

# 103<sup>rd</sup> Scientific Assembly and Annual Meeting

November 26 to December 1  
McCormick Place, Chicago



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# Friday

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RC801

## Imaging of Cardiothoracic Emergencies

Friday, Dec. 1 8:30AM - 10:00AM Room: E353C

CA CH ER

AMA PRA Category 1 Credits™: 1.50  
ARRT Category A+ Credit: 1.75

### LEARNING OBJECTIVES

1) To review imaging manifestations of common life-threatening complications of thoracic trauma. 2) To highlight common difficulties radiologists encounter when interpreting imaging studies in patients with thoracic trauma. 3) Overview current imaging strategies and key facts in Pulmonary Embolism imaging. 4) Provide an update on current issues and challenges in Pulmonary Embolism imaging. 5) Improve their recognition of the appearances of different thoracic aortic repair techniques. 6) Understand normal post operative findings which can be confused for pathology. 7) Be able to recognize frequently seen complications and understand their importance. 8) Overview current imaging strategies and key facts in pulmonary embolism imaging. 9) Provide an update on current issues and challenges in pulmonary embolism imaging. 10) Describe current appropriateness criteria for imaging of patients with suspected acute coronary syndrome. 11) Identify the findings of acute coronary syndrome on imaging studies.

### SAM

New in 2017: PLEASE NOTE - All courses designated for SAM credit at RSNA 2017 will require attendees bring a personal device e.g. phone, iPad, laptop to complete the required test questions during the live session.

### Sub-Events

#### RC801A Thoracic Trauma

Participants

Santiago Martinez-Jimenez, MD, Kansas City, MO (*Presenter*) Author, Reed Elsevier; Author, Oxford University Press

### LEARNING OBJECTIVES

1) To review imaging manifestations of common life-threatening complications of thoracic trauma. 2) To highlight common difficulties radiologists encounter when interpreting imaging studies in patients with thoracic trauma. 3) Overview current imaging strategies and key facts in Pulmonary Embolism imaging. 4) Provide an update on current issues and challenges in Pulmonary Embolism imaging.

### Honored Educators

Presenters or authors on this event have been recognized as RSNA Honored Educators for participating in multiple qualifying educational activities. Honored Educators are invested in furthering the profession of radiology by delivering high-quality educational content in their field of study. Learn how you can become an honored educator by visiting the website at: <https://www.rsna.org/Honored-Educator-Award/> Santiago Martinez-Jimenez, MD - 2014 Honored Educator Santiago Martinez-Jimenez, MD - 2015 Honored Educator Santiago Martinez-Jimenez, MD - 2017 Honored Educator

#### RC801B Imaging of the Repaired Thoracic Aorta: Normal Appearances and Complications

Participants

Constantine A. Raptis, MD, Saint Louis, MO (*Presenter*) Nothing to Disclose

### LEARNING OBJECTIVES

1) Improve their recognition of the appearances of different thoracic aortic repair techniques. 2) Understand normal post operative findings which can be confused for pathology. 3) Be able to recognize frequently seen complications and understand their importance.

#### RC801C Pulmonary Embolism

Participants

Ioannis Vlahos, MRCP, FRCR, London, United Kingdom (*Presenter*) Research Consultant, Siemens AG; Research Consultant, General Electric Company;

**For information about this presentation, contact:**

johnny.vlahos@stgeorges.nhs.uk

### LEARNING OBJECTIVES

1) Overview current imaging strategies and key facts in pulmonary embolism imaging. 2) Provide an update on current issues and challenges in pulmonary embolism imaging.

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**RC801D Acute Coronary Syndrome**

Participants

Harold I. Litt, MD, PhD, Philadelphia, PA (*Presenter*) Research Grant, Siemens AG ; Research Grant, Heartflow, LLC ;

**LEARNING OBJECTIVES**

1) Describe current appropriateness criteria for imaging of patients with suspected acute coronary syndrome. 2) Identify the findings of acute coronary syndrome on imaging studies.

RC804

## Osteoarthritis: Beyond the Basics

Friday, Dec. 1 8:30AM - 10:00AM Room: E450A

MR MK

AMA PRA Category 1 Credits™: 1.50  
ARRT Category A+ Credit: 1.75

### Participants

Thomas M. Link, MD, PhD, San Francisco, CA (*Director*) Research Grant, General Electric Company; Research Consultant, General Electric Company; Research Consultant, InSightec Ltd; Research Grant, InSightec Ltd; Royalties, Springer Nature; Consultant, Springer Nature; Research Consultant, Pfizer Inc;

### For information about this presentation, contact:

thomas.link@ucsf.edu

### LEARNING OBJECTIVES

1) To comprehend the epidemiology of osteoarthritis and the role of imaging in diagnosing osteoarthritis and evaluating its disease burden. 2) To understand the role of biomechanics in the evolution of osteoarthritis. 3) To know radiographic findings associated with osteoarthritis and what technique is best suited to evaluate osteoarthritis. 4) To be able to recognize MRI findings related to osteoarthritis and to know what MR sequences are most suitable. 5) To be familiar with new MR imaging technologies and new concepts in interpreting osteoarthritis.

### SAM

New in 2017: PLEASE NOTE - All courses designated for SAM credit at RSNA 2017 will require attendees bring a personal device e.g. phone, iPad, laptop to complete the required test questions during the live session.

### Sub-Events

#### RC804A Epidemiology of Osteoarthritis and the Role of Imaging

Participants

Leena Sharma, MD, Chicago, IL (*Presenter*) Nothing to Disclose

### LEARNING OBJECTIVES

1) Understand the role of MRI in the investigation of the natural history of osteoarthritis (OA). 2) Gain insight into the current state of knowledge concerning early OA disease pathogenesis, as illuminated by MRI. 3) Gain familiarity with recent studies of OA risk prediction models incorporating MRI findings. 4) Understand potential application of MRI to define presence of osteoarthritic disease.

#### RC804B Impact of Biomechanics on the Evolution of Osteoarthritis

Participants

Christine B. Chung, MD, La Jolla, CA (*Presenter*) Nothing to Disclose

### LEARNING OBJECTIVES

View Learning Objectives under main course title

#### RC804C Radiographic Techniques and Evaluation

Participants

Frank W. Roemer, MD, Erlangen, Germany (*Presenter*) Chief Medical Officer, Boston Imaging Core Lab LLC; Director of Research, Boston Imaging Core Lab LLC; Shareholder, Boston Imaging Core Lab LLC; ;

### For information about this presentation, contact:

froemer@bu.edu

### LEARNING OBJECTIVES

1) To understand the challenges of radiographic acquisition in a clinical and research context. 2) To learn about the different assessment instruments currently available including semi-quantitative and quantitative approaches. 3) To gain insight into advanced radiographic assessment including bone structural analysis. 4) To understand the shortcomings of radiography as a predictor or outcome measure.

### ABSTRACT

Conventional radiography remains the most commonly applied imaging technique for the evaluation of osteoarthritis (OA) in both clinical practice and research. Radiography allows the detection of OA-associated bony features such as osteophytes, subchondral sclerosis and cysts but has limitations in visualizing soft tissue changes. Radiography can also determine joint space width, a surrogate marker for cartilage thickness and meniscal integrity in knees, but direct visualization of these articular structures is impossible using radiographic techniques. The lack of sensitivity and specificity of radiography for the detection of most of OA-

associated articular tissue damage and its poor sensitivity to change over time are other limitations of radiography. Changes in joint positioning will affect measurement of various radiographic parameters including joint space width. Despite these limitations radiography remains to be the gold standard for establishing an imaging-based diagnosis of OA and for assessment of structural modification in clinical trials of OA.

#### **RC804D MRI - Morphological Imaging - Techniques and Findings**

##### **Participants**

Thomas M. Link, MD, PhD, San Francisco, CA (*Presenter*) Research Grant, General Electric Company; Research Consultant, General Electric Company; Research Consultant, InSightec Ltd; Research Grant, InSightec Ltd; Royalties, Springer Nature; Consultant, Springer Nature; Research Consultant, Pfizer Inc;

##### **For information about this presentation, contact:**

thomas.link@ucsf.edu

##### **LEARNING OBJECTIVES**

1) To be able to apply optimized sequence protocols to MR imaging of osteoarthritis. 2) To analyze typical MRI findings related to osteoarthritis including cartilage defects, meniscal tears, bone marrow edema pattern and ligamentous abnormalities. 3) To comprehend the differential diagnosis of typical MRI findings and to be familiar with more uncommon abnormalities seen in osteoarthritis.

#### **RC804E MRI - Compositional Imaging - Techniques and Interpretation**

##### **Participants**

Hollis G. Potter, MD, New York, NY (*Presenter*) Research support, General Electric Company; Institutional research agreement, General Electric Company

##### **LEARNING OBJECTIVES**

1) To become familiar with the options for assessment of early matrix depletion in hyaline and fibrocartilage. 2) To understand the technical limitations and requirements for each of these applications. 3) To demonstrate the clinical utility of parametric mapping in clinical and research design, both to assess the rate of progression of osteoarthritis in susceptible cohorts as well as in cartilage repair.

#### **RC804F Imaging of Synovitis and New Concepts in OA Imaging**

##### **Participants**

Ali Guermazi, MD, PhD, Boston, MA (*Presenter*) President, Boston Imaging Core Lab, LLC; Research Consultant, Merck KGaA; Research Consultant, sanofi-aventis Group; Research Consultant, TissueGene, Inc; Research Consultant, OrthoTrophix, Inc; Research Consultant, AstraZeneca PLC; Research Consultant, General Electric Company; Research Consultant, Pfizer Inc

##### **For information about this presentation, contact:**

guermazi@bu.edu

##### **LEARNING OBJECTIVES**

1) To understand various ways of imaging synovitis in osteoarthritis. 2) To appreciate the limitations of radiography as an imaging tool to define an outcome for clinical trials. 3) To understand available quantitative measurement techniques in osteoarthritis. 4) To gain insight into the different phenotypes of osteoarthritis.

##### **Honored Educators**

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RC805

## Horse or Zebra? Mimics of Common Neuro and Head & Neck Lesions (An Interactive Session)

Friday, Dec. 1 8:30AM - 10:00AM Room: E451B

HN NR

AMA PRA Category 1 Credits™: 1.50  
ARRT Category A+ Credit: 1.75

FDA Discussions may include off-label uses.

### Participants

Deborah R. Shatzkes, MD, New York, NY (*Moderator*) Nothing to Disclose  
Christopher P. Hess, MD, PhD, Mill Valley, CA (*Moderator*) Research Grant, General Electric Company; Research Grant, Quest Diagnostics Incorporated;

### Sub-Events

#### RC805A Brain Tumor or Mimic?

Participants

Timothy J. Amrhein, MD, Cary, NC (*Presenter*) Nothing to Disclose

#### LEARNING OBJECTIVES

1) List some important mimics of brain tumors. 2) Identify and describe imaging features helpful in distinguishing between brain tumors and their mimics.

#### RC805B Lymph Node or Mimic?

Participants

Bronwyn E. Hamilton, MD, Loma Linda, CA (*Presenter*) Editor, Reed Elsevier

#### For information about this presentation, contact:

hamiltob@ohsu.edu

#### LEARNING OBJECTIVES

1) Recognize normal anatomical structures and pathology that mimic lymph nodes on cross sectional imaging.

#### RC805C Stroke or Mimic?

Participants

Kambiz Nael, MD, New York, NY (*Presenter*) Medical Advisory Board, Toshiba Medical Systems Corporation

#### For information about this presentation, contact:

kambiznael@gmail.com

#### LEARNING OBJECTIVES

1) To become familiar with common brain pathologies associated with restricted diffusion using MR diffusion-weighted Imaging (DWI). 2) To distinguish ischemic stroke from stroke mimics using DWI pattern recognition. 3) To apply other MR methodology and understand their potential added value to DWI in differentiating stroke from stroke mimics.

#### RC805D Sinonasal Polyp or Mimic?

Participants

Kristen L. Baugnon, MD, Atlanta, GA (*Presenter*) Nothing to Disclose

#### For information about this presentation, contact:

kmlloyd@emory.edu

#### LEARNING OBJECTIVES

1) Identify important potential mimics of sinonasal polyposis. 2) Describe imaging features of polypoid nasal cavity masses on CT that should prompt further workup.

RC811

## Emerging Technology: Immuno Imaging Probes—Opportunities and Challenges

Friday, Dec. 1 8:30AM - 10:00AM Room: E261

MI NM OI US

AMA PRA Category 1 Credits™: 1.50  
ARRT Category A+ Credit: 1.75

FDA Discussions may include off-label uses.

### Sub-Events

#### RC811A A Primer on 89Zr-ImmunoPET

##### Participants

Brian M. Zeglis, PhD, New York, NY (*Presenter*) Nothing to Disclose

##### LEARNING OBJECTIVES

1) To learn about the basic physical and chemical properties of the radioisotope 89Zr. 2) To understand the basic components of a 89Zr-labeled radioimmunoconjugate. 3) To understand how 89Zr-labeled radioimmunoconjugates are synthesized and purified. 4) To gain an appreciation of the forces behind the recent advent of 89Zr-based immunoPET imaging. 5) To explore the PSMA-targeting radioimmunoconjugate 89Zr-DFO-J591 as a case study for the journey of an immunoPET imaging agent from the laboratory to the clinic.

#### RC811B Engineered Antibodies for ImmunoPET: Probes for Profiling Tumors and Immune Responses

##### Participants

Anna M. Wu, PhD, Los Angeles, CA (*Presenter*) Stockholder, ImaginAb, Inc; Consultant, ImaginAb, Inc; Consultant, Avidity Biosciences LLC;

##### For information about this presentation, contact:

awu@mednet.ucla.edu

##### LEARNING OBJECTIVES

1) Identify key properties of antibodies that can be modified/improved to produce probes optimized for in vivo imaging. 2) Discuss applications of new immunoPET tracers to address challenges in oncology and immunology. 3) Describe the process and potential of translating immunoPET probes into clinical use.

#### RC811C Clinical Applications of Immuno Probes in Oncology

##### Participants

Elisabeth G.E. de Vries, MD, PhD, Groningen, Netherlands (*Presenter*) Institutional Research Grant, F. Hoffmann-La Roche Ltd ; Institutional Research Grant, Amgen Inc; Institutional Research Grant, Synthron Holding BV; Institutional Research Grant, AstraZeneca PLC; Institutional Research Grant, Radius Health, Inc; Institutional Research Grant, CytomX Therapeutics, Inc; Institutional Research Grant, Nordic Nanovector ASA; Consultant, Synthron Holding BV; Consultant, Pfizer Inc

##### For information about this presentation, contact:

e.g.e.de.vries@umcg.nl

##### LEARNING OBJECTIVES

1) To learn about the answers immuno probes can provide in clinical oncology. 2) To learn about the potential of the immuno probes consisting of radioactively labeled antibodies as well as fluorescently labeled antibodies in the clinic.

##### ABSTRACT

Currently monoclonal antibodies (mAbs) are an expanding innovative class of cancer drugs. Numerous mAbs, including several antibody-drug conjugates, are in advanced clinical development, forming an important part of the many molecularly targeted anticancer therapeutics currently in development. Development and treatment decisions for registered mAbs could benefit from quantitative biomarkers, enabling visualization of the tissue distribution of (potentially modified) therapeutic mAbs to confirm effective whole-body target expression, engagement, and modulation and to evaluate heterogeneity across lesions and patients. Such biomarkers may be realized with positron emission tomography (PET) imaging of radioactively labeled antibodies, a process called immunoPET or with a fluorescently labeled antibodies and optical imaging. This approach could potentially increase the power and value of trials and clinical practice by improving patient selection, optimizing dose and schedule, and rationalizing observed drug responses.

#### RC811D Companion Imaging Diagnostics: Small Molecule Ligands versus Immune-Based Agents

##### Participants

Michael D. Farwell, MD, MA, Philadelphia, PA (*Presenter*) Nothing to Disclose

##### For information about this presentation, contact:

michael.farwell@uphs.upenn.edu

**LEARNING OBJECTIVES**

1) Describe desirable properties of a companion diagnostic imaging probe. 2) Discuss likely clinical scenarios where a companion diagnostic might be used. 3) List advantages and disadvantages of small molecule versus immune-based probes as companion diagnostics.



RC812

## Peripheral Artery Disease (PAD)

Friday, Dec. 1 8:30AM - 10:00AM Room: E351

VA CT MR

AMA PRA Category 1 Credits™: 1.50  
ARRT Category A+ Credit: 1.75

FDA Discussions may include off-label uses.

### Participants

Stephen T. Kee, MD, Stanford, CA (*Moderator*) Nothing to Disclose  
Jeremy D. Collins, MD, Chicago, IL (*Moderator*) Consultant, Guerbet SA; Grant, Siemens AG; Grant, C. R. Bard, Inc

### For information about this presentation, contact:

collins@northwestern.edu

### 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.

### Sub-Events

#### RC812A Clinical Overview of PAD

Participants  
Stephen T. Kee, MD, Stanford, CA (*Presenter*) Nothing to Disclose

### LEARNING OBJECTIVES

View learning objectives under main course title.

#### RC812B Lower Extremity CTA

Participants  
Richard L. Hallett II, MD, Stanford, CA (*Presenter*) Nothing to Disclose

### For information about this presentation, contact:

hallett@stanford.edu

### 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.

### Active Handout: Richard Lee Hallett

[http://abstract.rsna.org/uploads/2017/13012018/Active\\_RC812B.pdf](http://abstract.rsna.org/uploads/2017/13012018/Active_RC812B.pdf)

#### RC812C Lower Extremity MRA

Participants  
Harald Kramer, MD, Munich, Germany (*Presenter*) Research Consultant, Bayer AG; Speakers Bureau, b.e. imaging AG

### For information about this presentation, contact:

harald.kramer@med.lmu.de

## 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.

## RC812D Endovascular Treatment of PAD

Participants

Stephen T. Kee, MD, Stanford, CA (*Presenter*) Nothing to Disclose

## LEARNING OBJECTIVES

View learning objectives under main course title.

RC813

## Pediatric Neurooncology Imaging

Friday, Dec. 1 8:30AM - 10:00AM Room: E353A

NR OI PD

AMA PRA Category 1 Credits™: 1.50  
ARRT Category A+ Credit: 1.75

### SAM

New in 2017: PLEASE NOTE - All courses designated for SAM credit at RSNA 2017 will require attendees bring a personal device e.g. phone, iPad, laptop to complete the required test questions during the live session.

### Sub-Events

#### RC813A Pediatric Supratentorial Tumors

Participants

Usha D. Nagaraj, MD, Cincinnati, OH (*Presenter*) Co-author with royalties, Reed Elsevier

#### LEARNING OBJECTIVES

1) Review the differential of supratentorial pediatric brain tumors involving the cerebral hemispheres. 2) Review imaging findings of some of the most common pediatric supratentorial hemispheric brain tumors.

#### RC813B Pediatric Suprasellar Tumors

Participants

Maura E. Ryan, MD, Chicago, IL (*Presenter*) Nothing to Disclose

#### For information about this presentation, contact:

mryan@luriechildrens.org

#### LEARNING OBJECTIVES

1) Identify relevant anatomy of the sellar/suprasellar region. 2) Become familiar with the classic imaging appearance and imaging surveillance of pediatric suprasellar neoplasms. 3) Recognize common mimics of pediatric suprasellar tumors.

#### Active Handout: Maura E. Ryan

[http://abstract.rsna.org/uploads/2017/17000796/Active RC813B.pdf](http://abstract.rsna.org/uploads/2017/17000796/Active_RC813B.pdf)

#### RC813C Pediatric Posterior Fossa Tumors

Participants

Alok I. Jaju, MD, Chicago, IL (*Presenter*) Nothing to Disclose

#### LEARNING OBJECTIVES

1) Become familiar with the different types of pediatric posterior fossa tumors. 2) Recognize the imaging features of these lesions and be able to provide a differential diagnoses based on location and imaging appearance. 3) Recognize the imaging findings that have clinical and prognostic implications.

#### Active Handout: Alok Indraprakash Jaju

[http://abstract.rsna.org/uploads/2017/17000797/Active RC813C.pdf](http://abstract.rsna.org/uploads/2017/17000797/Active_RC813C.pdf)

#### RC813D Pediatric Spinal Cord Tumors

Participants

Nadja Kadom, MD, Atlanta, GA (*Presenter*) Nothing to Disclose

#### For information about this presentation, contact:

nkadom@emory.edu

#### LEARNING OBJECTIVES

1) Discuss various types of spinal tumors in children. 2) List causes of spinal metastatic disease. 3) List state-of-the art MRI techniques.

RC815

## Breast Imaging: Politics & Practice

Friday, Dec. 1 8:30AM - 10:00AM Room: E451A

BR

AMA PRA Category 1 Credits™: 1.50  
ARRT Category A+ Credit: 1.75

### Participants

Cherie M. Kuzmiak, DO, Chapel Hill, NC (*Moderator*) Nothing to Disclose

### Sub-Events

#### RC815A Screening Controversies

##### Participants

Daniel B. Kopans, MD, Waban, MA (*Presenter*) Royalties, Cook Group Incorporated

### LEARNING OBJECTIVES

1) Understand the data that support breast cancer screening for women ages 40 and over. 2) Understand the decades of misinformation that has confused women and their physicians and will be provided with scientifically supported facts about breast cancer screening. 3) Understand specifically how flawed analyses have led to major overestimates of 'overdiagnosis'.

### ABSTRACT

Unfortunately there has been a great deal of misinformation that has made its way past poor peer review in medical journals with undeclared biases against breast cancer screening. From the claim that there was no benefit from screening anyone; to the claim that the benefit did not begin until the age of 50; to the claim of massive 'overdiagnosis' of breast cancer, the 'alternative facts' have been allowed to proliferate and confuse women and their physicians. This presentation will provide the true facts and the science that supports screening starting at the age of 40.

#### RC815B Economic Challenges

##### Participants

Wendy B. Demartini, MD, Stanford, CA (*Presenter*) Nothing to Disclose

#### RC815C Overdiagnosis/Overtreatment

##### Participants

Stephen A. Feig, MD, Orange, CA (*Presenter*) Nothing to Disclose

### For information about this presentation, contact:

sfeig@uci.edu

### LEARNING OBJECTIVES

1) To understand what is meant by 'overdiagnosis.' 2) To discuss the strengths, limitations, and validity of the different methods used to estimate the rate of overdiagnosis at breast cancer screening. 3) To appreciate potential clinical approaches to reduce overtreatment.

RC816

**Medicolegal Issues for Radiologists: To Divulge or Not to Divulge: Diagnostic Misses and Errors (Sponsored by the RSNA Professionalism Committee)**

Friday, Dec. 1 8:30AM - 10:00AM Room: E353B

PR

AMA PRA Category 1 Credits™: 1.50  
ARRT Category A+ Credit: 0

**Participants**

Ronald L. Eisenberg, MD, JD, Boston, MA (*Moderator*) Nothing to Disclose  
Stephen D. Brown, MD, Boston, MA (*Presenter*) Nothing to Disclose  
Priscilla J. Slanetz, MD, MPH, Boston, MA (*Presenter*) Nothing to Disclose  
Brent J. Wagner, MD, Reading, PA (*Presenter*) Nothing to Disclose  
Darlene King, Lancaster, PA (*Presenter*) Nothing to Disclose

**For information about this presentation, contact:**

Brent.Wagner@readinghealth.org

**LEARNING OBJECTIVES**

- 1) Describe the responsibilities of the radiologist in terms of the peer review role inherent in the assessment of a comparison study.
- 2) Develop an approach to a robust peer review program that encourages reporting and review of diagnostic errors.
- 3) Define the parameters that impact the balance of error disclosure in the context of the potential missed finding.

**ABSTRACT**

The radiologic interpretation involves multiple facets. Most importantly, it is intended to convey a meaningful assessment that will result in either the exclusion of a diagnosis - in which case the clinical evaluation can proceed along a different path - versus establishing a diagnosis (or set of diagnostic possibilities) to guide further management. For a wide variety of reasons, imaging findings often identified in retrospect were not detected during the initial interpretation. This is especially problematic when balancing two distinct functions of a diagnostic interpretation, which not only includes the current examination but also comparison to (and, therefore, review of) a prior study dictated by a colleague. When there is a difference in the assessment of the prior study, the radiologist is potentially faced with two competing obligations: acknowledging that the interests of the patient supersede all other concerns, the radiologist must also respect the role of a structured peer review process that is an inherent part of modern-day safety culture and professional quality improvement. This exercise requires us to examine the nuance of "missed diagnoses" vs "interpretative errors" vs "findings identified in retrospect." While there is an ethical argument concerning respect for patient autonomy and right to know everything about one's own body and health, it is important for radiologists to know how to communicate such findings with care, sensitivity, and lack of defensiveness. This course not only reviews the foundational science but also examines the expectations and challenges faced by diagnostic radiologists (and the profession) when they encounter a difference regarding the assessment of a prior imaging study. Academic and private practice perspectives will be presented, as well as commentary from an experienced defense attorney who will address the balance between disclosure and peer review protection.

**SAM**

New in 2017: PLEASE NOTE - All courses designated for SAM credit at RSNA 2017 will require attendees bring a personal device e.g. phone, iPad, laptop to complete the required test questions during the live session.

RC825

## Quantitative Imaging Mini-Course: Statistical Analysis/Metrology Issues

Friday, Dec. 1 8:30AM - 10:00AM Room: E263

**BQ** **PH** **RS**

AMA PRA Category 1 Credits™: 1.50  
ARRT Category A+ Credit: 1.75

### Participants

Michael F. McNitt-Gray, PhD, Los Angeles, CA (*Coordinator*) Institutional research agreement, Siemens AG; ; ; ; ;

### Sub-Events

#### RC825A The Role of Metrology in Quantitative Imaging

##### Participants

Hyung J. Kim, PhD, Los Angeles, CA (*Presenter*) Research Consultant, MedQIA

##### For information about this presentation, contact:

gracekim@mednet.ucla.edu

### LEARNING OBJECTIVES

1) Understand the role of quantitative imaging (QI) and the measurement. 2) Apply a study design for developing, evaluation, and validating a measurement of QI in a targeted population. 3) Contribute a unified terminology for aggregating information toward bias and variation of QI markers. Many applications of using QI biomarkers or in the field of radiomics have been reported in numerous scientific publications. Challenges are to obtain a universally consistent terminology or methods in reporting a variation of QI marker under the various conditions of scanners, readers, and software. Understanding variation of 'measureland' (the quantity intended to be measured (VIM clause 2.3) in radiological imaging is critical to set a clinically meaningful benchmark of a QI. To estimate a variation of measureland, the study design is a critical basis for the each stage of development, evaluation, and validation of a QI biomarker or measurement from radiomics using a standard metric of variation. Reporting an estimated measureland universally is an initial step for combining the knowledge across studies and centers as part of evaluation and validation by an independent party. The information can be used for meta-analysis for aggregating bias and variability of a measureland. We will discuss the procedure: initialing research question, study design, and corresponding statistical methods toward development, evaluation, and validation of a measurement of QI marker in a targeted population. Furthermore, we will discuss the potential direction of meta-analysis when we use the common terminology of QI biomarkers and measurements from radiomics.

### ABSTRACT

Challenges and benchmarks have been used successfully in a number of scientific domains to make significant advances in the field by providing a common platform for collaboration and competition. By providing a common dataset and a common set of metric of evaluation, QI driven biomarkers and measurements from radiomics can facilitate a fair and rigorous evaluation of algorithms and eventually can be used clinically. Metrology is the science of measurement, including all theoretical and practical aspect of measurement at any level of uncertainty. Statistical design and evaluation in metrology is to describe the uncertainty of measurement and to derive a clinically meaningful metric in quantitative imaging.

#### RC825B Methods for Technical Performance Assessment: What to Assess and How

##### Participants

Nicholas Petrick, PhD, Silver Spring, MD (*Presenter*) Nothing to Disclose

##### For information about this presentation, contact:

nicholas.petrick@fda.hhs.gov

### LEARNING OBJECTIVES

1) Understand how to assess repeatability and reproducibility through test-retest studies. 2) Understand how to assess bias and linearity through phantom studies (or studies with an established reference standard). 3) Understand how technical performance can affect the utility of a quantitative imaging biomarker or radiomic signature.

### ABSTRACT

Developments in extracting biological information from medical images have given rise to a number of proposed quantitative imaging (QI) biomarkers and the field of radiomics. Critical to these research areas are the establishment of accurate and reproducible QI tools and the establishment of appropriate and widely accepted assessment methods. In this section of the refresher course, we will update the audience on the latest recommendations for assessing the technical performance of QI tools. We will also present examples of applying the concepts discussed in this course to actual QI biomarkers.

#### RC825C Statistical Methods and Principles for Algorithm Comparison Assessment

##### Participants

Gene Pennello, PhD, Silver Spring, MD (*Presenter*) Nothing to Disclose

**For information about this presentation, contact:**

gene.pennello@fda.hhs.gov

**LEARNING OBJECTIVES**

1) Understand objectives of algorithm comparison studies and study design principles. 2) Identify methods for testing hypotheses, estimating performance, and producing descriptive summaries for algorithm comparison. 3) Apply the statistical methods to real data and interpret the results.

**ABSTRACT**

A quantitative imaging biomarker can be defined as a physical quantity for which a measurement can be extracted from medical image(s), e.g., pulmonary nodule volume from CT scan and fracture callus size (mm<sup>2</sup>) from plain radiograph. Algorithms for deriving these measurements may be evaluated for accuracy (agreement with true value of the measurand), imprecision (variability of repeated measurements) and clinical performance (association with current or future health state). Algorithms may also be compared for agreement with each other in a method comparison study. In this talk, I'll survey performance evaluations of quantitative imaging algorithms, including graphical representations, unscaled performance metrics that are in the units of measurement, and scaled performance metrics that standardize the evaluation to a unitless scale. I'll review recent advances in measurement assessment as well as traditional metrics. I'll also review study designs including those with repeated measurements, and statistical analysis of a performance metric that account for random sampling variability, algorithm measurement error, and missing data.

RC827

## How to Take on the Role of Quality Officer in Radiology - Just Do It!

Friday, Dec. 1 8:30AM - 10:00AM Room: E260

ED HP SQ

AMA PRA Category 1 Credits™: 1.50  
ARRT Category A+ Credit: 1.75

### Participants

Kimberly E. Applegate, MD, MS, Lexington, KY (*Moderator*) Nothing to Disclose

### For information about this presentation, contact:

keapple@uky.edu

### LEARNING OBJECTIVES

1) To understand the key differences between operations and quality officer roles. 2) To be able to identify key resources that are local, web based, and organizational for training in quality and process improvement. 3) To become familiar with both qualitative and quantitative skills for the successful radiology quality officer role. 4) To be able to distinguish quality control, quality assurance, and quality improvement terminology. 5) To understand the rationale and collective learning opportunities for peer review, imaging registries, and practice quality improvement. 6) To be familiar with a team teaching format, professionalism assessment, feedback, and improvement.

### Sub-Events

#### RC827A Quality and Safety in Radiology: The Basics

Participants

Kimberly E. Applegate, MD, MS, Lexington, KY (*Presenter*) Nothing to Disclose

### LEARNING OBJECTIVES

View Learning Objectives under main course title

#### RC827B Creating a Dashboard and Metrics Worth Tracking

Participants

Hani H. Abujudeh, MD, MBA, Camden, NJ (*Presenter*) Royalties from books

### LEARNING OBJECTIVES

View Learning Objectives under main course title

#### RC827C Training in Process and Quality Improvement - Just Do It!

Participants

Michael A. Bruno, MD, Hershey, PA (*Presenter*) Nothing to Disclose

### For information about this presentation, contact:

mbruno@pennstatehealth.psu.edu

### LEARNING OBJECTIVES

1) The learner will better understand the range of skills needed for the quality role. 2) The learner will gain an understanding of the types of training opportunities available. 3) The learner will be able to assess their own skill-set in the light of #1 and #2 and plan a strategy to obtain any needed or remedial training in order to optimally prepare themselves for the quality role.

### ABSTRACT

In this presentation we will review the range of skills needed to function well in the role of quality officer, and discuss training options and opportunities which are available. Emphasis will be on self-assessment and self-directed learning. The role of formal training (e.g., Lean Six-Sigma Yellow and Green-belt levels) will also be discussed, as well as educator resources for teaching Quality & Safety to trainees (residents/fellows in Radiology).



RC829

## Six Common Difficult Problems in GI and GU MRI: The Experts' Approach

Friday, Dec. 1 8:30AM - 10:00AM Room: E450B

GI GU MR

AMA PRA Category 1 Credits™: 1.50  
ARRT Category A+ Credit: 1.75

FDA Discussions may include off-label uses.

### Participants

Hero K. Hussain, MD, Ann Arbor, MI (*Moderator*) Nothing to Disclose

### LEARNING OBJECTIVES

1) Describe the differences between extracellular and hepatobiliary contrast. 2) Explain the types of liver lesion seen on CT that may benefit from imaging with hepatobiliary contrast. 3) Limitation of CT imaging in characterization of small renal masses (with focus on discriminating benign/indolent renal tumors from aggressive renal cancer). 4) Role of MRI as a problem solving tool in characterizing cystic and solid renal masses. 5) Evolving role of MRI in renal mass (histologic) subtyping and assessment of renal tumor aggressiveness. 6) Review normal anatomy of the anal sphincter complex and surrounding pelvic structures. 7) Discuss etiology, pathophysiology and classification of perianal fistulas. 8) Correlate implication of imaging findings on disease management. 9) Familiarize themselves with MR protocol for assessment of pelvic floor dysfunction. 10) Learn techniques for improving patient cooperation for dynamic images. 11) Identify normal anatomy of anterior, middle and posterior compartments. 12) Apply reference lines and angles used in assessment of pelvic floor dysfunction. 13) Identify and grade the severity of pelvic floor relaxation. 14) Identify and grade the severity of pelvic organ prolapse. 15) Review the common causes of non obstetric pelvic pain in pregnancy. 16) Recognize the unique diagnostic and therapeutic challenges in the pregnant patient with pelvic pain. 17) Discuss the safety considerations of imaging in pregnancy. 18) Review the evolving imaging and clinical literature on appropriate investigation of acute pelvic pain pregnancy. 19) Discuss the utility of MRI as a supplement to US in the pregnant patient.

### SAM

New in 2017: PLEASE NOTE - All courses designated for SAM credit at RSNA 2017 will require attendees bring a personal device e.g. phone, iPad, laptop to complete the required test questions during the live session.

### Sub-Events

#### RC829A The CT Indeterminate Lesion in the Non-Cirrhotic Liver: Extracellular or Hepatobiliary Contrast-Enhanced MRI

##### Participants

Hero K. Hussain, MD, Ann Arbor, MI (*Presenter*) Nothing to Disclose

### LEARNING OBJECTIVES

1) Describe the differences between extracellular and hepatobiliary contrast. 2) Explain the types of liver lesion seen on CT that may benefit from imaging with hepatobiliary contrast.

#### RC829B Is MRI Needed to Further Evaluate a CT Indeterminate Renal Mass?

##### Participants

Hersh Chandarana, MD, New York, NY (*Presenter*) Equipment support, Siemens AG; Software support, Siemens AG; Advisory Board, Siemens AG;

##### For information about this presentation, contact:

hersh.chandarana@nyumc.org

### LEARNING OBJECTIVES

1) Limitation of CT imaging in characterization of small renal masses (with focus on discriminating benign/indolent renal tumors from aggressive renal cancer). 2) Role of MRI as a problem solving tool in characterizing cystic and solid renal masses. 3) Evolving role of MRI in renal mass (histologic) subtyping and assessment of renal tumor aggressiveness.

#### RC829C Perianal Fistulae: What Does the Surgeon Want to Know?

##### Participants

Mahmoud M. Al-Hawary, MD, Ann Arbor, MI (*Presenter*) Nothing to Disclose

### LEARNING OBJECTIVES

1) Review normal anatomy of the anal sphincter complex and surrounding pelvic structures. 2) Discuss etiology, pathophysiology and classification of perianal fistulas. 3) Correlate implication of imaging findings on disease management.

## **RC829D How Do I Perform and Interpret MRI of Pelvic Floor Weakness?**

Participants

Victoria Chernyak, MD,MS, Bronx, NY (*Presenter*) Nothing to Disclose

**For information about this presentation, contact:**

vichka17@hotmail.com

### **LEARNING OBJECTIVES**

1) Familiarize themselves with MR protocol for assessment of pelvic floor dysfunction. 2) Learn techniques for improving patient cooperation for dynamic images. 3) Identify normal anatomy of anterior, middle and posterior compartments. 4) Apply reference lines and angles used in assessment of pelvic floor dysfunction. 5) Identify and grade the severity of pelvic floor relaxation. 5) Identify and grade the severity of pelvic organ prolapse.

## **RC829E Is MRI the Next Step after US to Evaluate Non-Obstetric Pelvic Pain in Pregnancy?**

Participants

Reena C. Jha, MD, Washington, DC (*Presenter*) Nothing to Disclose

**For information about this presentation, contact:**

jhar@gunet.georgetown.edu

### **LEARNING OBJECTIVES**

1) Review the common causes of non obstetric pelvic pain in pregnancy. 2) Recognize the unique diagnostic and therapeutic challenges in the pregnant patient with pelvic pain. 3) Discuss the safety considerations of imaging in pregnancy. 4) Review the evolving imaging and clinical literature on appropriate investigation of acute pelvic pain pregnancy. 5) Discuss the utility of MRI as a supplement to US in the pregnant patient.

## **RC829F How Do I Perform a Diagnostic MRI in a Non-Cooperative Patient?**

Participants

Mustafa R. Bashir, MD, Cary, NC (*Presenter*) Research support, Siemens AG; Research support, General Electric Company; Research support, NGM Biopharmaceuticals, Inc; Research support, TaiwanJ Pharmaceuticals Co, Ltd; Research support, Madrigal Pharmaceuticals, Inc; Consultant, RadMD

**For information about this presentation, contact:**

mustafa.bashir@duke.edu

### **LEARNING OBJECTIVES**

1) Describe patient and technical factors that may contribute to suboptimal or nondiagnostic body MRI examinations. 2) Discuss methods for reducing the impact of the above factors using clinically-available MRI techniques.

### **ABSTRACT**

Patient motion is a major issue in abdominal MRI. Not only are some patients unable to sustain a breath-hold, but breathing motion can be unpredictable. In this talk we will discuss a variety of techniques for combating motion, including fast imaging, special k-space filling trajectories, and respiratory gating using extrinsic and intrinsic signals.

RC832

## Physician Leadership Through Change

Friday, Dec. 1 8:30AM - 10:00AM Room: E350

LM

AMA PRA Category 1 Credits™: 1.50  
ARRT Category A+ Credit: 0

### Participants

John T. Wald, MD, Rochester, MN (*Presenter*) Nothing to Disclose  
Amy L. Kotsenas, MD, Rochester, MN (*Presenter*) Nothing to Disclose  
Leonardo Vedolin, MD, PhD, Sao Paulo, Brazil (*Presenter*) Nothing to Disclose

### LEARNING OBJECTIVES

1) Develop a physician leadership skillset to gain influence and organizational support during change in your organization. 2) Gain a better understanding of dos and don'ts of physician leadership. 3) Define key physician leadership traits that allow physicians to position their organizations for success. 4) Discuss the Mayo Clinic model of physician/administrator leadership and its role in leading through change. 5) Determine appropriate and practical strategies to manage change in your organization.

