



# Monday

Program subject to change until 12/16/2019.



105<sup>TH</sup> Scientific Assembly and Annual Meeting  
December 1-6 | McCormick Place, Chicago





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December 1-6 | McCormick Place, Chicago

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SPDL20

## Radiology Stranger Things: A Journey into the Upside Down (Case-based Competition)

Monday, Dec. 2 7:15AM - 8:15AM Room: E451B

**ED ER MK**

AMA PRA Category 1 Credit™: 1.00  
ARRT Category A+ Credit: 0

### Participants

Eric B. England, MD, Cincinnati, OH (*Presenter*) Nothing to Disclose  
Carl C. Flink, MD, Cincinnati, OH (*Presenter*) Nothing to Disclose

### Special Information

*This interactive session will use RSNA Diagnosis Live™. Please bring your charged mobile wireless device (phone, tablet or laptop) to participate.*

### LEARNING OBJECTIVES

1) Review "strange" presentations of common and uncommon Musculoskeletal and Emergency Radiology pathology. 2) Discuss imaging findings associated with a variety of Musculoskeletal Radiology cases. 3) Differentiate Emergent from non-Emergent imaging findings associated with a variety of conditions. 4) Use mobile wireless device (tablet, phone, laptop) to electronically respond to various imaging case challenges; participants will be able to monitor their individual and team performance in real time. 5) Receive a personalized self-assessment report via email that will review the case material presented during the session, along with individual and team performance.

Printed on: 10/29/20



SPSC20

## Controversy Session: Are We Over Diagnosing Pulmonary Emboli?

Monday, Dec. 2 7:15AM - 8:15AM Room: E450A

CH

AMA PRA Category 1 Credit™: 1.00  
ARRT Category A+ Credit: 1.00

### Participants

Ioannis Vlahos, MRCP,FRCR, Houston, TX (*Moderator*) Director, Grayscale Ltd; Co-owner, Grayscale Ltd

### LEARNING OBJECTIVES

1) To understand the concepts of overdiagnosis of Pulmonary Embolism. 2) To explore whether overdiagnosis is different from CTPA over-utilization and mis-diagnosis of pulmonary embolism. 3) To debate the balance of imaging and detection of pulmonary emboli, their need for treatment, and impact of their treatment on clinical outcome.

### Sub-Events

#### SPSC20A Are We Over Diagnosing Pulmonary Embolism? Yes!

##### Participants

Linda B. Haramati, MD, MS, New Rochelle, NY (*Presenter*) Spouse, Board Member, Kryon Systems Ltd

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

lharamati@gmail.com

### ABSTRACT

Since the 1960 trial validating anticoagulation for treatment of pulmonary embolism (PE), the spectrum of disease has radically shifted with advances in noninvasive imaging to include less severe disease. Overdiagnosis represents the diagnosis of clinically unimportant disease. PE is particularly prone to overdiagnosis because some PE are likely physiological rather than pathological as one of the functions of the pulmonary capillary bed is to filter and lyse small silent PE. There is strong evidence of overdiagnosis of PE on CTPA, which was quickly adopted into practice in the 1990s and surpassed VQ scintigraphy as the dominant PE imaging modality in the USA in 2001. PE overdiagnosis at the population level is overwhelmingly supported by the results of multiple studies. This evidence base will be reviewed. Overdiagnosis of PE is not the same as subsegmental PE, which can have high morbidity in patients with poor cardiopulmonary reserve and the occasional patient with substantial DVT. Overtreatment with anticoagulation for nonsignificant PE has important complications and costs. Radiologists, used to making diagnoses based on imaging, need to be more aware of the nuances and complexities surrounding the diagnosis and overdiagnosis of PE in order to optimize outcomes based treatment for our patients.

#### SPSC20B Are We Over Diagnosing Pulmonary Embolism? No!

##### Participants

Martine J. Remy-Jardin, MD, PhD, Lille, France (*Presenter*) Research Grant, Siemens AG; Speaker, Siemens AG

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

martine.remy@chru-lille.fr

### LEARNING OBJECTIVES

1) To discuss the concept of overdiagnosis. 2) To review the unanswered questions on the natural history of acute pulmonary embolism. 3) To understand the missing links between acute and chronic thromboembolic disease.

### ABSTRACT

The concept of overdiagnosis is counterbalanced by a series of unanswered questions regarding the natural history of acute pulmonary embolism (PE) and the missing links between acute and chronic thromboembolic disease. The main reasons against overdiagnosis of PE can be found in the context of modern diagnostic tools and will be reviewed during this session. As we are not certain that the concept of overdiagnosis will survive, a cautious approach to patient management should be kept in mind. In particular, it is difficult to agree with the imaging recommendations currently proposed, such as to 'image less' or 'consider less sensitive imaging'. The common drawback of these solutions is to consider acute PE as the main diagnosis suspected by clinicians. However, it is often one hypothesis among a longer list of potential causes for nonspecific clinical symptoms such as dyspnea. As a consequence, we cannot recommend imaging less or using less sensitive tests, as only a few respiratory diseases can be evaluated without cross-sectional imaging. All these aspects of the current debate will be reviewed during this session.

Printed on: 10/29/20



SPSH20

### Hot Topic Session: Radiomics in Thoracic Imaging

Monday, Dec. 2 7:15AM - 8:15AM Room: E350

**AI** **CH**

AMA PRA Category 1 Credit™: 1.00  
ARRT Category A+ Credit: 1.00

#### Participants

Hugo Aerts, PhD, Boston, MA (*Moderator*) Stockholder, Sphera Inc

#### LEARNING OBJECTIVES

1) Learn about the motivation and methodology of A.I. technologies for cancer quantification. 2) Learn about the existing and future potential role of radiologic AI with other -omics data for precision medicine. 3) Learn about open-source informatics developments.

#### Sub-Events

##### SPSH20A Deep Learning for Lung Screening

#### Participants

Bram van Ginneken, PhD, Nijmegen, Netherlands (*Presenter*) Stockholder, Thirona; Co-founder, Thirona; Royalties, Thirona; Research Grant, Varian Medical Systems, Inc; Royalties, Varian Medical Systems, Inc; Research Grant, Canon Medical Systems Corporation; Royalties, Canon Medical Systems Corporation; Research Grant, Siemens AG;

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

bram.vanginneken@radboudumc.nl

##### SPSH20B Using AI-Radiomics for Cancer Characterization

#### Participants

Hugo Aerts, PhD, Boston, MA (*Presenter*) Stockholder, Sphera Inc

##### SPSH20C AI-based Radiomic Biomarkers at the Intersection of Oncology and Cardiology

#### Participants

Udo Hoffmann, MD, Boston, MA (*Presenter*) Research Grant, Kowa Company, Ltd; Research Grant, Abbott Laboratories; Research Grant, HeartFlow, Inc; Research Grant, AstraZeneca PLC;

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MSAS21

## Globally Competent Professionals in the Workforce (Sponsored by the Associated Sciences Consortium)

Monday, Dec. 2 8:30AM - 10:00AM Room: S105AB

PR

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

### Participants

Sharon Wartenbee, RT, Sioux Falls, SD (*Moderator*) Nothing to Disclose  
Dimitris Katsifarakis, MSc, Athens, Greece (*Moderator*) Nothing to Disclose

### Sub-Events

#### MSAS21A Global Competencies for a Global Workforce

##### Participants

Robert Walker, PhD, Ogden, UT (*Presenter*) Nothing to Disclose

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

[rwalker2@weber.edu](mailto:rwalker2@weber.edu)

##### LEARNING OBJECTIVES

1) Be able to identify what are global Competencies. 2) Obtain knowledge of what specific skills do globally competent professional have. 3) Be introduced to education's role with global competencies. 4) Be able to identify qualities of a globally competent professional. 5) Be introduced to plan for the future.

