureau, Bayer AG Speakers Bureau, Siemens AG  
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**Kruskal, J. B.** - Author, UpToDate, Inc  
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**Kukreja, K. U.** - Institutional research collaboration, Koninklijke Philips Electronics NV  
**Kuribayashi, S.** - Research Grant, General Electric Company

## L

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**Lubner, M. G.** - Grant funding, GE-AUR Radiology Research Academic Fellowship

## M

**Machac, J.** - Consultant, General Electric Company Research collaboration, Koninklijke Philips Electronics NV Researcher, Lantheus Medical Imaging, Inc  
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**Matthew, S.** - Research funded, Guerbet SA  
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**Muthupillai, R.** - Research support, Koninklijke Philips Electronics NV

## N

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## O

**O'Connell, T.** - President, Resolve Radiologic Ltd  
**Olsen, J. R.** - Dfine, Inc. Provision of consulting services regarding the use of radiotherapy for palliative treatment of bone metastases.  
**Osterhues, S.** - Employee, Vygon SA

## P

**Palmer, S. L.** - Research Consultant, Halt Medical, Inc  
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**Pua, B. B.** - Consultant, Kimberly-Clark Corporation

## Q

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## R

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## S

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**Scharf, S.** - Consultant, Koninklijke Philips Electronics NV  
**Schoenberg, S. O.** - Institutional research agreement, Siemens AG  
**Schoepf, U.** - Research Grant, Bracco Group Research Grant, General Electric Company Research Consultant, Siemens AG Research Grant, Siemens AG  
**Scholz, F. J.** - Owner, FSpoon Company  
**Schultz, K.** - Employee, Toshiba Corporation  
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**Sugimura, K.** - Research Grant, Toshiba Corporation Research Grant, Koninklijke Philips Electronics NV Research Grant, Bayer AG Research Grant, Eisai Co, Ltd Research Grant, DAIICHI SANKYO Group  
**Sun, M. R.** - Investigator, Bracco Group

## T

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## U

**Umutlu, L.** - Consultant, Bayer AG

## V

**Van Beek, E. J.** - Research support, Toshiba Corporation Research support, Siemens AG Founder and owner, QCTIS, Inc Speaker, Toshiba Corporation  
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**Veltri, A.** - Speakers Bureau, Eli Lilly and Company Speakers Bureau, Bayer AG  
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**Viswanathan, C.** - Consultant, Hollister Incorporated  
**Von Tengg-Kobligh, H.** - Research Grant, W. L. Gore & Associates, Inc  
**Von Walter, M.** - Employee, Hemoteq AG

## W

**Wakayama, T.** - Employee, General Electric Company  
**Wallace, M. J.** - Speaker, Siemens AG Research support, Siemens AG  
**Wasiak, C.** - Employee, Fraunhofer-Gesellschaft

**Webb, J.** - Consultant, Edwards Lifesciences Corporation  
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**Westcott, M. A.** - Consultant, Sirtex Medical Ltd  
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**Wood, D.** - Consultant, Edwards Lifesciences Corporation Consultant, St. Jude Medical, Inc  
**Woodard, P. K.** - Research support, Siemens AG Meeting travel, Siemens AG Research support, Astellas Group Consultant, Medtronic, Inc Consultant, BIOTRONIK GmbH & Co KGC Consultant, GE Healthcare

## Y

**Yamashita, Y.** - Consultant, DAIICHI SANKYO Group  
**Yarmohammadi, H.** - Research Grant, Repligen Corporation Researcher, Galil Medical Ltd  
**Yuan, C.** - Research Grant, Koninklijke Philips Electronics NV Research Grant, VP Diagnostics, Inc Consultant, Medpace, Inc Consultant, Bristol-Myers Squibb Company Consultant, Boehringer Ingelheim GmbH

## Z

**Zabic, S.** - Employee, Koninklijke Philips Electronics NV  
**Zamboni, G. A.** - Speaker, Guerbet SA  
**Zhang, J.** - Research support, Koninklijke Philips Electronics NV  
**Zulliger, M. A.** - Former Employee, SCANCO Medical AG