### Active Handout: Leonardo Vedolin

[http://abstract.rsna.org/uploads/2017/17000746/Active RC832.pdf](http://abstract.rsna.org/uploads/2017/17000746/Active_RC832.pdf)

RC852

## Liver Elastography (Hands-on)

Friday, Dec. 1 8:30AM - 10:00AM Room: E264

GI

AMA PRA Category 1 Credits™: 1.50  
ARRT Category A+ Credit: 1.75

### Participants

Richard G. Barr, MD, PhD, Campbell, OH (*Presenter*) Consultant, Siemens AG; Consultant, Koninklijke Philips NV; Research Grant, Siemens AG; Research Grant, SuperSonic Imagine; Speakers Bureau, Koninklijke Philips NV; Research Grant, Bracco Group; Speakers Bureau, Siemens AG; Consultant, Toshiba Medical Systems Corporation; Research Grant, Esaote SpA; Research Grant, BK Ultrasound; Research Grant, Hitachi, Ltd  
Carlo Filice, MD, Pavia, Italy (*Presenter*) Speaker, Koninklijke Philips NV; Speaker, Hitachi, Ltd ; Research Grant, Hitachi, Ltd; Research Grant, Toshiba Medical Systems Corporation; Research Grant, Esaote SpA  
Vito Cantisani, MD, Roma, Italy (*Presenter*) Speaker, Toshiba Medical Systems Corporation; Speaker, Bracco Group; Speaker, Samsung Electronics Co, Ltd  
Fabrizio Calliada, MD, Pavia, Italy (*Presenter*) Research Grant, Toshiba Medical Systems Corporation; Speakers Bureau Member, Hitachi, Ltd; Speakers Bureau Member, Shenzhen Mindray Bio-Medical Electronics Co, Ltd  
Ann E. Podrasky, MD, Coral Gables, FL (*Presenter*) Consultant, Siemens AG  
Michelle L. Robbin, MD, Birmingham, AL (*Presenter*) Consultant, Koninklijke Philips NV;  
Nitin G. Chaubal, MD, MBBS, Mumbai, India (*Presenter*) Nothing to Disclose  
Hisham A. Tchelepi, MD, Los Angeles, CA (*Presenter*) Research Grant, General Electric Company Research Grant, Roper Industries, Inc  
Norihsa Yada, MD, Kyoto, Japan (*Presenter*) Nothing to Disclose  
Laura Maiocchi, MD, Pavia, Italy (*Presenter*) Nothing to Disclose  
Patrick Warren, MD, Columbus, OH (*Presenter*) Nothing to Disclose  
Maija Radzina, MD, PhD, Riga, Latvia (*Presenter*) Nothing to Disclose  
Anil Chauhan, MD, Philadelphia, PA (*Presenter*) Nothing to Disclose  
Raffaella Lissandrin, Pavia, Italy (*Presenter*) Nothing to Disclose  
Giovanna Ferraioli, MD, Pavia, Italy (*Presenter*) Speaker, Koninklijke Philips NV; Speaker, Hitachi Ltd; Speaker, Toshiba Medical Systems Corporation  
Cheng Fang, MBBS, FRCR, London, United Kingdom (*Presenter*) Nothing to Disclose

### For information about this presentation, contact:

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### LEARNING OBJECTIVES

1) Improve basic knowledge and skills relevant to clinical practice in Liver elastography of the participants. 2) Teach how to practice liver elastography. 3) Show live how to do a proper examination, providing tips and tricks and updating current knowledge on different techniques. 4) Practical hands-on and slide presentation with key messages will be used.

### Honored Educators

Presenters or authors on this event have been recognized as RSNA Honored Educators for participating in multiple qualifying educational activities. Honored Educators are invested in furthering the profession of radiology by delivering high-quality educational content in their field of study. Learn how you can become an honored educator by visiting the website at: <https://www.rsna.org/Honored-Educator-Award/> Richard G. Barr, MD, PhD - 2017 Honored Educator

RC854

## Next Generation Reporting: Informatics to Improve the Value of Reporting

Friday, Dec. 1 8:30AM - 10:00AM Room: E352

IN

AMA PRA Category 1 Credits™: 1.50  
ARRT Category A+ Credit: 1.75

### Participants

Arun Krishnaraj, MD, MPH, Charlottesville, VA (*Moderator*) Nothing to Disclose

### For information about this presentation, contact:

arunk@virginia.edu

### LEARNING OBJECTIVES

1) Identify unmet needs of current and future practices with regards to radiology reporting. 2) Apply existing and emerging informatics applications to improve report generation, including a focus on patient centered reporting. 3) Demonstrate an understanding of how best to apply emerging machine intelligence tools to create structured automated recommendations.

### Sub-Events

#### RC854A The Actionable Patient Facing Report

##### Participants

Arun Krishnaraj, MD, MPH, Charlottesville, VA (*Presenter*) Nothing to Disclose

### For information about this presentation, contact:

ArunK@virginia.edu

### LEARNING OBJECTIVES

1) Appreciate the current state of radiology reporting in the United States. 2) Identify areas for improvement in reporting. 3) Demonstrate an understanding of the potential of patient portals. 4) Understand how patient facing actionable reports can lead to better care through shared decision making.

#### RC854B The Interactive Multimedia Report: What Is It and Is It Ready for Prime Time?

##### Participants

Cree M. Gaskin, MD, Keswick, VA (*Presenter*) Author with royalties, Oxford University Press; Author with royalties, Thieme Medical Publishers, Inc; Research Grant, Carestream Health, Inc; ;

### For information about this presentation, contact:

cree@virginia.edu

### LEARNING OBJECTIVES

1) Identify characteristics of an interactive multimedia radiology report. 2) Comprehend the value of improved communication that occurs with interactive multimedia reporting. 3) Describe barriers to overcome during the implementation of interactive multimedia reporting and integration of advanced reports into the electronic health record.

#### RC854C Interactive Reporting

##### Participants

Les R. Folio, DO, MPH, Bethesda, MD (*Presenter*) Research agreement, Carestream Health, Inc

### For information about this presentation, contact:

les.folio@nih.gov

### LEARNING OBJECTIVES

1) Comprehend the difference between plain text and interactive multimedia radiology reports. 2) Identify characteristics and components suitable for an interactive multimedia radiology report. 3) Demonstrate the value of improved communication using multimedia reports by example.

### ABSTRACT

1. The radiology report is the primary communication between radiologists and referring clinicians that rely heavily upon them to manage their patients; however, has not changed since Roentgen's discovery of the x-ray; until now. Now in our third year, the NIH Clinical Center routinely hyperlinks abnormal findings, measurements (e.g. linear, area, volume, Hounsfield Units, SUV) and symbols (arrows, ovals, text) in radiology reports to image annotations. Bookmark lists are automatically populated in our PACS database each time a radiologist or assistant annotates an image within a study. 2. Over the last several years, we codeveloped the capability to provide multimedia reports through a research agreement with our PACS vendor (VuePACS 12.1 Carestream

Health; Rochester, NY) to include hyperlinked text to image annotations and prior exams, measurement and metadata tables. In our experience, hyperlinked report text to image annotation is an overwhelming success and performed routinely by radiologists evidenced by rapidly rising adoption rates shortly after initial implementation over two years ago. Following automatic or manual relation of target lesions over time results in automated calculations such as RECIST, tumor burden trajectory can be graphed on a separate tumor report. Key images can be included in both radiologist and tumor reports. 3. Multimedia reporting has greatly improved our communication with NCI investigators of cancer trials at the NIH clinical center; with added report value to clinicians of all medical disciplines. Hyperlinked target lesion measurements in reports allow radiologists and oncology staff (including oncologists, nurse managers, research coordinators) to expeditiously assess metastatic lesions through report hyperlinks without having hunt for measurements buried in text only reports and obviating the need to scroll through hundreds of images in cross sectional exams. We have shown preferences for multimedia reports (Folio L. Survey of Oncologists and Radiologists. AJR 2015) as well as documenting improved content, consistency of measurements and efficiency in cancer trials that optimizes therapeutic response determination (Machado L. Radiology Reports With Hyperlinks Improve Target Lesion Selection. AJR 2017). Other medical specialties are increasingly producing multimedia reports along with most imaging vendors supporting this capability, becoming known as enterprise imaging.

#### **RC854D      Structured Automated Recommendations: Reporting in the Era of Artificial Intelligence**

Participants

Tarik K. Alkasab, MD, PhD, Boston, MA (*Presenter*) Nothing to Disclose

SST01

## Breast Imaging (Multimodality Diagnostic)

Friday, Dec. 1 10:30AM - 12:00PM Room: E450B

**BR** **MR**

AMA PRA Category 1 Credits™: 1.50  
ARRT Category A+ Credit: 1.75

**FDA** Discussions may include off-label uses.

### Participants

Mary S. Newell, MD, Atlanta, GA (*Moderator*) Stockholder, Kimberly-Clark Corporation ; Stockholder, E. I. du Pont de Nemours & Company ; Stockholder, Bristol-Myers Squibb Company; Stockholder, Merck & Co, Inc; Stockholder, Johnson & Johnson ; Stockholder, Eli Lilly and Company  
Sarah M. Friedewald, MD, Chicago, IL (*Moderator*) Consultant, Hologic, Inc; Research Grant, Hologic, Inc;

### Sub-Events

#### SST01-01 Specialized Second Opinion Interpretations of Breast Imaging: Impact on Additional Workup and Management

Friday, Dec. 1 10:30AM - 10:40AM Room: E450B

### Participants

Robert J. Weinfurter, MD, Tampa, FL (*Presenter*) Nothing to Disclose  
Leena Kamat, MD, Tampa, FL (*Abstract Co-Author*) Nothing to Disclose  
Yasmin Mekhail, MD, Tampa, FL (*Abstract Co-Author*) Nothing to Disclose  
Emily Aguila, BS, Tampa, FL (*Abstract Co-Author*) Nothing to Disclose  
Bethany L. Niell, MD, Tampa, FL (*Abstract Co-Author*) Nothing to Disclose  
Jennifer S. Drukteinis, MD, Tampa, FL (*Abstract Co-Author*) Nothing to Disclose  
Shannon Falcon, MD, Tampa, FL (*Abstract Co-Author*) Nothing to Disclose

### PURPOSE

Patients with breast imaging often seek second opinion review at tertiary care centers. The goal of our study is to evaluate the impact of these second opinions on patient management.

### METHOD AND MATERIALS

A retrospective chart review was conducted on 504 consecutive patients with second opinion radiology interpretations performed by six sub-specialized breast radiologists at a cancer center from January 1st through September 1st of 2014. Outside imaging reports were compared to second opinion reports to categorize interpretation discrepancies. Interpretations were considered discrepant in cases with a clinically relevant BI-RADS category change or identification of previously undiagnosed additional extent of disease greater than 5 cm. The frequencies of discrepant BI-RADS categorizations, clinically significant alterations in surgical management, and incremental cancer detection were measured. Statistical analyses were performed with Fisher's exact test with a p-value <0.05 considered significant.

### RESULTS

Presenting diagnoses at second opinion interpretation included invasive malignancy (356), Ductal Carcinoma in Situ (78), high risk lesions (16), suspicious findings (21), probably benign findings (4), BI-RADS 0 (1), and negative or benign findings (28). Second opinions resulted in interpretation discrepancies in 287 patients (57%) and percutaneous image-guided biopsies in 94 (19%). Additional sites of cancer were detected in 48 (10%), including 13 ipsilateral and 8 contralateral breast malignancies, and 27 axillary metastases. Another 5 biopsies yielded high-risk pathology. Second opinion interpretations altered surgical management in 58 (12%) due to the detection of additional cancer, a high risk lesion at biopsy, additional extent of disease, or stage 4 disease. Factors associated with increased discrepancy frequency included diagnosis of invasive or in situ cancer at presentation (p=0.003), dense breasts (p=0.005), and the absence of prior studies available for comparison (p=0.007).

### CONCLUSION

Though additional imaging and resources are required, pre-operative second opinion radiology review by subspecialized radiologists increases cancer detection and results in clinically relevant changes in patient management.

### CLINICAL RELEVANCE/APPLICATION

Second opinion interpretation of breast imaging by subspecialized breast radiologists resulted in additional cancer detection in 10% and altered surgical management in 12% of patients.

#### SST01-02 Radiomics Signature on 3T DCE-MRI for Estrogen Receptor-Positive Invasive Breast Cancers: Preliminary Results in Predicting Oncotype DX Test Recurrence Score

Friday, Dec. 1 10:40AM - 10:50AM Room: E450B

### Participants

Kyung Jin Nam, MD, PhD, Yangsan-si, Korea, Republic Of (*Presenter*) Nothing to Disclose

Eun Sook Ko, MD, Seoul, Korea, Republic Of (*Abstract Co-Author*) Nothing to Disclose  
Boo-Kyung Han, MD, PhD, Seoul, Korea, Republic Of (*Abstract Co-Author*) Nothing to Disclose  
Eun Young Ko, MD, PhD, Seoul, Korea, Republic Of (*Abstract Co-Author*) Nothing to Disclose  
Ji Soo Choi, MD, PhD, Seoul, Korea, Republic Of (*Abstract Co-Author*) Nothing to Disclose

**For information about this presentation, contact:**

kj-violet@hanmail.net

## **PURPOSE**

To evaluate the ability of quantitative computer extracted imaging features on 3T dynamic contrast-enhanced (DCE) magnetic resonance imaging (MRI) to distinguish estrogen receptor (ER)-positive invasive breast cancers between the low and non-low Oncotype DX risk categories.

## **METHOD AND MATERIALS**

Between May 2011 to March 2016, we retrospectively enrolled 67 ER-positive invasive breast cancer patients who performed preoperative 3T breast DCE-MRI and Oncotype DX assay. We divided the patients into low (Oncotype DX recurrence score [RS] <18) and non-low risk (RS  $\geq$  18) groups. Extracted radiomics features included morphological, histogram-based, and higher-order texture features. The least absolute shrinkage and selection operator (LASSO) method was used for feature selection, and radiomics signature (Rad-score) was calculated via a linear combination of selected radiomics features. Logistic regression analysis was performed to investigate the association between Oncotype DX risk groups and clinicopathologic, MR imaging, and Rad-score. Receiver operating characteristic analysis and the area under the receiver operating characteristic curve (Az) were used to assess classification performance.

## **RESULTS**

The Rad-score was constructed for each tumor by extracting thirteen of 158 radiomics features (8.2 %). Multivariate regression analysis showed that there was a significant difference in the Rad-score between the low and non-low Oncotype DX risk groups ( $P = 0.001$ ). The Rad-score was able to differentiate between low and non-low risk Oncotype DX groups with an Az of 0.822. The significant pathologic factors in univariate analysis achieved an Az of 0.574. Addition of Rad-score to the significant pathologic factors in univariate analysis showed an Az of 0.889.

## **CONCLUSION**

The Rad-score that incorporates the radiomics features of DCE-MRI was highly associated with the low and non-low Oncotype DX risk classifications in patients with ER-positive invasive breast cancers.

## **CLINICAL RELEVANCE/APPLICATION**

The Rad-score could allow for non-invasively predicting which ER-positive patients might have little to no benefit from adjuvant chemotherapy.

## **SST01-03 Volume-Based Metabolic Parameter of Tumor on Preoperative 18F-FDG PET/CT May Predict Axillary Lymph Node Metastasis**

Friday, Dec. 1 10:50AM - 11:00AM Room: E450B

### **Participants**

Seon Young Park, MD, Suwon-si, Korea, Republic Of (*Presenter*) Nothing to Disclose  
Youngjin Yoo, Suwon, Korea, Republic Of (*Abstract Co-Author*) Nothing to Disclose  
Hye Lin Kim, MD, Suwon, Korea, Republic Of (*Abstract Co-Author*) Nothing to Disclose  
Doo Kyoung Kang, MD, Suwon, Korea, Republic Of (*Abstract Co-Author*) Nothing to Disclose  
Taehee Kim, MD, PhD, Suwon, Korea, Republic Of (*Abstract Co-Author*) Nothing to Disclose

## **PURPOSE**

The purpose of our study was to evaluate the association between metabolic parameters on FDG PET/CT and axillary lymph node metastasis (ALNM) in patients with invasive breast cancer.

## **METHOD AND MATERIALS**

From January 2012 to December 2012, we analyzed 173 patients with invasive ductal carcinoma (IDC) who underwent both initial breast MRI and 18F-FDG PET/CT examinations. All metabolic parameters were measured from the tumor volume segmented by a gradient-based method. Once the primary target lesion was segmented, maximum standardized uptake value (SUVmax), mean standardized uptake value (SUVmean), metabolic tumor volume (MTV) and total lesion glycolysis (TLG) were calculated automatically by the MIMvista software.

## **RESULTS**

Mean age of 173 patients was 49 years old. Of 173 patients, 45 (26%) showed axillary lymph node metastasis. On univariate analysis, larger tumor size ( $> 2.2$  cm;  $p=0.002$ ), presence of lymphovascular invasion ( $p < 0.001$ ), higher SUVmax ( $> 2.82$ ;  $p=0.038$ ), higher SUVmean ( $> 1.2$ ;  $p=0.027$ ), higher MTV ( $> 2.38$ ;  $p < 0.001$ ) and higher TLG ( $> 3.98$ ;  $p = 0.007$ ) were associated with a higher probability of axillary lymph node metastasis. On multivariate analysis, presence of lymphovascular invasion (adjusted odds ratio [OR], 11.053; 95% CI, 4.403-27.751;  $p < 0.001$ ) and higher MTV ( $> 2.38$ ) (adjusted OR, 2.696; 95% CI, 1.079-6.739;  $p=0.034$ ) maintained independent significance in predicting ALNM. In subgroup analysis of T2/T3 breast cancer, lymphovascular invasion (adjusted OR, 20.976; 95% CI, 5.431-81.010;  $p < 0.001$ ) and higher MTV ( $> 2.38$ ) (adjusted OR, 4.906; 95% CI, 1.616-14.896;  $p=0.005$ ) were independent predictors of ALNM. However in T1 breast cancer, lymphovascular invasion (adjusted OR, 16.096; 95% CI, 2.517-102.939;  $p=0.003$ ) and larger SUV mean ( $> 1.2$ ) (adjusted OR, 13.275; 95% CI, 1.233-142.908;  $p=0.033$ ) were independent predictors while MTV was not.

## **CONCLUSION**

MTV may be associated with ALNM in patients with invasive breast cancer, particularly T2 and T3 stages. In T1 breast cancer, SUVmean was associated with ALNM.



## CLINICAL RELEVANCE/APPLICATION

Metabolic tumor volume in 18F-FDG PET/CT may be associated with axillary lymph node metastasis in patients with invasive breast cancer, particularly T2 and T3 stages.

### SST01-04 Visibility of Mammographically Occult Breast Cancer on Diffusion-Weighted MRI versus Ultrasound

Friday, Dec. 1 11:00AM - 11:10AM Room: E450B

#### Awards

##### Student Travel Stipend Award

#### Participants

Nita Amornsiripanitch, MD, Worcester, MA (*Presenter*) Nothing to Disclose  
Habib Rahbar, MD, Seattle, WA (*Abstract Co-Author*) Research Grant, General Electric Company  
Averi Kitsch, BS, Seattle, WA (*Abstract Co-Author*) Nothing to Disclose  
Diana L. Lam, MD, Seattle, WA (*Abstract Co-Author*) Nothing to Disclose  
Brett Weitzel, MD, Salt Lake City, UT (*Abstract Co-Author*) Nothing to Disclose  
Savannah C. Partridge, PhD, Seattle, WA (*Abstract Co-Author*) Research Grant, General Electric Company

#### For information about this presentation, contact:

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#### PURPOSE

There is widespread interest in identifying an effective and affordable breast cancer screening exam that can supplement mammography. While dynamic contrast-enhanced (DCE)-MRI is highly sensitive and currently recommended for high-risk women, cost and gadolinium-related safety concerns limit its wider use. Screening ultrasound (US) can identify some mammographically-occult malignancies but is time consuming and associated with low specificity. Diffusion-weighted MRI (DWI) is emerging as a promising non-contrast technique for breast cancer detection. We sought to investigate the visibility of mammographically-occult cancers on DWI versus US.

#### METHOD AND MATERIALS

This IRB-approved study retrospectively evaluated patients with 3T DCE-MRI detected mammographically-occult cancers who underwent pre-biopsy targeted US (12/2010 to 12/2013). DWI was performed during clinical breast MRI exams (b= 0, 100, and 800 s/mm<sup>2</sup>). Lesion visibility on DWI was scored visually (1=iso-intense to 5=focal hyperintensity) by three independent readers (not blinded to DCE). DWI visibility was defined as a mean score of  $\geq 2.5$ . US visibility was determined from imaging reports. Clinical factors (age, breast density, lesion size, morphology, and histology) were collected, and DWI and US lesion visibility were compared across and within subgroups using McNemar's Test.

#### RESULTS

During the study period, 60 mammographically-occult cancers (53 invasive; 7 DCIS) were imaged by both DWI and US in 53 women (median age 53 years, range 23-75 years). Cancers ranged in size from 4 to 102mm (median, 12mm) and included 39 masses, 20 non-masses, and 1 focus. More cancers were visible on DWI (47/60, 78%) than on US (38/60, 63%;  $p=0.049$ ), with 32 (53%) visible on both modalities and 7 (12%) not visible on either. Subanalyses suggested better visualization by DWI versus US in particular for larger cancers ( $\geq 1$ cm;  $p=0.011$ ), which had a higher proportion of non-masses than smaller cancers (51% vs. 8%), and for cancers in younger women ( $<50$ years;  $p=0.06$ , trend).

#### CONCLUSION

Mammographically-occult breast cancers may be more visible on DWI than ultrasound. DWI continues to show promise as a cost-effective supplemental screening tool, and warrants further investigation.

## CLINICAL RELEVANCE/APPLICATION

Diffusion-weighted MRI may be more sensitive than ultrasound for detecting mammographically occult cancer, and may provide a safe, fast, and affordable supplemental tool for screening women.

### SST01-05 Outcomes in Patients with a Focal Area of Clinical Concern Assessed as Probably Benign on Diagnostic Imaging

Friday, Dec. 1 11:10AM - 11:20AM Room: E450B

#### Participants

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#### PURPOSE

The American College of Radiology (ACR) Appropriateness Criteria support either short-term follow-up or biopsy for women presenting with a palpable solid breast mass demonstrating probably benign (BIRADS category 3) features on imaging. To support

decision-making in this clinical scenario, we measured outcomes of BIRADS 3 cases in a large population of women presenting with a focal area of clinical concern.

## **METHOD AND MATERIALS**

Following IRB approval, review of the electronic medical records identified 15,548 cases of diagnostic mammography with ultrasound that evaluated a focal area of clinical concern from 3/2006 to 3/2014. Each breast with one or more focal areas of clinical concern was designated as a case. Outcomes were determined by imaging, biopsy or any pathology in our hospital tumor registry at 24-month follow-up. Performance measures were defined according to the ACR BIRADS atlas, 5th edition.

## **RESULTS**

Of the 15,548 cases, 965 (6.2%) were assessed as BIRADS 3 in 861 women (average age 47.7, range 24-89). During the 24-month follow-up, only one cancer, an invasive ductal carcinoma, was diagnosed with a cancer yield of 0.1% (1/965). In addition to the one biopsy-proven malignancy, another 29 cases underwent biopsy/tissue sampling for a positive predictive value (PPV3) of 3.3% (1/30) within the follow-up period.

## **CONCLUSION**

The risk of subsequent breast malignancy diagnosis in patients presenting with focal areas of clinical concern assessed as BIRADS 3 is extremely low (0.1%). These findings strongly support the current ACR guidelines suggesting surveillance as a safe alternative to biopsy in these patients. Given the high likelihood of benignity and the low PPV3 (3.3%), additional research may facilitate reclassification of a subgroup of probably benign lesions as benign by imaging (BIRADS 2) with recommendation for clinical follow-up.

## **CLINICAL RELEVANCE/APPLICATION**

Follow-up of symptomatic probably benign lesions has a low rate of malignancy, supporting the ACR guidelines with opportunity to improve stratification of benign vs. probably benign palpable masses.

### **SST01-06 Deep Learning through Convolution Neural Networks Using a Breast MRI Tumor Dataset Can Predict Oncotype Dx Recurrence Score**

Friday, Dec. 1 11:20AM - 11:30AM Room: E450B

#### **Participants**

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#### **PURPOSE**

We hypothesize that CNNs can be used to predict Oncotype Dx Recurrence Score (RS), which is a validated, gene-expression-based, aggressiveness assay using a breast MRI tumor dataset.

#### **METHOD AND MATERIALS**

An IRB approved retrospective review of our database from 1/2010 to 6/2016 identified 134 patients with ER+/HER2- invasive ductal carcinoma who underwent both breast MRI and Oncotype Dx RS evaluation. Patients were classified to 3 groups: Low risk (group 1, RS < 18), intermediate risk (group 2, RS of 18- 30) and high risk (group 3, RS > 30). For deep learning, 134 cases were separated into 80% (107/134) training set and 20% (27/134) test set. For each breast MRI, tumor was identified on first T1 post contrast dynamic images and underwent 3D segmentation using an open source software platform 3D Slicer. Then, 32x32 patch was extracted from the center slice of the segmented tumor data. A CNN was designed for Oncotype DX class prediction based on each of these cropped images. In brief, CNN consisted of 4 convolution layers, max-pooling layers and dropout of 0.25 after each convolution layer. Two models were created, one for three class Oncotype Dx prediction (group 1, group 2 or group 3) and a second for two class prediction (group 1 vs. group 2 and group 3). Code was implemented in open source software Keras with TensorFlow on a Linux workstation with NVIDIA GTX 1070 Pascal GPU.

#### **RESULTS**

Three class Oncotype Dx prediction model was evaluated in 3 groups consisting of 77, 40 and 17 patients in groups 1, 2 and 3. The CNN achieved an overall accuracy of 80% in three class prediction. Two class Oncotype Dx prediction model was evaluated in 2 groups consisting of 77 and 57 patients (group 1 vs. groups 2 and 3). The CNN achieved an overall accuracy of 92% in two class prediction.

#### **CONCLUSION**

Current deep CNN architectures can be trained with relatively small MRI data set to achieve useful performance at predicting Oncotype DX RS. Research is underway with a larger dataset to improve our prediction model.

#### **CLINICAL RELEVANCE/APPLICATION**

Deep learning through convolution neural networks (CNNs) have demonstrated strong performance in various image classification tasks in recent years and may be used to predict patients' likelihood of breast cancer recurrence.

### **SST01-07 Classifying Breast Lesions with Initial Enhancement Kinetics from High Temporal-Resolution DCE-MRI**

Friday, Dec. 1 11:30AM - 11:40AM Room: E450B

#### **Participants**

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**PURPOSE**

To identify parameters descriptive of initial lesion enhancement on high-temporal resolution breast DCE-MRI that may aid in ruling out malignancies

**METHOD AND MATERIALS**

46 patients with dense breasts and BIRADS 4 or 5 on screening mammograms were enrolled. Participants received an MRI prior to biopsy, including high temporal resolution DCE-MRI ('ultrafast') during the first minute after contrast administration, followed by a standard high-spatial resolution acquisition. Patients were scanned on 1.5T and 3T scanners with temporal resolutions from 3.5 to 10 seconds. Relative signal enhancement was calculated on a voxel-by-voxel basis. Signal enhancement was fit to an empirical model with 3 parameters: upper limit of enhancement, uptake rate, and time of initial enhancement (TIE). Initial slope and initial area under the curve (iAUC) were calculated from the fit parameters. The time of initial arterial enhancement was measured in the internal mammary arteries and lesion enhancement times were calculated relative to this time

**RESULTS**

65 lesions were included in this analysis (27 benign, 38 malignant). Two cases showed no abnormal enhancement (on ultrafast or standard DCE); both biopsy results were benign. Benign and malignant lesions had average TIEs of  $9.5 \pm 12.8s$  and  $5.7 \pm 3.3s$ , respectively. The difference was not significant but 10 benign lesions (37%) had higher TIEs than the maximum TIE for all malignant lesions (12.1s). Initial slope and iAUC were significantly different ( $p < 0.005$ ) between benign and malignant lesions, with average malignant-to-benign ratios of  $1.96 \pm 0.06$  and  $1.49 \pm 0.04$ . The negative predictive value of iAUC was 93%

**CONCLUSION**

These preliminary results suggest that IAUC, initial slope, and TIE from ultrafast DCE-MRI have strong negative predictive value, and may be used to rule out cancer and reduce unnecessary biopsies. This type of analysis requires only 1 minute of high-temporal resolution imaging. Ultrafast imaging allows reliable measurements of initial kinetics that are less sensitive to global variables (e.g., cardiac output) and descriptive of lesion physiology

**CLINICAL RELEVANCE/APPLICATION**

High-temporal resolution DCE allows accurate measurements of very early enhancement kinetics, when differences between benign and malignant lesions may be largest, and may provide strong negative predictive power

**SST01-08 A Reader Study of MARIA Radiowave Breast Imaging Compared with X-Ray Mammography for the Symptomatic Breast**

Friday, Dec. 1 11:40AM - 11:50AM Room: E450B

**Participants**

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**PURPOSE**

MARIA is a new, non-ionising, non-compressing radiowave breast imaging modality with good dense breast performance which has early potential as an adjunct to x-ray mammography (MMG). This study presents a sensitivity comparison of MARIA and MMG using offline reads of the respective images.

**METHOD AND MATERIALS**

Females attending a symptomatic breast clinic at one of 3 UK symptomatic clinics (Southmead - Bristol, Thirlestaine - Cheltenham, Great Western - Swindon), were identified by clinicians as having a palpable lump. Following informed consent, eligible patients meeting inclusion criteria were scanned in the prone position with MARIA, a non-ionising, multi-static radar system (Yorkshire & The Humber and South Yorkshire REC 15/YH/0084) ClinicalTrials.gov NCT02493595. Patients had ultrasound scan (US) and/or mammography (MMG). Cytology/ histology was conducted as necessary as part of normal clinical procedure and final diagnosis was determined. Both MARIA and MMG were read offline by independent readers who had no knowledge of the clinical outcome. Features identified in either modality were subsequently compared to the diagnosis on discharge (including histology/ cytology where available) to determine a sensitivity score.

**RESULTS**

145 single breast studies were analysed. MMG sensitivity, defined as successful detection of the symptomatic index lesion, was 79% (42/52) in lucent (BI-RAD a,b) while MARIA sensitivity in lucent was 71% (37/42). For dense breasts (BI-RAD c, d), sensitivity for MMG was 54% (50/92) while for MARIA it was 77% (71/92).

**CONCLUSION**

Initial results suggest that the MARIA system offers the provision of a safer (non-ionising), more comfortable (no breast

Initial results suggest that the MARIA system offers the provision of a safer (non-ionising), more comfortable (no breast compression) and inexpensive breast screening alternative compared to other modalities, which has been shown to be effective at detecting cancers in younger, pre-menopausal women with dense breasts. MARIA may also overcome some of the challenges posed by trying to optimise the balance between benefit and harm of MMG screening in women of younger age.

#### CLINICAL RELEVANCE/APPLICATION

The sensitivity of MMG is low for women with dense breasts (DB). MARIA shows great promise as a whole-breast adjunct offering a benign, more comfortable, sensitive diagnostic for women with DB.

#### SST01-09 Quantitative Assessment of Breast DCE-MRI BPE and Mammographic Breast Density Changes over Time

Friday, Dec. 1 11:50AM - 12:00PM Room: E450B

##### Participants

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David Gur, PhD, Pittsburgh, PA (*Abstract Co-Author*) Nothing to Disclose  
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#### PURPOSE

Breast DCE-MRI background parenchymal enhancement (BPE) has been reported associated with breast cancer risk, potentially independent of the established mammographic breast density (MBD). We investigated quantitative characteristics and temporal changing patterns of BPE and MBD on a large (1792) set of MRI scans and mammogram examinations acquired from breast cancer-free women.

#### METHOD AND MATERIALS

We retrospectively identified 886 longitudinal breast DCE-MRI scans (2006-2015) and 886 mammogram examinations acquired in the same year with the MRI from 266 high-risk screening women (each with 2-9 sequential scans). For the 886 MRIs, the average age-at-scan was 50.4±9.3 YO, average between-scan time was 419±165 days, and 552 (62%) were post-menopausal with the rest pre-menopausal. All 266 women remain breast cancer-free at the time of this study. Fully automated computerized methods were applied to quantify BPE and area-based MBD (an average on CC and MLO view), both at unilateral and bilateral levels. BPE was computed from the first post-contrast sequence as the volumetric percentage of enhanced voxels over the fibroglandular tissue. Descriptive statistics, nonparametric regression, and linear mixed effects modeling were used to assess distributions and changing patterns of BPE and MPD over time.

#### RESULTS

Mean BPE was 22.2%±13.5 for all scans, and was 25.3%±14.8 for pre- and 20.4%±12.4 for post-menopausal scans (unpaired t-test p<0.0001). Likewise for MBD, mean was 29.7%±16.6 for all mammogram examinations, 31.9%±16.5 for pre- and 28.4%±16.7 for post-menopausal (p=0.0027). The Pearson's correlation coefficient between left and right BPE (or MBD) was 0.85 (or 0.90). Both BPE and MBD change over time in a roughly linear decreasing trend and both statistically significant (p<0.05) with respect to the evaluation of accumulated-years-since-first-scan, but the rate of change for MBD (0.7 percentage point/year, 95% CI 0.2-1.2) is somewhat less than for BPE (0.9 percentage point/year, 95% CI 0.5-1.3).

#### CONCLUSION

In longitudinal imaging scans of breast cancer-free women, both BPE and MBD are higher among pre- than post-menopausal women. They both decrease roughly linearly over time, but the trend of MBD is less pronounced than BPE.

#### CLINICAL RELEVANCE/APPLICATION

Quantitative assessment of temporal changing characteristics of BPE and MPD in cancer-free women can help determine their performance and mechanisms as independent breast cancer risk biomarkers.

SST02

## Cardiac (General Topics, CT, SPECT, and PET)

Friday, Dec. 1 10:30AM - 12:00PM Room: E450A

CA CT NM

AMA PRA Category 1 Credits <sup>TM</sup>: 1.50  
ARRT Category A+ Credit: 1.75

FDA Discussions may include off-label uses.

### Participants

Pamela K. Woodard, MD, Saint Louis, MO (*Moderator*) Research agreement, Siemens AG; Research, Eli Lilly and Company; Research, F. Hoffmann-La Roche Ltd; ; ; ;

Karen G. Ordovas, MD, San Francisco, CA (*Moderator*) Advisor, Arterys Inc

### Sub-Events

#### SST02-01 Automatic Segmentation and Volume Quantification of Fat Surrounding the Heart in Non-Contrast CT using Deep Learning

Friday, Dec. 1 10:30AM - 10:40AM Room: E450A

### Participants

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### PURPOSE

Increased volume of thoracic fat surrounding the heart (TFV) is predictive of major adverse cardiovascular events, however, its measurement has previously relied on time-consuming manual quantification which is prone to variability. We developed a fast and robust algorithm to automatically quantify TFV using deep learning methods.

### METHOD AND MATERIALS

The Deep Learning method was divided into two parts: (i) a convolutional network used for heart segmentation for non-contrast CT axial slices and (ii) a second convolutional neural network used to identify superior and inferior heart limits. These two networks, implemented with the standard Caffe library on graphics display cards for fast training performance, were combined to provide a binary mask of the heart and thoracic fat. Standard fat range attenuation (-190 to -30 HU) was then applied and allowed for fat segmentation. Deep Learning was validated using 10-fold cross validation in 250 non-contrast coronary calcium scoring CT datasets, with expert fat and heart identification as the reference standard.

### RESULTS

Median TFV was 130.354 cm<sup>3</sup> (Inter-quartile range [IQR]: 89.121-198.183) and 130.936 cm<sup>3</sup> (IQR: 87.244-193.696) for expert and automatic quantifications, respectively, with no significant difference ( $p > 0.99$ ). An excellent correlation was obtained between the two measures ( $R = 0.944$ ,  $p < 0.00001$ ), with a non-significant bias of -0.003 cm<sup>3</sup> (95% confidence interval: -3.287 to 3.280) according to Bland-Altman analysis. The algorithm is now implemented in our homemade visualization software and allows for automatic TFV quantification of a new case within 20 seconds on a standard personal computer compared to approximately 10 minutes of expert measurement.

### CONCLUSION

Using deep learning methods, we developed a fast, fully automated algorithm to segment the heart and quantify TFV from non-contrast CT data sets, with high correlation and agreement with expert measurement. This algorithm may allow for routine, efficient TFV quantification to aid cardiovascular risk assessment and improve the prediction of major adverse cardiovascular events.

### CLINICAL RELEVANCE/APPLICATION

Deep Learning algorithm can perform fast and robust quantification of fat surrounding the heart in non-contrast CT data sets and allow for clinical routine quantification and prediction studies.

## SST02-02 Use of 18-F FDG PET/CT for Diagnosis of Cardiac Device Infections

Friday, Dec. 1 10:40AM - 10:50AM Room: E450A

### Participants

Maryam Mahmood, MBChB, Rochester, MN (*Presenter*) Nothing to Disclose  
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### PURPOSE

Cardiac device infections can be challenging to diagnose, there is growing evidence to support the role of 18-F fluorodeoxyglucose (FDG) PET/CT imaging as a complementary diagnostic tool in patients with suspected cardiac device infections. We hypothesize that nuclear imaging will be useful in excluding cardiac device infections, particularly in cases with a low or intermediate pre-test probability of infection.

### METHOD AND MATERIALS

Patients with possible cardiac device infection who underwent 18-F FDG PET/CT as part of the evaluation for possible cardiac device infection at a tertiary institution from 2006-2016 were retrospectively reviewed to evaluate the utility of PET/CT as an adjunctive diagnostic tool. We collected clinical, microbiologic, echocardiographic, imaging and outcomes data for at least 90 days following imaging. PET/CT and echocardiograms were reviewed again for the purposes of the study by independent investigators.

### RESULTS

Thirty patients with possible cardiac device infection who underwent 18-F FDG PET/CT were reviewed. The most common presenting symptoms were fever in 60% and generator pocket site skin changes or tenderness in 40%. Blood cultures were positive in 59%; the most common organisms identified were coagulase negative Staphylococcus (23%), *Staphylococcus aureus* (23%) and Enterococcus (23%). Average maximum standardized uptake values (SUVmax) were 4.81 for positive PET/CT and 1.38 for negative PET/CT scans. Positive PET/CT was correlated with presence of generator pocket signs ( $p=0.0027$ ) and positive generator pocket cultures ( $p=0.0145$ ). PET-CT results were not correlated with fever ( $p=0.06$ ), leukocytosis ( $p=0.70$ ), elevated ESR or CRP ( $p=0.10$ ), positive blood cultures ( $p=0.26$ ) or positive echocardiographic findings ( $p=0.39$ ). Overall 18-FDG PET/CT demonstrated sensitivity of 86.67% (95% confidence interval [CI] 59.54% to 98.34%) and specificity of 93.33% (95% CI 68.05% to 99.83%) for diagnosis of cardiac device infections.

### CONCLUSION

18-F FDG PET/CT is a valuable adjunctive diagnostic tool with a high sensitivity of 86.67% and specificity of 93.33% for diagnosis of possible cardiac device infections.

### CLINICAL RELEVANCE/APPLICATION

18-F FDG PET/CT is a useful adjunctive diagnostic tool in challenging cases of cardiac device infections.

## SST02-03 Reliability and Homogeneity of the CT Attenuation at Different Contrast Medium Concentration on 16cm Wide-Detector Revolution CT: A Phantom Experiment Study

Friday, Dec. 1 10:50AM - 11:00AM Room: E450A

### Participants

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### PURPOSE

To evaluate CT attenuation homogeneity and reliability of 16cm wide-detector revolution CT at different contrast medium concentration with a phantom experiment study.

### METHOD AND MATERIALS

A phantom (QSP-1, FUYO) with nine cylindrical tubes of 18-mm-diameter and 16-cm-length placed into water tank was used. One was in central region filled with saline and other eight tubes were in periphery region filled with contrast medium concentration of 2.0, 5.0, 10.0, 15.0, 20.0, 25.0, 30.0mg/mL. The phantom was scanned on revolution CT at 120 kVp using both axial 16cm protocol and helical 4cm protocol with 5mm thickness, respectively. Circular regions of interest of the same area were placed at the center of each tube to measure the CT attenuation value and the standard deviation. CT attenuation homogeneity of each tube was evaluated by variation range (VR: maximum attenuation-minimum attenuation) and degree of dispersion (DD: defined as percentage of variance range divided by mean attenuation), and coefficient of variation (CV: defined as percentage of standard deviation of CT attenuation divided by mean attenuation). Data were analyzed by using paired t test.

### RESULTS

The variation range (VR) of CT attenuation, degree of dispersion (DD) and coefficient of variation (CV) of each tube filled with different density of iodine contrast medium was (5.65HU, 9.99%, 2.47%), (5.99HU, 4.68%, 1.15%), (6.66HU, 5.02%, 1.12%),

(12.46HU ,3.30%, 0.79%), (15.04HU,3.06%, 0.77%), (16.86HU, 2.86%, 0.81%), (20.07HU (2.87%, 0.77%) for axial 16-cm mode whereas those values for helical 4-cm mode were (7.17HU, 12.07%, 2.78%), (9.97HU ,7.75%, 2.21%), (13.78HU ,10.43%, 3.20%), (17.07HU ,4.56%, 1.16%), (8.88HU ,1.8%, 0.51%), (7.73 HU, 1.31%, 0.32%), (8.51HU ,1.21%, 0.31%). There were no significant differences between axial 16-cm mode and helical 4-cm mode in VR of CT attenuation, DD and CV (P = 0.642,0.343,0.332, respectively).