##### ABSTRACT

Global competency is a key component to overall success in today's job market. Today's imaging professional must be globally ready to compete in an ever-changing healthcare system. Tomorrow's imaging profession will need to be open-minded, nonjudgmental, and accept differences. Successful globally competent people will need to be adaptable, flexible, and able to communicate across cultural boundaries. Understanding global and geographic competency will become a critical competency for all imaging professionals in the near future.

#### MSAS21B Impact of Global Health

##### Participants

Casey Neville, RT, Taylor, UT (*Presenter*) Nothing to Disclose

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

[caseyneville@weber.edu](mailto:caseyneville@weber.edu)

##### LEARNING OBJECTIVES

1) Be able to recognize global healthcare considerations. 2) Obtain knowledge of global health initiatives that improve healthcare and propel. 3) Be introduced to ways in which healthcare providers can become actively involved with global health initiatives. 4) Be able to identify barriers to obtaining healthcare as a result of geographical location and how to address those barriers. 5) Be introduced to leadership skills that promote the global advancement of healthcare.

##### ABSTRACT

With extensive technological advancements in these modern times, the impact on global health has become more pertinent than ever. Healthcare now requires advanced global engagement in order to maintain and prevail in health care initiatives and improve overall population health. As healthcare providers, it is pertinent that we understand and identify barriers to healthcare initiatives as well as producing creative ways to accomplish a culture of wellness. Global engagement in healthcare provides benefits to both the individuals receiving care as well as those providing care. As we participate in global health initiatives, we become leaders in our profession and increase our compassionate care skills.

Printed on: 10/29/20



MSCN21

## Case-based Review of Neuroradiology (Interactive Session)

Monday, Dec. 2 8:30AM - 10:00AM Room: S100AB

NR

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

### Participants

Pina C. Sanelli, MD, MPH, Manhasset, NY (*Director*) Nothing to Disclose

### LEARNING OBJECTIVES

1) Identify the application of basic anatomic, pathologic and physiologic principles to specific disease processes and diagnostic and therapeutic procedures in neuroimaging. 2) Analyze Imaging and Therapeutic Techniques and apply this knowledge to protocol development, patient management and safety. 3) Compare indications and contraindications of specific imaging procedures in Neuroradiology.

### ABSTRACT

This course is designed to highlight the vital role of neuroimaging in the diagnosis, treatment and management of neurologic diseases. A wide range of applications will be covered including brain, spine, head & neck, pediatric and interventional imaging. Our goal is to provide a broad update in the field while addressing new opportunities and challenges for everyday practice.

### Sub-Events

#### MSCN21A Train Your Brain: Amazing Adult Cases

Participants

Pamela W. Schaefer, MD, Boston, MA (*Presenter*) Nothing to Disclose

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

pschaefer@partners.org

#### MSCN21B Brain: Neoplasm or NOT?

Participants

Jacqueline A. Bello, MD, New York, NY (*Presenter*) Nothing to Disclose

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

jbello@montefiore.org

#### MSCN21C Let's Opine on Clandestine Spine

Participants

Adam E. Flanders, MD, Narberth, PA (*Presenter*) Nothing to Disclose

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

adam.flanders@jefferson.edu

#### MSCN21D Spine Intervention: Follow the Contrast: It Will Lead You to the Diagnosis and Keep You Out of Trouble!

Participants

Vinil Shah, MD, San Francisco, CA (*Presenter*) Nothing to Disclose

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MSMC21

**Cardiac CT Mentored Case Review: Part I (In Conjunction with the North American Society for Cardiovascular Imaging) (Interactive Session)**

Monday, Dec. 2 8:30AM - 10:00AM Room: S406A



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

**Participants**

Jill E. Jacobs, MD, New York, NY (*Moderator*) Nothing to Disclose

**LEARNING OBJECTIVES**

1) To be able to identify and understand normal cardiac anatomy. 2) To be able to identify and understand some of the common coronary anomalies.

**Sub-Events**

**MSMC21A Normal Coronary Anatomy**

Participants

Brian B. Ghoshhajra, MD, Boston, MA (*Presenter*) Research Grant, Siemens AG

**MSMC21B Anomalous Coronary Arteries**

Participants

Prachi P. Agarwal, MD, Canton, MI (*Presenter*) Nothing to Disclose

**LEARNING OBJECTIVES**

1) List the various coronary artery anomalies. 2) Identify the CT imaging features and hemodynamics of clinically significant coronary artery anomalies. 3) Apply the knowledge of treatment options to understand normal postoperative appearance and postoperative complications.

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MSMI21

## Molecular Imaging Symposium: Basics of Molecular Imaging

Monday, Dec. 2 8:30AM - 10:00AM Room: S405AB

**BQ** **MR** **MI** **NM** **US**

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

### Participants

Zaver M. Bhujwala, PhD, Baltimore, MD (*Moderator*) Nothing to Disclose  
Jan Grimm, MD, PhD, New York, NY (*Moderator*) Nothing to Disclose

### For information about this presentation, contact:

Grimmj@mskcc.org

### Sub-Events

#### MSMI21A Molecular Imaging using Radioactive Tracers

Participants

Jan Grimm, MD, PhD, New York, NY (*Presenter*) Nothing to Disclose

### LEARNING OBJECTIVES

1) Discuss the various radio tracers and their applications in Molecular Imaging studies. 2) Understand in which situations to use which radio tracers, what to consider when developing the imaging construct and what controls to obtain for nuclear imaging studies. 3) Examples will contain imaging with small molecules, with antibodies and nanoparticles as well as with cells in order to provide the participants with examples how to correctly perform their imaging studies. 4) Most of the examples will be from the oncology field but their underlying principles are universally applicable to other areas as well.

#### MSMI21B Molecular Imaging with MRI and MRS

Participants

Zaver M. Bhujwala, PhD, Baltimore, MD (*Presenter*) Nothing to Disclose

### LEARNING OBJECTIVES

1) To list the basic principles of magnetic resonance (MR) molecular imaging. 2) To describe the uses of noninvasive multi-nuclear MRI and magnetic resonance spectroscopic imaging (MRSI) for molecular imaging applications that provide spatial and temporal information on vasculature, metabolism and physiology. 3) To identify the applications of targeted MR contrast agents to detect receptor and gene expression. 4) To describe strategies that combine detection with therapy for theranostic imaging and for metabolotheranostics. 5) To provide examples of translational applications of molecular imaging and theranostics.

### ABSTRACT

Noninvasive multi-nuclear magnetic resonance (MR) imaging and spectroscopic imaging (MRSI) provide a wealth of spatial and temporal information on vasculature, metabolism and physiology. Novel targeted contrast agents have widened the scope of MR techniques for molecular imaging applications to detect receptor and gene expression. In cancer, molecular imaging can be applied to identify targets specific to cancer with imaging, design agents against these targets to visualize their delivery, and monitor response to treatment, with the overall purpose of minimizing collateral damage. Genomic and proteomic profiling can provide an extensive 'fingerprint' of each tumor. With this cancer fingerprint, theranostic agents can be designed to personalize treatment for precision medicine of cancer, and minimize damage to normal tissue.

#### MSMI21C Molecular Imaging with Nanoparticles

Participants

Heike E. Daldrup-Link, MD, Palo Alto, CA (*Presenter*) Nothing to Disclose

### LEARNING OBJECTIVES

1) To understand important safety aspects of ultrasmall superparamagnetic iron oxide nanoparticles (USPIO). 2) To understand the biodistribution of ferumoxytol nanoparticles and implications for imaging diagnoses. 3) To recognize the value of ferumoxytol nanoparticles for cancer MR imaging and PET/MR imaging.

### ABSTRACT

Gadolinium chelates as contrast agents for MRI have been associated with mounting concerns about nephrogenic sclerosis and gadolinium deposition in the brain. Therefore, a search for safe alternatives is currently underway. In North America, the iron supplement ferumoxytol has gained considerable interest as an MR contrast agent. In Europe, ferumoxtran-10 is re-entering clinical trials. Both ferumoxytol and ferumoxtran-10 provide long-lasting blood pool enhancement, which can be used for MR imaging exams that require detailed and/or long-lasting vessel delineation for MR angiographies, tissue perfusion studies, and whole body tumor staging. Iron oxide nanoparticles are slowly phagocytosed by macrophages in the reticuloendothelial system, making them ideal for MR imaging detection of tumors in the liver, spleen, lymph nodes, and bone marrow. Similarly, iron oxide nanoparticles are slowly phagocytosed by tumor-associated macrophages in cancers; which can be used to grade tumor-associated inflammation and monitor the efficacy of new cancer immunotherapies. This presentation provides an introduction to the use of iron oxide



nanoparticles for clinical MR and PET/MR imaging, including safety data acquired in children thus far, recent insights and mechanisms of rare, but potentially severe adverse reactions, applications that impact patient care and comparisons with gadolinium chelates. New developments for image guided therapy and theranostics are under way.

#### **MSMI21D    Ultrasound Molecular Imaging with Targeted Bubbles**

##### Participants

Alexander L. Klibanov, PhD, Charlottesville, VA (*Presenter*) Co-founder, Targeson, Inc, now dissolved; Shareholder, Targeson, Inc, now dissolved; Institutional research collaboration, AstraZeneca PLC; NIH Grant subcontract to UVA lab, SoundPipe Therapeutics;

##### **LEARNING OBJECTIVES**

1) Understand the principles of microbubble design-how to prepare fully biocompatible and safe ultrasound contrast agent particles that are clinically translatable, stable on storage, provide strong acoustic response and high sensitivity of detection by clinical ultrasound imaging systems, and could be targetable. 2) Understand the principles of selection of disease-specific targeting ligands usable for contrast ultrasound imaging, based on receptor levels in the vasculature in the disease issues, as well as vascular biomechanics. 3) Assess the results of early stage clinical trials performed with targeted microbubbles, and opportunities for clinical translation in diagnostic imaging and image-guided interventions.

##### **ABSTRACT**

Ultrasound is the most widespread clinical imaging modality. Therefore, enabling molecular imaging potential in an ultrasound setting will lead to the expanded and improved clinical diagnostic benefit. Ultrasound contrast microbubbles are already used in clinic as blood pool contrast agents, with excellent detection sensitivity: single particles with sub-picogram mass can be observed with clinical imaging systems in real time, at a depth of several cm. To achieve biomarker-selective molecular imaging, microbubble shell surface is decorated with targeting ligand molecules (antibodies, peptides, carbohydrates) that assure selective binding and retention in the areas of disease. Clinical microbubbles are typically 1-3 um in diameter; they do not extravasate, so target biomarker receptors should be located on the luminal surface of vessel wall, e.g., vascular endothelium. Microbubbles are targeted to the biomarkers in the areas of inflammation and ischemia-reperfusion injury (P- and E-selectin, VCAM-1, ICAM-1) or to tumor neovasculature (VEGFR2). The latter, a heterodimeric peptide-targeted contrast microbubble from industry, has successfully completed Phase 1-2 clinical trials for imaging of ovarian, breast and prostate cancer lesions. Overall, targeted microbubbles empower molecular ultrasound imaging; they could also be used in conjunction with image-guided interventions, such as targeted biopsy and therapy.

#### **MSMI21E    Quantitative Imaging Biomarkers and Radiogenomics**

##### Participants

Lawrence H. Schwartz, MD, New York, NY (*Presenter*) Nothing to Disclose

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MSRO21

## BOOST: Head and Neck-Anatomy and Treatment Planning (Interactive Session)

Monday, Dec. 2 8:30AM - 10:00AM Room: S402AB

HN NR RO

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

### Sub-Events

#### MSRO21A Larynx and Hypopharynx

##### Participants

Sung Kim, MD, New Brunswick, NJ (*Presenter*) Consultant, Nanobiotix  
Suresh K. Mukherji, MD, Carmel, IN (*Presenter*) Nothing to Disclose

##### LEARNING OBJECTIVES

1) Review the normal anatomy of the larynx. 2) Discuss the spread patterns of the different primary sites of the larynx. 3) Explain the information that imaging provides that directly affects staging and management.

##### ABSTRACT

This session will demonstrate the value of laryngeal imaging. This talk will review the normal anatomy of the larynx. The talk will also discuss the spread patterns of the different primary sites of the larynx and illustrate the information that imaging provides that directly affects staging and management of laryngeal cancer.

#### MSRO21B Oral Cavity and Oropharynx

##### Participants

Sung Kim, MD, New Brunswick, NJ (*Presenter*) Consultant, Nanobiotix  
Suresh K. Mukherji, MD, Carmel, IN (*Presenter*) Nothing to Disclose

##### LEARNING OBJECTIVES

1) Review the normal anatomy of the oral cavity and oropharynx. 2) Illustrate the normal spread patterns of the various subsites of the oral cavity and oropharynx. 3) Explain the information that imaging provides that directly affects staging and management.

##### ABSTRACT

Imaging plays a crucial role in evaluating the evaluating the primary site. The information provided on pre-treatment imaging directly affects the stage of the tumor and provides information regarding management and treatment that cannot be ascertained through physical exam or staging. This talk will review the normal anatomy and malignancies involving the oral cavity and oropharynx. The presentation will also provide information on technique and provide a "checklist" of information that should be included in the radiologist's report that will help determine treatment and management.

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## 105<sup>TH</sup> Scientific Assembly and Annual Meeting

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MSRO25

### **BOOST: Breast-Case-based Multidisciplinary Review (Interactive Session)**

Monday, Dec. 2 8:30AM - 10:00AM Room: S103CD

**BR** **OI** **RO**

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

#### **Participants**

Jonathan B. Strauss, MD, Chicago, IL (*Presenter*) Reviewer, WellPoint, Inc

Bethany L. Niell, MD, PhD, Tampa, FL (*Presenter*) Nothing to Disclose

Cesar A. Santa-Maria, MD, Baltimore, MD (*Presenter*) Research funded, AstraZeneca PLC; Research funded, Pfizer Inc; Research

funded, Tesaro; Advisory Board, Polyphor; Advisory Board, Halozyme Therapeutics, Inc; Advisory Board, Genomic Health, Inc

Brian J. Czerniecki, MD, PhD, Tampa, FL (*Presenter*) Nothing to Disclose

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

Jonathan1804@gmail.com

bethany.niell@moffitt.org

#### **LEARNING OBJECTIVES**

1) Describe the latest advances in breast cancer imaging before, during, and after treatment. 2) Facilitate a multidisciplinary approach to the diagnosis, management, and treatment of breast cancer.

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RC201

## Practical HRCT of the Lung (Interactive Session)

Monday, Dec. 2 8:30AM - 10:00AM Room: N227B



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

### Participants

Daria Manos, MD, FRCPC, Halifax, NS (*Moderator*) Nothing to Disclose

### For information about this presentation, contact:

Daria.manos@nshealth.ca

### LEARNING OBJECTIVES

- 1) Identify and distinguish common and important CT patterns of diffuse and interstitial lung disease.
- 2) Understand the clinical importance of HRCT pattern recognition, the overlap between patterns and the key imaging features to help avoid diagnostic error.
- 3) Use clinical context to tailor HRCT differential diagnosis.