## CONCLUSION

Axial 16-cm wide-detector scanning protocol on revolution CT at different density of iodine contrast medium can provide the same CT attenuation homogeneity and reliable CT value with helical 4-cm standard-detector scanning protocol.

## CLINICAL RELEVANCE/APPLICATION

The wide-detector scanning technique with VHD reconstruction can provide excellent CT attenuation homogeneity which is comparable to standard-detector scanning technique. It will have good potential applications and clinical feasibility for TAG and FFRCT of coronary CT imaging

## SST02-04 Analysis of Raw High Speed Myocardial Perfusion SPECT Images by Deep Convolutional Networks Improve Prediction of Potentially Significant Ischemic Defects

Friday, Dec. 1 11:00AM - 11:10AM Room: E450A

### Participants

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## PURPOSE

We aimed to assess the abilities of deep convolutional neural networks (CNN) for automatic prediction of obstructive coronary stenosis from raw fast myocardial perfusion SPECT imaging (MPI) data.

## METHOD AND MATERIALS

1468 patients (67% males) undergoing stress-first high speed SPECT in 7 national and international sites were studied. All patients were assessed for obstructive stenosis  $\geq 70\%$  by invasive coronary angiography (ICA). Left ventricular myocardium was segmented using standard Cedars-Sinai Quantitative Perfusion SPECT (QPS) and verified by one expert reader. Stress total perfusion deficit (TPD) was also automatically computed by statistical comparison to normal limits. The CNN approach was evaluated in a stratified 10-fold cross-validation procedure using supine stress raw polarmaps exported from QPS (10° angle resolution), and implemented using the Caffe Deep Learning Framework. CNN comprised three consecutive convolutional units, followed by two dense fully connected layers with a rectified linear unit activation, and a final softmax loss function for the optimization of the network. Area under the curve (AUC) comparison by Delong test was used to compare the performance of the CNN score and TPD to predict potentially significant ischemic defects. Net reclassification improvement (NRI) for TPD at 5% threshold and for the CNN score was also computed. Two-graph ROC technique was used to compute the optimal CNN score cutoff for NRI comparison.

## RESULTS

From the total 1468 patients, 882 (60%) had obstructive stenosis  $\geq 70\%$ . 864 (60%) out of 1448 (99%) patients with no suspected coronary artery disease had ICA stenosis. The left ventricular contour assigned by standard QPS was adjusted in 323 (22%) stress images. AUC for CNN score was significantly higher than for stress TPD (0.81 vs 0.78,  $P < 0.01$  by Delong test). The optimal CNN score cutoff was found to be 0.7. A net reclassification improvement of 6.6% [95% CI: 2.2%-11%] ( $P < 0.01$ ) was significant for the optimal CNN cutoff as compared to stress TPD at 5%.

## CONCLUSION

CNN improved the prediction of potentially significant ischemic defects and has the potential to enhance automatic interpretation of MPI studies. CNN combination of multiple polarmaps and patient information may bring further improvement.

## CLINICAL RELEVANCE/APPLICATION

Automatic CNN interpretation of SPECT MPI may provide improved automatic scan interpretation without the needing of normal databases as for TPD.

## SST02-05 Evaluation of Coronary Artery Calcium using Dual Energy Chest X-rays: Digital Phantom Study

Friday, Dec. 1 11:10AM - 11:20AM Room: E450A

### Participants

Bo Zhou, Cleveland, OH (*Presenter*) Nothing to Disclose  
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**PURPOSE**

Despite proponents of CT coronary artery calcification (CAC) score, which provides proof of disease and predicts future events, it is not recommended for screening because of cost and radiation. Previously, we have demonstrated ability to identify CAC using 2-shot, dual energy (DE) chest x-rays, giving an opportunity to screen CAC from an already ordered exam. Here we will use digital simulations, backed up by measurements, to characterize DE calcium signals and the role of potential confounds such as beam hardening, xray scatter, cardiac motion, and pulmonary artery pulsation. For the DE calcium signal, we will consider quantification, as compared to CT calcium score, and visualization.

**METHOD AND MATERIALS**

We created stylized and anatomical digital 3D phantoms which included CAC. We simulated high and low kV x-ray acquisitions with xray spectra, energy dependent attenuation, scatter, ideal detector, and automatic exposure control (AEC). Phantoms allowed us to vary CAC size and density, adipose thickness, cardiac motion, etc. We used specialized dual energy coronary calcium (DECC) processing that includes corrections for scatter, beam hardening, and motion correction.

**RESULTS**

With DECC processing, beam hardening over a wide range of adipose thickness (0-30 cm) reduced CAC signal ( $\Delta$ ICAC) by <3%. Scatter correction errors of  $\pm 50\%$  affected  $\Delta$ ICAC by  $\pm 9\%$ . If a simulated pulmonary artery fills with blood between exposures, it can give rise to a residual signal in DECC images, explaining pulmonary artery visibility in some clinical bone images. Residual misregistration can be mostly compensated by integrating signals in an enlarged region encompassing registration artifacts. DECC calcium score compared favorably to CT mass score over a number of phantom perturbations.

**CONCLUSION**

Simulations indicate that proper DECC processing can faithfully recover coronary calcium signals. Beam hardening, errors in scatter estimation, cardiac motion, calcium residual misregistration, are all manageable. Simulations are valuable as we continue to optimize DE coronary calcium image processing and quantitative analysis.

**CLINICAL RELEVANCE/APPLICATION**

CAC detection from already ordered chest xrays would give benefits of CT CAC without its costs (patient charge and radiation), and lead to patients' adoption/adherence to lifestyle/drug therapies.

**SST02-06 Diagnostic Performance of Computed Tomography Area Measurements of the Suprahepatic Segment of the Inferior Vena Cava to Predict Central Venous Pressure and Mortality in Patients Undergoing Transcatheter Aortic Valve Implantation**

Friday, Dec. 1 11:20AM - 11:30AM Room: E450A

**Participants**

Matthias Eberhard, MD, Zurich, Switzerland (*Presenter*) Nothing to Disclose  
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Micheal Ho, Zurich, Switzerland (*Abstract Co-Author*) Nothing to Disclose  
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Francesco Maisano, Milan, Italy (*Abstract Co-Author*) Co-founder, 4Tech Cardio Ltd; Consultant, Abbott Laboratories; Consultant, Medtronic plc; Consultant, Valtech Cardio Ltd; Royalties, Edwards Lifesciences Corporation  
Felix C. Tanner, Zurich, Switzerland (*Abstract Co-Author*) Nothing to Disclose  
Thi Dan Linh Nguyen-Kim, Zurich, Switzerland (*Abstract Co-Author*) Nothing to Disclose

**PURPOSE**

To evaluate correlation of computed tomography (CT) area measurements of the suprahepatic segment of the inferior vena cava (IVC) with central venous pressure (CVP) and its performance to predict CVP and mortality in patients with severe symptomatic aortic stenosis.

**METHOD AND MATERIALS**

We retrospectively analyzed 153 consecutive patients (median age 84, 78 females) undergoing transcatheter aortic valve implantation (TAVI) at the University Hospital Zurich between January 2010 and December 2014. Only patients undergoing right heart catheterization (RHC) and CT within 1 consecutive day as part of preinterventional TAVI assessment were included. Patient baseline characteristics and outcome data after one year were recorded. Area measurements of the suprahepatic IVC were performed on axial CT slices. Correlations were assessed with Pearson's correlation coefficient. The optimal cutoff point for IVC area measurements to predict an elevated CVP ( $\geq 10$ mmHg) or mortality was determined using receiver operating characteristics (ROC) analysis.

**RESULTS**

RHC showed elevated CVP in 34 patients (25%) at baseline. IVC area measurements indicated a moderate correlation with CVP ( $r=0.47$ ;  $p<0.001$ ). For area measurements ROC analysis showed an AUC of 0.77 ( $p<0.001$ ) to predict elevated CVP and an AUC of 0.77 ( $p<0.001$ ) to predict one year mortality. A cutoff of 639mm<sup>2</sup> for IVC area had a specificity of 80% and a sensitivity of 64% to predict a CVP  $\geq 10$ mmHg. Whereas a little higher cutoff of 665mm<sup>2</sup> for IVC area showed a specificity of 80% and a sensitivity of 60% to predict one year mortality. Indexing area measurements to body surface area did not lead to better diagnostic performance. Multivariate logistic regression analysis controlling for age, sex, body surface area and logistic EuroSCORE II indicated that an IVC area  $\geq 665$ mm<sup>2</sup> is a significant predictor of one year mortality with an odds ratio of 6.8 (95%CI: 2.2-21.1).



## CONCLUSION

Our study suggests that area measurements of the suprahepatic segment of the IVC has the potential to non-invasively predict elevated CVP with moderate sensitivity but good specificity. Furthermore, an enlarged IVC seems to be a predictor of one year mortality in TAVI patients.

## CLINICAL RELEVANCE/APPLICATION

Assessing the inferior vena cava to predict central venous pressure is an established method in ultrasound but has not been assessed in CT as a robust and reproducible examination modality, so far.

### SST02-07 Lower Annual Cardiac Events in Diabetics with a Normal Exercise GMPI and a Functional Capacity $\geq 7$ METS on Treadmill

Friday, Dec. 1 11:30AM - 11:40AM Room: E450A

#### Participants

Maseeh U. Zaman, MBBS, Karachi, Pakistan (*Presenter*) Nothing to Disclose  
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Ibrahim Hashmi, MBBS, Dubai, United Arab Emirates (*Abstract Co-Author*) Employee, General Electric Company  
Areeba Zaman, Karachi, Pakistan (*Abstract Co-Author*) Nothing to Disclose  
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## PURPOSE

Good exercise capacity has a high negative predictive value (NPV) in patients with known or suspected coronary artery disease (CAD) similar to a normal gated myocardial perfusion imaging (GMPI). However, previous studies have suggested that diabetic patients undergoing single photon emission computed tomography (SPECT) myocardial perfusion imaging (MPI) are at greater risk for cardiac events than non-diabetic patients with both normal and abnormal MPIs. Aim of this study was to evaluate NPV of functional capacity during treadmill exercise in diabetics with normal GMPI in Pakistani population.

## METHOD AND MATERIALS

This was a prospective study which included 338 diabetics with normal exercise GMPI. On the basis of metabolic equivalents (METS) achieved during exercise, these patients were divided into Group A:  $\geq 7$  METS (140 patients) and Group B:  $< 7$  METS (198 patients). These patients were followed up on telephone (for 18  $\pm$  3 months) for fatal or non-fatal myocardial infarction (FMI and NFMI respectively). Regarding risk factors in Group A and B, like obesity (50 vs. 54%), hypertension (61 vs. 60%), smoking (14 vs. 15%), dyslipidemia (32 vs. 42%) and family history (32 vs. 30%), no significant difference was found.

## RESULTS

The mean age predicted HR (MAPHR) achieved in group was significantly higher than Group B (86% vs. 83%). No significant difference was found between LV functional parameters (like ejection fraction, end diastolic and systolic volumes) of two groups. During follow up period, the overall all cardiac events reported in Group A was 03 (all NFMI and no FMI) while in Group B 16 events (15 NFMI and 01 FMI) were reported. Annualized event rate for overall events, NFMI and FMI in two groups were 1.43 vs. 5.39%, 1.43 vs. 5.05 and 0% vs. 0.3% respectively.

## CONCLUSION

We conclude that NPV of a normal GMPI is higher in diabetic patients with a functional capacity  $\geq 7$  METS than their counterparts who could achieve  $< 7$  METS on treadmill.

## CLINICAL RELEVANCE/APPLICATION

Gated MPI has comparable diagnostic accuracy for CAD in diabetics but its prognostic strength is very high. Effort tolerance  $> 7$  METS with a negative MPI enhances the NPV in diabetics who are found to have high event rate despite of a normal MPI with vasodilator or workload  $< 7$  METS

### SST02-08 Increased Epicardial Fat Volume is Related to Diabetes Mellitus, Early Subclinical Atherosclerosis and Serum Levels of Inflammatory Biomarkers in Asymptomatic Patients

Friday, Dec. 1 11:40AM - 11:50AM Room: E450A

#### Participants

Markus Goeller, MD, Erlangen, Germany (*Presenter*) Nothing to Disclose  
Stephan Achenbach, MD, Erlangen, Germany (*Abstract Co-Author*) Research Grant, Siemens AG Research Grant, Bayer AG Research Grant, Abbott Laboratories Speaker, Guerbet SA Speaker, Siemens AG Speaker, Bayer AG Speaker, AstraZeneca PLC Speaker, Berlin-Chemie AG Speaker, Abbott Laboratories Speaker, Edwards Lifesciences Corporation  
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Heidi Gransar, Los Angeles, CA (*Abstract Co-Author*) Nothing to Disclose  
Nathan Wong, PhD, Irvine, CA (*Abstract Co-Author*) Nothing to Disclose  
Sebastien J. Cadet, MS, BS, Los Angeles, CA (*Abstract Co-Author*) Nothing to Disclose  
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Balaji Tamparappoo, Los Angeles, CA (*Abstract Co-Author*) Nothing to Disclose  
Daniel S. Berman, MD, West Hollywood, CA (*Abstract Co-Author*) Nothing to Disclose  
Damini Dey, PhD, West Hollywood, CA (*Abstract Co-Author*) Nothing to Disclose

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## **PURPOSE**

We aimed to investigate whether increased epicardial fat volume (EFV) is related to inflammatory serum biomarkers, diabetes mellitus (DM) and early atherosclerotic disease in asymptomatic patients.

## **METHOD AND MATERIALS**

We evaluated 456 asymptomatic patients from the EISNER (Early Identification of Subclinical Atherosclerosis using Non-invasive Imaging Research) registry. EFV was quantified using semi-automated QFAT version 2.0 software from non-contrast CT data sets. EFV was assessed in patients with a coronary calcium score (CCS) of 0, early atherosclerosis (CCS 1-99) and advanced atherosclerosis (CCS  $\geq$ 100). EFV was examined in relation to CCS, serum levels of inflammatory biomarkers and presence of DM.

## **RESULTS**

Mean EFV was lowest in 144 patients with a CCS of 0 [74 cm<sup>3</sup>, interquartile range (IQR): 53-91] and was significantly higher in 144 patients with early atherosclerosis [87 cm<sup>3</sup>, IQR: 56-111,  $p=0.016$ ] and in 168 subjects with advanced atherosclerosis [89 cm<sup>3</sup>, IQR: 61-112,  $p=0.002$ ]. In multivariable analysis, log-transformed EFV was strongly associated with DM [Odds Ratio (OR) 4.6 (95% CI: 2.1-9.8),  $p<0.001$ ], over hypertension ( $p=0.023$ ), family history of coronary artery disease (CAD) ( $p=0.026$ ), CCS ( $p=0.042$ ) or other risk factors ( $p>0.05$ ). EFV was correlated with serum biomarkers endothelial plasminogen activator inhibitor 1 (PAI-1) ( $r=0.29$ ,  $p<0.001$ ), monocyte chemoattractant protein 1 (MCP-1) ( $r=0.20$ ,  $p<0.001$ ), vascular cell adhesion molecule 1 (VCAM-1) ( $r=0.12$ ,  $p=0.026$ ) and inversely correlated with adiponectin ( $r=-0.18$ ,  $p<0.001$ ), while CCS was not correlated with serum levels of biomarkers ( $p>0.05$ ). In multivariate regression analysis adjusted for age, cardiovascular risk factors and CCS EFV remained independently associated with PAI-1, MCP-1 and VCAM-1 (all  $p<0.05$ ).

## **CONCLUSION**

EFV is significantly increased in patients with coronary calcium compared to those with a CCS of 0; with no significant differences in patients with early atherosclerosis or advanced atherosclerosis. Increased EFV is associated with DM and serum levels of inflammatory biomarkers, suggesting that it may be linked to early plaque formation, metabolic abnormality and plaque inflammation.

## **CLINICAL RELEVANCE/APPLICATION**

As a metabolically active fat depot increased epicardial fat volume predicts adverse cardiac events, however, its relationship to early coronary atherosclerosis, inflammatory biomarkers and diabetes mellitus remains unknown.

SST03

## Chest (Functional Lung Imaging/Radiation Dose Reduction)

Friday, Dec. 1 10:30AM - 12:00PM Room: E451B

**CH** **CT** **MR** **SQ**

AMA PRA Category 1 Credits™: 1.50  
ARRT Category A+ Credit: 1.75

**FDA** Discussions may include off-label uses.

### Participants

Brett W. Carter, MD, Houston, TX (*Moderator*) Editor, Reed Elsevier  
Yoshiharu Ohno, MD, PhD, Kobe, Japan (*Moderator*) Research Grant, Toshiba Medical Systems Corporation; Research Grant, Koninklijke Philips NV; Research Grant, Bayer AG; Research Grant, DAIICHI SANKYO Group; Research Grant, Eisai Co, Ltd; Research Grant, Fuji Pharma Co, Ltd; Research Grant, FUJIFILM Holdings Corporation; Research Grant, Guerbet SA;

### Sub-Events

#### SST03-01 Measuring Specific Ventilation using Four-dimensional Magnetic Resonance Ventilation Imaging: A Novel Physiological Biomarker of Asthma

Friday, Dec. 1 10:30AM - 10:40AM Room: E451B

### Awards

#### Trainee Research Prize - Resident

#### Participants

Dante Capaldi, BS, London, ON (*Presenter*) Nothing to Disclose  
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A J. McLeod, London, ON (*Abstract Co-Author*) Nothing to Disclose  
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### PURPOSE

Specific ventilation (SV) is defined as a dimensionless quantity of inhaled gas ventilation that occurs during tidal breathing and is calculated as tidal volume divided by functional residual capacity (Lewis *et al*, 1978). 1H MRI was previously proposed to regionally quantify SV, using inhaled O<sub>2</sub> as a contrast agent (Sa *et al*, 2010). Our objective was to develop a novel and rapid way to measure whole lung and regional SV using free-breathing 1H MRI without exogenous contrast agents and over a short tidal breathing scan using conventional equipment. We also aimed to directly compare 1H MRI SV with hyperpolarized inhaled noble gas MRI ventilation and ventilation percent (VP).

### METHOD AND MATERIALS

We evaluated 10 asthmatics (50±12yrs) and two healthy volunteers (27±6yrs) who provided written informed consent to MRI, spirometry and whole body plethysmography. Pulmonary hyperpolarized noble gas MRI (Kirby *et al*, 2012) and dynamic 2D multi-slice, whole lung coverage, free tidal-breathing 1H MRI using a bSSFP sequence (Capaldi *et al*, 2015) were acquired on a 3T system (GEHC). Free-breathing 1H MRI was retrospectively gated to generate tidal inspiration/expiration lung volumes that were co-registered using optical flow deformable registration (Lucas *et al*, 1981). 4DMRI SV maps were generated on a voxel-by-voxel basis using the co-registered volumes to generate local SV distribution maps. MRI ventilation percent (VP=ventilation volume normalized to thoracic cavity volume) and whole lung mean 4DMRI specific ventilation were determined and compared using Pearson correlation coefficients (r).

### RESULTS

In Figure 1, 4DMRI SV and 3He MRI for an asthmatic (27yr female FEV<sub>1</sub>=74%pred, SV=0.08, VP=97.4%) shows qualitative agreement in the right-upper-lobe. For all subjects, there was a significant relationship for MRI specific ventilation and inhaled noble gas MRI ventilation percent (r=.67, p=.02), FEV<sub>1</sub>/FVC (r=.74, p=.007) and plethysmography SV (r=.77, p=.003).

### CONCLUSION

In asthmatics, 4DMRI ventilation defects were spatially related with hyperpolarized inhaled noble gas MRI ventilation defects; 4DMRI SV also strongly correlated with experimentally measured SV and inhaled gas MRI ventilation percent.

### CLINICAL RELEVANCE/APPLICATION

Free-breathing 4DMRI was exploited to generate specific ventilation maps that strongly correlated with experimentally acquired specific ventilation and inhaled noble gas MRI ventilation percent.

## **SST03-02 Preoperative Assessment of Localized Pleural Adhesion: Utility of Software-Assisted Analysis on 4-Dimensional Ultra-Low-Dose CT (4D-ULDCT)**

Friday, Dec. 1 10:40AM - 10:50AM Room: E451B

### Participants

Masayuki Hashimoto, Otsu, Japan (*Presenter*) Nothing to Disclose  
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### PURPOSE

To assess the usefulness of software analysis using 4-dimensional ultra-low-dose CT (4D-ULDCT) for localized pleural adhesion (LPA).

### METHOD AND MATERIALS

Twenty-four consecutive patients scheduled to undergo surgery underwent both 4D-ULDCT during a single respiration and conventional high-resolution chest CT as preoperative assessments. Four radiologists, who were blinded to patient status, independently evaluated the presence and severity of LPA in 3 grading-scale (non-LPA, mild LPA and severe LPA) for 6 measurement points (MPs) (upper and lower area on ventral, lateral and dorsal aspects) on the chest CT by 2 different methods: (i) observing conventional high-resolution CT images (static), reconstructed in the axial, coronal, and sagittal directions; (ii) observing 4D-ULDCT images (movie), while another radiologist similarly evaluated the presence and severity of LPA by the other method: (iii) observing adhesion map (A-map), which is colored gradient map created by research software using 4D-ULDCT that suggested the absence/presence of LPA based on the difference in the movements between the lung surface and chest wall. The presence and severity of LPA was confirmed in an identical fashion by their intraoperative thoracoscopic findings. Diagnostic accuracy in 3 grade scaling and the LPA presence were conducted between (i) and (iii), between (ii) and (iii) using t-test for a single sample, and between (ii) and (iii) using Wilcoxon signed-rank test.

### RESULTS

The presence of LPA was surgically confirmed on 23MPs in 8 patients: 20MPs with mild LPA, 3MPs with severe LPA. For the LPA assessment, A-map method (iii) achieved significant better diagnostic performance with higher accuracy in 3-grade scaling of 78.5%, and higher sensitivity of 73.9%, PPV of 44.7% and NPV of 94.3%, comparable specificity of 82.6% for the LPA presence, in comparison with the other methods ((i), (ii)) ( $p < 0.05$ ). No significant difference in diagnostic performance were shown between conventional CT (i) and 4D-ULDCT (ii) ( $p > 0.05$ ).

### CONCLUSION

Four-D ULDCT in combination with A-map method could be useful as a novel imaging approach for accurate preoperative analysis of LPA.

### CLINICAL RELEVANCE/APPLICATION

This is the first study to demonstrate the clinical usefulness of software-aided, 4D-ULDCT images for the preoperative diagnosis of the presence and severity of LPA.

## **SST03-03 Quantification of Lung Perfusion and Ventilation in Patients with Chronic Thromboembolic Pulmonary Hypertension (CTEPH) Before and After Pulmonary Endarterectomy Using Phase Resolved Fourier Decomposition MRI**

Friday, Dec. 1 10:50AM - 11:00AM Room: E451B

### Participants

Gesa H. Hauck, MD, Hannover, Germany (*Presenter*) Nothing to Disclose  
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Frank K. Wacker, MD, Hannover, Germany (*Abstract Co-Author*) Nothing to Disclose  
Jens Vogel-Claussen, MD, Hannover, Germany (*Abstract Co-Author*) Nothing to Disclose

### PURPOSE

To evaluate Fourier decomposition (FD) imaging of the lung as a radiation free, non-contrast-enhanced method for detection of perfusion and ventilation changes in CTEPH patients before and after pulmonary endarterectomy (PEA).

### METHOD AND MATERIALS

We investigated 27 patients with diagnosed CTEPH before and 2 weeks after PEA. All patients underwent DCE time-resolved angiography with stochastic trajectories (TWIST) in one breathhold and a 2D fast low-angle shot (FLASH) sequence in free breathing in supine position, on a 1.5 T MRI. Coronal acquisition of FD imaging of the lung was performed. After nonrigid image registration (ANTS), and manual segmentation, perfusion and ventilation maps were generated using an image-sorting algorithm.

Histograms were calculated to visualize the distribution of ventilation and perfusion. Ventilated, but not perfused lung voxels were defined as perfusion defect, perfused, but not ventilated lung voxels were classified as ventilation defect.

## RESULTS

Using DCE MRI as reference, the median PBF increased from 30,1ml/min/100ml (25-75% quartile range: 26-50) to 54,5ml/min/100ml (25-75 quartile range: 49-71,  $p<0,0001$ ). Using FD MRI, the median perfusion defect percentage of the whole lung decreased from 46% (25-75% quartile range: 39-50%) to 33% (25%-75% quartile range: 27 -39%) after PEA ( $p<0.0001$ ). The ventilation defect percentage of the whole lung was minimal and did not change (pre and post procedural median: 1% (25-75% quartile range: 0-3%). There was a significant difference of the perfusion defect percentage in the right lower lobe (median: pre 42%, median post: 17%,  $p<0,0001$ ), the right upper lobe (median: pre 53%, median post: 28%,  $p=0.0005$ ) and in the middle lobe (median: pre 46%, median post: 25%,  $p=0.0002$ ). No significant difference of perfusion defect percentage was observed in the left lower (median: pre 48%, median post: 52%,  $p=0.48$ ) and upper (median: pre 35%, median post: 41%,  $p=0.13$ ) lobes.

## CONCLUSION

Phase resolved Fourier Decomposition MRI is a feasible method to monitor regional ventilation and perfusion in CTEPH patients pre and post PEA. Especially left lower lobe results may be influenced by cardiac motion, which could interfere with the phase measurements of the parenchymal blood flow.

## CLINICAL RELEVANCE/APPLICATION

These promising results may enable a proton-based, radiation and contrast free monitoring option of therapeutic effects after PEA in CTEPH patients in the future.

### SST03-04 Blood Volume-Based MR Imaging with Ultra-Short TE vs Quantitatively and Qualitatively Assessed CT vs Perfusion SPECT: Capability for Prediction of Postoperative Lung Function in Non-Small Cell Lung Cancer Patients

Friday, Dec. 1 11:00AM - 11:10AM Room: E451B

#### Participants

Yoshiharu Ohno, MD, PhD, Kobe, Japan (*Presenter*) Research Grant, Toshiba Medical Systems Corporation; Research Grant, Koninklijke Philips NV; Research Grant, Bayer AG; Research Grant, DAIICHI SANKYO Group; Research Grant, Eisai Co, Ltd; Research Grant, Fuji Pharma Co, Ltd; Research Grant, FUJIFILM Holdings Corporation; Research Grant, Guerbet SA; Masao Yui, Otawara, Japan (*Abstract Co-Author*) Employee, Toshiba Medical Systems Corporation  
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## PURPOSE

To directly compare the capability of contrast-enhanced (CE-) pulmonary thin-section MR imaging with ultra-short TE (UTE) as semi-quantitatively assessed blood-volume based MR imaging (BV-MRI with UTE) for prediction of postoperative lung function in non-small cell lung cancer (NSCLC) patients as compared with quantitatively and qualitatively assessed CT and perfusion SPECT.

## METHOD AND MATERIALS

29 NSCLC patients (16 men and 13 women) underwent unenhanced and contrast-enhanced pulmonary thin-section MR imaging with UTE at a 3T system, thin-section CT, perfusion SPECT, and measurements of FEV1% before and after lung resection. In each patient, BV MRI was generated as percent signal change between unenhanced and CE-pulmonary thin-section MR imaging by pixel-by-pixel analyses after non-rigid registration. On BV-MRI with UTE, postoperative FEV1% (poFEV1%) was predicted from semi-quantitatively assessed blood volumes within total and resected lungs. Quantitatively predicted poFEV1% using CT was determined from the functional lung volumes within total and resected lungs by commercially available software. Qualitatively predicted poFEV1% using CT was determined from the number of segments of total and resected lungs. On perfusion SPECT, poFEV1% was predicted from uptakes within total and resected lungs. Then, each predicted poFEV1% was correlated with actual poFEV1%, and the limits of agreement between actual and each predicted poFEV1% were also evaluated by Bland-Altman analysis.

## RESULTS

poFEV1% predicted by BV-MRI with UTE ( $r=0.82$ ,  $p<0.0001$ ) and quantitative CT ( $r=0.86$ ,  $p<0.0001$ ) had better correlation with actual poFEV1%, when compared with qualitatively assessed CT ( $r=0.79$ ,  $p<0.0001$ ) and SPECT ( $r=0.78$ ,  $p<0.0001$ ). The limits of agreement between predicted and actual poFEV1% by BV-MRI with UTE ( $4.3\pm 12.7\%$ ) and quantitatively assessed CT ( $3.5\pm 10.8\%$ ) were smaller than those by qualitatively assessed CT ( $5.1\pm 13.9\%$ ) and SPECT ( $4.2\pm 14.5\%$ ).

## CONCLUSION

BV-MRI with UTE can more accurately predict postoperative lung function than qualitatively assessed CT and perfusion SPECT, and is at least as valuable as quantitatively assessed CT in NSCLC patients.

## CLINICAL RELEVANCE/APPLICATION

Blood volume-based MRI with UTE can more accurately predict postoperative lung function than qualitatively assessed CT and perfusion SPECT, and is at least as valuable as quantitatively assessed CT in NSCLC patients.

### SST03-05 Correlation between Diaphragmatic Excursion and Decrease in Lung Volume on Expiratory Phase Imaging in Asthma Patients

## Awards

### Student Travel Stipend Award

#### Participants

Lea Azour, MD, New York, NY (*Presenter*) Nothing to Disclose

David S. Mendelson, MD, Larchmont, NY (*Abstract Co-Author*) Spouse, Employee, Novartis AG Advisory Board, Nuance Communications, Inc Advisory Board, General Electric Company Advisory Board, Toshiba Medical Systems Corporation Advisory Board, Bayer AG

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### PURPOSE

Inspiratory and expiratory phase imaging is often requested in asthma patients to evaluate air trapping, however, there is no radiographic measure of optimal expiration. Diaphragmatic excursion may be a reliable surrogate for lung volume assessment to gauge adequacy of expiration, particularly as the trachea may not change in configuration despite decrease in tracheal and/or lung volume.

### METHOD AND MATERIALS

Between January 1, 2016 and December 31, 2016, a total of 226 CT exams with inspiratory and expiratory phase imaging were performed, 63 in individuals with asthma. Patients with supine imaging acquired with the same parameters in each phase were included (n= 33, mean age = 62, M=15, F=15). Diaphragmatic excursion was calculated as the difference between axial slices through the lungs on inspiration and expiration, using the lung apex and the cranial bound and diaphragm caudally. Lung and tracheal volumes were measured for each patient at inspiration and expiration.

### RESULTS

Average inspiratory (I) and expiratory (E) lung volume was greater for men (I=5007 mL, E=3122 mL) than women (I=3122mL, E=1503mL). Similarly, average tracheal volumes were higher in men (I=61mL, E=45) than women (I=44, E=30). Average change in lung volume was 1500mL (range -564mL to 4109mL). Diaphragmatic excursion was found to range from -0.6cm to 6.8cm, with an average change in diaphragmatic excursion of 2.5 cm between inspiratory and expiratory scans (2.3 cm in women, and 2.7 cm in men). There was a very strong positive correlation between diaphragmatic excursion and change in lung volume between inspiratory and expiratory scans ( $r=0.83$ ), and strong positive correlation with change in tracheal volume ( $r=0.79$ ). A strong correlation was also found between change in tracheal volume and change in lung volume ( $r=0.67$ ).

### CONCLUSION

Diaphragmatic excursion is a strong quantitative measure of actual expiratory effort as validated by both lung and tracheal volumes, and may be more reliable than qualitative features such as tracheal morphology.

### CLINICAL RELEVANCE/APPLICATION

Diaphragmatic excursion is a reliable quantitative surrogate for lung volume, and is an easily applicable clinical tool to assess the adequacy of expiratory phase image acquisition.

## SST03-06 Pulmonary Function Diagnosis Based On Temporal Changes in Lung Density with Dynamic Flat-Panel Detector (FPD) Imaging: An Animal-Based Study

Friday, Dec. 1 11:20AM - 11:30AM Room: E451B

#### Participants

Rie Tanaka, PhD, Kanazawa, Japan (*Presenter*) Nothing to Disclose

Toru Tani, MD, PHD, Otsu, Japan (*Abstract Co-Author*) Nothing to Disclose

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Noritsugu Matsutani, Hachioji, Japan (*Abstract Co-Author*) Employee of Konica Minolta, Inc.

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### PURPOSE

X-ray translucency of the lungs changes with respiration. This is caused by relative increases and decreases in the volume of the lung vessels and bronchi per unit lung volume; pulmonary function can be evaluated based on temporal changes in the image density of the lung regions. The aim of the present study was to investigate the diagnostic performance of dynamic chest radiography for pulmonary function diagnosis based on respiratory changes in lung density.

### METHOD AND MATERIALS

Sequential chest radiographs of six domestic pigs (body weight ca. 20-30 kg) were obtained during respiration using a dynamic flat-panel detector system (100 kV; 0.25 mAs/pulse; 15 frames/s; Test model, Konica Minolta). The pigs were intubated under

anesthesia, and respiratory control was ensured with a ventilator (100, 200, 300, 400, and 500 mL). We created porcine models of atelectasis using a catheter procedure, and analyzed the correlation between the inspired volume and changes in the pixel value measured in the lungs. To facilitate visual evaluation, differences in pixel values between an image taken at maximum expiration and those during respiration were sequentially calculated and then superimposed on the original images as a color display, employing a color table in which higher X-ray translucency (increased air) is shown in cold colors, creating functionally colored images.

## RESULTS

Average pixel values in the lung regions changed according to forced respiration. High linearity was seen between changes in pixel value and inspired volume ( $r = 0.9$ ). Changes in pixel value related to the inspired volume were successfully visualized as changes in color intensity on the functional colored images. In addition, areas of atelectasis were revealed as decreased changes in pixel values. Trapped air and airflow restriction were detected as higher and lower color intensity on functionally colored images, respectively (Fig. 1).

## CONCLUSION

Dynamic chest radiography allowed for the evaluation of pulmonary function based on temporal changes in lung tissue image density. Inspired volume is quantified as changes in pixel value, and ventilation defects are detected as reduced changes in pixel value even without the use of contrast media.

## CLINICAL RELEVANCE/APPLICATION

The method presented here is a simple and cost-effective functional imaging technique that can be performed as an adjunctive examination for conventional chest radiography.

### SST03-07 CT Measurement of Atrioesophageal Adipose Tissue and Correlation with Metabolic Syndrome: Preliminary Results

Friday, Dec. 1 11:30AM - 11:40AM Room: E451B

#### Participants

Dennis P. Gilroy, DO, Rochester, NY (*Presenter*) Nothing to Disclose  
Hakan Sahin, MD, Rochester, NY (*Abstract Co-Author*) Nothing to Disclose

## PURPOSE

Epicardial adipose tissue measurements on cardiac imaging planes have demonstrated association with atrial fibrillation and coronary artery disease. We wanted to investigate the utility of adipose measurements between the left atrium and esophagus on conventional axial and sagittal planes of routine chest CTs performed with ECG-gating in predicting the presence/complications of metabolic syndrome.

## METHOD AND MATERIALS

The study protocol has been approved by the IRB. In this preliminary analysis, 50 patients with cardiac-gated CT performed for cardiac morphology or suspected aortic dissection were included, prospectively recorded, and retrospectively analyzed. The size of the atrioesophageal adipose tissue was measured on axial and sagittal images. Clinical conditions associated with metabolic syndrome were also recorded (hypertension, diabetes mellitus, BMI, dyslipidemia and atrial fibrillation). The association between the size of the adipose tissue and the clinical conditions was investigated.

## RESULTS

Preliminary analysis reveals statistically significantly larger atrioesophageal fat in patients with dyslipidemia, compared with those who did not ( $p$  value 0.006). Additionally, this relationship extends to those with elevated systolic blood pressure ( $p$  value 0.05). The optimal threshold within the atrioesophageal fat measurement was determined to be greater than 4.1 mm in the sagittal plane (72.7% sensitivity and 62.5% specificity for the presence of dyslipidemia). Additional correlation exists between the axial measurement of atrioesophageal fat and BMI, albeit not statistically significant with the current data.

## CONCLUSION

CT based epicardial fat quantification, using conventional imaging planes, is a simple tool that can be applied in everyday practice to identify patients with components of metabolic syndrome and possibly predict complications. While these results are preliminary, it is felt that the correlation between atrioesophageal fat measurement and additional various clinical parameters of metabolic syndrome will exist at statistically significant levels with a larger population.

## CLINICAL RELEVANCE/APPLICATION

CT-based identification of patients with metabolic syndrome during routine CT evaluation using conventional imaging planes can serve as a value-added service leading to prediction of complications such as atrial fibrillation and alter therapeutic management due to known subsequent recurrence.

### SST03-08 Effect of New Model-Based Iterative Reconstruction on Computer-Aided Detection for Quantitative Analysis of Airway Tree in Low-Dose Chest CT: Comparison with Adaptive Statistical Iterative Reconstruction in Routine Dose

Friday, Dec. 1 11:40AM - 11:50AM Room: E451B

#### Participants

Yongjun Jia, MMed, Xianyang City, China (*Abstract Co-Author*) Nothing to Disclose  
Yun Shen, PhD, Beijing, China (*Presenter*) Employee, General Electric Company Researcher, General Electric Company  
Yong Yu, Xianyang City, China (*Abstract Co-Author*) Nothing to Disclose  
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Haifeng Duan, Xianyang City, China (*Abstract Co-Author*) Nothing to Disclose  
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Xirong Zhang, Xianyang, China (*Abstract Co-Author*) Nothing to Disclose  
Xiaoxia Chen, MMed, Xianyang City, China (*Abstract Co-Author*) Nothing to Disclose  
Taiping He, Xianyang, China (*Abstract Co-Author*) Nothing to Disclose

## PURPOSE

To evaluate the new model-based iterative reconstruction (MBIRn) with balanced setting (MBIRSTND) and spatial resolution preference (MBIRRP20) and adaptive statistical iterative reconstruction (ASIR) in low-dose and ASIR in routine dose on the performance of computer-aided detection (CAD) for quantitative airway analysis.

## METHOD AND MATERIALS

30 patients had follow up scan for pulmonary disease on a GE Discovery CT750 HD system. Image acquisition was performed at routine dose and reduced dose level by increasing noise index (NI) from 14HU to 28HU using automatic tube current modulation. Tube voltage was fixed at 120kVp. Data of routine dose were reconstructed with ASIR, while low-dose were reconstructed with ASIR, MBIRSTND and MBIRRP20. Airway dimensions measured from the four reconstructions using an automated, quantitative software that was designed to segment and quantify the bronchial tree, and a skeletonization algorithm to extract the center-line of airway trees automatically (Figure 1). For each patients and reconstruction algorithm chose the right middle lobe bronchus with the least tortuous and bifurcation to measure the bronchial length of the matched airways. Two radiologists used a semi-quantitative 5-point scale (-2: inferior; 0, equal to ASIR in routine dose; 2: superior) to rate subjective image quality of airway trees on the low-dose images reconstructed with ASIR and MBIRn. Using paired t and Wilcoxon signed-rank tests for comparison.

## RESULTS

Median effective dose was  $3.01 \pm 1.89$  mSv at routine dose and  $0.88 \pm 0.83$  mSv at 71% dose reduction. Algorithm impacts the measurement variability of the length of bronchus in low-dose chest CT, and MBIRSTND and MBIRRP20 were better than ASIR for the airway trees, while MBIRSTND displayed longer bronchus than ASIR in routine dose ( $P < 0.05$ ) (Table 1, Figure 2). MBIRSTND for the low dose chest CT also had higher subjective scores for the airway trees than ASIR in routine dose (Table 2, Figure 2).

## CONCLUSION

The quantification accuracy of airway is strongly influenced by reconstructions. MBIRSTND and MBIRRP20 algorithms allow the desired airway quantification accuracy of CAD for chest to be achieved for 71% radiation dose reduction.