### Sub-Events

#### RC201A Approach to Nodular Patterns

Participants

Daria Manos, MD, FRCPC, Halifax, NS (*Presenter*) Nothing to Disclose

### For information about this presentation, contact:

daria.manos@nshealth.ca

### LEARNING OBJECTIVES

- 1) Use the traditional anatomic approach to 'micronodular' patterns on chest CT.
- 2) Understand the limitations to the anatomic approach and use additional strategies for a more refined differential diagnosis.
- 3) Be familiar with common diseases that result in a nodular pattern on chest CT.

#### RC201B Diffuse Airspace Disease: Practical Tips

Participants

Elsie Nguyen, MD, Toronto, ON (*Presenter*) Nothing to Disclose

### LEARNING OBJECTIVES

- 1) Describe an approach to diffuse airspace disease detected on CT chest.
- 2) List 3 common causes of acute diffuse airspace disease.
- 3) List 3 common causes of chronic diffuse airspace disease.

#### RC201C Cystic Lung Disease: What Are You Missing?

Participants

Judith L. Babar, MBChB, Shelford, United Kingdom (*Presenter*) Nothing to Disclose

### LEARNING OBJECTIVES

- 1) Accurately identify the common and important features of cystic lung disease on HRCT.
- 2) Recognize distinguishing features from other mimics of cystic lung disease on HRCT.
- 3) Use clinical context and other ancillary findings to tailor HRCT differential diagnosis.

#### RC201D Fibrotic Lung Disease: Not Always UIP

Participants

Susan J. Copley, MD, FRCR, London, United Kingdom (*Presenter*) Nothing to Disclose

### LEARNING OBJECTIVES

- 1) Accurately identify the common and important features of fibrotic lung disease on HRCT.
- 2) Describe the common and important HRCT features of UIP.
- 3) Recognize distinguishing features of other patterns of fibrotic lung disease on HRCT.

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RC202

## Artificial Intelligence and Precision Education: How AI Can Revolutionize Training in Radiology

Monday, Dec. 2 8:30AM - 10:00AM Room: E450A



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

### Participants

Falgun H. Chokshi, MD, Devon, PA (*Moderator*) Advisor, Graticule, Inc; Shareholder, Graticule, Inc

### LEARNING OBJECTIVES

1) Understand the basics of machine learning/AI. 2) Identify limitations of machine learning/AI.

### Sub-Events

#### RC202A AI: Capabilities and Limitations

### Participants

Falgun H. Chokshi, MD, Devon, PA (*Presenter*) Advisor, Graticule, Inc; Shareholder, Graticule, Inc

### LEARNING OBJECTIVES

1) Understand qualitative basics of machine learning/AI. 2) Identify limitations of machine learning/AI. 3) List potential uses of machine learning/AI in Radiology education.

#### RC202B State of Radiology Education: Opportunities for Change

### Participants

Soonmee Cha, MD, San Francisco, CA (*Presenter*) Nothing to Disclose

### LEARNING OBJECTIVES

1) Identify methods of critical assessment of radiology learners. 2) Describe innovative and individualized radiology training curriculum in the era of ever-changing technology and artificial intelligence. 3) Examine tools and resources to educate the educators. 4) Compare methods of effective feedback and reinforcement. 5) Develop strategies to promote lifelong learning in radiology.

#### RC202C Multi-stakeholder Panel

### Participants

George L. Shih, MD, New York, NY (*Presenter*) Consultant, MD.ai, Inc; Stockholder, MD.ai, Inc;

Janak Joshi, MBA, Newton, MA (*Presenter*) Nothing to Disclose

Mark E. Mullins, MD, PhD, Atlanta, GA (*Presenter*) Nothing to Disclose

Lindsey A. Shea, MD, Indianapolis, IN (*Presenter*) Nothing to Disclose

Khan M. Siddiqui, MD, Hinsdale, IL (*Presenter*) Founder and CEO, IntellixAI, Inc (DBA "HOPPR"); Founder and CMO, high SH Holdings, Inc; Stockholder, Lunit Inc; Advisory Board, Lunit Inc; Stockholder, Inference Analytics, Inc; Advisory Board, Inference Analytics, Inc; Advisory Board, Envoy AI, Inc; Stockholder, mHealthCoach, Inc; Advisory Board, mHealthCoach, Inc; Stockholder, KaiMed, Inc; Advisory Board, KaiMed, Inc; Advisory Board Member, Pier88health, Inc

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RC203

## Infections and Inflammatory Cardiac Disorders

Monday, Dec. 2 8:30AM - 10:00AM Room: E353A

CA

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

FDA

Discussions may include off-label uses.

### Participants

Diana Litmanovich, MD, Haifa, Israel (*Moderator*) Nothing to Disclose

### LEARNING OBJECTIVES

1) Understand the imaging features and pathophysiology of cardiac infectious and inflammatory processes to include endocarditis, pericarditis, and myocarditis.

### Sub-Events

#### RC203A Endocarditis (Including Loefflers)

Participants

Harold Goerne, MD, Zapopan, Mexico (*Presenter*) Nothing to Disclose

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

haroldgoerne@hotmail.com

### LEARNING OBJECTIVES

1) To identify the imaging features of endocarditis. 2) To apply diagnostic algorithm using different imaging modalities. 3) To illustrate the appearance of endocarditis and its complications. 4) To recognize several differential diagnosis.

#### RC203B Pericarditis

Participants

Diana Litmanovich, MD, Haifa, Israel (*Presenter*) Nothing to Disclose

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

dlitmano@bidmc.harvard.edu

### LEARNING OBJECTIVES

1) To identify the imaging features of pericarditis. 2) To apply diagnostic algorithm using different imaging modalities. 3) To illustrate the appearance of pericarditis and its complications. 4) To be familiar with differential diagnosis of pericarditis.

#### RC203C Myocarditis

Participants

Jens Bremerich, MD, Basel, Switzerland (*Presenter*) Nothing to Disclose

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

jens.bremerich@usb.ch

### LEARNING OBJECTIVES

1) To understand pathophysiology of myocarditis. 2) To review the impact of imaging on clinical decision making. 3) To enhance knowledge of technical aspects of imaging.

#### RC203D Chagas Disease and other Cardiovascular Infections

Participants

Carlos E. Rochitte, MD, PhD, Sao Paulo, Brazil (*Presenter*) Nothing to Disclose

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

rochitte@incor.usp.br

### LEARNING OBJECTIVES

1) Recognize MRI characteristics of Chagas disease and other infectious diseases affecting the heart and understand their basic pathophysiology. 2) Gain information on new and recent research data on MRI use to investigate and understand pathophysiology of Chagas disease and other infectious disease. 3) Recognize signs in cardiovascular MR images to suspect or make the probable diagnosis of Chagas disease and other infections.





RC204

## Musculoskeletal Series: MRI of Ankle and Foot

Monday, Dec. 2 8:30AM - 12:00PM Room: E451B

MR MK

AMA PRA Category 1 Credits™: 3.00  
ARRT Category A+ Credits: 3.50

### Participants

William E. Palmer, MD, Boston, MA (*Moderator*) Nothing to Disclose  
Corrie M. Yablon, MD, Ann Arbor, MI (*Moderator*) Nothing to Disclose  
Yulia Melenevsky, MD, Vestavia, AL (*Moderator*) Nothing to Disclose  
Hilary R. Umans, MD, Ardsley, NY (*Moderator*) Nothing to Disclose

### Sub-Events

#### RC204-01 MRI of Anatomic Variants of the Foot and Ankle and Their Significance

Monday, Dec. 2 8:30AM - 8:50AM Room: E451B

### Participants

Yulia Melenevsky, MD, Vestavia, AL (*Presenter*) Nothing to Disclose

### For information about this presentation, contact:

yuliavm@gmail.com

### LEARNING OBJECTIVES

1) List common anatomic variants of foot and ankle. 2) Recognize and describe MRI appearances of foot and ankle anatomic variants. 3) Determine clinical significance based on imaging appearance and clinical presentation.

#### RC204-02 MRI of Ankle Instability

Monday, Dec. 2 8:50AM - 9:10AM Room: E451B

### Participants

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

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### LEARNING OBJECTIVES

1) Describe MRI signs of ankle instability. 2) Differentiate primary and secondary signs of instability. 3) Identify MRI findings in lateral and medial instability.

#### RC204-03 MRI Patterns of Acute Distal Tibiofibular Syndesmotic Injuries in the Pediatric Population

Monday, Dec. 2 9:10AM - 9:20AM Room: E451B

### Participants

William Walter, MD, New York, NY (*Presenter*) Nothing to Disclose  
Zehava S. Rosenberg, MD, Hoboken, NJ (*Abstract Co-Author*) Nothing to Disclose

### For information about this presentation, contact:

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### PURPOSE

To compare pediatric MRI patterns of acute distal tibiofibular syndesmotic ligamentous injuries to those of adults. To the best of our knowledge, this has not been previously described.

### METHOD AND MATERIALS

3 cohorts of patients with ankle MRIs were retrospectively identified via PACS database search: 1) pediatric patients ( $\leq 16$  years) with normal distal tibiofibular syndesmosis based on non-traumatic indications and no MRI findings of acute or chronic trauma, 2) pediatric patients and 3) adult patients ( $\geq 17$  years) with unequivocal MRI evidence of acute tears of the syndesmotic ligaments (anterior, posterior inferior tibiofibular and/or interosseous ligaments/membrane), based on previously established literature criteria. Studies were reviewed in consensus by 2 MSK radiologists with 3 and 25 years of experience, respectively, for MRI appearance of normal and torn syndesmotic ligaments, presence of avulsion fractures, and periosteal tearing. Pertinent electronic medical record data were also reviewed.

### RESULTS

68 ankle MDTs were identified from a total of 274 MDTs (25 pediatric patients with average age 13.9 years, standard deviation



60 ankle MRIs were identified from a total of 374 MRIs (25 pediatric patients with average age 13.3 years, standard deviation (SD)=2.2 years) with normal syndesmosis, and 20 pediatric (13.3 years, SD=1.7 years) and 23 adult (53.2, SD=12.1 years) cases with syndesmotom injuries). -Fibrous and cambrial periosteal layers were identified in all normal pediatric cases; normal ligaments were attached to tibial and fibular fibrous periosteum prior to full bony ossification. MRIs with syndesmotom ligamentous injury depicted stripping of tibial periosteum in 8/20 (40.0%) of pediatric and 1/23 (4.0%) of adult cases. 1/20 (5%) pediatric and 4/23 (17.4%) of adult cases with syndesmotom injuries demonstrated avulsion fractures.

## CONCLUSION

There is a spectrum of MRI appearances of distal tibiofibular syndesmotom injuries among pediatric and adult patients. Osseous avulsions appear to be more common in adults whereas periosteal stripping, which should not be mistaken for a tibial fracture, is seen almost exclusively in pediatric patients. This may be due to the syndesmotom ligaments' insertion to periosteum rather than to bone.

## CLINICAL RELEVANCE/APPLICATION

Tibial periosteal stripping in children, in the setting of acute distal tibiofibular syndesmotom ligamentous injuries, should not be misinterpreted as tibial fractures but rather be recognized as part of MRI patterns of ligamentous injuries in this population.

### RC204-04 Calcaneofibular Ligament Anatomy Under Different Ankle Positions

Monday, Dec. 2 9:20AM - 9:30AM Room: E451B

#### Participants

Yoshihiro Akatsuka, RT, Sapporo, Japan (*Presenter*) Nothing to Disclose  
Atsushi Teramoto, MD, PhD, Sapporo, Japan (*Abstract Co-Author*) Nothing to Disclose  
Hiroyuki Takashima, PhD, Sapporo, Japan (*Abstract Co-Author*) Nothing to Disclose  
Rui Imamura, Sapporo, Japan (*Abstract Co-Author*) Nothing to Disclose  
Tomoyuki Suzuki, MD, Sapporo, Japan (*Abstract Co-Author*) Nothing to Disclose  
Kota Watanabe, MD, PhD, Sapporo, Japan (*Abstract Co-Author*) Nothing to Disclose  
Toshihiko Yamashita, MD, PhD, Sapporo, Japan (*Abstract Co-Author*) Nothing to Disclose

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

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## PURPOSE

To investigate the anatomical changes of the calcaneofibular ligament (CFL) under different ankle positions and obtain basic data to use in functional CFL assessments, injury diagnoses, and determination of treatment effects.

## METHOD AND MATERIALS

We enrolled 10 healthy volunteers (10 ankles) with a mean age of 27.8 years and no history of ankle disease. We took ankle images (neutral position, maximum dorsiflexion, and maximum plantar flexion) using a 3-T MRI and 3-dimensional fast imaging employing steady-state acquisition cycled phases (3D FIESTA-C). We processed the 3D images of the CFL, peroneal muscle tendons, fibula, and calcaneus at a workstation, and measured CFL variables.

## RESULTS

In all positions, the CFLs showed a gently curving course with the peroneal muscle tendons as a fulcrum. The tortuosity angle was significantly smaller in plantar flexion ( $30.0^\circ \pm 7.4^\circ$ ) than in the neutral position ( $41.7^\circ \pm 8.3^\circ$ ).

## CONCLUSION

Our 3D MRI images showed that, in all positions, the CFLs were curved due to the influence of the peroneal muscle tendons. With maximum plantar flexion, the CFL tortuosity angles were small, which is probably due to CFL tension. This should be considered when diagnosing CFL injuries and evaluating treatment outcomes.

## CLINICAL RELEVANCE/APPLICATION

Clarification of the normal CFL functional anatomy will aid to diagnose CFL injuries and may facilitate accurate evaluations of treatment outcomes.

### RC204-05 MRI of Ankle Impingement

Monday, Dec. 2 9:30AM - 9:50AM Room: E451B

#### Participants

Corrie M. Yablon, MD, Ann Arbor, MI (*Presenter*) Nothing to Disclose

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

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## LEARNING OBJECTIVES

1) List the causes of ankle impingement. 2) Describe the MR imaging findings of ankle impingement. 3) Discuss common potential sites of ankle impingement.

### RC204-06 MRI of the Midfoot

Monday, Dec. 2 10:20AM - 10:40AM Room: E451B

#### Participants

Hilary R. Umans, MD, Ardsley, NY (*Presenter*) Nothing to Disclose

## LEARNING OBJECTIVES

1) Describe the normal MRI anatomy of the midfoot. 2) Discuss osseous abnormalities of the Chopart joint and Lisfranc joint complex. 3) Identify tendinous pathology of the midfoot.

**Active Handout:**Hilary Ruth Umans

[http://abstract.rsna.org/uploads/2019/19000740/Active RC204-06.pdf](http://abstract.rsna.org/uploads/2019/19000740/Active_RC204-06.pdf)

### **RC204-07 Dynamic-Imaging of the Lisfranc Joint by Utilizing a Novel: MRI Compatible Stress Device**

Monday, Dec. 2 10:40AM - 10:50AM Room: E451B

Participants

Drew Gunio, MD, MS, New York, NY (*Presenter*) Nothing to Disclose

Carlos L. Benitez, MD, New York, NY (*Abstract Co-Author*) Nothing to Disclose

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

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#### **PURPOSE**

To evaluate the applicability of a novel, MRI-stress device in the evaluation of Lisfranc joint injury

#### **METHOD AND MATERIALS**

This is a prospective study that evaluated Lisfranc joint injury by utilizing a joint specific, MRI-compatible stress device. The MRI-stress device applies a multidimensional load to the foot to simulate weight bearing. We obtained non-stressed and stressed MR images of the injured and non-injured (control) feet and measured changes in ligament morphology and joint alignment between stressed and non-stressed images. Patient recruitment occurred over a three-year period.