## CLINICAL RELEVANCE/APPLICATION

Compare ASIR, MBIRSTND and MBIRRP20 from MBIRn algorithm potentially allows the desired airway quantification accuracy to be achieved on the performance of CAD with low-dose chest CT, especially for MBIRSTND.

## SST03-09 Modified CT Fluoroscopy-Guided Lung Nodule Biopsy versus Conventional CT-Guided Biopsy: A Prospective Controlled Study to Assess Radiation Doses and Complication Rate

Friday, Dec. 1 11:50AM - 12:00PM Room: E451B

### Participants

Ting Liang, Xian, China (*Presenter*) Nothing to Disclose  
Gang Niu, MD, Xian, China (*Abstract Co-Author*) Nothing to Disclose  
Jin Shang, Xian, China (*Abstract Co-Author*) Nothing to Disclose  
Jian Yang, MD, PhD, Xian, China (*Abstract Co-Author*) Nothing to Disclose

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## PURPOSE

The aim of the study was to evaluate complication rate and radiation doses of lung nodule biopsy by the CT modified fluoroscopy-guided and conventional CT-guided methods.

## METHOD AND MATERIALS

A total of 100 patients in single radiology unit were prospectively enrolled to receive CT-guided lung biopsy. 50 patients were undergoing modified CT fluoroscopy-guided (CTF) biopsy (Group 1), and other half was checked by traditional CT-guided methods (Group 2). The modified biopsy plan referred to the method of using axial scan with step by step for the nodule. 2 experienced chest radiologists performing thoracic biopsies performed CT-guided biopsy. 64 slice spiral CT (Toshiba) were performed with CT-guided pulmonary biopsy with the Japan 16G cutting biopsy needle. Radiation dose and diagnostic accuracy of patient were outcome measurements. Differences between proportions were analyzed with the chi-square test. Dose-length product (DLP) was compared between 2 groups. Sensitivity, specificity and accuracy were calculated based on 80 patient's results.

## RESULTS

There were no significant between the two groups for the pulmonary nodules characteristics : size, group 1:  $34 \pm 18$  mm (mean  $\pm$  standard deviation) vs. group 2:  $38 \pm 20$  mm ( $p = 0.845$ ); depth from pleura,  $13 \pm 12$  mm vs.  $12 \pm 9$  mm ( $p = 0.595$ ) (Table 1). The total DLP of the study group (median 3.8 mSv) was significantly reduced compared to that of the comparison group (median 11.1 mSv,  $p > 0.05$ ).

## CONCLUSION

CT modified fluoroscopy-guided lung nodule biopsy provides high diagnostic accuracy and more lower radiation doses compared to conventional methods, and may be alternatively used for appropriate lung nodule.

## CLINICAL RELEVANCE/APPLICATION

The CT modified fluoroscopy-guided pulmonary biopsy which can significant reduce the radiation dose and complication rate should be selected in clinical practice.



SST04

## Science Session with Keynote: Gastrointestinal (Hepato-Biliary Imaging)

Friday, Dec. 1 10:30AM - 12:00PM Room: E353B

CT GI MR

AMA PRA Category 1 Credits™: 1.50  
ARRT Category A+ Credit: 1.75

### Participants

Aliya Qayyum, MBBS, Houston, TX (*Moderator*) Spouse, Founder, In Context Reporting  
Shahid M. Hussain, MD, PhD, Omaha, NE (*Moderator*) Nothing to Disclose  
David D. Bates, MD, Boston, MA (*Moderator*) Director, Imaginglink Inc

### Sub-Events

#### SST04-01 Gastrointestinal Keynote Speaker: What is New and Hot in Hepato Biliary MR imaging

Friday, Dec. 1 10:30AM - 10:40AM Room: E353B

### Participants

Shahid M. Hussain, MD, PhD, Omaha, NE (*Presenter*) Nothing to Disclose

#### SST04-02 Utility of Longitudinal Measurement of the Liver on Ultrasound in Comparison to CT Liver Volume in Assessing Hepatomegaly

Friday, Dec. 1 10:40AM - 10:50AM Room: E353B

### Awards

#### Student Travel Stipend Award

### Participants

Devaki Shilpa S. Surasi, MD, MBBS, Oklahoma City, OK (*Presenter*) Nothing to Disclose  
Sammer Jazbeh, MD, Oklahoma City, OK (*Abstract Co-Author*) Nothing to Disclose  
Aashka Patel, Oklahoma City, OK (*Abstract Co-Author*) Nothing to Disclose  
Rosemarie Zanabria, Oklahoma City, OK (*Abstract Co-Author*) Nothing to Disclose  
Jason M. Wagner, MD, Oklahoma City, OK (*Abstract Co-Author*) Nothing to Disclose

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### PURPOSE

The purpose of the study is to retrospectively compare the longitudinal measurement of the liver on ultrasound (US) with liver volume as measured on CT.

### METHOD AND MATERIALS

This IRB approved retrospective study with prospective image analysis included adult patients with US examinations of the liver or abdomen and CT examinations of the abdomen or abdomen/pelvis performed within 2 weeks of each other from 1/1/2010 to 4/30/2016. We recorded the longitudinal length measurement of the right lobe of the liver on the US study. The liver volume was calculated using manual 3D segmentation (AW suite). Hepatomegaly was defined as a liver volume of 2000 cc or greater. SPSS software was used for statistical analysis which included Receiver operating characteristic curve (ROC) analysis.

### RESULTS

The sample had 130 patients including 64 males and 66 females. Liver length measured on US had a moderate positive correlation with liver volume measured on CT, with a Pearson correlation coefficient of 0.71. ROC curve was generated with area under the curve (AUC) of 0.78 (95% CI of 0.70-0.86/Standard error of 0.04). Based on this, an US cutoff of 16.4 cm was found to be an optimal threshold to identify hepatomegaly. Using this cutoff, the sensitivity for hepatomegaly was 83.3% (95% CI of 71.3 - 91%) and the specificity was 63.2% (51.9% - 73.1%). Using a maximum ultrasound liver length of 17 cm, the sensitivity for hepatomegaly was 81.5% (95% CI of 69.7% - 90.3%) and the specificity was 76.3% (65.6% - 84.5%). Using a maximum ultrasound liver length of 18 cm, the sensitivity was 63.0% (49.6%-74.6%) and the specificity was 84.2% (74.4% - 90.7%).

### CONCLUSION

Liver length measured with US has only a moderate correlation with liver volume. Commonly used US liver length maximum values of 17 cm and 18 cm produce a significant number of false negatives and false positives. US length of 16.4 cm was found to be an optimal threshold to identify hepatomegaly. Improved methods for measuring liver size with US are needed.

### CLINICAL RELEVANCE/APPLICATION

There is only a moderate correlation between liver length measured with US and liver volume measured on volumetric CT, potentially resulting in incorrect liver size estimates with US.

#### SST04-03 Acute Cholecystitis: Implications of Ultrasound Findings on Surgical and Clinical Outcomes

Friday, Dec. 1 10:50AM - 11:00AM Room: E353B

#### Participants

Daniel Van Roekel, MD, Boston, MA (*Presenter*) Nothing to Disclose  
Christina A. LeBedis, MD, Boston, MA (*Abstract Co-Author*) Nothing to Disclose  
Jeffrey Santos, Boston, MA (*Abstract Co-Author*) Nothing to Disclose  
Deepan Paul, Boston, MA (*Abstract Co-Author*) Nothing to Disclose  
Mustafa Qureshi, Boston, MA (*Abstract Co-Author*) Nothing to Disclose  
George Kasotakis, MD, Boston, MA (*Abstract Co-Author*) Nothing to Disclose  
Avneesh Gupta, MD, Boston, MA (*Abstract Co-Author*) Nothing to Disclose

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#### PURPOSE

To identify sonographic signs of acute cholecystitis that predict surgical and clinical outcomes.

#### METHOD AND MATERIALS

The Institutional Review Board approved this HIPAA-compliant retrospective study. Informed consent was waived. 380 patients who underwent cholecystectomy between 06/22/2014 and 03/01/2016 and received abdominal ultrasound (US) prior to surgery were included. Individual US signs, including the presence of stones, gallbladder distention (> 4 cm transverse or > 10 cm long), wall thickening (> 3 mm), pericholecystic fluid, and abscess were graded in a blinded fashion. Outcomes included operating room (OR) duration, drain placement, surgical pathology, bile leak and surgical site infection. The US signs and outcomes were analyzed using an ANOVA or Chi square test.

#### RESULTS

Of 380 patients, 366 had documented OR times, of which 155 showed gallbladder distention on US. Patients with distention had increased OR times (22.7 minutes longer,  $p < 0.0001$ ), increased rate of partial cholecystectomy (odds ratio 5.9, 95% CI: 1.22 to 28.01;  $p = 0.0192$ ), surgical drain placement (odds ratio 2.7; 95% CI: 1.278-5.629,  $p = 0.0071$ ) and pathology diagnosis of acute and chronic cholecystitis (odds ratio 4.3; 95% CI: 2.60 to 7.12,  $p < 0.001$ ) when compared with the non-distended group. Of 380 patients, 144 showed wall thickening. Patients with wall thickening had increased OR times (18.7 minutes longer,  $p = 0.0008$ ), increased rate of partial cholecystectomy (odds ratio 4.0; 95% CI: 1.01 to 15.60,  $p = 0.0455$ ), drain placement (odds ratio 3.2; 95% CI 1.52-6.70,  $p = 0.0014$ ), and pathology diagnosis of acute and chronic cholecystitis (odds ratio 2.7, 95% CI: 1.66 to 4.35,  $p < 0.0001$ ) than the group with normal wall thickness. US findings including gallstones, pericholecystic fluid and abscess were not positively associated with any of the studied clinical outcomes. Likewise, bile leak, site infection and pathology diagnosis of acute or chronic cholecystitis did not show a positive association with any of the US parameters.

#### CONCLUSION

Gallbladder distention and wall thickening on US are predictive of extended operating room times, partial cholecystectomy and surgical drain placement in patients presenting with acute cholecystitis.

#### CLINICAL RELEVANCE/APPLICATION

Gallbladder distention and wall thickening are important sonographic findings that can help the surgeon to predict difficult cholecystectomy cases.

#### SST04-04 Improved Detection of Small Liver Metastases Located Adjacent to Vessels Using Single Shot 2-Dimensional (2D) Magnetization-Prepared Gradient-Echo (MPGRE) Images Acquired at Hepatocytic Phase (HP) of Liver-Specific Contrast Agent (LSCA)

Friday, Dec. 1 11:00AM - 11:10AM Room: E353B

#### Awards

##### Student Travel Stipend Award

#### Participants

Arthur J. Pesch III, MD, Charlottesville, VA (*Presenter*) Nothing to Disclose  
James Patrie, MS, Charlottesville, VA (*Abstract Co-Author*) Nothing to Disclose  
John P. Mugler III, PhD, Charlottesville, VA (*Abstract Co-Author*) Research Grant, Siemens AG Research Consultant, Siemens AG  
Eduard E. De Lange, MD, Charlottesville, VA (*Abstract Co-Author*) Nothing to Disclose

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#### PURPOSE

MRI with LSCA (Gadoxetic-Disodium, Gd-EOB-DTPA) performed 20-40 mins after intravenous administration has become the standard for assessing liver metastases. Image acquisition is typically done with a 3D fat saturated gradient echo (FSGRE) technique. At HP metastases display low signal intensity (SI) and are well seen against the high SI liver background. Since vessels also display low SI, detection of small lesions may be difficult, particularly when adjacent to vessels. MPGRE, also known as TurboFLASH (Siemens), IR FSPGR (GE), or TFE (Philips), with use of a slice selective MP pulse, provides high SI of the vessels from inflowing unsaturated blood. The goal was to investigate the use of HP-MPGRE for improved lesion detection, especially those adjacent to vessels.

#### METHOD AND MATERIALS

Thirty-eight consecutive patients with known liver metastases had HP FSGRE (3mm slice thickness) and MPGRE (4mm) at 20 min after LSCA dosing; 23 were imaged at 1.5T and 15 at 3T. Regions of interest were drawn in each case to measure the signal of the largest lesion, the normal liver tissue while avoiding the major vessels, the inferior vena cava representative of vessels, and the

background noise. Contrast-to-noise ratios (CNR) were calculated using the formula  $(S1-S2)/SD$ , where S1 was the SI of tissue 1, S2 the SI for tissue 2, and SD the standard deviation of background noise.

## RESULTS

Mean (SD) lesion/vessel CNR for the 23 cases imaged at 1.5T and the 15 at 3T were -61.2 (24.4) and -169.3 (75.9) for MPGRE, and 5.3 (53.4) and -9.6 (11.3) for FSGRE, respectively, which, in absolute value, was greater for the former technique than the latter ( $p < 0.05$  for both). Mean (SD) lesion/liver CNR for the 23 at 1.5T and the 15 at 3T were 24.4 (18.7) and 51.2 (52.2), and 43.8 (18.9) and 60.2 (21.4), respectively, which is greater for the latter than the former ( $p < 0.05$  for both). While both MPGRE and FSGRE yielded high CNR for lesions compared to liver, only MPGRE provided consistently high CNR for lesions compared to vessels.

## CONCLUSION

Lesion/vessel CNR on HP-LSCA-enhanced MRI was significantly and substantially greater for MPGRE than FSGRE, indicating visualization of liver metastases adjacent to vessels was markedly improved using the former technique.

## CLINICAL RELEVANCE/APPLICATION

The addition of HP-MPGRE in a LSCA-enhanced liver metastasis MRI protocol is recommended as it markedly facilitates the detection of lesions, particularly those adjacent to vessels.

### SST04-05 Abbreviated Liver-MRI vs Full Protocol Liver-MRI Including Hepatobiliary Phase Imaging to Screen for Liver Metastases in Patients with Solid Tumors: Preliminary Results

Friday, Dec. 1 11:10AM - 11:20AM Room: E353B

#### Participants

Alexandra Barabasch, MD, Aachen, Germany (*Presenter*) Nothing to Disclose  
Martina Distelmaier, Aachen, Germany (*Abstract Co-Author*) Nothing to Disclose  
Nils A. Kraemer, Aachen, Germany (*Abstract Co-Author*) Nothing to Disclose  
Philipp Bruners, MD, Aachen, Germany (*Abstract Co-Author*) Nothing to Disclose  
Christiane K. Kuhl, MD, Bonn, Germany (*Abstract Co-Author*) Nothing to Disclose

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## PURPOSE

To investigate whether an abbreviated liver-MRI protocol (AP), consisting of axial T2w-TSE, DWI and pre-contrast T1w-GRE in- and opposed phase (IP/OP) is appropriate to detect and classify liver metastases.

## METHOD AND MATERIALS

Ongoing reader study on so far 71 consecutive patients with solid tumors who underwent liver-MRI to search for metastatic disease. All patients underwent a standardized full protocol (FP) hepatic MRI at 1.5T with axial and coronal T2w-TSE  $\pm$  fat-saturation (fs), axial T1w-GRE (IP/OP), axial and coronal DWI ( $b=0, 50, 800$ ), multi-phase T1w-dynamic GRE before and after i.v. gadoxetate disodium, and axial T1w-GRE + fs in the hepatobiliary phase. Body radiologists with between 9 and 12 years of experience first reviewed only the abbreviated protocol, and made their diagnosis regarding the presence or absence of focal liver lesions, as well as to the likelihood of malignancy on a 5-point scale. Results of the full MRI-protocol as well as imaging follow-up or histopathology of liver lesion was used as ground truth.

## RESULTS

Acquisition time for the AP was 10.3 min., vs 39.8 min. for the FP. Based on the interpretation of the AP images, reader 1 identified all 56 patients with focal liver lesions that were also identified by reading images of the FP; reader 2 identified 54 of the 55 patients with focal liver lesions identified by the respective FP readings. Accordingly, the sensitivity to identify patients with focal liver lesions based on the AP- vs. the FP-readings was 100% (for reader 1) and 98.2% (for reader 2). Regarding characterization of focal liver lesions (positive predictive value), reader 1 had one additional false-positive diagnosis with AP compared to FP, for a PPV of 92% vs. 94% (35/38 vs. 34/36); 95%-CI: 79 %-98 % vs 81% -99%. Reader 2 had 3 additional false-positive diagnoses with AP vs. FP, for a PPV of 88% vs. 97% (30/34 vs. 33/34); CI: 73%-97% vs. 85%-100%. Average time to read the AP was 43sec. for reader 1 and 72sec. for reader 2.

## CONCLUSION

An MRI acquisition time of 10.3 min. and a reading time between 43 and 72 sec. is sufficient to identify patients with malignant focal liver lesions; it offers identical sensitivity and similar specificity and PPV as does a full, dynamic contrast enhanced liver MRI protocol that included hepatobiliary phase imaging.

## CLINICAL RELEVANCE/APPLICATION

Abbreviated liver MRI seems useful to allow fast MRI-screening for metastatic spread to the liver in cancer patients.

### SST04-06 Diagnostic Performance of an Abbreviated Gadoteric Acid-Enhanced MRI Protocol for Colorectal Cancer Liver Metastases Surveillance

Friday, Dec. 1 11:20AM - 11:30AM Room: E353B

#### Participants

Rodrigo Canellas, MD, Boston, MA (*Presenter*) Nothing to Disclose  
Aoife Kilcoyne, MBBCh, Boston, MA (*Abstract Co-Author*) Nothing to Disclose  
Dushyant V. Sahani, MD, Boston, MA (*Abstract Co-Author*) Research support, General Electric Company; Medical Advisory Board, Allena Pharmaceuticals, Inc

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## PURPOSE

To evaluate the diagnostic performance of an abbreviated gadoteric acid-enhanced MRI protocol in colorectal cancer (CRC) liver metastases surveillance.

## METHOD AND MATERIALS

In this IRB approved retrospective study, gadoteric acid-enhanced (Eovist, Bayer healthcare) MRI scans of 43 patients with histologically proven liver metastases from colorectal cancer (mCRC) were assessed. Two readers independently assessed two sets of images of each patient. The first set consisted of T2WI + 15-20 min delayed T1-WFS followed by DWI (b values ranging from 50 to 800 s/mm<sup>2</sup>) and ADC maps. Readers evaluated liver lesions and characterized them as benign or malignant. A maximum number of 10 lesions per patient were recorded. Malignant classification was based on low signal on the 15-20 min T1-FS, high signal on the DWI and low signal on ADC. Benign diagnosis was based on T2 bright, hypo-intense 15-20 min T1-FS and no restricted diffusion. The full MRI protocol (set 1 + set 2 + dynamic study + other sequences) was used as our reference standard. Cohen kappa analysis was used to assess the agreement between the readers.

## RESULTS

Reader 1 characterized 184 lesions as malignant and reader 2 characterized 200 lesions as malignant with a good inter-reader agreement. Although useful in lesion characterization, DWI did not add much in terms of lesion detection compared to hepatobiliary phase T1-WFS. Full MRI exam with dynamic study was found useful in characterizing previously treated 3 small metastatic lesions, but did not improve the detection of metastatic liver lesions nor the characterization of few small lesions deemed indeterminate by the abbreviated protocol. The mean time for an abbreviated protocol takes around 15 minutes to be completed compared to 35 minutes of the the full MRI protocol.

## CONCLUSION

An abbreviated gadoteric acid-enhanced MRI protocol (T2WI, DWI and 15-20 min delayed T1FS) is faster, has robust quality and provides high diagnostic performance in detection and characterization of liver lesions in mCRC surveillance.

## CLINICAL RELEVANCE/APPLICATION

MRI is a scarce resource and has high demand due to the clinical benefits in variety of clinical settings. Workflow strategies need to be engineered to meet the clinical demands without compromising the diagnostic performance of MRI. An abbreviated liver MRI protocol can serve as potentially faster and lower-cost alternative to conventional MRI protocol.

## SST04-07 Multiparametric Imaging Correlations with Pathology in a HCC Rat Model

Friday, Dec. 1 11:30AM - 11:40AM Room: E353B

### Participants

David Fuentes, Houston, TX (*Abstract Co-Author*) Nothing to Disclose  
Nina M. Munoz, PhD, Houston, TX (*Abstract Co-Author*) Nothing to Disclose  
Kiersten Maldonado, Houston, TX (*Abstract Co-Author*) Nothing to Disclose  
Charles Kingsley, Houston, TX (*Abstract Co-Author*) Nothing to Disclose  
Keith Michel, Houston, TX (*Abstract Co-Author*) Nothing to Disclose  
Houra Taghavi, Houston, TX (*Abstract Co-Author*) Nothing to Disclose  
Richard R. Bouchard, PhD, Houston, TX (*Abstract Co-Author*) Nothing to Disclose  
Hideyuki Nishiofuku, Kashihara, Japan (*Abstract Co-Author*) Nothing to Disclose  
Andrea Cortes, Houston, TX (*Abstract Co-Author*) Nothing to Disclose  
James Bankson, PhD, Houston, TX (*Abstract Co-Author*) Nothing to Disclose  
Rony Avritscher, MD, Houston, TX (*Presenter*) Nothing to Disclose

## PURPOSE

To correlate multiparametric MR imaging with histopathological features of tumor response using a computer-implemented predictive model. This work quantifies MR imaging and pathology correlations in a hepatocellular carcinoma (HCC) rat model treated with sorafenib. Correlations of characteristic tissue hypoxia and nuclear crowding pathology features with MRI enable a non-invasive 'virtual biopsy' for understanding HCC response to sorafenib.

## METHOD AND MATERIALS

Rat HCC McA-RH7777 cells were orthotopically implanted in the liver of 22 male Buffalo rats, and after 2 weeks, the animals were assigned to receive 7.5 mg/kg of sorafenib daily for 2 weeks (n=12) or to remain untreated (n=10). MR Imaging at 4.7 T was performed weekly, including anatomic, dynamic contrast-enhanced (DCE) and blood oxygenation level-dependent (BOLD) sequences. Pathology was co-registered with imaging using anatomical landmarks. Pimonidazole (PIMO) and Haematoxylin and Eosin (H&E) staining were segmented using Gaussian mixture model to identify hypoxia, viable, and necrotic tissue. Tumor heterogeneity on pathology was quantified using the entropy of the hypoxic, viable, and necrotic tissue. The Maurer distance of each tissue type was compute to characterize the necrotic core and hypoxia relative to the HCC tumor boundary.

## RESULTS

Lower entropy of the necrotic tissue was observed in the control group (p<.05) than the treatment group. For the PIMO stains, the distance of the hypoxic tissue in the treatment group was closer (p=.1) to the tumor boundary than the control group. Entropy in the pathology staining was also strongly correlated with T2star imaging (r=.29) but weakly correlated with BOLD effect.

## CONCLUSION

Initial results demonstrate the feasibility of establishing quantitative correlations of imaging and pathology in this HCC rat model. Significant differences in entropy between groups can be used to evaluate treatment effect. Our analytical modeling platform has the potential to help predict response to sorafenib.

## CLINICAL RELEVANCE/APPLICATION

Sorafenib is the only approved systemic therapy for advanced hepatocellular carcinoma. Disease control rate is achieved in less than 50% of advanced HCC patients, while nearly 10% experience grade 3-4. Therefore, imaging biomarkers are needed to identify

patients most likely to respond to sorafenib therapy.

#### **SST04-08 Magnetic Resonance Imaging Biomarkers in Hepato-cellular Carcinoma: Correlation to Outcomes in Liver Transplant Candidates**

Friday, Dec. 1 11:40AM - 11:50AM Room: E353B

##### **Participants**

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##### **PURPOSE**

To determine hepatocellular carcinoma (HCC) magnetic resonance imaging (MRI) biomarkers that enable prediction of delisting from tumor progression versus successful orthotopic liver transplantation (OLT).

##### **METHOD AND MATERIALS**

With IRB approval and HIPPA compliance, from a database of 1108 OLT listed patients with HCC from 2006-2015, patients who were delisted due to tumor progression and who had MRI at HCC diagnosis were identified. A comparison cohort of patients who went on to successful OLT without tumor recurrence matched for tumor stage and bridging therapies were then identified. Patient characteristics and MRI features upon consensus read by 3 abdominal radiologists were compared between the groups by bivariable and multivariable analysis. The significant features were used to generate a prediction model based on MRI. Statistical analyses were performed using SAS version 9.4 (SAS Institute Inc., Cary, NC).

##### **RESULTS**

There were 53 patients included in each cohort (delist-ed vs OLT with no recurrence). Significant ( $p < 0.05$ ) MR features associated with tumor progression resulting in delisting were: T2 hyper-intensity (odds ratio [OR]= 16; 95% confidence interval [CI]: 2.49, 670.95), internal rim enhancement (OR=23.32; 95% CI: 3.42, inf), infiltrative margins (OR= 22.45; 95% CI: 4.37, 115.22), corona enhancement (OR= 4.0; 95% CI: 1.13, 14.18), and bileduct dilatation (OR= 8.17, CI: 1.54, inf). A significant favorable MR features associated with successful OLT was intralesional fat, (OR=0.36, 95% CI: 0.13, 0.99). A prediction model derived from these variables showed an area under the receiver operating characteristic curve (AUC) of 0.86 in the prediction of delisting versus successful transplantation.

##### **CONCLUSION**

MRI findings are significantly associated with risk of tumor progression in patients awaiting liver transplantation.

##### **CLINICAL RELEVANCE/APPLICATION**

MRI features of HCC has the potential to be included in an integrated liver transplantation selection model as biomarkers of tumor biology.

#### **SST04-09 CT Attenuation of Liver Metastases before Chemotherapy is a Predictor of Overall Survival in Colorectal Cancer: Results from the Randomized, Open-Label FIRE-3/AIO KRK0306 Trial**

Friday, Dec. 1 11:50AM - 12:00PM Room: E353B

##### **Participants**

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##### **PURPOSE**

To investigate the prognostic value of pretherapeutic computed tomography (CT) attenuation values of liver metastases for overall survival (OS) in metastatic colorectal cancer (mCRC).

##### **METHOD AND MATERIALS**

In the open-label, randomized, prospective phase III FIRE-3 trial, 592 patients with histologically confirmed mCRC received 5-fluorouracil, leucovorin, and irinotecan (FOLFIRI) with either EGFR-antibody cetuximab or VEGF-antibody bevacizumab. Mean baseline attenuation [Hounsfield units (HU)] of up to five liver metastases was retrospectively measured in contrast-enhanced CT

scans of the abdomen (n=338, portal venous phase, slice thickness  $\leq 5$  mm) using semi-automated volumetry. We analyzed the prognostic value of baseline HU values on overall survival (OS) using Kaplan-Meier estimate, log-rank statistics, and Cox proportional hazard regression. In addition, Receiver Operating Characteristic (ROC) analysis was employed to determine the optimal cutoff for baseline HU as predictor of prolonged OS.

## **RESULTS**

Median baseline CT attenuation of liver metastases was 59.49 HU (IQR 49.08-68.73). In ROC analysis, baseline attenuation  $>61.66$  HU was determined as optimal cutoff for increased OS (649 (95%-CI 587-730) days vs. 931 (777-1128),  $p < 0.01$ ). This result was confirmed in univariate parametric Cox-regression (per 1 HU: HR=0.984, 95%-CI 0.975-0.993,  $p < 0.01$ ). Results were consistent for subgroups based on quartiles with higher HU values being consistently associated with longer OS (median OS Q1 588 (95%-CI 460-806) days vs. Q2 663 (578-853) vs. Q3 800 (663-1096) vs. Q4 990 (777-1198)).

## **CONCLUSION**

Increased baseline CT attenuation values  $>62$  HU are a predictor of prolonged OS in mCRC. Measurements of CT attenuation are fast- and easy-to-perform in clinical routine and may serve as valuable prognostic imaging biomarkers in mCRC patients. Higher CT attenuation values may be the radiological representation of better vascularization of lesions. As a result, these lesions may be better to reach by and therefore more susceptible to systemic treatments.

## **CLINICAL RELEVANCE/APPLICATION**

Liver lesions are the most common metastatic site in colorectal cancer. This work provides insights on the predictive value of the routinely assessed baseline attenuation of liver lesions on overall survival in patients from a large phase III trial.

SST05

## Genitourinary (CT and MRI of Urothelium)

Friday, Dec. 1 10:30AM - 12:00PM Room: E351

**CT** **GU** **MR**

AMA PRA Category 1 Credits™: 1.50  
ARRT Category A+ Credit: 1.75

**FDA** Discussions may include off-label uses.

### Participants

Paul Nikolaidis, MD, Chicago, IL (*Moderator*) Nothing to Disclose  
David D. Childs, MD, Clemmons, NC (*Moderator*) Nothing to Disclose

### Sub-Events

#### SST05-01 Upper Tract Urothelial Carcinoma: Characterization of Lesions Missing with Ureterorenoscopy despite Previous Detection and Localization with CT Urography

Friday, Dec. 1 10:30AM - 10:40AM Room: E351

### Participants

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### PURPOSE

To retrospectively determine nondiminutive upper tract urothelial carcinomas (UTUCs) prospectively detected by using CT urography (CTU) but not confirmed with subsequent nonblinded ureterorenoscopy (URS).

### METHOD AND MATERIALS

The institutional review board approved our study. Between 2003 and 2016, 8250 consecutive patients (mean age, 58 years±10.3) underwent 9133 CTU, which yielded 450 unique nondiminutive suspected UTUC lesions. Of 425 lesions that underwent subsequent nonblinded URS with knowledge of CTU findings-including size, location and morphology, 75 (17.7%) discordant lesions were not found at the initial unblinded URS. After discordant lesions review, 30 lesions were classified as likely CTU false-positive findings without the necessity of further follow-up, and 45 lesions were classified as possible URS false-negative (FN) findings.

### RESULTS

Nineteen of 75 (25.3%) of all discordant lesions after initial nonblinded URS were confirmed to be actual URS FN results, including 57.5% (19 of 33) of lesions with URS and/or CTU follow-up assessment. The average size of lesions with URS FN results was 7.5mm±3.2 and were identified with higher confidence at the prospective CTU by using the three-point scale (2.7±0.4 vs. 2.0±0.3, P=0.002). URS FN lesions were significantly more likely than concordant lesions in the calyceopelvis (73.6%, 14 of 19 vs. 41.4 %, 145 of 350; P=0.015). Eight lesions missed by using URS but confirmed by subsequent URS with surgical resection revealed adherent blood clot in one lesion and benign disease in seven lesions, and five lesions (62.5%) located in the calyceopelvis.

### CONCLUSION

A priori knowledge of CTU for lesions missed at URS is more likely to have higher diagnostic confidence of the initial CTU.

### CLINICAL RELEVANCE/APPLICATION

A priori knowledge of CTU for lesions missed at URS is more likely to have higher diagnostic confidence of the initial CTU.

#### SST05-02 Does Split-Bolus Injection Truly Influence the Ability of Renal and Urinary Lesion Detection at CT Urography? Multi-Center Prospective Randomized Comparison between Split-Bolus and Single-Bolus Injection Techniques

Friday, Dec. 1 10:40AM - 10:50AM Room: E351

### Participants

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## PURPOSE

To determine if split-bolus injection influences the ability of CT urography (CTU) for diagnosing the lesions in the kidney and the urinary tract.

## METHOD AND MATERIALS

Institutional review board approved this multicenter prospective study. 299 patients from 11 institutions (male: female = 211: 88) had been randomly assigned to undergo CTU with split-bolus (n=148) or single-bolus (n=151) injection of CM. The degree of the renal enhancement was assessed with 3-point scale, and presence of renal cystic or solid lesion were evaluated. The urinary tract was divided into four regions (renal pelvis, upper, middle, and lower ureter), and the degree of opacification, as well as the suspicion of lesions were evaluated for each region. CT values of the renal parenchyma, renal lesions, and the renal pelvis were measured in each phase [nephrographic (NP) and excretory (EP) for single-bolus; mixed (MP) for split-bolus] and contrast ratio (CR) were calculated.

## RESULTS

Although there were no differences in CTDI<sub>vol</sub> between single- and split-bolus injection, total DLP of split-bolus was significantly lower than those of single-bolus (1,425±60 vs. 2,013±59 mGycm; p<.0001). There was no difference in the degree of the urinary tract opacification between single- and split-bolus (p>.05). The renal parenchymal enhancement in NP of single-bolus achieved significantly better qualitative score than those in MP of split-bolus (p<.05), and significantly greater CT values than MP of split-bolus (162±31 vs. 128±22 HU; p<.0001). Nevertheless, there was no statistically significant difference in CR of renal lesion between in NP of single-bolus and MP of split-bolus (0.72±0.21 vs. 0.68±0.26; p>.05). CT values of the renal pelvis were significantly higher in EP of single-bolus than MP of split bolus (730±505 vs. 560±421HU; p=.0009). The AUC, Sens, Spec, and Accu of urinary tract lesions were; 0.99, 100%, 94.6%, 94.7% for split-bolus, 0.99, 100%, 95.8%, 95.8% for single-bolus without NP, 0.97, 92.3%, 94.7%, 94.7% for single-bolus including NP.

## CONCLUSION

CTU with split-bolus injection technique can accurately depict the lesions in the renal parenchyma and the urinary tract as single-bolus injection with reduced radiation dose.

## CLINICAL RELEVANCE/APPLICATION

Split-bolus technique should be applied for the CTU considering radiation dose.

## SST05-03 Analysis of Treatment Response of Bladder Cancer on CT Scans: Improved Assessment by Synergistic Combination of Radiomic Features and Clinically Estimated Feature

Friday, Dec. 1 10:50AM - 11:00AM Room: E351

### Participants

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## PURPOSE

To evaluate the accuracy of automatically extracted radiomic features from CT scans and clinically estimated feature in treatment response assessment of bladder cancer.

## METHOD AND MATERIALS

Our Auto-Initialized Cascaded Level Set (AI-CALS) system is designed to extract 3D lesion boundary based on level sets. 47 radiomic features (RF) based on pre- and post- treatment changes in volume (V), 5 gray level (GL) and 9 shape (S) descriptors and 32 texture features (RLS) were extracted from the segmented lesions. A clinically estimated feature, the bimanual exam under anesthesia (EUA), was also collected from the clinical reports. Linear discriminant analysis was used to generate two combined response indices: one by the RFs alone (CRI-RF), and the other with both RFs and EUA (CRI-RF-EUA). With IRB approval, pre- and post-chemotherapy treatment CT scans of 98 patients with bladder cancers were collected. For all cases, cystectomy was performed after treatment and the disease outcome was available as reference standard of treatment response. 25% of patients had pT0 disease (complete response) at cystectomy. A radiologist marked 122 temporal pairs of primary site cancers. Stepwise feature selection and leave-one-case out cross-validation and receiver operating characteristic (ROC) analysis were performed. The area under the ROC curve (AUC) was calculated to estimate the accuracy for predicting pT0 stage (complete response) at cystectomy by V, CRI-RF and CRI-RF-EUA methods. Two radiologists also provided the likelihood of pT0 stage of the tumor by reading the pre- and post-treatment paired CT scans.



## RESULTS

For the 122 cancers, the AUC for prediction of pT0 disease at cystectomy was  $0.70 \pm 0.05$  for V. The AUC for CRI-RF based on 2 Contrast and 2 RLS features was  $0.74 \pm 0.05$  and increased to  $0.78 \pm 0.05$  when EUA was added (CRI-RF-EUA). Prediction of pT0 disease by radiologists resulted in AUCs of  $0.77 \pm 0.05$  and  $0.75 \pm 0.05$ , respectively. The differences did not reach significance ( $p > 0.05$ ).

## CONCLUSION

Both CRI-RF and CRI-RF-EUA performed similar to the radiologists and better than V for estimation of treatment response. The addition of EUA further improved the accuracy of treatment response assessment.

## CLINICAL RELEVANCE/APPLICATION

The combined response index using both the radiomic features and clinically estimated EUA has the potential to provide accurate treatment response assessment and is superior to volume change alone.

### SST05-04 Quantification of Microvascular Changes to Predict ypT1N0 in Chemotherapeutic Response in Bladder Cancer

Friday, Dec. 1 11:00AM - 11:10AM Room: E351

#### Participants

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#### PURPOSE

To apply a parametric MRI methodology to quantify the microvascular changes in bladder tumors at the mid-treatment point of neoadjuvant chemotherapy (NAC) to predict the response with ypT1N0 endpoint.

#### METHOD AND MATERIALS

Thirty-eight muscle-invasive bladder cancer patients were included. Each patient had a pre-chemotherapy, a mid-chemotherapy (after 2 cycles), and a post-chemotherapy MRI, followed by radical cystectomy. The pathological findings of cystectomy specimens were used as reference standard. A patient with  $\leq$ ypT1N0 was defined as a responder. MRI was performed with T2W-MRI prior to DCE-MRI on a 3T multi-transmit system (Ingenia CX, Philips Healthcare). Two pharmacokinetic parameters (Amp - signal enhancement amplitude, and  $k_{ep}$  - the exchange rate between the interstitial space and the plasma space) were estimated. For each patient, the k-means clustering of a voxel-wise Amp and  $k_{ep}$  data matrix was performed to segment their bladder tumor in 3 clusters. The volume fraction (VF) changes of 3 clusters from pre- to mid-chemotherapy MRIs were calculated and correlated with NAC response.  $P < 0.017$  was considered statistically significant for tri-parametric analysis. ROC curve analysis was performed when significant difference was found.

## RESULTS

Based on pathological findings, nineteen patients with  $\leq$ ypT1N0 were classified as responders, and the other nineteen patients as non-responders. The k-means clustering segmented a tumor in 3 clusters: Cluster 1 contained voxels with both low Amp and  $k_{ep}$ ; Cluster 2 had voxels with high Amp and low  $k_{ep}$ ; Cluster 3 had voxels with low Amp and high  $k_{ep}$ . The correlation with chemotherapeutic response showed that responders had significantly higher VF change of cluster 2 ( $P < 0.001$ ) and lower VF change of cluster 1 ( $P < 0.005$ ). There was no correlation found in the VF change of cluster 3. The ROC curve analysis calculated that AUC values were 0.81 for cluster 1 VF change and 0.78 for cluster 2 VF change.

## CONCLUSION

The quantitative MRI methodology can quantify the complex microvascular changes in bladder tumor at the mid-treatment point to characterize the tumor response. The quantitative assessment can provide valuable information to predict pT1N0 endpoint before the end of NAC.

## CLINICAL RELEVANCE/APPLICATION

Accurate prediction of NAC response can make substantial impact on treatment stratification to improve the outcomes of bladder cancer patients.

### SST05-05 Bladder Cancer Staging in CT Urography Using Radiomic Biomarkers

Friday, Dec. 1 11:10AM - 11:20AM Room: E351

#### Participants

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**PURPOSE**

To evaluate the accuracy of a decision support system for staging of bladder cancers based on automatically extracted radiomic biomarkers from CT urography (CTU) merged in a predictive model by machine learning techniques.

**METHOD AND MATERIALS**

Bladder cancers at stage T2 or above are recommended for neoadjuvant chemotherapy treatment clinically. Correct staging is crucial for the decision of neoadjuvant chemotherapy and minimizing the risk of under- or over-treatment. Pre-treatment CTUs of 84 patients with bladder cancers were retrospectively collected with IRB approval. 43 cancers were below stage T2 and 41 cancers were at stage T2 or above. Our Auto-Initialized Cascaded Level Set (AI-CALS) system was used to extract 3D lesion boundary from all lesions. 87 radiomic biomarkers including 55 tumor heterogeneity and 32 morphological features (volume (V), 23 gray level (GL) and 8 shape (S)) were extracted from the segmented lesions. Linear discriminant classifier (LDA), support vector machine (SVM), and backpropagation neural network (NN), with stepwise feature selection based on F-statistics, as well as a random forest (RAF) classifier were used to combine the biomarkers into 4 predictive models for comparison. The dataset was partitioned into independent Set 1 and Set 2 for two-fold cross validation. The predictive models including feature selection were trained on one partition set and tested on the other partition set and vice versa. The area under the receiver operating characteristic curve (AUC) was calculated for each model to estimate its performance in predicting cancer stage ( $\geq T2$  or  $< T2$ ).

**RESULTS**

The test AUC on Set 1 was 0.89, 0.92, 0.91, and 0.86 for LDA, SVM, NN and RAF, respectively. The test AUC on Set 2 was 0.90, 0.89, 0.95, and 0.96 for LDA, SVM, NN and RAF, respectively. The differences between the models did not reach statistical significance. The useful biomarkers included 2 heterogeneity features, 2 gray level features, and a contrast feature.