#### **RESULTS**

We recruited 10 patients with Lisfranc joint injuries, 8 males and 2 females (mean age 35.5 years). 9 patients reported an axial-loading mechanism of injury with 1 midfoot crush injury. Time from injury to imaging was 3 to 42 days. Interosseous Lisfranc ligament (ILL), plantar capsular ligament (PCL), and dorsal capsular ligament (DCL) injuries ranged from Grade 1 sprains to complete tears. All morphologically normal ligaments on standard MR imaging lacked stress-induced ligament lengthening and laxity, whereas all ligaments with abnormal signal or morphology demonstrated measurable, stress-induced ligament laxity. Abnormal morphology and inducible laxity were most prominent in the PCL, followed by the ILL; suggesting a plantar to dorsal propagation of force and ligament tearing during injury. 5 patients demonstrated dorsal subluxation of the tarsometatarsal joint, requiring high-grade tearing of both the ILL and PCL and at least mild partial tearing of the DCL for stress-induced subluxation to occur. Comitant, moderate tearing of the ILL and PCL alone did not result in stress-induced dorsal subluxation. Higher grade injuries revealed more prominent stress-induced, morphological changes. Interrogation of lower grade injuries allowed the Orthopedic surgeons to pursue conservative management.

#### **CONCLUSION**

Our MRI stress device provides physiologic evaluation of the Lisfranc joint beyond that of traditional, static MRI examinations and may allow Orthopaedic surgeons to better determine patient management and surgical candidacy.

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

Dynamic MR imaging allows high resolution imaging under reproducible and physiologic conditions, ultimately allowing the Radiologist to provide a more thorough evaluation of joint pathology and degree of injury.

### **RC204-08 Tricomponent T2\* Analyses Performed on Ultrashort Echo Time (UTE) MRI Images Correlate Significantly with Mechanical Properties of Cortical Bone**

Monday, Dec. 2 10:50AM - 11:00AM Room: E451B

Participants

Saeed Jerban, PhD, San Diego, CA (*Presenter*) Nothing to Disclose

Xing Lu, San Diego, CA (*Abstract Co-Author*) Nothing to Disclose

Erik W. Dorthe, La Jolla, CA (*Abstract Co-Author*) Nothing to Disclose

Salem Alenezi, Riyadh, Saudi Arabia (*Abstract Co-Author*) Nothing to Disclose

Yajun Ma, San Diego, CA (*Abstract Co-Author*) Nothing to Disclose

Lena Kakos, San Diego, CA (*Abstract Co-Author*) Nothing to Disclose

Hyungseok Jang, La Jolla, CA (*Abstract Co-Author*) Nothing to Disclose

Robert Sah, La Jolla, CA (*Abstract Co-Author*) Nothing to Disclose

Eric Y. Chang, MD, San Diego, CA (*Abstract Co-Author*) Nothing to Disclose

Darryl D'Lima, MD, PhD, La Jolla, CA (*Abstract Co-Author*) Research funded, Stryker Corporation; Consultant, Advanced Mechanical Technology, Inc; Research funded, ConforMIS, Inc; Consultant, Ossur HF; Officer and Stockholder, XpandOrtho, Inc

Jiang Du, PhD, San Diego, CA (*Abstract Co-Author*) Nothing to Disclose

#### **PURPOSE**

To investigate the relationship between human cortical bone mechanical properties and bone bound and pore water fractions estimated with tricomponent ultrashort echo time (UTE) MRI T2\* fitting.

#### **METHOD AND MATERIALS**

135 cortical bone strips (~4×2×40 mm<sup>3</sup>) were harvested from the tibial and femoral midshafts of 37 donors (61±24 yo). Specimens were scanned using a 1-inch diameter T/R birdcage coil on a 3T clinical scanner (MR750, GE). Ten sets of dual-echo 3D-UTE-Cones sequences with different echo time from 0.032ms to 24.0ms (TR=28ms, flip angle=10°, and 26 μs rectangular RF pulse) were performed for T2\* bicomponent (2-com) and tricomponent (3-com) decay analyses. Other imaging parameters included: field of view=40×40mm<sup>2</sup>, matrix=160×160, slice-thickness=2mm, bandwidth=±62.5kHz. Specimens were later scanned using a Skyscan 1076 (Kontich, Belgium) μCT at 9 μm<sup>3</sup> voxel size to measure bone porosity and bone mineral density (BMD). Finally, mechanical

properties of the bone specimens (Young's modulus, yield stress, ultimate stress, and failure energy) were estimated using 4-point bending tests. Pearson's correlation coefficients were calculated between water fractions-estimated with 3-com and 2-com UTE-MRI T2\* analyses-and  $\mu$ CT measures of porosity and BMD, as well as mechanical properties.

## RESULTS

Fig.1a shows a representative UTE-MRI image at the middle of a cortical bone specimen. Figs. 1c,d depict 2-com and 3-com fitting for the selected specimen, respectively. From 2-com fitting, bound water fraction (FracBW) and pore water fraction (FracPW) showed significant ( $p<0.01$ ) moderate correlations with bone porosity and BMD ( $R=0.61-0.65$ ), as well as with mechanical properties ( $R=0.52-0.54$ ). From 3-com fitting, FracBW showed significant strong correlations with porosity and BMD ( $R=0.70-0.73$ ). It also demonstrated significant moderate correlation with mechanical properties ( $R=0.58-0.62$ ) at a level higher than the correlations presented by 2-com analysis. Figs. 1e-j show the scatter plots and linear regressions of porosity, yield stress, and ultimate stress on FracBW from both 2-com and 3-com T2\* fittings, respectively.

## CONCLUSION

Consideration of the fat signal contribution in UTE-MRI using the 3-com T2\* fitting model can improve the correlations between estimated bound and pore water fractions and bone mechanics.

## CLINICAL RELEVANCE/APPLICATION

An MRI technique that improves water quantifications in cortical bone may help diagnose bone diseases.

### RC204-09 Non-Invasive Measurements of Microstructural and Mechanical Properties from the Achilles Tendon (AT) in Healthy Humans Using UTE MRI and Shear Wave US Elastography

Monday, Dec. 2 11:00AM - 11:10AM Room: E451B

#### Participants

Felix Gonzalez, MD, Atlanta, GA (*Presenter*) Nothing to Disclose  
Adam D. Singer, MD, Atlanta, GA (*Abstract Co-Author*) Nothing to Disclose  
Zahra Hosseini, Atlanta, GA (*Abstract Co-Author*) Employee, Siemens AG  
Monica B. Umpierrez, MD, Atlanta, GA (*Abstract Co-Author*) Nothing to Disclose  
David Reiter, Atlanta, GA (*Abstract Co-Author*) Nothing to Disclose

## PURPOSE

Bicomponent UTE T2\* MRI relaxation parameters show sensitivity to distinct microstructural tissue compartments in tendon. Shear wave US elastograms provide tissue mechanical properties like elastic modulus (E) and wave speed (v) that relate to function and load bearing capacity. The purpose is to compare these modalities in healthy adult AT.

## METHOD AND MATERIALS

Healthy volunteers were recruited for this study (N=9, 4 females, ave+/-SD 39+/-13.2 yrs) under the approval of an institutional IRB. MR imaging was performed using a 3T Siemens Prisma with a flexible 4-ch coil wrapped around the left ankle. UTE images (Fig1a) were acquired in the sagittal plane with 4mm slice thickness, 0.625mm in plane resolution, and 16 non-linearly spaced echoes between 60 $\mu$ s and 30ms. Region of interest analysis was performed for biexponential modeling of relaxation (i.e. fs, T2\*s, and T2\*I) at the mid-substance of the AT. Ultrasound analysis was performed on the left AT using a 2D SWE GE Logiq s8 ultrasound machine (Fig1b,c). Measurements were performed in neutral-relaxed (NR) and under voluntary active maximum dorsiflexion (VAMD). E and v were determined in both the long axis and short axis planes relative to the AT.

## RESULTS

T2\*s was positively associated with age ( $p=.0006$ ) and T2\*I showed a weak negative trend (n.s.) with age (Fig1d,e). NR SWE-derived E and v showed weak trends (n.s.) with age. VAMD SWE-derived E and v showed modest trends with age with short axis v showing a significant association ( $p=.04$ ), suggesting an increase in stiffness (Fig1f). T2\*s and T2\*I showed no association with NR SWE values. T2\*s and T2\*I showed weak (n.s.) trends with short axis v ( $\rho=.52$  and  $-.47$ , resp).

## CONCLUSION

Changes in bicomponent relaxation parameters, surrogates for collagen fibril and interstitial microstructure, are consistent with age-related disorganization of collagen fibril structure and desiccation of interstium; these changes are consistent with observed SWE-derived increase in mechanical stiffness. These preliminary data from this ongoing study show emerging relationships between tendon microstructure and mechanical properties in healthy individuals. This approach could provide non-invasive characterization of tendon pathology.

## CLINICAL RELEVANCE/APPLICATION

Non-invasive measures of tendon microstructural and mechanical properties can provide information specific to tissue function that could be used to evaluate pathology and therapeutic intervention.

### RC204-10 Elastosonography Evaluation after ESWT (Extracorporeal Shock Wave Therapy) Treatment in Plantar Fasciopathy

Monday, Dec. 2 11:10AM - 11:20AM Room: E451B

#### Participants

Giuseppe Schillizzi, Roma, Italy (*Presenter*) Nothing to Disclose  
Daniela Elia, Roma, Italy (*Abstract Co-Author*) Nothing to Disclose  
Daniele Fresilli, Roma, Italy (*Abstract Co-Author*) Nothing to Disclose  
Carlo Catalano, MD, Rome, Italy (*Abstract Co-Author*) Nothing to Disclose  
Ferdinando D'Ambrosio, Rome, Italy (*Abstract Co-Author*) Nothing to Disclose  
Vito Cantisani, MD, Roma, Italy (*Abstract Co-Author*) Speaker, Canon Medical Systems Corporation; Speaker, Bracco Group; Speaker, Samsung Electronics Co, Ltd;  
Antonello Rubini, MD, Roma, Italy (*Abstract Co-Author*) Nothing to Disclose  
Marzia Russomando, Rome, Italy (*Abstract Co-Author*) Nothing to Disclose

Eriselda Kutrolli, JD, Rome, Italy (*Abstract Co-Author*) Nothing to Disclose  
Federica Alviti, Rome, Italy (*Abstract Co-Author*) Nothing to Disclose

## PURPOSE

To evaluate the clinical role of elastosonography to assess plantar fascia elasticity features and variation in patients with diagnosis of plantar fasciitis before and after ESWT treatment.

## METHOD AND MATERIALS

20 Patients with diagnosis of plantar fasciitis with the following criteria were enrolled in this study: (1) plantar fascia thickness > 4mm, (2) pain assessed through VAS scale > 4 out of 10 and (3) more than 3 months of heel pain non responsive to previous noninvasive conservative treatment with nonsteroidal anti-inflammatory medication. Clinical and ultrasound evaluation (including Shear Wave Elastography and Compression Elastography) were performed at baseline (T0), when patients underwent the first ESWT treatment, 1 month (T1) and 3 months (T2) after treatment ended. Patients were treated with 3 session, once a week of ESWT.

## RESULTS

At baseline, (T0) statistically significant differences were found in SWE velocity between the affected side and healthy side with higher value in healthy side with value equal to 3.8 (1.5; 5.1) ms<sup>-1</sup> and 4.7 (4.07;7.04) ms<sup>-1</sup> respectively (p=0,006; z=2,758), while no significant differences were found for strain ratio (p=0.656; z=0.445). One month after ESWT treatment (T1) the strain ratio of the affected side increased, with median value equal to 0.89 (0.3-1.5) at baseline to 1.16 (0.3-1.6) at 1 month and decreased at three months (T2) with median value equal to 0.82 (0.38-1.12). No statistically significant differences were found. Significant differences were found in shear wave velocity over time, with an increase of SWE velocity after shock-wave treatment (p=0.04;  $\chi^2=11.167$ ), results showed significant differences from T0 to T2 with median value varying from 3.8 (1.5-5.1) ms<sup>-1</sup> at baseline and 5.23 (4.55-6.74) ms<sup>-1</sup> a three months after treatment ended respectively (p=0.003).

## CONCLUSION

Shear Wave Elastography seems to be more accurate to assess soft tissue stiffness, it provides more objective results and less technical variation than compression elastography. SWE seems effective tool to assess ESWT treatments efficacy.

## CLINICAL RELEVANCE/APPLICATION

US-elastography especially with shear wave may increase ultrasound accuracy for plantar fasciitis diagnosis and can be an important additional tool to evaluate ESWT efficacy.

### RC204-11 MRI of Achilles and Plantar Fascia

Monday, Dec. 2 11:20AM - 11:40AM Room: E451B

Participants

Roar Pedersen, Tonsberg, Norway (*Presenter*) Nothing to Disclose

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

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## LEARNING OBJECTIVES

1) Identify the normal anatomy and variants of the Achilles tendon and the plantar fascia. 2) Describe pathology of the Achilles tendon and its insertion. 3) Describe pathology of the plantar fascia. 4) Consider differential diagnoses of the heel not related to the tendon and fascia.

### RC204-12 MRI of the Nerves in the Foot and Ankle

Monday, Dec. 2 11:40AM - 12:00PM Room: E451B

Participants

Michel O. De Maeseneer, MD, PhD, Jette , Belgium (*Presenter*) Nothing to Disclose

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## LEARNING OBJECTIVES

1) Define the different nerves about the foot and ankle and discuss the aspect on anatomy and MRI. 2) Identify common pathological conditions of the nerves. 3) Classify pathologies affecting the webspaces (Bursitis, Plantar plate tear, Morton's neuroma).

Printed on: 10/29/20



RC205

## Neuroradiology Series: AI in Neuroradiology

Monday, Dec. 2 8:30AM - 12:00PM Room: S406B

AI NR

AMA PRA Category 1 Credits™: 3.25  
ARRT Category A+ Credits: 4.00

FDA Discussions may include off-label uses.

### Participants

Greg Zaharchuk, MD, PhD, Stanford, CA (*Moderator*) Research Grant, General Electric Company; Research Grant, Bayer AG; Stockholder, Subtle Medical  
Christopher G. Filippi, MD, New York, NY (*Moderator*) Research Consultant, Syntactx, LLC; Consultant, Biogen Idec Inc; ; ;

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### LEARNING OBJECTIVES

1) Review the impact of AI on neuroradiology to date. 2) Understand how AI techniques can be used to improve the acquisition and safety of neuroimaging. 3) Evaluate studies using deep learning to diagnose disease and segment images. 4) Learn what infrastructure changes are needed to implement AI in a clinical neuroradiology practice. 5) How to analyze the quality of an AI study.