**CONCLUSION**

The machine learning techniques are promising in selecting effective radiomic biomarkers and merging them into predictive models that may provide useful decision support for bladder cancer stage assessment.

**CLINICAL RELEVANCE/APPLICATION**

An objective decision support system that merges computer-extracted radiomic biomarkers in a predictive model may assist clinicians in making more accurate and consistent cancer staging assessment.

**SST05-06 Prospective Study of DWI and Intravoxel Incoherent Motion (IVIM) MRI as Biomarkers to Predict Clinical Aggressiveness in Bladder Cancer**

Friday, Dec. 1 11:20AM - 11:30AM Room: E351

**Participants**

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**PURPOSE**

To evaluate the utility of the DWI and IVIM-MRI derived parameters in prediction of aggressiveness in bladder cancer.

**METHOD AND MATERIALS**

Fifty-eight patients (49 men, 9 women, mean age 61 years) were inspected through DWI and IVIM MR examination from April 2016 to March 2017. Bladder cancer (BC) was categorized in three different aggressiveness levels according to the classification criterion proposed by Kobayashi et al. The aggressiveness was classified as low- (including stage Ta and histological low-grade T1), intermediate- (high-grade T1) or high-aggressiveness (stage T2 or greater). Spearman Correlation Analysis was adopted to assess the correlation between aggressiveness and all parameters (apparent diffusion coefficient ADC, true diffusion coefficient D, pseudodiffusion coefficient D\*, and perfusion fraction f). Comparisons of ADC value and IVIM parameters in different aggressiveness levels were performed using One-way analysis of variance (ANOVA). Diagnostic performance was calculated by means of receiver operating characteristics (ROC) analysis.

**RESULTS**

Aggressiveness of bladder cancer was negatively correlated with ADC value ( $r=-5.99$ ,  $P < 0.001$ ), D value ( $r=-5.07$ ,  $P < 0.001$ ) and f value ( $r=-3.64$ ,  $P < 0.05$ ). ADC, D, and f values in high-aggressive BC were significantly lower than both those in low-aggressive BC ( $P < 0.05$ ) and those in intermediate-aggressive BC ( $P < 0.05$ ). There was not any significant difference between values of low- and intermediate-aggressive BC. The ROC analysis provided an AUC for ADC value to differentiate high-aggressive BC from low- and intermediate-aggressive BC (AUC=0.858, cut-off value =1.38mm<sup>2</sup>/s) with a sensitivity of 63.16%, a specificity of 100% and an accuracy of 75.87%, an AUC for D value (AUC=0.818, cut-off value =0.877mm<sup>2</sup>/s) with a sensitivity of 65.79%, a specificity of 95% and an accuracy of 75.86%, and an AUC for f value (AUC=0.782, cut-off value =0.33) with a sensitivity of 84.21%, a specificity of 70% and an accuracy of 79.3%.

**CONCLUSION**

ADC value and IVIM-derived parameters are promising biomarkers to predict aggressiveness in BC.

**CLINICAL RELEVANCE/APPLICATION**

(dealing with ADC value and aggressiveness)"The ADC value in DW-MRI can serve as a biomarker to predict the clinical aggressiveness of bladder cancer."

## **SST05-07 Comparison between Conventional Cystourethrography and MRI with Voiding MR-Cystourethrography in the Evaluation of Male Urethral Strictures**

Friday, Dec. 1 11:30AM - 11:40AM Room: E351

### Participants

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### PURPOSE

To evaluate the accuracy of conventional retrograde and voiding cystourethrography and MRI together with voiding MR-cystourethrography in the evaluation of male urethral strictures.

### METHOD AND MATERIALS

We evaluated 39 male patients with urethral strictures diagnosed with urine flow velocity recording and conventional retrograde and voiding cystourethrography. All these patients underwent MRI and voiding MR-cystourethrography using a 1.5T superconductive magnet. The patients had urine-filled bladders and high-resolution sagittal TSE T2-weighted scans were performed (TR:6250ms; TE:90ms;sl.thick.:3mm; acq.time:3'38"). Voiding MR-cystourethrography was performed with T1-weighted spoiled 3D gradient-echo acquisitions on sagittal plane (TR:12ms; TE:2,7ms; flip-angle:40°; sl.thickness: 2mm; acq.time:12s) after the filling of bladder lumen with contrast-material-enhanced urine obtained by the i.v administration 20 mg of furosemide followed by ¾ of the normal dose of a paramagnetic contrast agent (Magnevist, Bayer Pharma, Germany). After micturition high-resolution coronal TSE T2-weighted scans were performed at the level of the stenosis. Two radiologists in consensus evaluated the morphology and length of the urethral stenosis with the two modalities and with MRI the entity and the site of spongio-fibrosis was assessed.

### RESULTS

6 patients were not able to perform voiding MR-cystourethrography. In 33 patients evaluated with two imaging modalities 42 urethral strictures were detected. The measurement of the stenosis length was equal or superior with voiding MR cystourethrography and the analysis of 3D sagittal scans allowed a better evaluation of the morphology of the urethral strictures in comparison with conventional cystourethrography. 32 strictures with Spongio-fibrosis were found (76%). The site of spongio-fibrosis was always assessed with MRI (dorsal, ventral, dorsal and ventral and circular fibrosis).

### CONCLUSION

MRI with voiding MR-cystourethrography shows the morphology and the length of the urethral strictures better than conventional cystourethrography and allows the detection and site of spongio-fibrosis, avoiding radiation exposure to the gonads and urinary catheterization.

### CLINICAL RELEVANCE/APPLICATION

MRI could be proposed as all-in-one technique for the evaluation of urethral stenosis, allowing their detection and length assessment and determining the presence and site of spongiofibrosis.

## **SST05-08 Diagnostic Accuracy of MRI for T-Staging of Urothelial Bladder Cancer: Systematic Review and Meta-Analysis**

Friday, Dec. 1 11:40AM - 11:50AM Room: E351

### Awards

#### Student Travel Stipend Award

### Participants

Niket Gandhi, MD, Ottawa, ON (*Presenter*) Nothing to Disclose  
Matthew D. McInnes, MD, FRCPC, Ottawa, ON (*Abstract Co-Author*) Nothing to Disclose  
Scott Morgan, Ottawa, ON (*Abstract Co-Author*) Nothing to Disclose  
Trevor A. Flood, MD, FRCPC, Ottawa, ON (*Abstract Co-Author*) Nothing to Disclose  
Rodney H. Breau, MD, Ottawa, ON (*Abstract Co-Author*) Nothing to Disclose  
Christopher M. Booth, MD, FRCPC, Kingston, ON (*Abstract Co-Author*) Nothing to Disclose  
Satheesh Krishna, MD, Ottawa, ON (*Abstract Co-Author*) Nothing to Disclose  
Nicola Schieda, MD, Ottawa, ON (*Abstract Co-Author*) Nothing to Disclose

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### PURPOSE

To determine the diagnostic accuracy of MRI for T-staging ( $\geq T2$ ) of urothelial bladder cancer (UBCa). Multi-disciplinary panel determined *a priori* that a sensitivity of >95% was necessary to obviate the need for re-resection of tumor after initial TURBT identifying

### METHOD AND MATERIALS

Search of multiple databases was performed on Jan 26, 2017. Inclusion criteria: humans with UBCa who underwent pelvic MRI (>1.5T) for local staging; reference standard (surgical pathology); no chemo- or radiotherapy prior to imaging. Inclusion and data extraction was performed independently. Risk of bias was assessed using QUADAS-2. Summary estimates for diagnostic accuracy

were generated using bivariate random effects model and subgroup analyses evaluated for sources of heterogeneity.

## RESULTS

13 studies (979 patients) were included. Pooled sensitivity and specificity for: A) 7 studies using only T2-W MRI = 89% (95%CI 78-95) and 55% (95%CI 45-65) and B) 8 studies using DWI = 78% (95%CI 69-85) and 78% (95%CI 70-84). Area under ROC curve (AUC) for T2WI was 0.71 and for DWI was 0.84. Summary ROC curve (SROC) is depicted in Figure 1; 95% prediction regions for T2WI and DWI do not overlap. Moderate risk of bias was identified in patient selection (3/13 studies), index test (4/13) and, reference standard (12/13); all primarily from lack of clear reporting.

## CONCLUSION

MRI for T staging of UBCa demonstrates higher specificity and overall accuracy for DWI compared to only T2W-MRI. Caution is warranted; most comparisons were indirect and the majority of studies had moderate risk of bias in at least one domain.

## CLINICAL RELEVANCE/APPLICATION

T-staging accuracy of UBCa (>T2) with MRI demonstrates variability with higher accuracy identified using DWI compared to T2W-MRI alone. Neither DWI nor T2W-MRI met our pre-specified criteria of >95% sensitivity suggesting that MRI is not an appropriate replacement test for re-resection of tumor following initial TURBT identifying

## SST05-09 Bladder Cancer: MRI as an Alternative to Repeat Transurethral Resection of Bladder Tumor for Local Staging

Friday, Dec. 1 11:50AM - 12:00PM Room: E351

### Awards

#### Student Travel Stipend Award

#### Participants

Christian B. Van Der Pol, MD, Boston, MA (*Presenter*) Nothing to Disclose

Atul B. Shinagare, MD, Boston, MA (*Abstract Co-Author*) Advisory Board, Arog Pharmaceuticals, Inc.; Research grant, GTX, Inc.

Sreeharsha Tirumani, MBBS, MD, Boston, MA (*Abstract Co-Author*) Nothing to Disclose

Mark Preston, Boston, MA (*Abstract Co-Author*) Nothing to Disclose

Mark Vangel, PhD, Charlestown, MA (*Abstract Co-Author*) Nothing to Disclose

Stuart G. Silverman, MD, Brookline, MA (*Abstract Co-Author*) Nothing to Disclose

## PURPOSE

Transurethral resection of bladder tumor (TURBT) frequently understages muscle invasive bladder cancer and needs to be repeated. The purpose of this study was to determine test characteristics of multiparametric MRI (mpMRI) for the local staging of bladder cancer following TURBT, using cystectomy as the reference standard.

## METHOD AND MATERIALS

This retrospective study was institutional review board approved and is HIPAA compliant. Between August 2011 and October 2016, 45 consecutive patients (median age 73 years) met inclusion criteria, which included a TURBT procedure followed by mpMRI then cystectomy without intervening neoadjuvant or intra-vesical therapies. Median time between TURBT and MRI was 43 days (SD 130, range 17-627 days). Two fellowship-trained abdominal radiologists, blinded to cystectomy staging, reviewed each mpMRI independently to document tumor T stage and regional nodal disease using all available sequences and each sequence in isolation. Sensitivity and specificity for the presence of muscle invasion ( $\geq$ T2) and peri-vesical invasion ( $\geq$ T3) were calculated on a stage-by-stage basis. Sensitivity and specificity for presence of regional nodal disease was assessed. Inter-observer agreement was measured using Cohen's Kappa coefficient.

## RESULTS

Sensitivity/specificity for presence of muscle invasion was 92%/74% for reader 1 and 88%/84% for reader 2. Sensitivity/specificity for presence of peri-vesical invasion was 72%/92% for reader 1 and 67%/92% for reader 2. Sensitivity/specificity for regional nodal disease was 45%/93% for reader 1 and 45%/90% for reader 2. T2-WI was the most sensitive sequence for both readers for determining the presence of muscle invasion and peri-vesical invasion, while DWI was the most sensitive for regional nodal disease. The most specific sequence varied between readers. Inter-observer agreement was substantial for presence of muscle invasion, peri-vesical invasion and regional nodal disease when all sequences were used.

## CONCLUSION

mpMRI is sensitive and specific at determining bladder cancer muscle and peri-vesical invasion in patients who have undergone prior TURBT. mpMRI was specific but not sensitive for assessing regional nodal disease.

## CLINICAL RELEVANCE/APPLICATION

Multiparametric MRI is sensitive and specific at bladder cancer local staging following TURBT. Current bladder cancer management guidelines could consider mpMRI as an alternative to repeat TURBT.

SST06

## Science Session with Keynote: Musculoskeletal (Spine)

Friday, Dec. 1 10:30AM - 12:00PM Room: E451A

CT MK MR

AMA PRA Category 1 Credits™: 1.50  
ARRT Category A+ Credit: 1.75

### Participants

William E. Palmer, MD, Boston, MA (*Moderator*) Nothing to Disclose  
Marcelo Bordalo-Rodrigues, MD, PhD, Sao Paulo, Brazil (*Moderator*) Nothing to Disclose

### Sub-Events

#### SST06-01 Musculoskeletal Keynote Speaker: Update in Spine Imaging

Friday, Dec. 1 10:30AM - 10:40AM Room: E451A

### Participants

William E. Palmer, MD, Boston, MA (*Presenter*) Nothing to Disclose

#### SST06-02 CT-Based Structural Analysis Predicts Failure of Human Spines with Simulated Osteolytic Defects under Functional Loads

Friday, Dec. 1 10:40AM - 10:50AM Room: E451A

### Participants

Ron N. Alkalay, PhD, Boston, MA (*Presenter*) Nothing to Disclose  
Robert Adamson, MSc, Boston, MA (*Abstract Co-Author*) Nothing to Disclose  
David B. Hackney, MD, Boston, MA (*Abstract Co-Author*) Nothing to Disclose

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N/A

### PURPOSE

To compare the accuracy of a) CT based structural analysis protocol (CT-SAP) b) bone mineral density (BMD) and c) lesion size in predicting vertebral strength in a lytic lesion model of human vertebral metastatic disease.

### METHOD AND MATERIALS

We created lytic defects in the middle vertebra of 40 cadaver thoracic and lumbar 3-level spinal segments from donors aged 48-57 years (Fig 1). The segments were imaged using a clinical CT spine protocol (field of view = 16cm, voxel dimensions: (0.31\*0.31\*0.625)mm). The segments were then tested to failure in either compression or in compression + torsion (3Nm). Linear regression models (JMP 9, SAS, NC) tested the correlations of a) defect size, b) BMD and c) CT-SAP predicted failure load with measured vertebral strength.

### RESULTS

- Compression loading: Within an intentionally small range of defect diameters, lesion size was not correlated with vertebral strength (Fig 2.C). CT-SAP showed significantly higher prediction accuracy for vertebral strength than did BMD (Fig 2.B), (ANCOVA,  $p < 0.01$ ), Fig 2.A. - Compression + torsion loading: Lumbar vertebrae showed 12% reduction in mean strength than in pure compression Thoracic spines showed 34% higher strength than in compression alone ( $p < 0.05$ ). CT-SAP again had significantly higher prediction accuracy than BMD (Fig 2.C),  $p < 0.05$ , but both measures showed lower prediction accuracy compared to the compression-only tests.

### CONCLUSION

CT-SAP is superior to lesion size and BMD in predicting the strength of human vertebrae with lytic defects. These results are achieved by modeling the material properties and spatial distribution of the bone throughout the vertebral volume. Incorporation of a more realistic loading regime (compression + torsion) brings this in vitro model closer to actual stresses applied in vivo. The novel finding of regional differences in the effect of torsional loading on vertebral strength highlights the need to incorporate local variation in facet geometry in intervertebral kinematics, effecting local load transfer, in order to improve CT-SAP prediction accuracy.

### CLINICAL RELEVANCE/APPLICATION

There are no objective and precise methods for predicting fracture risk in patients with spinal metastases. Subjective protocols such as SINS have limited accuracy. CT-SAP appears to provide more reliable objective predictions.

#### SST06-03 The Differential Diagnosis of Benign and Malignant Vertebral Compression Fracture with MR Fat-Water Separation Dixon Technique at 3.0T: A Retrospective Study

Friday, Dec. 1 10:50AM - 11:00AM Room: E451A

## Participants

Hui Tan, Xianyang, China (*Presenter*) Nothing to Disclose  
Qiuju Fan, Xianyang, China (*Abstract Co-Author*) Nothing to Disclose  
Nan Yu, MD, Xian Yang, China (*Abstract Co-Author*) Nothing to Disclose  
Qi Yang, Xianyang, China (*Abstract Co-Author*) Nothing to Disclose  
Shaoyu Wang, Shanghai, China (*Abstract Co-Author*) Nothing to Disclose  
Yong Yu, Xianyang City, China (*Abstract Co-Author*) Nothing to Disclose

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## PURPOSE

The purpose of our study was to explore the value of fat-water separation Dixon technique in differential diagnosis of benign and malignant vertebral compression fractures.

## METHOD AND MATERIALS

We retrospectively analyzed 76 patients with vertebral lesions who scanned at a CT scanner, and can not confirm the diagnosis. Then all patients underwent fat-water separation Dixon T1WI sequence on a MAGNETOM Skyra 3.0T MR scanner (Siemens AG, Erlangen, Germany). The patients were identified as either benign compression fractures (35 osteoporotic fractures, 5 traumatic fractures, 3 infective fractures; age, 28-76 years) or malignant compression fractures (28 metastatic fractures, 3 multiple myeloma, 2 non-Hodgkin lymphoma; age, 34-81 years) based on clinical follow-up or pathologically results. Besides general protocols for vertebral disease, the water-fat separation Dixon T1-VIBE protocol was included with the following parameters, TR/TE= 600/9.5ms, slice thickness=3mm, FOV= 340mm, matrix =384x384, iPAT = 2, Number of slices=16, and Average= 1. Four series of images (in/opposed phases, fat/water only) generated by the system were used for FF analysis. The signal intensity ratio was defined as SIR= SI<sub>opp-phase</sub>/ SI<sub>in-phase</sub> and the fat fraction was defined as FF= SI<sub>fat</sub>/ SI<sub>in-phase</sub>×100%.

## RESULTS

The value of FF (27.43±6.77) in the benign group was significantly higher than that in the malignant group (11.88±4.23) (P<0.01). The SIR (0.72±0.28) in the benign group was significantly lower than that in the malignant group (1.38±0.21) (P<0.01). Through drawing ROC curve used the FF and SIR of benign and malignant vertebral compression fractures, the diagnostic critical value of benign and malignant vertebral compression fractures was 12.75 and 0.86. The AUC of FF and SIR were 0.75 and 0.86.

## CONCLUSION

The vertebral signal intensity and fat fraction through 3.0T MR fat-water separation Dixon technique can reflect the change of the vertebral body fat content in patients, and is helpful in differentiation in between benign and malignant vertebral compression fractures.

## CLINICAL RELEVANCE/APPLICATION

(dealing with MR Dixon technique) '3.0T MR fat-water separation Dixon technique can demonstrate alterations in vertebral body fat content and this exam is recommended when the underlying cause of vertebral lesion is unclear.'

## SST06-04 Validation of T2 Weighted Images for Assessing Fat Infiltration in Paraspinal Muscles Using an Osirix Application

Friday, Dec. 1 11:00AM - 11:10AM Room: E451A

## Participants

Cristobal Arrieta, Santiago, Chile (*Abstract Co-Author*) Nothing to Disclose  
Pablo Besa, Santiago, Chile (*Abstract Co-Author*) Nothing to Disclose  
Ignacio J. Osorio, Santiago, Chile (*Abstract Co-Author*) Nothing to Disclose  
Cristian Montalba, Santiago, Chile (*Abstract Co-Author*) Nothing to Disclose  
Daniel Hasson, MD, Santiago, Chile (*Abstract Co-Author*) Nothing to Disclose  
Daniela Esparza, Santiago, Chile (*Abstract Co-Author*) Nothing to Disclose  
Marcelo Andia, MD, PhD, Santiago, Chile (*Abstract Co-Author*) Nothing to Disclose  
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Sergio A. Uribe Sr, PhD, MS, Santiago, Chile (*Presenter*) Nothing to Disclose

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## PURPOSE

Fat infiltration in paraspinal muscles has shown to be related to low back pain risk and it has been quantified using a manual thresholding yielding to quantification errors. Moreover, although the segmentation is typically done in T2w images, this has not been validated. We proposed a software to automatically segment FI in PM using T2w images. The software was validated against manual segmentations using Dixon images as a gold standard since they do not contain water nor B0 inhomogeneities.

## METHOD AND MATERIALS

We used T2w and Dixon images from 10 healthy volunteers and 10 patients, acquired in a Philips Ingenia 3.0T scanner (TE 110ms, TR 4160ms for T2w) with an acquisition matrix of 324x324 and a pixel resolution of 0.4x0.4x4mm. To segment fat, we developed an Osirix plugin based on PyOsirix, which allows for running Python scripts over the Osirix database. We manually define 4 ROIs per slice for the erector spinae and multifidus muscles and from L1-L2 to L5-S1. An automatic threshold is determined for each ROI. For the gold standards, we copy the same ROIs into the Dixon images and then we found a threshold manually. For the statistical analysis, we performed two-tail paired t-test, Pearson correlation, Bland Altman analysis and linear regression.

## RESULTS

Two-tail paired t-test of the segmented areas showed that there is not significant difference between gold standard and our method ( $P=0.61$ ). Linear regression showed the good agreement between the two methods ( $Y=0.91X+0.21 \text{ cm}^2$ ). Pearson correlation was 0.89 and Bland Altman plots showed a low bias ( $-0.016 \text{ cm}^2$ ) and limits of agreement of  $[-1.270, 1.238] \text{ cm}^2$ . Fortin and Batié (2012) reported 9 minutes for manually finding the threshold for fat segmentation in T2w images. Our Osirix plugin performs the segmentation in a fraction of second per ROI.

## CONCLUSION

We developed an Osirix plugin to automatically quantify FI in PM using T2w images. Our plugin showed an excellent agreement and no significant difference with manual segmentation using Dixon images. Our plugin reduces the processing time from minutes to a few seconds. As future work, we are developing techniques for facilitating the PM delimitations to define the ROIs.

## CLINICAL RELEVANCE/APPLICATION

We validated a software to automatically segment the fat infiltration in paraspinal muscles using T2w images. We used manual segmentation in Dixon images as a gold standard.

## SST06-05 Quantitative T2 Magnetic Resonance Imaging Compared to Morphological Grading of the Early Cervical Disc Degeneration in Asymptomatic Volunteers by T2 Relaxation Mapping

Friday, Dec. 1 11:10AM - 11:20AM Room: E451A

### Participants

Chenglong Ren, Shanxi, China (*Presenter*) Nothing to Disclose  
Nan Yu, MD, Xian Yang, China (*Abstract Co-Author*) Nothing to Disclose  
Yongjun Jia, MMed, Xianyang City, China (*Abstract Co-Author*) Nothing to Disclose  
Guangming Ma, Xianyang, China (*Abstract Co-Author*) Nothing to Disclose  
Yong Yu, Xianyang City, China (*Abstract Co-Author*) Nothing to Disclose  
Chuangbo Yang, MMed, Xianyang City, China (*Abstract Co-Author*) Nothing to Disclose

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## PURPOSE

The purpose of this study was to assess cervical disc degeneration quantitatively by using T2 Relaxation mapping.

## METHOD AND MATERIALS

22 asymptomatic young subjects (11 men and 11 women;  $21.73 \pm 2.01$  years) were enrolled in this study. All data were collected on a 3.0 T MRI (Skyra, Siemens Healthcare, Erlangen, Germany); therefore, the morphological data of 132 cervical disc covering C2 to T1 were obtained (Cervical sagittal T2-weighted, sagittal and axial T2 relaxation MRI) covering discs C2-C3 to C7-T1. All MR images in this study were acquired in the afternoon to minimize the diurnal variation of T2 values in the discs. All the discs were morphologically assessed according to the Miyazaki grade. Morphological evaluation of images were carried out by 2 radiologists with 10 years experience of musculoskeletal radiology in consensus. Six discs (C2-T1) of the cervical spine were put Regions of interest (ROIs) over axial T2 mappings images, including nucleus pulposus (NP), anterior and posterior annulus fibrosus (AF). To minimize the error in identifying nucleus pulposus (NP) anatomic structure, free hand ROIs were put carefully matched to the NP shape. The value of AF was calculated by the average between AAF and PAF. Mean T2 values were recorded using Siemens SyngoVIA workstation. Wilcoxon signed rank test, Kruskal-Wallis test, and Spearman rank correlation were performed. Correlations were considered as strong for  $r > 0.7$ , moderate for  $0.5 < r < 0.7$ , and weak for  $r < 0.5$ . All statistical analysis was performed by SPSS software (v16.0, SPSS Inc., Chicago, IL, USA),  $P < 0.05$  was considered statistically significant.

## RESULTS

The difference in T2 values between NP and AF were highly significant ( $P < 0.001$ ). The trends of decreasing T2 mapping values of both NP and AF with increasing Miyazaki grades was significant ( $P < 0.01$ ), particularly between Miyazaki grade I and II ( $P < 0.001$ ). Miyazaki grades were inversely significantly correlated with T2 values in the NP ( $r = -0.8901$ ,  $P < 0.001$ ) and AF ( $r = -0.7446$ ,  $P < 0.001$ ).

## CONCLUSION

The process of cervical disc degeneration can be detected by T2 mapping, particularly at early stage. It displays comparable trends as Miyazaki grades does.

## CLINICAL RELEVANCE/APPLICATION

Quantitative, objective and non-invasive evaluation of T2 mapping in intervertebral disc degeneration can prevent, diagnose and evaluate the clinical effect of spinal diseases.

## SST06-06 Value of Psoas Proximal Insertion for Numbering Lumbar Vertebrae

Friday, Dec. 1 11:20AM - 11:30AM Room: E451A

### Participants

Francois n. Ropars, Brest, France (*Presenter*) Nothing to Disclose  
Jawad Mesrar, MD, Brest, France (*Abstract Co-Author*) Nothing to Disclose  
Julien Ognard, MD, MSc, Brest, France (*Abstract Co-Author*) Nothing to Disclose  
Solene Querellou, Brest, France (*Abstract Co-Author*) Nothing to Disclose  
Jean Rousset, MD, Brest, France (*Abstract Co-Author*) Nothing to Disclose  
Marc Garetier, MD, Brest, France (*Abstract Co-Author*) Nothing to Disclose

## PURPOSE

To evaluate the value of psoas muscle proximal insertion for correct numbering of the lumbar vertebrae in MRI, in particular in case of lumbosacral transitional vertebra (LSTV).

## METHOD AND MATERIALS

Two radiologists assessed independently 477 MRI of the lumbar spine with coronal STIR sequence and a sagittal localizer sequence on the whole spine. The last lumbar vertebra was by counting caudally from C2, and its morphology was evaluated according to Castellvi classification as modal lumbosacral junction (N) or LSTV (C). The proximal insertion level of psoas muscle was assessed on coronal STIR sequence. It was named as the most proximal vertebrae with psoas over half of its body. The same parameters were assessed on 207 PET-CT of other patients including the whole spine to compare MRI and CT data with a Fisher's exact test, considering CT as gold standard for anatomical consideration, due to millimetric slices and possibility of multiplanar reconstructions.

## RESULTS

Among the 477 patients, 405 patients (84,9%) had a modal last lumbar vertebra (L5N), 43 patients (9%) a LSTV (L4/5/6C+) and 29 patients (6,1%) a missing or supernumerary lumbar vertebra without LSTV (L4/6N). The psoas proximal insertion was L1 in 449 patients (94,1%), T12 in 8 patients (1,7%) and L2 in 20 patients (4,2%). It was L1 in 98,5% in case of L5N, 81,0% in case of LSTV, and 81,3% and 15,4% in case of L4N or L6N respectively. The interreader agreement for determination of psoas proximal insertion was excellent ( $\text{Kappa} = 0.96$ ). There was no statistically significant difference between MRI and CT data ( $p < 0,05$ ).

## CONCLUSION

Coronal STIR sequence has a high-performance for the determination of the psoas proximal insertion. Determination of psoas proximal insertion is an accurate, valuable and easy way for correctly number lumbar vertebrae. In case of a modal anatomy (L5N), it's almost always L1 (98%). Controversely, this insertion is not necessarily T12 or L2 according to the presence of missing or supernumerary lumbar vertebrae, with or without LSTV. In these situations, psoas even keeps an insertion on L1 in the majority of cases, except in L6N group.

## CLINICAL RELEVANCE/APPLICATION

Radiologists should have a look on psoas proximal insertion in lumbar spine MRI. If this insertion is not 5 vertebral bodies above the lumbosacral joint, there is a high probability of variation in the number of lumbar vertebrae.

## SST06-07 The Value of Golden-Angle RAdial Sparse Parallel (GRASP) Imaging for Differentiation between Infectious Degenerative Modic Type 1 Changes of the Spine

Friday, Dec. 1 11:30AM - 11:40AM Room: E451A

### Participants

Meritxell Garcia, Basel, Switzerland (*Presenter*) Nothing to Disclose  
Kai Tobias Block, PhD, New York, NY (*Abstract Co-Author*) Royalties, Siemens AG  
Oliver Bieri, PhD, Basel, Switzerland (*Abstract Co-Author*) Nothing to Disclose  
Dorothee Harder, Basel, Switzerland (*Abstract Co-Author*) Nothing to Disclose  
Bram Stieltjes, MD, PhD, Basel, Switzerland (*Abstract Co-Author*) Nothing to Disclose

## PURPOSE

The aim was to assess whether a T1w3D sequence with contrast for dynamic MR imaging, Golden-angle RAdial Sparse Parallel (GRASP) was able to distinguish between benign and pathologic vertebral compression fractures.

## METHOD AND MATERIALS

Twelve patients with non-necrotic metastases in non-fractured VBs (mean 66 years), 11 patients with VB compression fractures without a history of a malignancy (mean 74 years), and 8 patients with VB compression fractures caused by osseous metastases (63 years) were examined by conventional MRI and GRASP at 1.5 or 3T (Siemens). Imaging parameters of the GRASP sequence were: TA 4:20 min, TR/TE 5.92/1.78 msec, slice thickness 2.5 mm, voxel size 1x1x2.5 mm. A region of interest (ROI) was placed in the pathologic-appearing VB and in a normal-appearing VB, whereby the latter served as a reference. The ROIs of metastatic non-fractured VBs served as a further reference.

## RESULTS

The three patients groups did not show any difference in the maximum contrast-enhancement intensity, and all showed a higher contrast-enhancement than the normal-appearing VBs. In all VB fractures without malignancy the time-contrast-enhancement intensity course was almost parallel to that of the normal-appearing VB consisting of a fast increase of contrast enhancement (at 40-85 sec) shortly afterwards reaching a plateau (80-175 sec). On the other side, all metastases without fracture manifested a slightly earlier and very fast increase of contrast-enhancement (at 30-55 sec) immediately followed by a prolonged and weak decrease of enhancement towards a late plateau (>175 sec). The time-intensity contrast-enhancement curves of the pathologic fractures were quite similar to that of the metastatic non-fractured VBs (slope 35-65 sec, plateau >175 sec).

## CONCLUSION

Pathologic VB fractures, however, can be distinguished from benign compression fractures by a different time intensity contrast-enhancement curve, whereby the dynamic differences can be attributed to differences in cellularity, edema, and vascularity of the bone. We conclude that GRASP imaging may be a promising sequence for the differentiation between benign and pathologic fractures, which may be of great value in patients in which the primary cause for the fracture cannot be evaluated by conventional MRI.

## CLINICAL RELEVANCE/APPLICATION

GRASP imaging may be a promising tool for the differentiation between benign and pathologic fractures with MRI.

## SST06-08 Texture Analysis of Paraspinal Musculature in MRI of the Lumbar Spine: Analysis of the Lumbar Spinal Outcome Study (LSOS) Data

Friday, Dec. 1 11:40AM - 11:50AM Room: E451A

### Participants

Manoj Mannil, Zurich, Switzerland (*Presenter*) Nothing to Disclose  
Jakob Burgstaller, Zurich, Switzerland (*Abstract Co-Author*) Nothing to Disclose



Arjun Thanabalasingam, Zurich, Switzerland (*Abstract Co-Author*) Nothing to Disclose  
Sebastian Winklhofer, MD, Zurich, Switzerland (*Abstract Co-Author*) Nothing to Disclose  
Michael Betz, Zurich, Switzerland (*Abstract Co-Author*) Nothing to Disclose  
Ulrike Held, Zurich, Switzerland (*Abstract Co-Author*) Nothing to Disclose  
Roman Guggenberger, Zurich, Switzerland (*Abstract Co-Author*) Nothing to Disclose

## PURPOSE

To evaluate the clinical impact of fatty infiltration in paraspinal musculature on Spinal Stenosis Measure (SSM) Score and Walking Distance, at baseline and regarding changes after 12 months in patients suffering from lumbar spinal stenosis (LSS) using the qualitative Goutallier staging and quantitative Texture Analysis (TA) in Magnetic Resonance Imaging (MRI).

## METHOD AND MATERIALS

In this retrospective, institutional review board approved study, TA was performed on axial T2 weighted MR images at level L3/4 using dedicated software (MaZda) in 62 patients with LSS. The association between Goutallier and TA findings with two clinical outcome measures, Spinal Stenosis Measure (SSM) Score and Walking Distance, at baseline and regarding changes after 12 months were assessed using machine learning algorithms (Random Forest) for TA feature reduction, followed by multiple logistic regression models.

## RESULTS

Quantitative assessment of fatty infiltration using the histogram TA feature „mean" showed higher interreader reliability (ICC 0.83-0.97) compared to the Goutallier staging ( $\kappa = 0.69$  to  $0.93$ ). No correlation between Goutallier staging and two clinical outcome measures at baseline and after 12 months was observed. Among 151 TA features in all paraspinal muscle groups, only TA feature "mean" of the spinotransverse group showed a significant but weak correlation with worsened SSM ( $p = 0.046$ ) and TA feature "S(3,3) Entropy" as a measure of altered microarchitecture showed a significant but weak association with worsened walking distance over 12 months ( $p = 0.046$ ). However, after correction for multiple testing no clear association can be observed.

## CONCLUSION

MR TA is a reproducible tool to quantitatively assess paraspinal fatty infiltration, but its association with clinical outcomes in LSS patients is very limited.

## CLINICAL RELEVANCE/APPLICATION

MR TA is a reproducible tool to quantitatively assess paraspinal fatty infiltration and microarchitectural changes, but its association with clinical outcomes in Lumbar Spinal Stenosis patients is limited.

## SST06-09 Optimization of 2nd TE with Subtraction Image Using Ultra-Short TE for the Lumbar Cartilaginous Endplates in Human in Vivo

Friday, Dec. 1 11:50AM - 12:00PM Room: E451A

### Participants

Mika Yanagida, Sapporo, Japan (*Presenter*) Nothing to Disclose  
Hiroyuki Takashima, PhD, Sapporo, Japan (*Abstract Co-Author*) Nothing to Disclose  
Rui Imamura, Sapporo, Japan (*Abstract Co-Author*) Nothing to Disclose  
Hiroshi Nagahama, RT, Sapporo, Japan (*Abstract Co-Author*) Nothing to Disclose  
Mitsuhiro Nakanishi, RT, Sapporo, Japan (*Abstract Co-Author*) Nothing to Disclose  
Hiroki Shishido, RT, Sapporo, Japan (*Abstract Co-Author*) Nothing to Disclose  
Yoshihiro Akatsuka, RT, Sapporo, Japan (*Abstract Co-Author*) Nothing to Disclose  
Masamitsu Hatakenaka, MD, PhD, Sapporo, Japan (*Abstract Co-Author*) Research Grant, Toshiba Medical Systems Corporation

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## PURPOSE

Dual echo acquisition with later echo subtraction has been used for suppressing long T2 signals in ultra-short TE (UTE) imaging. In this study, we evaluated the optimal 2nd TE with subtraction images using UTE for lumbar cartilaginous endplates (CEP) in human in vivo.

## METHOD AND MATERIALS

The subjects were 20 patients who had low back pain and degenerative lumbar disorders (12 males, 8 females; average age:  $41.3 \pm 8.7$  years). All subjects were performed with a 3-tesla MR system (Ingenia, Philips Healthcare, The Netherlands) using a dS Torso coil. We used a 3D sequence (TR, 23ms; flip angle,  $15^\circ$ ) with fat suppression that UTE was acquired with a phased-encoded stack of spirals trajectory as the first TE and four gradient echoes as the second TE following the first echo. TEs were set at 0.16, 4.6, 9.2, 13.8, and 18.2ms. Scanning was performed around lumbar spine, sagittal slice orientation, 60 slices,  $0.94\text{mm} \times 0.94\text{mm} \times 4.8\text{mm}$  voxel size, and 17-minute scan time. Signal intensity of CEP and intervertebral discs (IVD) and vertebral bodies (VB) at the level of L3/L4 in region of interests (ROIs) were measured on the subtraction images (first TE minus second TEs). The ROIs were measured by a research scientist analyzing MR images and a spine surgeon. Furthermore, we calculated the contrast ratio (CR) of CEP/IVD and CEP/VB. To calculate the inter measurers variability, we expressed an intraclass correlation (ICC) with CR. The Friedman test was used for statistical significance, which was set at a p-value of  $<0.05$ . All statistics were performed in SPSS version 20.0 (IBM, SPSS Inc.).

## RESULTS

CR for CEP/IVD was  $47.9 \pm 15.5$  for 4.6ms,  $62.6 \pm 21.6$  for 9.2ms,  $65.8 \pm 20.4$  for 13.8ms, and  $48.5 \pm 22.0$  for 18.2ms. CR of 9.2 and 13.8ms was significantly higher than that of 4.6 and 18.2ms ( $p < 0.01$ ). Furthermore, CR for CEP/VB was  $9.3 \pm 4.1$  for 4.6ms,  $9.5 \pm 3.5$  for 9.2ms,  $18.7 \pm 4.3$  for 13.8ms, and  $22.3 \pm 5.8$  for 18.2ms. CR of 13.8 and 18.2ms was significantly higher than that of 4.6 and 9.2ms ( $p < 0.01$ ). ICC of two measurers was 0.939 for CEP/IVD and 0.924 for CEP/VB.

## CONCLUSION

The optimal 2nd TE with subtraction image was 13.8ms in human CEPs.

**CLINICAL RELEVANCE/APPLICATION**

Dual echo acquisition with UTE is useful for diagnosing degenerative changes of CEPs such as Modic changes.

SST07

## Nuclear Medicine (Chest Imaging)

Friday, Dec. 1 10:30AM - 12:00PM Room: E353C

**CH** **CT** **MR** **NM**

AMA PRA Category 1 Credits™: 1.50  
ARRT Category A+ Credit: 1.75

**FDA** Discussions may include off-label uses.

### Participants

Ephraim E. Parent, MD, PhD, Atlanta, GA (*Moderator*) Nothing to Disclose  
Andrew C. Homb, MD, Rochester, MN (*Moderator*) Nothing to Disclose

### Sub-Events

#### SST07-01 **Whole-Body FDG-PET/MRI: Comparison of its Capability for TNM Staging with that of Whole-Body MRI, Integrated FDG-PET/CT and Conventional Radiological Examination in Patients with Malignant Pleural Mesothelioma**

Friday, Dec. 1 10:30AM - 10:40AM Room: E353C

### Participants

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### PURPOSE

To directly and prospectively compare the TNM staging capability among whole-body co-registered FDG-PET/MRI, MRI with diffusion-weighted imaging (DWI), integrated FDG-PET/CT and conventional radiological examination in patients with malignant pleural mesothelioma.

### METHOD AND MATERIALS

23 consecutive pathologically diagnosed malignant mesothelioma patients (14 men, 9 women, mean age 69.2 years old) underwent whole-body MRI including DWI, integrated PET/CTs, conventional radiological examinations, pathological examinations and surgical reports as well as follow-up examinations. TNM staging was evaluated by three different reader groups including radiologists with more than three year experiences of whole-body MRI and PET/CT and nuclear medicine physicians. Kappa statistics were determined for evaluations of agreements of each factor and the clinical stage between each of the methods and final diagnosis. Finally, the diagnostic accuracy of each factor and of determination of the clinical stage was statistically compared with each other by using McNemar's test.

### RESULTS

T factor agreements were determined as substantial (PET/CT and conventional examination: kappa value=0.61) or almost perfect (PET/MRI and MRI: kappa value=0.86). N factor agreements were also determined as substantial (PET/CT: kappa value=0.73, conventional examination: kappa value=0.61) or almost perfect (PET/MRI and MRI: kappa value=1.00). M factor assessment, agreements were also determined as moderate (conventional examination: kappa value=0.47), substantial (MRI: kappa value=0.78) or almost perfect (PET/MRI and PET/CT: kappa value=1.00). In addition, clinical stage agreements were determined as substantial (PET/CT and conventional examination: kappa value=0.70) or almost perfect (PET/MRI and MRI: kappa value=0.87). Finally, accuracies of N factor evaluation on PET/MRI and MRI (100 [23/23] %) were significantly higher than that of conventional examination (73.9 [17/23] %, p=0.03).

### CONCLUSION

Whole-body PET/MRI and MRI with DWI are potentially more useful for TNM stage assessment than conventional radiological examination, and can be considered at least as effective as PET/CT.

### CLINICAL RELEVANCE/APPLICATION

Whole-body PET/MRI and MRI with DWI are potentially more useful for TNM stage assessment than conventional radiological

examination, and can be considered at least as effective as PET/CT.

## **SST07-02 Prognostic Value of Metabolic Variables of [18F]FDG PET/CT in Surgically Resected Stage I Lung Adenocarcinoma**

Friday, Dec. 1 10:40AM - 10:50AM Room: E353C

### **Participants**

Xiaoyi Wang, MD, Beijing, China (*Presenter*) Nothing to Disclose

### **PURPOSE**

The objective of this study was to assess the prognostic value of metabolic tumor burden measured by positron emission tomography/computed tomography (PET/CT) in patients with stage I lung adenocarcinoma.

### **METHOD AND MATERIALS**

We reviewed 127 consecutive patients with pathologically proven stage I lung adenocarcinoma who underwent pre-treatment [18F]FDG PET/CT scans in our hospital from 2005 June to 2012 June. The maximum, mean and peak standardized uptake value (SUVmax, SUVmean and SUVpeak), metabolic tumor volume (MTV), total lesion glycolysis (TLG) and computed tomography volume (CTV) were measured. The Kaplan-Meier and Cox proportional hazards model were used with age, gender, TNM stage, clinical stage, histological grade, nodule type, tumor size and metabolic parameters to predict progression-free survival (PFS). The cut-off point was determined through ROC curve.

### **RESULTS**

In univariate analysis, the histological grade, nodule type, diameter (cut-off value of 2.0cm), CTV (6.56cm<sup>3</sup>), SUVmax (3.25g/ml), SUVmean (1.58g/ml), SUVpeak (1.84g/ml), MTV (4.80cm<sup>3</sup>) and TLG (10.40) were significantly associated with PFS (all P value <0.05). Patients with poorly differentiated adenocarcinoma, solid nodule type, large size, high metabolic tumor burden were associated with poor prognosis. In multivariate analysis, only histological grade was independent prognostic factors for progression with a P value of 0.005 (RR, 0.355; 95 % CI, 0.173-0.728). Among five PET/CT metabolic parameters, only MTV was independent prognostic factors for progression with a P value of 0.031 (RR, 1.118; 95 % CI, 1.010-1.237).

### **CONCLUSION**

Histological grade was an independent predictor for progression in patients with stage I lung adenocarcinoma. Among five PET/CT metabolic parameters, only MTV was an independent predictor for progression.

### **CLINICAL RELEVANCE/APPLICATION**

Owing to the high heterogeneity, there is quite a limitation in treatment planning and prognosis predicting only based upon TNM stage and pathological type. Recently, several researches have already proved that SUVmax, MTV and TLG had prognostic and predictive value in NSCLC patients. However, previous studies focused primarily on advanced stage disease, few studies have reported the role of those parameters in early stage adenocarcinoma. This study was conducted to document the prognostic role of metabolic tumor burden parameters in patients with stage I lung adenocarcinoma.

## **SST07-03 Comparison of Different Automated Lesion Delineation Methods for Metabolic Tumor Volume of 18F-FDG PET/CT in Patients with Stage I Lung Adenocarcinoma**

Friday, Dec. 1 10:50AM - 11:00AM Room: E353C

### **Participants**

Xiaoyi Wang, MD, Beijing, China (*Presenter*) Nothing to Disclose

### **PURPOSE**

Defining metabolic tumor volume (MTV) of small and/or low uptake lesions using positron emission tomography/ computed tomography (PET/CT) is usually challenging since the variation is generally high. The aim of this paper is to investigate the suitable segmentation method in small, low uptake and heterogeneous stage I lung adenocarcinoma.

### **METHOD AND MATERIALS**

One-hundred and thirty-three stage I lung adenocarcinoma patients with 2-deoxy-2-[18F]fluoro-D-glucose PET/CT scans were enrolled in this retrospective study. All lesions were divided into different groups according to nodule density (16 non-solid, 30 part-solid and 87 solid), nodule size (53 small lesions with longest diameter ≤ 20 mm; 80 large lesions with longest diameter >20 mm) and the maximum standard uptake value (SUVmax) level (57 low uptake lesions with SUVmax ≤ 2; 76 high uptake lesions with SUVmax > 2). The MTVs of the four different PET segmentation methods were evaluated and compared with CT volume (CTV). Percentage volume error (%VE) compared to CTV was calculated and the correlations between MTVs and CTV were analyzed.

### **RESULTS**

The adaptive iterative algorithm (AT-AIA) had the highest accuracy in large, high uptake and solid nodules (72.5%, 72.4% and 65.6%, respectively). The method of adaptive thresholding at 40% SUVmax (AT40%) had the highest accuracy in small, low uptake and non-solid nodules (56.6%, 56.1% and 62.6%, respectively). In part-solid nodules, the accuracy of AT-AIA (60.0%) and AT40% (56.7%) were higher than that of the other two methods. The MTV of AT-AIA was in excellent consistent with the CTV in solid nodules (R=0.831, P=0.000) and in high uptake nodules (R=0.830, P=0.000). The MTV of AT40% was in good consistent with the CTV in non-solid nodules (R=0.686, P=0.003) and in part-solid nodules (R=0.731, P=0.000).

### **CONCLUSION**

AT40% showed best performance in small, low uptake, non-solid and part-solid lesions. AT-AIA was suitable for large, high uptake and solid lesions.

### **CLINICAL RELEVANCE/APPLICATION**

Up to now, defining metabolic tumour volume of small and/or low uptake lesions is still challenging since the variation is generally high. The aim of this study is to investigate the suitable segmentation method in small, low uptake and heterogeneous stage I lung

adenocarcinoma.

#### **SST07-04 Decrease in SUV Max of a Solitary Pulmonary Nodule (SPN) in Dual-Time FDG-PET/CT Imaging: Does it Reliably Exclude Malignancy?**

Friday, Dec. 1 11:00AM - 11:10AM Room: E353C

##### **Participants**

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##### **PURPOSE**

FDG-PET/CT is a well established modality for evaluating indeterminate solitary pulmonary nodules (SPN). Although the sensitivity for detecting malignancy is considered quite high, the specificity is lower. By adding delayed imaging (Dual-Time PET/CT), the specificity for malignancy improves, since malignant SPN increase glucose utilization over time, i.e. an increase by > 10% in the maximum standardized uptake value (SUV Max). By contrast, a decrease or no significant change in SUV Max suggests benign etiology. We observed, however, that it was not uncommon for biopsy-proven malignant nodules to show either no significant change or a decrease in SUV Max on delayed imaging. Our aim was to (1) determine the frequency of this pattern and (2) to correlate with histopathology.

##### **METHOD AND MATERIALS**

From 2007 through 2016, we collected all cases of FDG-PET/CT scans used for SPN evaluation in which the final diagnosis was lung malignancy, yet the SUV Max either did not significantly change, or decreased by 10% or more on delayed imaging.

##### **RESULTS**

A total of 86 patients met the above criteria, 50 men and 36 women. In 40 of the patients (Group A), the SUV Max decreased by  $\geq$  10%, which was considered a significant decrease. Of these, 23 patients had adenocarcinoma, 4 had squamous cell, 4 had small cell, and 13 had bronchoalveolar (BAC). The remaining 46 patients (Group B) demonstrated either no significant change in SUV Max, or a decrease less than 10%; 15 had adenocarcinoma, 13 had small cell, 7 had BAC, and 11 had squamous cell cancer.

##### **CONCLUSION**

(1) Although a significant increase in SUV Max in dual-point FDG PET/CT imaging generally indicates SPN malignancy, a decrease or lack of change in SUV does not necessarily mean a benign etiology. (2) Adenocarcinoma is the most common cell type in which SUV Max decreases or does not significantly change, likely a reflection of tumor differentiation.

##### **CLINICAL RELEVANCE/APPLICATION**

A lack of change or a significant decrease in SUV Max over time of an SPN does not exclude malignancy and this pattern is unreliable in SPN evaluation.

#### **SST07-05 18FDG Uptake Patterns by Mediastinal Lymph Nodes and EBUS in the Nodal Staging of Patients with Non-Pulmonary Malignancies**

Friday, Dec. 1 11:10AM - 11:20AM Room: E353C

##### **Participants**

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##### **PURPOSE**

To retrospectively compare 18FDG-PET scans and EBUS findings in patients with documented mediastinal lymphadenopathy and non-pulmonary primary malignancies.

##### **METHOD AND MATERIALS**

25 patients with documented mediastinal lymphadenopathy and non-pulmonary primary malignancies underwent 18FDG-PET scintigraphy followed by EBUS within the ensuing 3 weeks. One-two nodes (n = 29) were assessed in each patient, determined by 18FDG-PET findings and accessibility of the 18FDG-positive nodes. The mediastinal nodal status from each procedure was compared.

##### **RESULTS**

EBUS resulted in mediastinal nodal status downgrading in 60% patients. No upgrading was noted. Downgrading most likely occurred when there several non-enlarged lymph nodes of similar 18FDG-avidity distributed randomly and bilaterally in the mediastinum, often with bilateral hilar uptake (~80% of patients). 100% patients with positive EBUS findings for malignant disease demonstrated discrete 18FDG-avid lymph nodes ipsilaterally, with minimal-to-no 18FDG-avid nodes contralaterally. EBUS findings in 20% of patients were inconclusive, despite multiple sampling. Enlarged, rounded lymph nodes with avid FDG uptake (SUV>4) were also more likely to harbour metastatic disease.

##### **CONCLUSION**

The pattern of mediastinal 18FDG uptake was highly predictive of metastatic disease, and may circumvent the need for EBUS

evaluation. Prospective analysis of these parameters will be undertaken.

#### **CLINICAL RELEVANCE/APPLICATION**

Patterns of 18FDG uptake in mediastinal lymph nodes may circumvent the need for EBUS assessment.

#### **SST07-06 Short TE and Low Flip Angle VIBE Sequence for Lung Evaluation in PET-MRI**

Friday, Dec. 1 11:20AM - 11:30AM Room: E353C

##### **Participants**

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#### **PURPOSE**

Low-dose CT in standard PET/CT offers a better morphological lung characterization when compared with Dixon sequences in PET/MRI. Our aim is to improve diagnostic accuracy for lung lesions detection with PET/MRI avoiding a significant increase in the acquisition time, adding a short TE (Echo Time) and low FA (Flip Angle) T1-weighted sequence (gradient-echo volumetric interpolated breath-hold examination [VIBE]) to the standard acquisition protocol.

#### **METHOD AND MATERIALS**

We enrolled 21 oncological patients (11 M and 10 F) who underwent both thoracic CT scan and 3T PET-MRI (Siemens Biograph mMR) including lung dedicated short TE and low FA VIBE (inspiration, 3 mm slice thickness, axial plane). Time interval between the two examinations was < 2 weeks. VIBE sequences were retrospectively and independently evaluated by two radiologists for the detection of pulmonary nodules, parenchymal consolidations and dense bands; to assess inter-observer agreement Cohen's kappa coefficient ( $\kappa$ ) was calculated. Results were then compared with CT scans findings, considered as the gold standard. Sensitivity and specificity were calculated.

#### **RESULTS**

VIBE sensitivity in lung nodules evaluation was 80% (8/10 patients) for nodules >5 mm and 57,1 % (4/7 patients) for nodules  $\leq$  5 mm, compared to CT imaging. In both cases specificity was 100%. All dense bands and parenchymal consolidation were found both with CT scan and VIBE. Inter-observer agreement was 95 % for nodules >5 mm ( $\kappa = 0.90$ ,  $p < 0.001$ ), 85% for nodules  $\leq$  5 mm ( $\kappa = 0.44$   $p < 0.005$ ), 90% for dense bands ( $\kappa = 0.56$ ,  $p < 0.001$ ) and 100% for parenchymal consolidations.

#### **CONCLUSION**

VIBE showed high sensitivity in the evaluation of lung nodules > 5 mm; sensitivity was less satisfactory for smaller nodules. This sequence obtained also a very good inter-observer agreement, resulting a very reproducible imaging technique in pulmonary lesion investigation. Considering also the short acquisition time (15-18 s), it seems be reasonable to integrate PET/MRI protocols with a short TE and low FA VIBE, improving its diagnostic performance in lung evaluation.

#### **CLINICAL RELEVANCE/APPLICATION**

Short TE and low FA VIBE sequence can improve PET-MRI diagnostic performance in pulmonary lesions detection, without a significant increase in the acquisition time.

#### **SST07-07 Relative Effect Size of Different Clinical & PET Variables on NSCLC Patient's Survival Estimated with Random Survival Forest Model**

Friday, Dec. 1 11:30AM - 11:40AM Room: E353C

##### **Participants**

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#### **PURPOSE**

To assess relative effect size of the different clinical & PET variables on the overall survival (OS) in patients with non-small cell lung cancer (NSCLC), using permutation Variable Importance (VIMP) measure with a Random Survival Forest (RSF) model.

#### **METHOD AND MATERIALS**

A RSF model, which can address right censored data problem, was constructed based on 952 consecutive NSCLC patients with baseline PET/CT studies, but no brain metastasis or other type of primary cancer (separated into 604 for training and 348 for testing, according to their PET/CT study acquisition scanners). The RSF model included gender, age, race, smoking status, TNM stage (according to the 8th edition of the clinical TNM staging system), histology type, treatment types (with surgery, without surgery and no treatment), and maximum standard uptake value of whole-body tumor (SUV<sub>maxWB</sub>) and whole-body metabolic

tumor volume (MTVWB) measured on the PET/CT studies. The overall survival (OS) time served as independent variable. The VIMP, which is a measure of relative importance of parameters on survival (the higher value indicates higher importance), was calculated using permutation method included in the RSF R package (randomForestSRC). The trained RSF model was used to predict the survival rate for the patients in the test dataset and the results were compared to the standard Cox model.

## RESULTS

The top 3 highest VIMP coefficients of 0.047, 0.036 and 0.032, were from treatment type, clinical TNM stage and MTVWB, respectively. The coefficient of SUVmaxWB was 0.011. The histology type, race, smoking status and gender had similar coefficients of about 0.003, while age had the smallest VIMP of 0.001. When predicting the test patients' survival rate with the identical variables, our RSF model achieved moderate performance with C-index (a measure of predictive ability of a model) of 0.73, compared to 0.71 by the Cox model.

## CONCLUSION

Our model suggests that treatment types, TNM stage and MTVWB are relatively important variables on NSCLC patient's survival, among the commonly used clinical prognostic and PET tumor variables. SUVmaxWB has a moderate effect, while the histology type, race, smoking status, gender and age have small effect on patients overall survival.

## CLINICAL RELEVANCE/APPLICATION

This work suggests that treatment type, TNM stage, MTVWB and SUVmaxWB are important prognostic factors useful for the treatment decision making and prognosis of NSCLC patients.

## SST07-08 Active Contour-Based Segmentation for 18F-FDG PET Thoracic Oncology: A Powerful Alternative to the Clinical State-of-the-Art Expert-Based Segmentation

Friday, Dec. 1 11:40AM - 11:50AM Room: E353C

### Participants

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## PURPOSE

The aim of this study was to assess the performances of an active contour-based user GUI approach for the PET segmentation of complex-shaped lung tumours, in comparison to an optimized expert-based manual reference standard.

## METHOD AND MATERIALS

In this retrospective study, 75 complex-shaped lung tumours were blindly segmented using the same graphical user interface (GUI) ITK snap software. For each tumour, four independent raters semi-automatically segmented the 75 tumours twice (sessions 1 and 2) using the active contour based-procedure of the GUI software. A probabilistic estimate of each tumour ground truth was also computed from the set of six independent expert-based manual segmentation results using the Simultaneous Truth And Performance Level Estimate (STAPLE) algorithm. Accuracy of the semi-automatic procedure was assessed by measuring the spatial overlap between the raters segmentation outputs and the corresponding expert probabilistic reference standards, using the DICE similarity coefficient (DSC). Interrater and intrarater reliability analyses were also performed using the intra class correlation coefficients (ICC) estimates of the output volumes,(two-way mixed-model, individual-rating, absolute-agreement). For all tumours segmentation procedures, average time per procedure was also estimated.

## RESULTS

Overall accuracy of the user GUI active contour-based procedure was excellent with a DSC of 0.835 (95%CI = 0.775-0.895). Interrater reliabilities provided the following results: ICC = 0.941 (95%CI = 0.913-0.961) for the first session and ICC = 0.935 (95%CI = 0.906-0.956) for the second session. Intrarater reliabilities provided the following results: ICC = 0.993 (95%CI = 0.990-0.996) for the rater 1; ICC = 0.987 (95%CI = 0.976-0.993) for the rater 2; ICC = 0.972 (95%CI = 0.956-0.982) for the rater 3; and ICC = 0.977 (95%CI = 0.964-0.985) for the rater 4. Average time was 631 seconds for manual segmentation procedure, and 130 seconds for active contour-based procedure.

## CONCLUSION

Compared to the state of the art expert-based manual segmentation, the GUI-based active contour procedure provided excellent accuracy and reliability, with a mean procedure duration almost five-times faster than the manual reference standard.

## CLINICAL RELEVANCE/APPLICATION

Active contour based segmentation from ITK snap software is robust, fast, and easy enough to be routinely applied to segment

Active contour based-segmentation from ITK Snap software is robust, fast, and easy enough to be routinely applied to segment heterogeneous and complex-shaped lung tumours.

## **SST07-09 FDG-PET/CT Predicts Development of Thyroiditis due to Immunotherapy for Lung Cancer**

Friday, Dec. 1 11:50AM - 12:00PM Room: E353C

### **Participants**

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### **PURPOSE**

Determine if PET/CT parameters of FDG uptake in the thyroid gland pre-and post-immunotherapy with nivolumab for advanced lung cancer could predict the development of the immune-related adverse event, thyroiditis.

### **METHOD AND MATERIALS**

An IRB-approved retrospective chart review over 2 years found 18 patients with advanced lung cancer treated with nivolumab and with FDG-PET/CT scans pre and post therapy. The post-treatment FDG-PET/CT was performed approximately 6-9 weeks after the first dose of nivolumab. The standardized uptake value (mean and max) and total lesion glycolysis (TLG) of the thyroid gland were measured. Patients obtained monthly thyroid function testing as standard of care while receiving nivolumab. Results of the thyroid testing separated the patients into two groups, patients who developed new hypothyroidism (thyroiditis) and those who did not. Statistical t-test analysis used the FDG-PET/CT parameters to compare the two groups.

### **RESULTS**

In the hypothyroid group, 7 patients developed hypothyroidism after immunotherapy. In the euthyroid group, 9 patients remained euthyroid and 2 patients had a pre-existing history of hypothyroidism (including these 2 did not significantly affect statistics). T-test analysis demonstrated statistically significant higher post-therapy SUVs in the hypothyroid versus euthyroid group. The differences in average values between the two groups were SUV mean 0.77 ( $p < 0.04$ ), SUV max 0.96 ( $p < 0.04$ ) and TLG 0.96 ( $p < 0.02$ ). Pre-therapy SUVs showed no statistical difference. 4 out of 7 patients in the hypothyroid group were euthyroid at the time of the post-therapy PET scan and developed hypothyroidism months later.

### **CONCLUSION**

Nivolumab is an immune checkpoint inhibitor which works by activation of T cells against tumors and is associated with immune-related adverse events like thyroiditis. Increases in FDG uptake in the thyroid gland after immunotherapy indicate inflammation from thyroiditis and therefore predict the development of immunotherapy-induced hypothyroidism, potentially before laboratory testing or development of symptoms.

### **CLINICAL RELEVANCE/APPLICATION**

FDG-PET/CT can predict the development of immunotherapy-induced hypothyroidism and therefore the necessity for thyroid hormone replacement.

### **Honored Educators**

Presenters or authors on this event have been recognized as RSNA Honored Educators for participating in multiple qualifying educational activities. Honored Educators are invested in furthering the profession of radiology by delivering high-quality educational content in their field of study. Learn how you can become an honored educator by visiting the website at: <https://www.rsna.org/Honored-Educator-Award/> Elizabeth A. Krupinski, PhD - 2017 Honored Educator



SST08

## Neuroradiology/Head and Neck (Head and Neck Imaging: Testing the Limits)

Friday, Dec. 1 10:30AM - 12:00PM Room: E353A



AMA PRA Category 1 Credits™: 1.50  
ARRT Category A+ Credit: 1.75

### Participants

Brent D. Griffith, MD, Troy, MI (*Moderator*) Nothing to Disclose  
Amanda S. Corey, MD, Atlanta, GA (*Moderator*) Nothing to Disclose

### Sub-Events

#### SST08-01 Surgical Reconstruction of Ossicular Chain Defect with Custom 3D Printed Ossicular Prosthesis

Friday, Dec. 1 10:30AM - 10:40AM Room: E353A

### Participants

Jeffrey D. Hirsch, MD, Baltimore, MD (*Presenter*) Nothing to Disclose  
David Eisenman, MD, Baltimore, MD (*Abstract Co-Author*) Nothing to Disclose  
Richard Vincent, MD, Baltimore, MD (*Abstract Co-Author*) Nothing to Disclose

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### PURPOSE

Conductive hearing loss due to ossicular abnormalities occurs from many causes, including trauma, infection, cholesteatoma, surgery and congenital anomalies. Surgical reconstruction of the ossicular chain is a well-established procedure for repair of ossicular defects, but is still plagued by high failure rates. Underlying disease and proper sizing of prostheses are two challenges that lead to component failure. Three-dimensional (3D) printing has been used successfully to solve a number of medical prosthesis problems. Custom 3D printing an individualized ossicular prosthesis would be a potential solution for the wide range of anatomic variation encountered in the pathological middle ear, and could decrease the rate of post-operative prosthesis displacement by increasing the likelihood of a proper fit, in addition to decreasing surgical time.

### METHOD AND MATERIALS

The incus was removed from three formalin-fixed cadaveric human temporal bones with no macro- or microscopic evidence of pathology. Imaging of the cadaveric bone was obtained using a standard temporal bone CT protocol. A custom prosthesis for each cadaveric human temporal bone was designed using the Mimics Innovation Suite software (Materialise, Belgium) and fabricated on a Form2 3D printer (FormLabs, Somerville, Massachusetts). Four surgeons then performed insertion of each prosthesis into each middle ear, blinded to the bone from and for which each was designed. The surgeons were asked to match each prosthesis to its correct parent bone.

### RESULTS

Each prosthesis had unique measurements. Each of the four surgeons was able to correctly match the prosthesis model to its intended temporal bone. The chances of this occurring randomly are 1:1296.

### CONCLUSION

A custom 3D printed ossicular prosthesis is a viable solution for conductive hearing loss due to ossicular chain defects. Commercially available CT scanners can detect significant anatomic differences in normal human middle ear ossicles. These differences can be accurately represented with current 3D printing technology and, more significantly, surgeons can detect these differences.

### CLINICAL RELEVANCE/APPLICATION

This process overcomes a common technical challenge of properly sizing the prosthesis, as each model is custom made for an exact fit which should lead to an improved result and decreased operative time.

#### SST08-02 Assessment of Microvascular Compression for Facial-Acoustic Nerves: Role of Combined Isotropic 3D T2-DRIVE and 3D TOFMRA

Friday, Dec. 1 10:40AM - 10:50AM Room: E353A

### Participants

Bo Jiang, MD, PhD, Canton, China (*Presenter*) Nothing to Disclose  
Ximin Pan, Canton, China (*Abstract Co-Author*) Nothing to Disclose  
Meiyu Hu, Canton, China (*Abstract Co-Author*) Nothing to Disclose  
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## PURPOSE

To evaluate the application value of isotropic 3D T2-DRIVE combining isotropic 3D TOFMRA in detecting microvascular compression for facial-acoustic nerves.

## METHOD AND MATERIALS

Thirty-six patients were enrolled in the study with clinically suspected vascular compression of facial-acoustic nerves, of which both 3D T2-DRIVE and 3D TOFMRA sequences images were obtained of isotropy and identical voxel size at 0.7 mm×0.7 mm×0.7 mm. Source images and reformatted images were observed to evaluate the effects on demonstration of facial-acoustic nerves and culprit vessels, which was scored from 0 to 3 points in the order from poor to excellent. The differences were compared of effects on displaying both the facial-acoustic nerves and culprit vessels among the three approaches of 3D T2-DRIVE, 3D TOFMRA, and 3D T2-DRIVE+3D TOFMRA. The Kruskal-Wallis H test was employed in data processing, with  $P < 0.01$  for the statistically significant difference.

## RESULTS

In displaying facial-acoustic nerves, 3D T2-DRIVE+3D TOFMRA and T2 3D-DRIVE were superior to 3D TOFMRA ( $H=58.78$ ,  $P=0.0000$ ,  $H=53.18$ ,  $P=0.0000$ , respectively), and no statistically significant difference existed between 3D T2-DRIVE+3D TOFMRA and T2 3D-DRIVE ( $H=2.28$ ,  $P=0.1313$ ). In displaying culprit vessels, 3D-T2-DRIVE+3D TOFMRA was superior to T2 3D-DRIVE and 3D TOFMRA ( $H=54.12$ ,  $P=0.0000$ ,  $H=62.42$ ,  $P=0.0000$ , respectively), and no statistically significant difference existed between 3D T2-DRIVE and 3D TOFMRA ( $H=0.0083$ ,  $P=0.9274$ ). Of 36 patients, 32 were detected with arteriolar compression for facial-acoustic nerves by the approach of 3D T2-DRIVE combining 3D TOFMRA, and 4 with no compression. The results were confirmed by surgical findings or clinical follow-up, respectively. The sensitivity and specificity was 100%, 100% of 3D T2-DRIVE+3D TOFMRA in diagnosing microvascular compression for facial-acoustic nerves, respectively.

## CONCLUSION

The combination of isotropic 3D T2-DRIVE and isotropic 3D TOFMRA provides a precise and accurate diagnostic approach in identifying microvascular compression for facial-acoustic nerves.

## CLINICAL RELEVANCE/APPLICATION

Combined isotropic 3D T2-DRIVE and 3D TOFMRA has advantage over isotropic 3D T2-DRIVE in detecting microvascular compression for facial-acoustic nerves, and over isotropic 3D TOFMRA as well. The approach could be widely utilized in the radiologically diagnostic scenario of potential microvascular compression for cranial nerves.

## SST08-03 Static and Dynamic Evaluation with MRI of Larynx and Oro-Pharyngeal Cavity in Professional Opera Singers

Friday, Dec. 1 10:50AM - 11:00AM Room: E353A

### Participants

Marco Di Girolamo, MD, Rome, Italy (*Presenter*) Nothing to Disclose  
Paolo Bonome, Rome, Italy (*Abstract Co-Author*) Nothing to Disclose  
Cristiano Cantone, Rome, Italy (*Abstract Co-Author*) Nothing to Disclose  
Iliaria Mastroiacovo, Rome, Italy (*Abstract Co-Author*) Nothing to Disclose  
Gianni Ruoppolo, Rome, Italy (*Abstract Co-Author*) Nothing to Disclose  
Michele Rossi, MD, Rome, Italy (*Abstract Co-Author*) Nothing to Disclose

### For information about this presentation, contact:

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## PURPOSE

To assess the anatomical configuration of phonetic organs by MRI in professional opera singers with different vocal range.

## METHOD AND MATERIALS

26 professional opera singers (12 men (7 tenors and 5 basses) and 14 women (8 sopranos and 6 mezzosopranos) were evaluated with MRI. We performed both static and dynamic study with MRI. The static study was performed with TSE T2-weighted axial scans at the level of larynx (TR:2000 ms; TE:120ms; slice thick:3mm) in order to evaluate the area of superior surface of vocal cord. In the dynamic study, the singers were asked to perform a prolonged vocalization at a comfortable tonality of the fundamental vowel a. We performed a midsagittal Turbo Field Echo scan (TR:12ms; TE:6ms; fa:30°; acq.time:6s) at the level of the oro-pharyngeal cavity measuring the area of the mouth and pharyngeal lumen. These data underwent statistical evaluation using the Mann-Whitney U-test (non-parametric test) considering: 1) vocal tessitura; 2) size of the vocal cord; 3) area of the mouth and pharyngeal lumen during the utterance of the vowel a.

## RESULTS

The average size of the vocal cord was: 0.71 cm<sup>2</sup> for sopranos; 1.20 cm<sup>2</sup> for mezzosopranos; 1.58 cm<sup>2</sup> for tenors; 2.88 cm<sup>2</sup> for basses. The average area of mouth and pharyngeal lumen on midsagittal scan during the utterance of the vowel a was: 15.8 cm<sup>2</sup> for sopranos; 14.6 cm<sup>2</sup> for mezzosopranos; 23.6 cm<sup>2</sup> for tenors; 32.2 cm<sup>2</sup> for basses. We found that the differences in vocal cord size between sopranos and mezzosopranos ( $P: 0.0641$ ) and between tenors and basses ( $P: 0.0833$ ) are tendentially statistically significant. The variation in vocal tract size during the utterance of the vowel a between tenors and basses is considered tendentially statistically significant ( $P: 0.0833$ ) while the difference between sopranos and mezzosopranos is not considered statistically significant ( $P: 0.6434$ ). The difference in the vocal register between soprano and mezzosoprano is less considerable in comparison with tenor and bass or with soprano and contralto.

## CONCLUSION

Our results demonstrate a correlation between the surface of the vocal cord and the configuration of vocal tract and the vocal tessitura of a singer.

## CLINICAL RELEVANCE/APPLICATION

Long vocal cord and wide vocal tract are characteristic of singers with low-pitched voice types (bass, baritone, contralto) while short vocal cord and narrow vocal tract are characteristic of singers with high-pitched voice types (tenor, soprano).

#### **SST08-04 Basic Consideration for Facial Aging: Anatomic and Radiological Analysis of the Superficial Musculoaponeurotic System (SMAS)**

Friday, Dec. 1 11:00AM - 11:10AM Room: E353A

##### **Participants**

Itsuko Okuda, MD, Minato-Ku, Japan (*Presenter*) Nothing to Disclose  
Masahiro Irimoto, MD, Kunitachi, Japan (*Abstract Co-Author*) Nothing to Disclose  
Yasuo Nakajima, MD, Kawasaki, Japan (*Abstract Co-Author*) Nothing to Disclose  
Katsuhiko Abe, Minato-ku, Japan (*Abstract Co-Author*) Nothing to Disclose  
Keiichi Akita, MD, PhD, Tokyo, Japan (*Abstract Co-Author*) Nothing to Disclose

##### **PURPOSE**

Facial aging is caused not only by skin aging, but also by aging changes of the subcutaneous structures. The SMAS is situated in the superficial fascia. SMAS weakness was reported as one factor of cheek sagging related with facial aging. The purpose of this study is to analyze the anatomic radiological correlation of the SMAS, and establish CT findings of the SMAS.

##### **METHOD AND MATERIALS**

This retrospective study was approved by the institutional review board. Step 1: five cadaver faces were used to confirm the morphology and distribution of the SMAS. Right halves of those were dissected, and examined the structures of SMAS. The left were used for cross-sectional anatomic and histological examinations. Step 2: To select the interpretation sites of the SMAS, the SMAS's findings of the cadaveric studies were compared to the CT findings. Step 3: To confirm CT findings of SMAS, CT images of 18 females (age range, 21-82 years) without lesions that would influence the superficial structures of their faces were enrolled. Two observers assessed CT findings of the SMAS independently, and the criteria was used for the following three-grade scales: G-2 (entire visualization as a thick layer); G-1 (entire visualization as a thin layer); or G-0 (obscured or partial visualization as a thin layer). The interobserver differences were assessed by kappa coefficient.

##### **RESULTS**

The SMAS was observed as a subcutaneous fibro-membranous structure extending from the superficial temporal fascia to the parotid fascia, and contained the major and minor zygomatic muscles and platysma. CT showed the subcutaneous linear opacities corresponding to the fibro-membranous structures of the cadaveric studies. Among the 18 cases, observer 1 judged G-2:11, G-1:7, G-0:0. Observer 2 judged G-2:13, G-1:5, G-0:0. There was good agreement between 2 observers about CT findings of SMAS (kappa=0.75, p **CONCLUSION**

The SMAS is a definite anatomic structure that can be demonstrated as an anatomic membranous layer in subcutaneous adipose tissue from the superficial temporal fascia to the parotid fascia on CT. This analysis is applicable to evaluating age-related changes of the face, and can contribute to the elucidation of the mechanism of facial aging.

##### **CLINICAL RELEVANCE/APPLICATION**

CT is the useful tool to evaluate the SMAS that is important structures to maintain a young appearance, and clinical applications can contribute to the elucidation of the mechanism for facial aging.

#### **SST08-05 CT Texture Analysis of Lymphoid Tissues on FDG-PET/CT in HIV-positive Patient**

Friday, Dec. 1 11:10AM - 11:20AM Room: E353A

##### **Participants**

Hirofumi Kuno, MD, PhD, boston, MA (*Abstract Co-Author*) Nothing to Disclose  
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Margaret N. Chapman, MD, Boston, MA (*Abstract Co-Author*) Nothing to Disclose  
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Minh T. Truong, MD, Boston, MA (*Abstract Co-Author*) Nothing to Disclose  
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##### **PURPOSE**

Differentiating lymphoid malignancy from reactive lymphoid tissue in HIV-infected patients with 18F-FDG PET/CT can be challenging as increased FDG uptake secondary to inflammation and infection may cause false-positive results for assessment of lymphoid tissue, such as palatine tonsils. The purpose of this study was to assess the utility of CT texture analysis characteristics of lymphoid tissues in HIV-positive patients on 18F-FDG-PET/CT in making the distinction between malignancy and non-neoplastic process with increased FDG uptake.

##### **METHOD AND MATERIALS**

Fifty-eight HIV-positive patients (age 9-80 years; median age, 48 years; median absolute CD4 count, 237 cells/mm<sup>3</sup> [range; 17-1900]) who underwent contrast-enhanced CT with 18F-FDG-PET for various reasons were retrospectively reviewed. The whole normal right palatine tonsil was segmented on CT and texture analysis was performed using an in-house MATLAB-based texture analysis program. Forty-two texture features were extracted, including histogram-based, gray-level co-occurrence matrix-based (GLCM), gray-level run-length-based features (GLRL), gray level gradient matrix (GLGM), and Laws' features from the segmented volume. SUVmax values of the right palatine tonsil were obtained by manual selection of the lymphoid tissue at a PET/CT workstation. Multiple regression analyses were performed to assess the association between 42 texture features and the SUVmax value in palatine tonsil with adjustments for age and absolute CD4 cell counts.

## RESULTS

The median SUVmax in normal tonsil of HIV positive patients was 4.4 (range, 1.2-10.4). Significant correlation were seen in 2 GLCM features [entropy ( $P=.039$ ) and homogeneity ( $P=.008$ )], 7 GLRL features [RP ( $P=.018$ ), LGRE ( $P=.019$ ), HGRE ( $P=.018$ ), SRLGE ( $P=.019$ ), SRHGE ( $P=.001$ ), LRLGE ( $P=.001$ ), LRHGE ( $P=.003$ ), 7 Law's features [L1 ( $P=.040$ ), L2 ( $P=.002$ ), L3 ( $P=.033$ ), L4 ( $P=.003$ ), L5 ( $P=.043$ ), L7 ( $P=.042$ ), L9 ( $P=.037$ )] and 4 GLGM features [MGR ( $P<.001$ ), VGR ( $P<.001$ ), skewness ( $P<.001$ ) and kurtosis ( $P<.001$ )] with tonsil SUVmax value. There was no significant correlation between texture features and absolute CD4 cell counts in this model.

## CONCLUSION

Lymphoid tissue CT texture analysis parameters are associated with abnormal FDG uptake in patients with HIV.

## CLINICAL RELEVANCE/APPLICATION

CT texture analysis may be used as a type of noninvasive imaging biomarker capable of detecting obscure lymphoid inflammation in HIV positive patient.

## SST08-06 Ultrasound and Clinicopathological Features of Papillary Thyroid Carcinomas with BRAF and TERT Promoter Mutations

Friday, Dec. 1 11:20AM - 11:30AM Room: E353A

### Participants

Soo Yeon Hahn, MD, Seoul, Korea, Republic Of (*Presenter*) Nothing to Disclose  
Jung Hee Shin, MD, Seoul, Korea, Republic Of (*Abstract Co-Author*) Nothing to Disclose  
Hankyul Kim, MD, Seoul, Korea, Republic Of (*Abstract Co-Author*) Nothing to Disclose  
Jooyeon Cho, Seoul, Korea, Republic Of (*Abstract Co-Author*) Nothing to Disclose  
Seung Mi Ha, MD, Seoul, Korea, Republic Of (*Abstract Co-Author*) Nothing to Disclose  
Solbee Han, Seoul, Korea, Republic Of (*Abstract Co-Author*) Nothing to Disclose

## PURPOSE

To investigate if any relationship exists between the telomerase reverse transcriptase (TERT) promoter or BRAF mutation and ultrasound (US) and clinicopathological features of papillary thyroid carcinomas (PTCs).

## METHOD AND MATERIALS

The Institutional Review Board approved the study protocol and the use of human thyroid tissue. The study included 150 patients with surgically confirmed PTC from October 1994 to December 2004. The mean clinical and imaging follow up periods were  $149.6 \pm 24.6$  and  $143.1 \pm 34.5$  months, respectively. According to the existence of TERT promoter or BRAF mutations, we categorized patients into three groups (no mutation, BRAF mutation alone, or TERT+BRAF mutations) and analyzed the relationships between TERT promoter or BRAF mutation and US and clinicopathological features using uni- and multinomial logistic regression analysis and Cochran-Armitage trend test. The rate of recurrence or death according to mutation analysis was estimated by the Kaplan-Meier method.

## RESULTS

There were 35 (23.3%) cases with no mutation, 104 (69.3%) with BRAF mutation alone, and 11 (7.3%) with TERT+BRAF mutations. According to the results of the Cochran-Armitage trend test, as the number of genetic mutations increased from no mutation to BRAF mutation alone to both BRAF and TERT mutations, the proportions of hypoechoogenicity (31.4% vs. 66.4% vs. 54.5%,  $P = .0066$ ), non-parallel orientation (25.7% vs. 49.0% vs. 72.7%,  $P = .0023$ ), spiculated/microlobulated margin (45.7% vs. 51.9% vs. 90.9%,  $P = .0364$ ), microcalcifications (62.9% vs. 72.1% vs. 90.9%,  $P = .0822$ ), and K-TIRADS category 5 (48.6% vs. 71.1% vs. 63.6%,  $P = .0670$ ) increased. PTCs with TERT+BRAF mutations recurred more frequently than other groups (odds ratio [OR] = 17.921 and 31.468). The intervals to recurrence and overall survival were significantly shorter in the TERT+BRAF mutation group than in the other groups ( $P < .0001$  and  $P < .0001$ ).

## CONCLUSION

PTCs with no mutation, with BRAF mutation alone, and with both TERT and BRAF mutations linearly increase in the probability of displaying malignant US features. In PTCs, the coexistence of BRAF with TERT mutations is more strongly correlated with recurrence and mortality than BRAF mutation alone.

## CLINICAL RELEVANCE/APPLICATION

US imaging characteristics of PTCs based on molecular biomarkers including BRAF and TERT promoter mutations can serve as predictors of patient prognosis.

## SST08-07 Oral Carcinoma: Clinical Evaluation using Diffusion Kurtosis Imaging and its Correlation with Histopathologic Findings

Friday, Dec. 1 11:30AM - 11:40AM Room: E353A

### Participants

Ichiro Yamada, MD, Bunkyo-ku, Japan (*Presenter*) Nothing to Disclose  
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**PURPOSE**

To determine the clinical usefulness of diffusion kurtosis imaging (DKI) for patients with oral carcinoma as a noninvasive method of evaluating the histologic grades of oral carcinomas and lymph node metastasis by oral carcinomas.

**METHOD AND MATERIALS**

Twenty patients with oral carcinoma were examined with a 3-T MR system equipped with a 16-channel head and neck coil. DKI data were obtained by using a spin echo-based single-shot echo-planar imaging sequence: repetition time, 10000 ms; echo time, 94 ms; field of view, 250 mm x 204.25 mm; matrix, 120 x 98; section thickness, 4 mm without intersection gaps; four b values of 0, 500, 1000, and 2000 s/mm<sup>2</sup>; and motion-probing gradients set along three orthogonal directions. Diffusivity (D) and kurtosis (K) were calculated by using the equation:  $S = S_0 \cdot \exp(-b \cdot D + b^2 \cdot D^2 \cdot K/6)$ , and standard apparent diffusion coefficient (ADC) was also calculated by using the conventional monoexponential fit. The MR images were then compared with the histopathologic findings as the reference standard.

**RESULTS**

In all 20 oral carcinomas, the diffusivity was calculated as  $1.777 \pm 0.377 \times 10^{-3}$  mm<sup>2</sup>/s, kurtosis  $0.839 \pm 0.130$  (arbitrary unit [a.u.]), and ADC  $0.790 \pm 0.089 \times 10^{-3}$  mm<sup>2</sup>/s. With the histologic grades (Grades 1, 2, and 3) of the oral carcinomas, the diffusivity showed a statistically significant inverse correlation ( $r = -0.893$ ;  $P < 0.001$ ) and the kurtosis showed a statistically significant positive correlation ( $r = 0.851$ ;  $P < 0.001$ ), while the ADC showed no significant correlation ( $r = -0.341$ ;  $P = 0.196$ ). Furthermore, between metastatic lymph nodes and nonmetastatic lymph nodes, the diffusivity ( $1.365 \pm 0.395$  vs.  $1.985 \pm 0.540 \times 10^{-3}$  mm<sup>2</sup>/s;  $P < 0.05$ ) and kurtosis ( $1.110 \pm 0.242$  vs.  $0.746 \pm 0.078$ ;  $P < 0.01$ ) showed statistically significant differences, while the ADC ( $0.726 \pm 0.071$  vs.  $0.787 \pm 0.056 \times 10^{-3}$  mm<sup>2</sup>/s;  $P = 0.127$ ) showed no significant differences.

**CONCLUSION**

In patients with oral carcinoma, DKI seems to be clinically useful for evaluating the histologic grades of oral carcinomas and lymph node metastasis by oral carcinomas.

**CLINICAL RELEVANCE/APPLICATION**

By using DKI for patients with oral carcinoma, we may have an effective tool to noninvasively diagnose the histologic grades of oral carcinomas and lymph node metastasis by oral carcinomas.

**SST08-08 Computed Diffusion Weighted Imaging with Noise Reduction: Utility in Diagnosing Middle Ear Cholesteatoma**

Friday, Dec. 1 11:40AM - 11:50AM Room: E353A

**Participants**

Koji Yamashita, MD, PhD, Fukuoka, Japan (*Presenter*) Nothing to Disclose  
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Daichi Momosaka, Fukuoka, Japan (*Abstract Co-Author*) Nothing to Disclose  
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Nozomu Matsumoto, Fukuoka, Japan (*Abstract Co-Author*) Nothing to Disclose  
Taro Takahara, MD, PhD, Isehara, Japan (*Abstract Co-Author*) Nothing to Disclose  
Hiroshi Honda, MD, Fukuoka, Japan (*Abstract Co-Author*) Nothing to Disclose

**PURPOSE**

To evaluate whether computed DWI (cDWI) with noise reduction increases the contrast-to-noise ratio (CNR) compare to that without noise reduction algorithm in middle ear cholesteatoma.

**METHOD AND MATERIALS**

This retrospective study was approved by the institutional review board, and the requirement for informed consent was waived. Consecutive patients diagnosed with suspected cholesteatoma who underwent preoperative MR imaging between October 2014 and August 2016 were eligible for inclusion. cDWI (b = 800 sec/mm<sup>2</sup>) was generated from two b-values of 0 and 400 sec/mm<sup>2</sup> by voxel wise fitting on a 3D workstation (Ziostation2). Noise reduction was performed by the cutoff values of ADC < 0 (ADC0) and  $0.4 \times 10^{-3}$  mm<sup>2</sup>/sec (ADC0.4). Region-of-interests were manually placed on the cholesteatoma and background, respectively. Subsequently, the CNR was compared between ADC0, ADC0.4, and the control (without noise reduction algorithm) using one-way ANOVA followed by the Bonferroni correction for multiple comparison.

**RESULTS**

The study group consisted of 25 patients (M:F = 14:11, median age = 51 years). The CNR of ADC0 (mean  $\pm$  SD =  $6.72 \pm 1.77$ ) and ADC0.4 (mean  $\pm$  SD =  $7.00 \pm 2.21$ ) were significantly higher than those of the control ( mean  $\pm$  SD =  $5.17 \pm 1.43$ ;  $p < 0.01$  and  $p < 0.001$ , respectively).

**CONCLUSION**

The cholesteatoma-background CNR was increased using a noise reduction algorithm for cDWI.

**CLINICAL RELEVANCE/APPLICATION**

The computed DWI (cDWI) with noise reduction algorithm may be useful to distinguish cholesteatoma from adjacent soft tissues such as granulation or fibrous tissue. The increase of CNR could improve in the diagnostic accuracy of cholesteeatoma.

**SST08-09 Intravoxel Incoherent Motion Magnetic Resonance Imaging of the Normal-Appearing Parotid Glands in Patients with Differentiated Thyroid Cancer After Radioiodine Therapy**

Participants

Xiao\_quan Xu, Nanjing, China (*Presenter*) Nothing to Disclose

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**PURPOSE**

Radiation damage to the salivary gland is a common complication of radioiodine therapy (RIT) in the patients with differentiated thyroid cancer (DTC). To investigate the feasibility of using intravoxel incoherent motion (IVIM) magnetic resonance (MR) imaging to detect radiation-induced changes of normal-appearing parotid glands in the patients after RIT for DTC.

**METHOD AND MATERIALS**

We prospectively enrolled 20 patients with RIT-induced sialoadenitis and 20 healthy control (HC) participants. The patients were divided into intermediate and late groups, and questionnaire was used to assess the related symptoms. IVIM MR imaging was scanned using 9 b values (0, 50, 100, 150, 200, 400, 600, 800 and 1000 sec/mm<sup>2</sup>). Quantitative parameters (pseudodiffusion coefficient, D\*; perfusion fraction, f; tissue diffusivity, D) were obtained using a biexponential model, and compared among different groups using one-way analysis of variance (ANOVA) test. Correlations between significant parameters and symptom score were assessed using Spearman's correlation analysis.

**RESULTS**

The f and D value differed significantly (f, P=0.016; D, P=0.006) among different groups. Post hoc analysis showed that f and D value of intermediate group were significantly higher than those of HC group (f, P=0.012; D, P=0.004), while no significant differences between late group and HC group (f, P=0.852; D, P=0.707). Significant positive correlation was found between f value and the total symptom score of the patients in intermediate group (P=0.028, r=0.762).

**CONCLUSION**

The IVIM MR imaging might be feasible to detect the radiation-induced changes of parotid glands in the patients after RIT for DTC.

**CLINICAL RELEVANCE/APPLICATION**

Our study showed that both the perfusion fraction f and tissue diffusivity D of intermediate group were higher than the HC group. Perfusion fraction f had a significant correlation with symptom score. Our study results demonstrated that IVIM MR imaging was feasible to detect the radiation-induced changes of parotid glands of the patients after radioiodine therapy for DTC.

SST09

## Pediatrics (Neuroradiology)

Friday, Dec. 1 10:30AM - 12:00PM Room: E350

NR PD

AMA PRA Category 1 Credits™: 1.50  
ARRT Category A+ Credit: 1.75

FDA Discussions may include off-label uses.

### Participants

Bernard F. Laya, DO, Lincoln, IL (*Moderator*) Nothing to Disclose  
Usha D. Nagaraj, MD, Cincinnati, OH (*Moderator*) Co-author with royalties, Reed Elsevier

### Sub-Events

#### SST09-01 Quantitative Measurement of Cerebral Blood Flow in Preterm by Multiple Inversion Time Arterial Spin Labeling Magnetic Resonance Imaging: Initial Study

Friday, Dec. 1 10:30AM - 10:40AM Room: E350

### Participants

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### PURPOSE

To investigate the influence of cerebral blood flow in preterm with perinatal asphyxia using multiple inversion time arterial spin labeling (mTI-ASL) technique.

### METHOD AND MATERIALS

A total of 40 preterm infants at term-equivalent age underwent MRI examination in the study. A MRI examination including mTI-ASL prototype sequence and other conventional plain sequences was performed on MAGNETOM Skyra (Siemens Healthcare, Erlangen, Germany). According to clinical history and MR diagnosis, 40 preterm infants were divided into three groups: group 1 (n=14, no brain injury without perinatal asphyxia), group 2 (n=12, no brain injury with perinatal asphyxia) and group 3 (n=14, brain injury with prenatal asphyxia). Mean cerebral blood flow (CBF) values from ROIs drawn in the basal ganglia and thalami (BGT), gray matter (GM) including frontal lobe, temporal lobe and occipital lobe, and white matter (WM) were calculated and analyzed by SPSS 21.0 statistical software. CBF values for each ROIs were analyzed by one-way ANOVA across groups. And then if  $P < 0.05$ , q test for multiple comparison with SNK would be conducted.

### RESULTS

The difference of CBF<sub>BGT</sub> and CBF<sub>GM</sub> was statistically significant between Group 1 and Group 2 ( $P < 0.05$ ). The differences of CBF<sub>BGT</sub>, CBF<sub>GM</sub> and CBF<sub>WM</sub> were statistically significant between Group 2 and Group 3 (CBF<sub>BGT</sub>:  $P < 0.01$ ; CBF<sub>GM</sub>, CBF<sub>WM</sub>:  $P < 0.05$ ). However, the difference of CBF<sub>WM</sub> between Group 1 and Group 2 was not statistically significant. And CBF<sub>BGT</sub>, CBF<sub>GM</sub>, CBF<sub>WM</sub> between Group 1 and Group 3 were not statistically significant. In group 1, the difference of CBF was statistically significant between frontal lobe and occipital lobe, between temporal lobe and occipital lobe, whereas the difference of CBF was not statistically significant between frontal lobe and temporal lobe.

### CONCLUSION

mTI-ASL is a noninvasive MR method for accurately measuring CBF in neonates. Autoregulation of the cerebral blood flow has association with the outcome of preterm infants with perinatal asphyxia. Perinatal asphyxia may affect the regional regulation of CBF in gray matter.

### CLINICAL RELEVANCE/APPLICATION

mTI-ASL is a feasible approach to measuring brain perfusion and it offers the possibility to investigate the impact of cerebral hemodynamics in high-risk preterm infants.

#### SST09-02 Acute Ischemic Stroke in Patients Younger than 18: Why Not Wide the Therapeutic Window for Mechanical Thrombectomy?

Friday, Dec. 1 10:40AM - 10:50AM Room: E350

### Awards

Student Travel Stipend Award

## Participants

Carmen Parra-Farinas, MD, Barcelona, Spain (*Presenter*) Nothing to Disclose  
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## PURPOSE

This study aimed to analyze the safeness and effectiveness of endovascular approach in pediatric intracranial recanalization and to propose a diagnostic and therapeutic algorithm for patients younger than 18 with acute ischemic stroke based on our experience.

## METHOD AND MATERIALS

We studied patients prospectively included in SONIIA registry (2011-2015), a mandatory, externally audited registry that monitors the quality of reperfusion therapies in Catalonia. Clinical evaluation: neurological severity, functional independence. Radiological examination: multimodal CT/MRI. Treatment criteria: clinical-radiological mismatch. Analysis and outcome parameters: successful recanalization (TICI  $\geq 2b$ ), dramatic neurological improvement ( $\geq 10$  points decrease in NIHSS score at 24 hours), independent functional outcome (mRS  $\leq 2$ ) at three months.

## RESULTS

Among the 1640 patients included, mechanical thrombectomy occurred in five. Mean age was  $14.6 \pm 1.6$ , four female. Median NIHSS score: 13 (7-19) on arrival, 4 (1-5) at 24 hours. Underlying diseases: Osler-Weber-Rendu (n=1), congenital heart defect (n=1), none (n=3). Etiology: iatrogenic (n=1), non-compliance of anticoagulation (n=1), idiopathic (n=3). Clinical presentation: hemiparesis (n=4), aphasia (n=1). We used the neuroimaging standard protocol during acute ischemic stroke: multimodal CT (n=3), multimodal MRI (n=2). Occlusion site: internal carotid artery (n=2), middle cerebral artery (n=2), basilar artery (n=1). We combined stent-retriever technology plus distal aspiration in four patients (median number of passes: 2), direct aspiration first pass technique in one (duration of aspiration: 30 s). Procedural time:  $68.4 \pm 26.4$  min. All patients achieved successful recanalization. All procedures resulted in functional independence. No complications were reported.

## CONCLUSION

The presence of a clinical-radiological mismatch in acute ischemic stroke patients younger than 18 should let us consider an "aggressive treatment", such as mechanical thrombectomy, as it allows safe, effective, and prompt recanalization. The MRI should be the diagnostic technique in all types of stroke, diagnosing underlying conditions while reducing radiation exposure.

## CLINICAL RELEVANCE/APPLICATION

Acute ischemic stroke in children is difficult to diagnose and manage due to atypical presentation and imaging challenge. There is a lack of evidence-based data concerning mechanical thrombectomy for patients younger than 18 years old.

## SST09-03 Multi-Delay Arterial Spin Labeling MRI in Neonates: Regional Differences and Changes in Brain Perfusion during Brain Maturation

Friday, Dec. 1 10:50AM - 11:00AM Room: E350

## Participants

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Miran Han, MD, Suwon, Korea, Republic Of (*Abstract Co-Author*) Nothing to Disclose  
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## PURPOSE

The purpose of this study was to evaluate cerebral blood flow (CBF) in neonates using multi-delay arterial spin labeling (ASL).

## METHOD AND MATERIALS

A 7 post-labeling delay pseudo-continuous ASL was applied on 20 neonates (6 preterm vs. 14 term-equivalent age [TEA]) and 4 infants (mean age, 3 months). We adjusted longitudinal relaxation rate of blood in each patient with hematocrit values. CBF in the thalamus, frontal gray matter (F<sub>GM</sub>), occipital gray matter (O<sub>GM</sub>), frontal white matter (F<sub>WM</sub>), and occipital white matter (O<sub>WM</sub>) were measured in ml/100g min and relative CBF (rCBF) to that of the whole brain CBF (wbCBF) were calculated.

## RESULTS

In all neonates, CBF of O<sub>WM</sub> was significantly higher than F<sub>WM</sub> (16.5ml/100g min vs. 12.2ml/100g min,  $p = .001$ ), but CBF of O<sub>GM</sub> and F<sub>GM</sub> showed no significant difference (26.2ml/100g min vs. 27.5ml/100g min,  $p = .253$ ). Mean wbCBF significantly increased from 13.4ml/100g min at preterm to 18.0ml/100g min at TEA ( $p = .009$ ) and it further increased to 32.8ml/100g min at 3 months ( $p = .001$ ). From preterm to TEA, there was significant decrease of rCBF of thalamus (252% to 197%,  $p = 0.02$ ) and F<sub>GM</sub> (160% to 122%,  $p = .026$ ) and significant increase of rCBF of O<sub>GM</sub> (163% to 125%,  $p = .015$ ). From TEA to 3 months, rCBF were significantly decreased in thalamus (197% to 140%,  $p = .046$ ), F<sub>WM</sub> (108% to 57%,  $p = .001$ ), and O<sub>WM</sub> (139% to 79%,  $p = .003$ ).



## CONCLUSION

Multi-delay ASL showed differences and changes in regional CBF in neonates and infants, which may reflect metabolic and developmental stages of brain.

## CLINICAL RELEVANCE/APPLICATION

Multi-delay ASL can be a non-invasive tool to study brain maturation in neonates. Cerebral perfusion changes by hypoxic ischemic injury in neonates can further investigated with multi-delay ASL.

## SST09-04 Expression Changes in Lactate and Glucose Metabolism and Associated Transporters in Basal Ganglia Following Hypoxic-Ischemic Reperfusion Injury in Piglets

Friday, Dec. 1 11:00AM - 11:10AM Room: E350

### Participants

Yang Zheng, Shenyang, China (*Presenter*) Nothing to Disclose

Xiaoming Wang, MD, Shenyang, China (*Abstract Co-Author*) Nothing to Disclose

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## PURPOSE

To investigate the regulatory mechanisms of energy metabolism in neurons and astrocytes in the basal ganglia of a neonatal hypoxic-ischemic brain injury piglet model.

## METHOD AND MATERIALS

A total of 35 healthy piglets (3-5 days old, 1.0-1.5 kg) were selected. They were divided into control (n=5) and hypoxic-ischemic (HI) model groups. The HI model group was further divided into six groups according to 1H- MRS and PET/CT scan times after HI (0-2 h, 2-6 h, 6-12 h, 12-24 h, 24-48 h and 48-72 h; n = 5/group). The HI model was established by bilateral common carotid artery occlusion and simultaneous hypoxia treatment for 40 min. Piglets in the control group received the same surgical procedure without the hypoxia-ischemia process. 1H-MRS and 18F- FDG PET/CT imaging were performed at various time points after HI. The right basal ganglia were the ROI in 1H-MRS imaging for which data was processed by LCModel software. The bilateral basal ganglia (BG) and occipital cortex (OC) on the same slide were selected as the ROI for PET/CT imaging. Maximum standard uptake values (SUVmax) of basal ganglia to occipital cortex (BG/OC) ratios were determined. The right hemisphere was used for the pathological examination and immunohistochemical staining of glucose transporters (GLUTs) and monocarboxylate transporters (MCTs). The left hemisphere was immediately frozen at -80°C for western blotting.

## RESULTS

The lactate level became reduced after an initial increase, with the maximal level occurring around 2-6 h following HI. After HI, the BG/OC in the basal ganglia initially increased then decreased; the maximum value occurred at approximately 6-12 h. The content of lactate and the BG/OC showed a positive correlation ( $r = 0.74$ ,  $P=0.003$ ). The expression of GLUT-1 and GLUT-3 correlated positively with BG/OC ( $r = 0.64$ ,  $P=0.014$ , and  $r = 0.75$ ,  $P=0.036$ , respectively).

## CONCLUSION

These results indicate that lactate and glucose transporters have a synergistic effect on the energy metabolism of neurons and astrocytes following hypoxic-ischemic reperfusion brain injury.

## CLINICAL RELEVANCE/APPLICATION

The HI model monitor the regulatory mechanisms of energy metabolism after HI.

## SST09-05 3D Ultrasound Provides Accurate Tonsillar Volumes to Assess Hypertrophy

Friday, Dec. 1 11:10AM - 11:20AM Room: E350

### Participants

Daniel I. Chung, MD, Washington, DC (*Presenter*) Nothing to Disclose

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## PURPOSE

Each year, there are millions of hospital visits in the United States for obstructive sleep apnea (OSA), a disease that is primarily caused by adenotonsillar hypertrophy. Adenotonsillectomy (T&A) is an effective solution for OSA and the second most common surgical intervention in the country. We investigated the ability of 3D ultrasound (3DUS) imaging with quantitative imaging analysis to safely, accurately and objectively assess tonsillar hypertrophy for the potential identification of candidates for adenotonsillectomy.

## METHOD AND MATERIALS

A prospective study was performed evaluating patients (N=17) undergoing T&A for OSA symptoms ranging from 4-14 years with a mean of 7.8. Tonsillar imaging was performed by an attending radiologist using the Philips iU22 3DUS system with xMatrix probe. The volume and two principal axes (width and height) of the left and right tonsils were determined from 3DUS using ITKSnap software. The tonsils were then removed the same day in the operating room and immediately assessed by measuring the two principal axes of each tonsil using a Neiko 0417A Electronic Digital Caliper. The physical volume was then obtained by water submergence in a graduated cylinder. The findings from 3DUS and physical examination of the tonsils were compared using Bland-Altman analysis to determine their agreement (mean) and bias (mean $\pm$ 1.96 SD). Significance was assessed using the Wilcoxon signed-rank test.

## RESULTS

The average tonsillar physical measurements of width and height were 20±3.2 mm and 27.23±41.4 mm, and 16.11±2.14 mm and 29.76±27.75 mm from 3DUS estimations, respectively ( $p < 0.001$  for both). The average tonsillar volume was 3.84±1.23 ml and 4.29±1.14 ml from physical and 3DUS measurements, respectively ( $p=0.09$ ). The Bland-Altman agreement ± bias of the measured width, height, and volume results from the two measurements were -3.92±6.33 mm, 2.5±7.71 mm, and 0.45±2.32 ml, respectively.

## CONCLUSION

We demonstrated the potential of 3DUS with quantitative imaging analysis to safely, accurately and objectively estimate tonsillar volume for assessing hypertrophy. 3DUS tonsil volumes were similar to physical measurements and more reliable than 2D measures of width and height.

## CLINICAL RELEVANCE/APPLICATION

3DUS with quantitative imaging is an effective tool to objectively evaluate the tonsillar dimensions. This will allow for a more accurate selection for candidates for adenotonsillectomy.

## SST09-06 What is the Optimal Needle Gauge and Injection Rate for Contrast Enhanced Ultrasound in the Evaluation of Therapeutically Cooled Neonatal Brains after Hypoxic Ischemic Injury?: Preliminary Data from an Experimental in Vitro Study

Friday, Dec. 1 11:20AM - 11:30AM Room: E350

### Participants

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## PURPOSE

Therapeutic hypothermia for hypoxic-ischemic encephalopathy (HIE) in neonates is used to reduce morbidity and mortality. However, optimum ultrasound (US) contrast delivery under therapeutic hypothermia is not well known. We aimed to quantify microbubble contrast intensity under these temperature conditions to determine optimal microbubble delivery.

## METHOD AND MATERIALS

We injected Lumason® contrast agent into saline bags using 22 and 25-G needles under different injection rates: 0.1 mL/sec, 0.3 mL/sec, and 0.5 mL/sec. We performed injections at both 37°C and 33.5°C to reproduce normothermia and hypothermia conditions, respectively. We qualitatively evaluated for homogenous mixing and quantitatively assessed microbubble intensity with QLab US contrast quantification software installed on a Philips EPIQ scanner.

## RESULTS

We found that 22-G needles yielded significantly higher peak intensities than 25-G needles ( $p=0.0495$ ). Using 22-G needles, an injection rate of 0.3 mL/sec was optimal at 37°C, and a rate of 0.5 mL/sec was optimal at 33.5°C. There was no significant difference in the distribution of peak intensities between the two temperature groups using 22-G needles ( $p=0.2752$ ). Using 25-G needles, an injection rate of 0.5 mL/sec was optimal at 37°C, but at 33.5°C no injection rate appeared most optimal. Additionally, using 25-G needles, the peak intensities at 37°C were significantly higher than at 33.5°C ( $p=0.0495$ ).

## CONCLUSION

The temperature reduction significantly impacted microbubble behavior, reducing the ability of the microbubbles to homogeneously mix unless injected at a rate of 0.5 mL/sec. Additionally, 25-G needles increase microbubble destruction. Further study is needed to optimize contrast delivery under hypothermia conditions.

## CLINICAL RELEVANCE/APPLICATION

Contrast enhanced ultrasound is valuable imaging modality in assessing brain injury in hypoxic-ischemic encephalopathy. Contrast delivery must be optimized under therapeutic cooling conditions.

## SST09-07 Multispectral Data Analysis of Reduced FOV Diffusion Tensor Images of Pediatric Spinal Cord Injury

Friday, Dec. 1 11:30AM - 11:40AM Room: E350

### Participants

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## PURPOSE

A key challenge in the imaging of spinal cord injury (SCI) patients is the ability to accurately determine structural or functional

A key challenge in the imaging of spinal cord injury (SCI) patients is the ability to accurately determine structural or functional abnormality as well as level and severity of injury. Diffusion tensor imaging (DTI) allows the characterization of physical and functional properties of tissues. The purpose of this study is to assess quantitative multispectral texture (MST) features of diffusion tensor images and its potential clinical relevance in discriminating typically developing (TD) pediatric spinal cords and those with cervical spinal cord injury (SCI).

#### **METHOD AND MATERIALS**

A total of 15 subjects (10 TD and 5 cervical SCI patients) ranging in age from 6-16 yrs were recruited and scanned for DTI along cervical spinal cord using 3.0T Siemens Verio MR scanner. Initially, DTI images were corrected for motion induced artifacts and then robust estimation of tensor was used to generate DTI indices including fractional anisotropy (FA) and mean diffusivity (MD). Finally, 33 texture features were generated from both FA and MD maps. These features included 5 first order features (mean, variance, skewness, kurtosis and entropy), 16 second order feature vector elements calculated from grey level co-occurrence matrices (GLCM) in directions of 0°, 45°, 90° and 135° and 12 high order texture features generated from three different coefficients matrices in directions of horizontal (0°), vertical (45°), and diagonal (90°) of wavelet decomposition. These features then were compared between TD and cervical SCI subjects based on standard least squared linear regression model and restricted maximum likelihood method.

#### **RESULTS**

The experimental findings show that there are significant differences in texture values of FA and MD maps between TD and cervical SCI population. A total of 7 texture features from the FA map and 8 MST features from MD map showed statistically significant discrimination between TD and cervical SCI (tables1-3).

#### **CONCLUSION**

We have demonstrated experimentally that MST features have the potential for better discrimination of patients with SCI compared to the TD. MST features quantify macroscopic and also the microscopic abnormalities that may be undetectable using conventional DTI analysis.

#### **CLINICAL RELEVANCE/APPLICATION**

Texture descriptors could be used as quantitative imaging markers in addition to conventional MR imaging for the facilitation of diagnosis and characterization of the tissues in the pediatric spinal cord.

#### **SST09-08 Radiologic Features of Posterior Reversible Encephalopathy Syndrome (PRES) After Hematopoietic Stem Cell Transplantation in Pediatric Patients**

Friday, Dec. 1 11:40AM - 11:50AM Room: E350

#### **Participants**

Soheil Kooraki, MD, Tehran, Iran (*Abstract Co-Author*) Nothing to Disclose  
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#### **PURPOSE**

To assess the incidence and imaging features of posterior reversible encephalopathy syndrome (PRES) in pediatric patients after hematopoietic stem cell transplantation (HSCT)

#### **METHOD AND MATERIALS**

This prospective study was conducted on all pediatric patients who underwent HSCT between March 2014 and June 2016. Brain CT scan was carried out in all patients who developed neurologic symptoms/signs followed by brain MRI. In those with diagnosis of PRES, follow-up MRI was conducted within two months. MRI was performed using a 1.5 Tesla magnet (Avanto, Siemens) including DWI and SWI sequences.

#### **RESULTS**

A total of 254 patients (160 males, mean age:7.6±4 years) underwent HSCT including 65 individuals with thalassemia, 41 with fanconi anemia, 59 with lymphoma/leukemia and 89 with other miscellaneous disorders. Brain MRI revealed PRES in 23 (9.1%). Seizure was the most common presenting symptom followed by headache. Patients with fanconi anemia were at greater risk of developing PRES compared to other diseases as PRES was seen in 9 out of 41 of patients with fanconi anemia (p value: 0.004). MRI showed asymmetric lesions in 10 patients of which, unilateral hemispheric involvement was noted in two patients. Superior frontal sulcus distribution was the most frequent imaging pattern (8/23, 34.8%) followed by holo-hemispheric (6/23, 26.1%), dominant posterior (6/23, 26.1%) and partial (3/23, 13%) distributions. Transient restricted diffusion was noted in one patient with unremarkable follow-up MRI. Microhemorrhagic foci were depicted in 4 patients. Of them, one patient died shortly after PRES. Follow-up MRI showed persistent microhemorrhagic foci in the other three patients. Another patient with hemorrhagic PRES died later due to a second episode of PRES.

#### **CONCLUSION**

This study showed high incidence of PRES in children after HSCT especially in those with fanconi anemia. Various patterns of edema distribution is seen in brain MRI of pediatric population with PRES. Hemorrhagic PRES occurs in a minority of patients, which is possibly associated with worse prognosis.

#### **CLINICAL RELEVANCE/APPLICATION**

PRES shows various imaging patterns in pediatric patients following Hematopoietic stem cell transplantation with microhemorrhagic

PRES shows various imaging patterns in pediatric patients following hematopoietic stem cell transplantation; with microhemorrhagic PRES being probably associated with worse prognosis.

SST10

## Physics (CT: Image Quality and Techniques)

Friday, Dec. 1 10:30AM - 12:00PM Room: E264

CT PH SQ

AMA PRA Category 1 Credits <sup>TM</sup>: 1.50  
ARRT Category A+ Credit: 1.75

### Participants

Xiaochuan Pan, PhD, Chicago, IL (*Moderator*) Research Grant, Koninklijke Philips NV ; Research Grant, Toshiba Medical Systems Corporation; Research Grant, Varian Medical Systems, Inc  
Timothy P. Szczykutowicz, PhD, Madison, WI (*Moderator*) Equipment support, General Electric Company; License agreement, General Electric Company; Founder, Protocolshare.org LLC

### Sub-Events

#### SST10-01 Effect of Model-Based Iterative Reconstruction on Computer-Aided Detection for Quantitative Analysis of Airway Tree in Routine Dose Chest CT: Comparison with Adaptive Statistical Iterative Reconstruction

Friday, Dec. 1 10:30AM - 10:40AM Room: E264

### Participants

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Haifeng Duan, Xianyang City, China (*Abstract Co-Author*) Nothing to Disclose

### PURPOSE

The pulmonary airway display can reflect the image quality of the chest CT. This retrospective study comparative evaluation of model-based iterative reconstruction (MBIR), adaptive statistical iterative reconstruction (ASIR) with lung kernel on the performance of computer-aided detection (CAD) for quantitative analysis of airway in routine dose chest CT.

### METHOD AND MATERIALS

30 patients were included who were scanned for pulmonary disease using a clinical routine dose MDCT system (Discovery CT750 HD, GE Healthcare). Data were reconstructed with MBIR, ASIR (40% ASIR and 60% FBP mix). Airway dimensions were measured from the two reconstructions using an automated, quantitative software that was designed to segment and quantify the bronchial tree, and a skeletonization algorithm to extract the center-line of airway trees automatically (Figure 1). For each patient and reconstruction algorithm chose the right middle lobe bronchus with the least tortuous and bifurcation as a representative to measure the bronchial length of the matched airways. Two radiologists used a semi-quantitative 5-point scale (from -2 for inferior to +2, for superior; -1 for slightly inferior to +1 slightly superior; and 0, equal with ASIR) to rate subjective image quality of airway trees on the MBIR images. Using paired t and Wilcoxon signed-rank tests for comparison.

### RESULTS

Algorithm impacted the measurement variability of the length of bronchus in routine dose chest CT, and MBIR was better, which produced longer bronchus than ASIR ( $P < 0.05$ ) (Table 1, Figure 2). ( $P < 0.05$ ) (Table 1, Figure 2). MBIR reconstructions also had higher subjective scores for the airway trees than ASIR ( $P < 0.05$ ) (Table 2, Figure 3).

### CONCLUSION

The quantification accuracy of airway is strongly influenced by reconstruction algorithm. The MBIR algorithm potentially allows the desired airway quantification accuracy to be achieved, which may enable a wider clinical use of low-dose Chest MDCT.

### CLINICAL RELEVANCE/APPLICATION

Compare ASIR, MBIR algorithm potentially allows the desired airway quantification accuracy to be achieved on the performance of CAD in routine dose chest CT, which may be used to reduce radiation dose.

#### SST10-02 Optimization of Multi-Energy Non-Local-Means Denoising for Ultra High Resolution Photon Counting Detector CT Images

Friday, Dec. 1 10:40AM - 10:50AM Room: E264

### Participants

Andrea Ferrero, PhD, Rochester, MN (*Presenter*) Nothing to Disclose  
Wei Zhou, PhD, Rochester, MN (*Abstract Co-Author*) Nothing to Disclose  
Shengzhen Tao, Rochester, MN (*Abstract Co-Author*) Nothing to Disclose

Joel G. Fletcher, MD, Rochester, MN (*Abstract Co-Author*) Grant, Siemens AG; ;  
Cynthia H. McCollough, PhD, Rochester, MN (*Abstract Co-Author*) Research Grant, Siemens AG  
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**PURPOSE**

Ultra-high-resolution (UHR) photon-counting-detector (PCD) CT has been shown to produce clinical images of unsurpassed spatial resolution, with slices as thin as 0.25 mm. However, the substantially increased noise of UHR images at these thin slices could potentially degrade diagnostic value. In this work, we investigated how to optimize noise reduction with an image based multi-energy, non-local-means (MENLM) method without loss of anatomical details.

**METHOD AND MATERIALS**

After IRB approval, UHR-PCD CT images of patients were obtained for different diagnostic tasks, including high resolution chest and musculoskeletal exams. MENLM was applied to the 0.25-mm thick filtered-back-projection (FBP) images for each case with variable filter strengths. Each denoised image was then combined with the original FBP image with variable blending ratios. 2D noise power spectra (NPS) were generated from a clinically relevant anatomic region within the patient anatomy. The optimal combination of FBP weighting and MENLM filtration was determined as the one producing the largest amount of image noise reduction without significantly shifting the NPS towards lower spatial frequencies. A board-certified radiologist reviewed all combinations of denoised images and ranked them for image noise, sharpness, presence of artifacts and overall diagnostic quality.

**RESULTS**

Approximately equal weighting between FBP and aggressively filtered MENLM-denoised images was shown to be the best compromise for the evaluated clinical tasks. For both exams, the radiologist assessment of image quality confirmed the selection based on NPS profiles. The images that were ranked with the highest overall diagnostic quality showed 40% noise reduction for the knee exam and upwards of 50% noise reduction for the chest exam, compared to the original FBP images. In both cases, denoised images received much higher scores in every aspect of image quality that was assessed.

**CONCLUSION**

NPS profiles computed directly from a relevant anatomic region provide a useful reference to guide a clinical task-specific optimization of denoising algorithms for UHR PCD CT images, allowing noise to be reduced by 40-50% without alteration of fine details or noise texture.

**CLINICAL RELEVANCE/APPLICATION**

Noise reduction algorithms can be limited by degradation of fine structures. Blending aggressively denoised images with the FBP data resulted in improved performance with preserved anatomical details.

**SST10-03 Achieving Higher Image Quality at 75% Lower Dose with Model-Based Iterative Reconstruction in Abdominal CT**

Friday, Dec. 1 10:50AM - 11:00AM Room: E264

**Participants**

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**PURPOSE**

To assess image quality of a model-based iterative reconstruction (MBIR) in lower-dose abdominal CT, in comparison with the filtered back projection (FBP) reconstruction with standard dose.

**METHOD AND MATERIALS**

This study was approved by ethics committee and written consent was provided by all patients. Twenty patients underwent (75%) lower dose contrast-enhanced abdominal CT and reconstructed with MBIR after routine-dose contrast-enhanced CT which was reconstructed with conventional FBP algorithm. Two radiologists assessed the images blindly per the sharpness, image noise, diagnostic acceptability and artifacts with 5-point scoring (1-5 points, Grade 1: cannot be used for diagnosis; Grade 2: poor; Grade 3: acceptable; Grade 4: good; Grade 5: very good). Image noise and signal-to-noise ratio (SNR) and contrast-to-noise ratio (CNR) of abdominal organs relative to abdominal fat were assessed. The volume CT dose index (CTDIvol), dose length product (DLP) and dose reduction rate were also obtained.

**RESULTS**

CTDIvol and DLP were 3.04±1.48mGy and 95.56±47.17mGy\*cm for the lower-dose CT, 12.16±5.18mGy and 376.39±160.40mGy\*cm for the routine-dose CT, respectively with 75% reduction (Table 1). Lower-dose MBIR images had significantly lower objective image noise (6.12±1.03HU), higher SNR (11.56±3.30) and CNR (26.96±5.88) than both the lower-dose (39.61±4.55HU, 2.03±0.41 and 4.75±0.98, respectively) and routine-dose (21.45±3.92HU, 3.79±0.68 and 9.01±1.90, respectively) FBP images (all P<0.001) (Table 2). In addition, MBIR had better subjective scores (4.20±0.77) than FBP (2.70±0.66 in routine-dose and 1.55±0.51 in lower-

dose) in noise, sharpness and artifacts (Fig. A-D).

## CONCLUSION

The MBIR significantly improves the objective and subjective image quality in (75%) lower-dose abdominal CT scans, compared with the routine-dose FBP reconstructions.

## CLINICAL RELEVANCE/APPLICATION

The MBIR significantly improves the objective and subjective image quality in (75%) lower-dose abdominal CT scans, compared with the routine-dose FBP reconstructions.

## SST10-04 Combination of Dual Phase Acquisition and Snapshot Freeze Technique to Improve the Image Quality in Patients with Intermediate Heart-Rate

Friday, Dec. 1 11:00AM - 11:10AM Room: E264

### Participants

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## PURPOSE

To investigate the value of dual phase (45% and 75% of R-R interval) acquisition and snapshot freeze technique on the image quality of coronary computed tomographic angiography (CCTA) on patients with intermediate heart rate (70 to 80bpm), in comparison with single phase.

## METHOD AND MATERIALS

Forty-six patients [28 men and 18 women; age (M±SD), 55.3 ± 8.0 years; body mass index (BMI) (M±SD), 25.20±2.8kg/m<sup>2</sup>] with intermediate heart rate (70 to 80bpm) were scanned on a 256-row detector CT scanner (Revolution CT, GE healthcare). The volume and flow rate of the contrast medium were adapted to the patient's body weight. The scanning range was 140mm or 160mm from the level of the tracheal bifurcation to the diaphragm. Dual phase (45% and 75% of R-R interval) acquisition was performed for all the patients. For both phases, snapshot freeze (SSF) and standard (STD) reconstructions were applied for each patient. Two experienced radiologists, who were blinded to reconstruction information, independently graded the CT images in terms of visibility and artifacts with likert 4-point score (1 = insufficient, 4 = excellent) on a per-patient- and a per-artery-base analysis. Image interpretability of 45%+75% of R-R interval was compared with single 45% and 75% of R-R interval with paired Chi-square test. Image score of 45%+75% of R-R interval was compared with 45% and 75% of R-R interval with signed rank sum test.

## RESULTS

For STD reconstruction, dual phase showed higher interpretability than single 45% and 75% of R-R interval on per-artery level [84.8%(117/138) vs 62%(85/138) vs 67%(93/138), P<0.001], and on per-patient level [63%(29/46) vs 39%(18/46) vs 37%(17/46), P=0.021]. When combined with SSF reconstruction, image interpretability on per-artery level and per-patient level was further improved from [84.8%(117/138) and 63%(29/46)] to [96.4%(133/138) and 89.1%(41/46)]. The image quality score for dual phase was higher than single 45% and 75% of R-R interval on both per-artery level and per-patient level (both P<0.001).

## CONCLUSION

Combination of dual phase (45% and 75% of R-R interval) acquisition and snapshot freeze technique could improve the image quality and interpretability of CCTA of patients with intermediate heart rate.

## CLINICAL RELEVANCE/APPLICATION

Adequate selection of the cardiac phase with this SSF can provide acceptable diagnostic image in patients with an average  $70 \leq HR \leq 80$ .

## SST10-05 An Image Quality Assessment of the Noise Problem in Edge Preserving Regularization of Low-dose Statistical Iterative CT Image Reconstruction

Friday, Dec. 1 11:10AM - 11:20AM Room: E264

### Participants

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## PURPOSE

This report assesses a new regularization within the framework of statistical iterative image reconstruction in CT, which results in a more uniform noise distribution than other edge preserving regularizations.

## METHOD AND MATERIALS

Iterative image reconstruction with edge preserving penalties in CT is known for noise reduction while recovering high spatial resolution and low contrast details. However, a preserved edge is also known to keep the surface around anatomic features noisier

than the surrounding flat areas, which may degrade diagnostic performance of an observer. The new coherent L1 norm reduces the dimensionality of the noise reduction close to the surface between the two tissues and performs noise reduction more uniformly across the entire volume, while keeping the advantage of high spatial resolution.

## RESULTS

A medical doctor was asked to review 24 low dose CT abdomen cases, with each containing 4 images reconstructed using the new coherent L1 norm, total variation, Huber penalty and quadratic penalty regularizations. Special attention was paid to critical anatomy with known diseases, including stomach cancer, hemangioma, small cyst, cirrhosis, liver abscess, carcinoma, liver and pancreatic cancer. Total variation and Huber penalties produced images with rough edges, quadratic penalty produced images with low spatial resolution and coherent L1 norm images had both high spatial resolution and uniform noise performance, receiving the highest rating from the observer in all cases. A noise study was conducted on an analytic phantom with inserts of various contrast and image pixel noise variance was calculated for every voxel in the image. We compared the noise variation on the edge voxels and noise variation on the flat regions; the coherent L1 norm showed the least amount of difference on those regions of interest.

## CONCLUSION

Coherent L1 norm substantially improves the edge appearance in the reconstructed image with preserved low-contrast details and high-contrast spatial resolution.

## CLINICAL RELEVANCE/APPLICATION

Low-dose CT may result in images that have rough edges and leave a doubt with the physician about the condition of the patient. The main cause is the edge preserving regularization in CT reconstruction reduces the noise, but makes organ edges appear rough. Coherent L1 norm with its edge preserving and uniform noise reduction across the image volume has a potential to increase physicians diagnostic confidence.

### SST10-06 The Application of Deep Learning Algorithm Pixel Shine in Arterial Phase Pelvic CT for Image Quality Improvement

Friday, Dec. 1 11:20AM - 11:30AM Room: E264

#### Participants

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## PURPOSE

To assess the effect of a deep learning denoising algorithm, Pixel Shine (AlgoMedica, Inc, Sunnyvale, CA) on the quality of pelvic arterial phase CT images.

## METHOD AND MATERIALS

A retrospective analysis was performed on arterial phase pelvic CT images from 33 patients (BMI $\leq$ 20) obtained with a GE Revolution CT (70 kVp tube voltage, and ASIR-V-FBP 50% blending) and designated group A. Group B images were then obtained by applying Pixel Shine algorithm to group A image datasets. Subjective image quality was evaluated using a 5-point scoring system by two radiologists, and the scores of the groups were compared. Image signal was assessed using CT values of the urinary bladder. The CT and standard deviation (SD) values of the gluteus maximus were measured, and the SD values of the gluteus maximus were used to represent image noise. The signal-to-noise ratio (SNR) and contrast-to-noise ratio (CNR) of the bladder were then calculated. The image noise, SNR and CNR of two groups were compared using paired t-test.

## RESULTS

The subjective visual image quality score of groups A and B, respectively, were  $3.03\pm 0.17$  vs.  $3.85\pm 0.57$ , the image noise was  $15.79\pm 2.05$  HU vs.  $11.06\pm 2.22$  HU, the SNRs of bladder were  $0.50\pm 0.23$  vs.  $0.79\pm 0.39$ , the CNRs of bladder were  $3.72\pm 0.85$  vs.  $5.14\pm 1.27$ . Group B showed better subjective image quality, lower image noise, and improved SNR and CNR compared to group A; these differences were statistically significant ( $p<0.05$ ).

## CONCLUSION

Processing of arterial phase pelvic CT images reconstructed using ASIR-V technique by deep learning algorithm Pixel Shine significantly improved subjective image quality, reduced image noise, and increased SNR and CNR.

## CLINICAL RELEVANCE/APPLICATION

Superior image quality and reduced image noise may be achieved by processing of low-dose ASIR-V reconstructed pelvic CT images using deep learning algorithm such as Pixel Shine.

### SST10-07 Human Observer Performance for Localization of Liver Lesions: Correlation between Anatomical and Uniform Background

Friday, Dec. 1 11:30AM - 11:40AM Room: E264

#### Participants

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**PURPOSE**

To determine the correlation of human performance for localization of small low contrast lesions within uniform water background and within anatomical liver background under the conditions of varying dose, lesion size, and reconstruction algorithm.

**METHOD AND MATERIALS**

Liver lesions of 5, 7, and 9mm diameter (contrast -21HU) were digitally inserted into projection data of disease-free liver CT scans in regions free of major vessels. Noise was inserted into the full-dose projection data to create three image sets: full dose, simulated half dose, and simulated quarter dose. The images were reconstructed with a standard filtered back projection (FBP) and an iterative reconstruction (IR) algorithm. Lesion and noise insertion procedures were repeated for water phantom data at the same three dose levels. For each background, 2D regions of interest were selected, randomized, and independently reviewed by three medical physicists. Each region of interest had either one lesion present or no lesions present (66 lesion-present, 34 lesion-absent). The readers identified the most likely location of the lesion and provided a confidence score. The locations and confidence scores were assessed using the area under the localization receiver operating curve (AzLROC). We examined the correlation of human performance for the cases of uniform and liver backgrounds as dose level, lesion size, and reconstruction type varied.

**RESULTS**

As lesion size or dose increased, the readers' ability to locate the lesion improved. At full dose, the AzLROC for the 5, 7, and 9mm lesions in the liver background IR images were 0.53, 0.91, and 0.97, respectively. Similarly, the AzLROC in the uniform background IR images were 0.51, 0.96, and 0.99 for the 5, 7, and 9mm lesions. Similar trends were seen for the other dose levels. The performances between liver and uniform water backgrounds were highly correlated for both FBP and IR. For liver vs. uniform background, the average difference in AzLROC was  $0.03 \pm 0.03$  and had a Spearman correlation of  $\rho=0.97$ .

**CONCLUSION**

For the task of localizing low contrast liver lesions, human observer performance was highly correlated between anatomical and uniform backgrounds.

**CLINICAL RELEVANCE/APPLICATION**

Liver lesion localization studies may use uniform or anatomic backgrounds, as similar and highly correlated human performances were seen between uniform and liver backgrounds.

**SST10-08 Quantifying Quality: Correlating Phantom and Clinical Scan CT Noise Levels to Construct a Quality Reference Level**

Friday, Dec. 1 11:40AM - 11:50AM Room: E264

**Participants**

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**CONCLUSION**

This study represents a proof of concept method to develop and refine a Noise Reference Level for a given protocol and scanner. This represents a first step in establishing an automated Performance Reference Level for a given scan protocol that incorporates both radiation dose and image quality.

**Background**

The use of ionizing radiation in computerized tomography mandates risk-benefit understanding. However, this consideration may weight the presumed risk of the ionizing radiation at the expense of the benefits of the examination, with protocol optimization often focusing on dose reduction to the potential detriment of image quality, hence diagnostic value. In fact, the standardized Diagnostic Reference Levels (DRL) are based solely on dose metrics. The purpose of this study is to begin to systematically evaluate an efficient tool for image quality, an automated noise metric in CT to eventually develop a performance metric consisting of both radiation dose and image quality.

**Evaluation**

Using an IRB-exempt protocol, automated noise values were determined for 1904 contrast enhanced abdominopelvic (AP) and unenhanced chest CT scans on two different scanner models. These data were used to calculate a Noise Reference Level (NRL) by calculating a noise median across a 25-35 cm patient size range, defining the NRL as this median  $\pm 20\%$ . A variable diameter phantom was also scanned utilizing both protocols on both scanners, and the resultant noise-size curves for the phantom were compared to those utilizing clinical scan data.

**Discussion**

Utilizing our novel noise evaluation tool, noise-patient size curves demonstrate agreement between clinical scan and phantom data. Noise measurements were varied based on the region scanned, with the NRL interval between 25 and 37 HU for AP CT, and between 10 and 15 HU for chest CT. This demonstrates the utility of noise monitoring across large numbers of scans to generate a target noise range based on region scanned and scanner equipment, and to identify and evaluate image quality outliers. This automated tool can thus be used to compare performance in a single scanner and between scanners for similar sized patients independent of interpreting radiologist subjective biases.

## SST10-09 Quantification of Ellipticity Ratios for Head, Shoulders, Chest, and Abdomen and Their Impact on AEC in CT

Friday, Dec. 1 11:50AM - 12:00PM Room: E264

### Participants

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### PURPOSE

It has been reported that CT scanner automatic exposure control (AEC) systems consider patient ellipticity ratio when setting the dose level. In other words, two patients of identical water equivalent diameter (WED) would receive different doses if their ellipticity ratio differed. Because of this effect, understanding large aggregate dose datasets where one plots WED against dose requires incorporation of patient ellipticity ratio to fully predict and model a scanner AEC response.

### METHOD AND MATERIALS

We analyzed 884 patient CT scans under IRB approval. The average effective mAs, WED, and ellipticity ratio were calculated for each patient's scan. Data from routine head, chest, and abdomen/pelvis scans was included for both adults and pediatrics. These datasets were further broken into specific body regions corresponding to: head, chest, shoulders, thorax, abdomen, and abdomen/pelvis. We measured the ellipticity ratio by taking the ratio of the lateral to anterior-posterior patient dimension for each body region. We developed a theoretical model for the CT scanner's AEC function that includes parameters for angular tube current modulation, WED based dose compensation, and ellipticity based dose compensation. We applied the model to fit a dataset containing 294 adult abdomen/pelvis exams under IRB approval.

### RESULTS

As expected, the ellipticity ratio of the shoulder region was the highest at  $2.28 \pm 0.22$ . The abdomen/pelvis, chest, thorax, and abdomen regions all had ellipticity values near 1.5. The adult head had an ellipticity value of  $0.85 \pm 0.08$ . Our AEC model predicted changes in effective mAs for a given WED as a function of ellipticity as desired. We noted that issues due to patient truncation and the presence of metal implants caused our model to fail. The former is understandable as a truncated image produces a WED smaller than what the AEC systems assumed. Interestingly, the presence of metal orthopedics caused an increase in WED but not a corresponding increase in effective mAs.

### CONCLUSION

We measured and showed why patient ellipticity is important in understanding the function of a CT scanner's AEC system.

### CLINICAL RELEVANCE/APPLICATION

AEC systems are complex and take into consideration more than just the patient size in terms of WED. We report on and model how ellipticity of a patient influences the output of a CT scanner.

SST11

## Vascular Interventional (PAD)

Friday, Dec. 1 10:30AM - 12:00PM Room: E352

**IR MR VA**

AMA PRA Category 1 Credits™: 1.50  
ARRT Category A+ Credit: 1.75

**FDA** Discussions may include off-label uses.

### Participants

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Charles Martin III, MD, Pepper Pike, OH (*Moderator*) Scientific Advisory Board, Boston Scientific Corporation

### Sub-Events

#### SST11-01 MR Angiography in Small Animals Using Hyperpolarized Water

Friday, Dec. 1 10:30AM - 10:40AM Room: E352

### Participants

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### PURPOSE

The administration of Gadolinium based contrast agents is associated with the risk of allergic reactions and the development of a systemic nephrogenic fibrosis (NSF). Current research showed remnants of some types of Gadolinium based MR contrast agents in the brain - with unknown long-term effects. Purpose of our work is to examine dynamic nuclear polarization (DNP) as an alternative method for MR angiography.

### METHOD AND MATERIALS

The used liquid-state Overhauser DNP is a technique to achieve hyperpolarization by microwave irradiation of electron spins in TEMPOL radicals, which are coupled with the nuclear spins of water molecules. Our setup comprises a 42 GHz microwave source and a 1.5 T in-bore DNP MRI polarizer, equipped with a multimode resonator. The continuously hyperpolarized water was administered with a flow of 1.2 ml/min into the aorta of five C57BL/6 mice via catheterization (0.15 mm ID) through iliac vessels. The aorta and its branches were visualized with GRE-sequences (TR 110s, TE 3.8s, FoV 78x58x2 mm, Matrix 256x192 px) and intravascular DNP signal intensities, SNR and CNR values were measured and compared to its native values.

### RESULTS

Maximum intravascular signal intensities were increased 4.3-fold from 231±47 to 994±194 by infusion of hyperpolarized water. Thus better SNR and CNR values were measured for hyperpolarized vessels with an SNR increased 5.3-fold from 24±2 to 126±62 and CNR increased 26.3-fold from 3±2 to 79±49.

### CONCLUSION

The used in-bore DNP setup continuously creates hyperpolarized water, which features high T1 signal enhancements in MR imaging and a short relaxation time. In our mice experiments the strong enhancement and its high CNR made a visualization of the aorta and its branches possible - even using a standard clinical 1.5 T scanner.

### CLINICAL RELEVANCE/APPLICATION

Hyperpolarized water might be a promising future alternative to Gadolinium based contrast agents in MR angiographies without risking the potential adverse effects or intracorporal remnants of Gadolinium based contrast agents.

#### SST11-02 Type 2 Diabetes is Related to Increased Carotid Plaque Inflammation: A Novel Finding of Dynamic Contrast-Enhanced MR Imaging

Friday, Dec. 1 10:40AM - 10:50AM Room: E352

### Participants

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Huilin Zhao, Shanghai, China (*Abstract Co-Author*) Nothing to Disclose

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**PURPOSE**

Although many pathological study have demonstrated that more microvessels and macrophages which associated with increased inflammation was exhibit in diabetic plaques, in vivo study of carotid plaque inflammation in type 2 diabetes mellitus(T2DM) with dynamic contrast-enhanced (DCE) magnetic resonance (MR) imaging is rare. Thus our study aim to evaluate carotid plaque inflammation in stroke patients with and those without type 2 diabetes(T2DM) and to determine which risk factors might be associated with plaque inflammation in T2DM subjects.

**METHOD AND MATERIALS**

A total of 55 patients(25 T2DM and 30 non-T2DM) with carotid plaque ipsilateral to ischemic event were underwent bilateral carotid artery MRI examination. Multicontrast sequences for characterizing plaque morphologic and DCE MR images for assessing atherosclerotic plaque inflammation were obtained in T2DM and non-T2DM patients.

**RESULTS**

Compared with non-T2DM patients, patients with T2DM had more severe inflammation, as evidenced by higher Ktrans(transfer constant) (0.099 vs 0.061, P=0.005). Compared with well controlled diabetes(Hemoglobin A1c[HbA1c] <7%), poorly controlled diabetes(HbA1c >=7%) also have increased inflammation, as evidenced by higher Ktrans (0.126 vs 0.074±; P=0.009) and ve (extracellular extravascular volume fraction) (2.301% vs 6.187%; P=0.026). HbA1c level was independently associated with Ktrans in overall patients and T2DM patients after adjusting for plaque characterization and comprehensive confounding factors.

**CONCLUSION**

This study demonstrated an increased plaque inflammation in T2DM patients and poorly controlled T2DM patients. There have an independent pathophysiological link between the HbA1c level and Ktrans. Thus, DCE-MRI may be useful in monitoring the efficacy of some anti-hyperglycemic agents on atherosclerotic plaque inflammation in T2DM patients.

**CLINICAL RELEVANCE/APPLICATION**

Thus, this in vivo plaque inflammation imaging may potentially useful in providing a clinical tool to better understand the role of inflammation and angiogenesis in plaque progression/regression, and to monitor and predict therapeutic response to inflammation-targeted pharmacotherapy.

**SST11-03 Comparison of [18F] FDG-PET/CT and 3D-Black-Blood 3T-MRI for the Diagnosis of Large Vessel Vasculitis**

Friday, Dec. 1 10:50AM - 11:00AM Room: E352

**Participants**

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**PURPOSE**

To investigate the concordance of a high-resolution three-dimensional (3D) black-blood turbo spin echo (TSE) MRI sequence with variable flip angles and [18F]FDG-PET/CT for the diagnosis of large vessel vasculitis (LVV).

**METHOD AND MATERIALS**

24 consecutive patients with suspected LVV who underwent 3D-black-blood 3T-MRI and [18F]FDG-PET/CT imaging between 2013 and 2016 in our center were retrospectively reviewed. For image analysis 11 different vessel segments were evaluated in both modalities. The MRI-slides were analyzed for signs of vessel wall inflammation, which are concentric contrast enhancement (CCE) and concentric wall thickening (CWT) as well as image quality (IQ) and flow artifact intensity (FAI), using 4-point Likert scales. [18F]FDG-PET/CT analysis comprised qualitative, quantitative and semiquantitative methods. [18F]FDG uptake was analyzed in patients with and without immunosuppressive medication. Imaging findings were correlated with the final clinical diagnosis for each diagnostic method.

**RESULTS**

In 19 of 24 patients (79%), active or inactive LVV was confirmed by clinical follow-up. 3T-MRI was positive in 17 patients, while [18F]FDG-PET/CT identified vasculitis in 14 patients. On MRI, 72% of vessel segments showed no or only minor flow artifacts and 82% disposed an excellent or good IQ (82.2%). Among the patients with LVV, the frequency of CWT and CCE was comparable (62.5% vs. 63.1%) and both parameters showed high correlation (Spearman's R = 0.933; P<0.001). The subgroup analysis of patients with anti-inflammatory medication revealed no statistical difference regarding the results of the [18F]FDG-PET/CT examination.

**CONCLUSION**

Free breathing navigated black-blood MRI and [18F]FDG-PET/CT are promising imaging tools in diagnosing patients with LVV.

**CLINICAL RELEVANCE/APPLICATION**

3D-black-blood 3T-MRI could be a future radiation-free alternative to PET-CT for the diagnosis and follow-up of patients with LVV,

especially in young patients.

#### **SST11-04 Correlation of the Potential Biomarker for Ascending Aortic Aneurysms, MMP-9 with Quantitative Flow Parameters Measured by 4D Flow MRI**

Friday, Dec. 1 11:00AM - 11:10AM Room: E352

##### **Participants**

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##### **PURPOSE**

This translational study intends to evaluate if MMP-9, a matrix metalloproteinase involved in the degradation of extracellular matrix, in the serum of patients with thoracic aortic aneurysms (TAAs) could be used as potential biomarker for TAAs in the future. Therefore MMP-9 serum levels were correlated with quantitative hemodynamic flow parameters measured by 4D flow MRI.

##### **METHOD AND MATERIALS**

16 patients (age 56±13years) with aortic root/ascending aortic aneurysms >45mm underwent 4D flow MRI. Flow quantification was performed using ECG gated three-directional velocity encoding with full 3D coverage of the thoracic aorta. 4D flow MRIs were acquired in a sagittal oblique 3D volume using a flip angle of 8°, VENC: 150 cm/s, spatial resolution = (2.0-2,4)<sup>3</sup>mm<sup>3</sup>, and temporal resolution: 20-40 ms. Data analysis included 3D blood flow visualization (EnSight, CEI, USA) based on 3D particle traces and 3D streamlines. Time-resolved 2D data was extracted on a plane. The diameter, mean wall shear stress magnitude (meanWSSmag), 3D oscillatory shear index (OSI 3D) and percentage of retrograde flow were derived. MMP-9 levels in blood samples of these 16 patients were identified by ELISA tests. Patients were divided into two groups; Group A with bicuspid aortic valves (5 patients), Group B with tricuspid aortic valves (11 patients).

##### **RESULTS**

The following differences and correlations were shown in Groups A and B: MMP-9 levels were significantly higher in patients with BAV (Group A: 645.4(±203.9)ng/ml; Group B: 393.7(±129.1)ng/ml; +64%; p-value <0.05). Furthermore, within each group exist high correlations between MMP-9 levels and both meanWSSmag (Group A: r=0.74; Group B: r=0.5) and percentage of retrograde flow (Group A: r=0.69; Group B: r=0.5). There was also found to be a high negative correlation between MMP-9 and OSI 3D in Group B (r=0.54). The biggest diameters correlate in Group B to MMP-9 levels (r=0.54). No correlation was found for both of these parameters in Group A.

##### **CONCLUSION**

These results revealed a high correlation between quantifiable blood flow within TAAs and MMP-9. Further studies are warranted to investigate the influence of specific aneurysmatic blood circulation on the aortic wall and if MMP-9 can be used as potential biomarker for TAAs.

##### **CLINICAL RELEVANCE/APPLICATION**

MMP-9 could be used as an easy to gain biomarker for TAAs in the future. This would simplify the diagnosis.

#### **SST11-05 Diagnostic Efficacy of Free-Breathing Contrast-Enhanced T1 Gradient Echo Sequences Compared to Standard Breath-Hold T1 Gradient Echo Sequences in the Assessment of Thoraco-Abdominal Aorta Having CT Angiography as Standard of Reference**

Friday, Dec. 1 11:10AM - 11:20AM Room: E352

##### **Participants**

Camillo R. Talei Franzesi, Milan, Italy (*Presenter*) Nothing to Disclose  
Davide Ippolito, MD, Monza, Italy (*Abstract Co-Author*) Nothing to Disclose  
Silvia Girolama Drago, Monza, Italy (*Abstract Co-Author*) Nothing to Disclose  
Cecilia Cangiotti, MD, Monza, Italy (*Abstract Co-Author*) Nothing to Disclose  
Eleonora Orsini, MD, Monza, Italy (*Abstract Co-Author*) Nothing to Disclose  
Sandro Sironi, MD, Monza, Italy (*Abstract Co-Author*) Nothing to Disclose

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##### **PURPOSE**

To evaluate the diagnostic accuracy of contrast-enhanced T1 free-breathing gradient echo sequences in the evaluation of aortic disease, in comparison with standard MR-angiographic sequences and CT-angiography studies.

##### **METHOD AND MATERIALS**

Fifty-three patients, with known aortic disease at CT-angiography evaluation, were prospectively evaluated with a 1.5T magnet (Achieva, Philips), with a phased array multi-coil, after the intravenous injection of 0.1 mL\*kg of gadobutrol. A standard MR angiography examination was performed with 3D-angiographic sequences and T1 breath-hold sequences (THRIVE). Multiplanar T1 free-breathing gradient-echo fat-suppressed (THRIVE-FB) sequences were additionally performed in all the examinations. Two radiologists independently compared the diagnostic quality of MR-angiographic sequences and CT-angiography studies, in terms of visualization of aortic wall and lumen and main arterial branches. Vascular calipers measured at different aortic levels were compared between the MR-sequences and CT evaluations and statistically analyzed. The interobserver agreement was investigated using the Intraclass Correlation Coefficient (ICC).

## RESULTS

Free breathing sequences showed good diagnostic accuracy in the assessment of vascular calipers, with no significant differences compared to standard breath-hold MR-sequences and CT-studies. THRIVE-FB also demonstrated high sensitivity and specificity in the evaluation of vascular wall, plaques, thrombus and adjacent structures. Not significant differences were obtained in terms of diagnostic quality, between THRIVE-FB sequences, standard angiographic sequences and CT-angiography, with a good interobserver agreement (ICC of 0.85).

## CONCLUSION

Free-breathing contrast-enhanced T1 gradient-echo fat-suppressed sequences, combined with high relaxivity contrast agent, demonstrated high diagnostic efficacy, permitting to correctly evaluate the aorta and its major branches, with no significant differences in comparison with standard breath-hold MR-sequences and CT studies.

## CLINICAL RELEVANCE/APPLICATION

Angiographic free-breathing sequences may represent a useful tool in not-compliant patients, allowing to correctly evaluate main thoraco-abdominal arteries, with good diagnostic quality images.

### SST11-06 **Computed Tomography Guided Lumbar Sympathectomy (CTLS) as a Palliative Treatment in Patients with Critical Limb Ischemia Not Amenable to Therapeutic Revascularization**

Friday, Dec. 1 11:20AM - 11:30AM Room: E352

#### Participants

Anurag Chahal, MD, New Delhi, India (*Presenter*) Nothing to Disclose  
Madhusudhan Kumble Seetharama, MD, FRCR, New Delhi, India (*Abstract Co-Author*) Nothing to Disclose  
Sanjay Sharma, MD, FRCR, New Delhi, India (*Abstract Co-Author*) Nothing to Disclose  
Sunil Chumber, MS, New Delhi, India (*Abstract Co-Author*) Nothing to Disclose

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## PURPOSE

To evaluate the safety and efficacy of CTLS in the management of patients of critical limb ischemia without revascularization options To assess the effects of technical parameters of CTLS on the clinical success of the procedure

## METHOD AND MATERIALS

Patients with critical limb ischemia with angiographic anatomy not amenable for revascularization were included in the study. Exclusion criteria were patients not giving consent, unable to lay prone and deranged coagulation parameters. CTLS was performed with patient in prone position using 22 G chiba needle at L1-L3 vertebral level with a mixture of neurolytic solution (99% alcohol) and non-ionic contrast in the ratio of 10:1 after confirming the spread with a check solution of diluted contrast. Patients were observed for 4 hours before discharge. Peri-procedural complications were noted; Numerical pain score (NPS) and limb changes were assessed before and after the procedure at 3 weeks and 3 months. Spread of neurolytic mixture was categorized as medial or lateral with respect to lateral edge of vertebral body. Treatment results were categorized into improved, unchanged or worsened.

## RESULTS

22 patients (19 males, 3 females) with mean age 45.3 years (range: 25-78 years) were included. Bilateral procedure was done in 19 patients and unilateral in 3 patients. The mean volume of absolute alcohol injected per side was 7.5 mL. No procedure related complications were noted. 18 (81.8%) patients improved and 4 patients (18.2%) were unchanged. The mean NPS pre-procedure, 3 weeks and 3 months post procedure were 6.82, 3.32 and 3.05 respectively. ( $p < 0.0001$ ). Pain relief was significantly better in patients with medial spread of the neurolytic agent compared to those without medial spread ( $p = 0.027$ ). Interestingly, 7/16 (43.75%) patients reported ulcer healing in 3 months follow up.

## CONCLUSION

CTLS is a simple, safe and effective procedure in patients with critical limb ischemia due to infragenicular diffuse arterial disease. Medial spread of the neurolytic agent provides significantly better results.

## CLINICAL RELEVANCE/APPLICATION

CT guidance is optimal for exact needle positioning to achieve medial spread of neurolytic mixture which gives better results as seen in this study. CTLS helps in ulcer healing especially in patients with buergers disease who quit smoking since it provides pain relief and helps in opening collateral vessels via chemical sympatheticolysis.

### SST11-07 **String-Like Lumen in Below-the-Knee Chronic Total Occlusions on Contrast-Enhanced Magnetic Resonance Angiography Predicts Intraluminal Recanalization and Better Blood Flow Restoration**

Friday, Dec. 1 11:30AM - 11:40AM Room: E352

#### Participants

Yingsheng Cheng, MD, Shanghai, China (*Presenter*) Nothing to Disclose

## CONCLUSION

In patients with BTK CTOs, SL predicted intraluminal angioplasty and good blood-flow restoration for BTK CTOs.

## Background

To determine whether string-like lumina (SLs) on contrast-enhanced magnetic resonance angiography (CE-MRA) predict better outcomes in diabetic patients with below-the-knee (BTK) chronic total occlusions (CTOs)

## Evaluation

This study involved 317 long-segment (>5cm) BTK CTOs of 245 patients that were examined using CE-MRA and treated using endovascular angioplasty. A SL with a CTO was slowly filled with blood on conventional CE-MRA. SL-positive CTOs (n=60) achieved a higher technique success rate, preferred intraluminal angioplasty and better blood flow restoration than SL-negative CTOs (n=257 P<0.05). Multivariate analyses revealed that lesion length was the independent predictor of procedural success (P=0.028). SL was a predictor of intraluminal angioplasty (P<0.001) and good blood-flow restoration (P=0.004). Kaplan-Meier analyses at 12 months revealed a higher target lesion patency rate (P=0.04) and limb-salvage rate (P=0.35) in SL-positive CTOs.

## Discussion

Our main findings are as follows: (1) intraluminal recanalization was more frequently used for BTK CTOs with SLs than without SLs; (2) CTO length was the only independent predictor of successful CTO recanalization; (3) SL was the only predictor of intraluminal angioplasty in the BTK CTOs; (4) SL and CTO length were predictors of good blood-flow restoration after recanalization; and (5) restenosis-free and limb-salvage rates were better for SL-positive CTOs than SL-negative CTOs.

## SST11-08 **Ultrasound-Guided Percutaneous Thrombin Injection for the Treatment of Iatrogenic Femoral Pseudoaneurysms**

Friday, Dec. 1 11:40AM - 11:50AM Room: E352

### Participants

Huan Dong, MD, Philadelphia, PA (*Abstract Co-Author*) Nothing to Disclose

Brian C. Allen, MD, Durham, NC (*Presenter*) Nothing to Disclose

Erol Bozdogan, MD, Sanliurfa, Turkey (*Abstract Co-Author*) Nothing to Disclose

Tracy A. Jaffe, MD, Durham, NC (*Abstract Co-Author*) Nothing to Disclose

Chad M. Miller, MD, Durham, NC (*Abstract Co-Author*) Nothing to Disclose

Mustafa R. Bashir, MD, Cary, NC (*Abstract Co-Author*) Research support, Siemens AG; Research support, General Electric Company; Research support, NGM Biopharmaceuticals, Inc; Research support, TaiwanJ Pharmaceuticals Co, Ltd; Research support, Madrigal Pharmaceuticals, Inc; Consultant, RadMD

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## PURPOSE

To evaluate clinical and imaging factors that may affect successful ultrasound-guided percutaneous thrombin injection of iatrogenic femoral artery pseudoaneurysms.

## METHOD AND MATERIALS

This was an IRB approved, HIPAA compliant retrospective study. The study population consisted of 326 consecutive subjects (138 males, 188 females; mean age 68 years, range 18 - 95 years) who underwent ultrasound guided percutaneous thrombin injection for the treatment of an iatrogenic femoral artery pseudoaneurysm. The number of pseudoaneurysm lobes, longest dimension, and volume of thrombin injected was recorded along with pre-procedure laboratory values of international normalized ratio (INR), activated partial thromboplastin time (aPTT) and platelet count. A follow up ultrasound was available in 146 subjects.

## RESULTS

Technical success was achieved in 99.4% (324/326) of subjects. Technique efficacy, as measured by complete thrombosis on a follow up ultrasound, was achieved in 87.0% (127/146) of subjects. In 68% (13/19) of subjects who had not achieved complete thrombosis on follow up ultrasound, repeat thrombin injection was performed and deemed successful; 3 subjects required operative intervention and 3 subjects underwent no subsequent intervention. No imaging or procedure factor was associated with technique failure, including volume of thrombin injected (mean 476 units for complete thrombosis (CT) vs. 671 units for incomplete thrombosis (IT); p=0.105), number of pseudoaneurysm lobes (mean 1.33 for CT vs. 1.37 for IT; p=0.826) or largest size of pseudoaneurysm (mean 3.0 cm for CT vs. 3.6 cm for IT; p=0.133). No statistically significant difference in pre-procedure INR, aPTT or platelet count was found between subjects with CT and those with IT (p>0.125).

## CONCLUSION

Imaging guided percutaneous thrombin injection has a high technical success rate for the treatment of iatrogenic femoral artery pseudoaneurysm. No imaging, procedure or laboratory factors are predictive of technique failure.

## CLINICAL RELEVANCE/APPLICATION

Abnormal coagulation parameters do not affect technique efficacy for imaging guided percutaneous thrombin injection of iatrogenic femoral artery pseudoaneurysms.

## SST11-09 **Nephroprotective Imaging for Evaluation of Peripheral Arterial Occlusive Disease (PAOD): A Multi-Observer Comparison Study between Quiescent-Interval Single-Shot MR Angiography (QISS-MRA) and Invasive Angiography with Carbon Dioxide (CO2-DSA)**

Friday, Dec. 1 11:50AM - 12:00PM Room: E352

### Awards

#### Student Travel Stipend Award

### Participants

Christophe Arendt, MD, Frankfurt Am Main, Germany (*Presenter*) Nothing to Disclose

Doris Leithner, MD, Frankfurt Am Main, Germany (*Abstract Co-Author*) Nothing to Disclose

Lukas Lenga, Frankfurt, Germany (*Abstract Co-Author*) Nothing to Disclose

Rouben Czwikla, Frankfurt Am Main, Germany (*Abstract Co-Author*) Nothing to Disclose

Julian L. Wichmann, MD, Frankfurt, Germany (*Abstract Co-Author*) Speaker, General Electric Company; Speaker, Siemens AG

Tatjana Gruber-Rouh, Frankfurt Am Main, Germany (*Abstract Co-Author*) Nothing to Disclose

Thomas J. Vogl, MD, PhD, Frankfurt, Germany (*Abstract Co-Author*) Nothing to Disclose

## **PURPOSE**

Non-contrast QISS-MRA and CO2-DSA remain promising nephroprotective methods for accurate staging of PAOD in patients with chronic renal failure (CRF). The aim of our study was to assess the diagnostic value and subjective image quality of QISS-MRA in comparison with CO2-DSA.

## **METHOD AND MATERIALS**

Sixteen consecutive patients (77.5±12.6 years, 64% male) with impaired renal function (eGFR 23.9±7.9 ml/min/1.73 m<sup>2</sup>) who underwent QISS-MRA at 3 Tesla and CO2-DSA within two weeks were retrospectively included. Identification of significant (>=50%) stenoses of the lower extremity arteries (21-segment-model) was evaluated by 4 independent readers with different level of experience per-segment in random order. Subjective image quality was determined using a 5-point Likert scale (1, non-diagnostic quality; 5, excellent quality or non-perceivable artifacts). CO2-DSA of an experienced interventional radiologist was considered the standard reference method.

## **RESULTS**

115 segments were available for direct MRA-DSA comparison with a prevalence of >=50% stenoses of 27.8% (32/115). Diagnostic parameters of QISS-MRA yielded as follows: sensitivity 90.6% [95%CI: 84.2-95.1%], specificity 94.0% [95%CI: 90.9-96.3%], PPV 85.3% [95%CI: 79.1-89.9%], NPV 96.3% [95%CI: 93.8-97.8%], with an ICC of 0.89. Median values of qualitative imaging parameters for QISS-MRA were as follows: arterial signal intensity: 4 (pelvis), 4 (thigh), 5 (calf); venous overlay: 4, 4, 5; susceptibility artifacts: 5, 5, 5; motion artifacts: 4, 5, 5; ECG-related artifacts: 5, 5, 5. Values for ICC were 0.72, 0.73, 0.93, 0.69 and 0.79, respectively. Opacification of arteries at CO2-DSA was rated 3, 4, 3, with an ICC of 0.65.

## **CONCLUSION**

Non-invasive QISS-MRA offers high diagnostic performance for the detection and ruling out of PAOD in comparison with invasive CO2-DSA. In a direct comparison, image quality of QISS-MRA was preferred by observers over CO2-DSA.

## **CLINICAL RELEVANCE/APPLICATION**

Patients with symptomatic PAOD and CRF could undergo a non-invasive diagnostic evaluation of the lower extremities using QISS-MRA with subsequent guidance to vessels of interest for percutaneous intervention in DSA-technique.



SPFR61

## Friday Imaging Symposium: Imaging of the Acute Abdomen

Friday, Dec. 1 12:30PM - 3:00PM Room: E353C



AMA PRA Category 1 Credits™: 2.50  
ARRT Category A+ Credits: 3.00

### Participants

Douglas S. Katz, MD, Mineola, NY (*Moderator*) Nothing to Disclose  
Mariam Moshiri, MD, Seattle, WA (*Moderator*) Grant, Koninklijke Philips NV; Author, Reed Elsevier

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### Sub-Events

#### SPFR61A Current Role of Radiography and Fluoroscopy in the Emergency Department

##### Participants

William M. Thompson, MD, Albuquerque, NM (*Presenter*) Nothing to Disclose

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### LEARNING OBJECTIVES

1) Understand the use of radiography in the work up of emergency room patients. 2) Know the specific radiographic findings of extraluminal air. 3) Know the specific radiographic findings of small bowel and large bowel obstruction. 4) Know the proper techniques and positive findings in emergency gastrointestinal fluoroscopic studies.

#### SPFR61B Ultrasound of the Acute Abdomen: Current Role

##### Participants

Oksana H. Baltarowich, MD, Philadelphia, PA (*Presenter*) Nothing to Disclose

### LEARNING OBJECTIVES

1) Discuss causes of acute abdominal pain and the current role of ultrasound in diagnosis. 2) Identify usual and unusual manifestations of the entities. 3) Describe pitfalls in the diagnoses and address causes of technically inadequate studies.

#### SPFR61C Emergency Pelvic Sonography: Current Role

##### Participants

Robin B. Levenson, MD, Boston, MA (*Presenter*) Nothing to Disclose

### LEARNING OBJECTIVES

1) Discuss causes of acute female pelvis and the role of ultrasound in evaluation. 2) Identify important pelvic ultrasound imaging findings in the acute setting and recognize pearls and pitfalls in diagnosis. 3) Illustrate examples demonstrating range of imaging findings.

#### SPFR61D Is Oral Contrast Indicated for Acute Abdominal and Pelvic CT?

##### Participants

Michael N. Patlas, MD, FRCPC, Hamilton, ON (*Presenter*) Nothing to Disclose

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### LEARNING OBJECTIVES

1) To describe current trends and controversies in oral contrast administration. 2) To highlight factors affecting selection of patients who would and would not benefit from usage of oral contrast. 3) To discuss the impact of elimination of oral contrast on Emergency Department (ED) length of stay.

#### SPFR61E Dual-energy CT of the Acute Abdomen and Pelvis

##### Participants

Savvas Nicolaou, MD, Vancouver, BC (*Presenter*) Institutional research agreement, Siemens AG

### LEARNING OBJECTIVES

1) Brief introduction of Dual Energy CT/Spectral Imaging. 2) Introduction to Virtual Non-Contrast and Monoenergetic+ imaging

techniques. 3) Discuss and demonstrate the value of DECT/Spectral imaging on specific abdominal cases including GI Bleed, Bowel Ischemia and Renal Stones. 4) Select cases demonstrating problem solving capability of DECT/Spectral Imaging.

#### **SPFR61F CT of Bowel Obstruction and Ischemia**

Participants

Christina A. LeBedis, MD, Boston, MA (*Presenter*) Nothing to Disclose

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#### **LEARNING OBJECTIVES**

1) Understand the clinical implications of bowel obstruction and ischemia. 2) Apply tailored CT imaging techniques to evaluate these patients. 3) Analyze the CT imaging findings of bowel obstruction including "high grade", "low grade" and "closed loop" and bowel ischemia which help guide patient management. 4) Recognize pitfalls in CT interpretation of bowel obstruction and ischemia.

#### **SPFR61G Imaging of Acute Toxic and Foreign Body Ingestions**

Participants

Laura L. Avery, MD, Boston, MA (*Presenter*) Nothing to Disclose

#### **LEARNING OBJECTIVES**

1) Become familiar with the radiological appearances of various ingested or inhaled materials that may prove toxic or injurious to patients. 2) Improve time to recognition of these entities. 3) Understand the pathophysiology of injury after ingestion. 4) Learn imaging and treatment algorithms related to specific ingestions in order to guide clinical management.

#### **Honored Educators**

Presenters or authors on this event have been recognized as RSNA Honored Educators for participating in multiple qualifying educational activities. Honored Educators are invested in furthering the profession of radiology by delivering high-quality educational content in their field of study. Learn how you can become an honored educator by visiting the website at: <https://www.rsna.org/Honored-Educator-Award/> Laura L. Avery, MD - 2016 Honored Educator

#### **SPFR61H Controversies in Abdominal Trauma CT**

Participants

Mariano Scaglione, MD, Castel Volturno, Italy (*Presenter*) Nothing to Disclose

#### **LEARNING OBJECTIVES**

1) To discuss the areas of controversies in TC imaging protocol. 2) To understand the usefulness of the arterial phase in blunt trauma. 3) To discuss importance of a dual acquisition phase in the high deceleration injuries.

#### **ABSTRACT**

In this lectures the major areas of controversies in TC imaging in the high deceleration injuries will be discuss, including acquisition phases, TC parameters and radiation doses. Furthermore, the usefulness of the arterial phase in blunt trauma and the importance of post-processing techniques in the IR programme planning will be illustrated. Finally, the role of emergency radiologist in the ER and how this makes the difference will be emphasized.

#### **SPFR61I Imaging of the Acute Abdomen in Pregnancy: Overview of Current Recommendations**

Participants

Gabriele Masselli, MD, Rome, Italy (*Presenter*) Nothing to Disclose

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#### **LEARNING OBJECTIVES**

1) To discuss the current evidence-based recommendations regarding radiation dose concerns, the use of iodinated and gadolinium-based contrast agents, and the comparative advantages and drawbacks of multimodality imaging (ultrasound, CT, and MRI) during pregnancy. 2) To understand how to diagnose the most common causes of acute abdominal pain in pregnancy. 3) To review the imaging features of various pathologies which may present as acute abdominal pain during pregnancy.

#### **SPFR61J Role of Pelvic MR in the Emergency Department for Non-pregnant Patients**

Participants

Stephan W. Anderson, MD, Cambridge, MA (*Presenter*) Nothing to Disclose