### Sub-Events

#### RC205-01 Brain Tumors and Other Lesions: How Will AI Help?

Monday, Dec. 2 8:30AM - 9:00AM Room: S406B

### Participants

Jayashree Kalpathy-Cramer, MS, PhD, Portland, OR (*Presenter*) Research support, General Electric Company; Research support, F. Hoffmann-La Roche Ltd;

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### LEARNING OBJECTIVES

1) Learn about the use of machine learning for diagnosis, response assessment and risk stratification in brain tumors. 2) Learn about radiogenomics. 3) Learn about some of the challenges with deep learning including the 'black-box' nature, brittleness, need for large datasets. 4) Learn about emerging research areas including semi-supervised learning, explainable AI and generative adversarial networks.

#### RC205-02 Deep Learning-Enabled Brain Extraction: Reducing Processing Time While Retaining Accuracy

Monday, Dec. 2 9:00AM - 9:10AM Room: S406B

### Participants

Michael Yan, Orange, CA (*Abstract Co-Author*) Nothing to Disclose  
Michelle Bardis, MS, Orange, CA (*Presenter*) Nothing to Disclose  
Mikayla N. Howie, Orange, CA (*Abstract Co-Author*) Nothing to Disclose  
Anna Alber, MSc, Orange, CA (*Abstract Co-Author*) Nothing to Disclose  
Madeleine Shaver, BA, Orange, CA (*Abstract Co-Author*) Nothing to Disclose  
Leo P. Sugrue, MD, PhD, San Francisco, CA (*Abstract Co-Author*) Nothing to Disclose  
Christopher P. Hess, MD, PhD, San Francisco, CA (*Abstract Co-Author*) Research, Siemens AG; Consultant, General Electric Company;  
Brent D. Weinberg, MD, PhD, Atlanta, GA (*Abstract Co-Author*) Nothing to Disclose  
Jack Grinband, PhD, New York, NY (*Abstract Co-Author*) Nothing to Disclose  
Theodorus van Erp, PhD, Irvine, CA (*Abstract Co-Author*) Nothing to Disclose  
Daniel S. Chow, MD, Orange, CA (*Abstract Co-Author*) Nothing to Disclose  
Peter Chang, MD, San Francisco, CA (*Abstract Co-Author*) Nothing to Disclose

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### PURPOSE

Brain extraction, segmentation of the brain from non-brain tissue, is typically the first image preprocessing step in neuroimaging analysis. Currently, the reference standards for this involve either laborious manual segmentation or computationally taxing applications such as FreeSurfer that typically require hours of processing time. Deep learning has recently emerged as a promising tool for image analysis, and we hypothesized that a trained neural network can be optimized for inference to automatically

recognize prior features with high accuracy. This would enable brain extraction to be completed in a matter of seconds, rather than hours, freeing computational resources for other tasks.

## METHOD AND MATERIALS

MRIs of the brain were collected from two data sources: The University of California, Irvine Imaging Archive as well as the Open Access Series of Imaging Studies (OASIS), which is a publicly available database. All MRIs were passed through FreeSurfer brain extraction, which served as the gold standard. A customized version of U-net was developed for this study. Specifically, we designed a 3D/2D architecture capable of utilizing contextual information from adjacent MRI slices while also providing a memory-efficient method for brain extraction. To assess algorithm generalization, we used a 5-fold cross-validation approach. Performance of masks was assessed by comparing the Dice score coefficient and Pearson correlation.

## RESULTS

A total of 1,469 brain MRIs were included for this study. Brain extraction using the 3D/2D neural network approach resulted in a Pearson correlation of 0.98 and Dice scores of 0.98. The processing time for brain extraction averaged under 5 seconds and 42 minutes for the deep learning and FreeSurfer applications on a single CPU, respectively ( $p < 0.001$ ).

## CONCLUSION

The modified U-Net produced competitive brain extraction results compared to FreeSurfer while requiring seconds to perform per patient as opposed to hours. Future research will train the developed model to segment brain sub-structures.

## CLINICAL RELEVANCE/APPLICATION

Deep learning-enabled brain extraction can be accurately completed in seconds as opposed to hours, which can free computational resources for other tasks. This has important implications for neuroimaging research reliant on this step, including neurodegenerative imaging studies.

## RC205-03 Super Resolution Imaging Using Under-Sampled K-Space Images and Deep Learning

Monday, Dec. 2 9:10AM - 9:20AM Room: S406B

### Participants

Chandan Ganesh Bangalore Yogananda, MS, Dallas, TX (*Presenter*) Nothing to Disclose

Ben Wagner, BS, Dallas, TX (*Abstract Co-Author*) Nothing to Disclose

Sahil S. Nalawade, Arlington, TX (*Abstract Co-Author*) Nothing to Disclose

Gowtham Krishnan Murugesan, MS, Arlington, TX (*Abstract Co-Author*) Nothing to Disclose

Ananth J. Madhuranthakam, PhD, Dallas, TX (*Abstract Co-Author*) Institutional research support, Koninklijke Philips NV

Joseph A. Maldjian, MD, Dallas, TX (*Abstract Co-Author*) Consultant, BioClinica, Inc; Consultant, Koninklijke Philips NV

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## PURPOSE

MR images are often acquired using undersampled k-space either to shorten the examination times or improve spatial resolution. These are reconstructed using advanced parallel imaging algorithms such as SENSE, GRAPPA or more recently using compressed sensing. In this work, we designed a fully automated deep learning network to reconstruct and improve the resolution of retrospectively undersampled FLAIR & T1w pre-contrast MR images based on imaging characteristics only.

## METHOD AND MATERIALS

600 3D acquired FLAIR MR images (1mm isotropic) from the iTAKL study of sub concussive impacts were used. A Poisson distribution filter mask with size 256x256 that sampled only 1/5th of the total points (12395/65536) from the k-space was used to undersample the image in k-space (Fig 2). The undersampling was performed on a slice-based method in ky-kz-space representing the axial plane. Data preprocessing steps included N4BiasCorrection[3] to remove the RF inhomogeneity & intensity normalization to 0-mean and unit variance. Randomly selected 550 undersampled images with their corresponding high-resolution FLAIR images as ground truth were used for training the network. A dual loss function including structural similarity Index (SSIM) and Peak Signal to Noise Ratio (PSNR) were used during training. The network was tested on the remaining 50 held out subjects. The encoder part of the trained network was fine-tuned using 50 randomly selected undersampled T1w images with their corresponding high resolution T1w images as ground truth and was tested on the T1w images from the same 50 held out test subjects. A 32x32x32 patch-based 3D Dense-Unet was constructed to improve the resolution of the under sampled image. The network's performance in improving the resolution of under-sampled images was quantitatively evaluated using two metrics, SSIM and PSNR.

## RESULTS

In FLAIR images, the network improved SSIM from 0.65 to 0.96 and PSNR from 36dB to 52dB while it improved SSIM from 0.68 to 0.97 and PSNR from 37dB to 53dB on the T1w pre-contrast images.

## CONCLUSION

We demonstrate a network that significantly improves SSIM and PSNR in both T2-FLAIR and T1w pre-contrast images. This network took at most 3 minutes per image to improve its resolution.

## CLINICAL RELEVANCE/APPLICATION

The developed network may improve clinical workflow by reducing scan times from acquiring undersampled images with subsequent reconstruction for improving resolution and eliminating artifacts.

## RC205-04 MR Angiography Without Additional Scan: Deep Learning for Generating MRA from 3D Quantitative Synthetic MRI

Monday, Dec. 2 9:20AM - 9:30AM Room: S406B

### Participants

Shohei Fujita, MD, Tokyo, Japan (*Presenter*) Nothing to Disclose  
Yujiro Otsuka, Tokyo, Japan (*Abstract Co-Author*) Employee, Milliman Inc  
Akifumi Hagiwara, MD, Tokyo, Japan (*Abstract Co-Author*) Nothing to Disclose  
Masaaki Hori, MD, Tokyo, Japan (*Abstract Co-Author*) Nothing to Disclose  
Naoyuki Takei, Hino, Japan (*Abstract Co-Author*) Employee, General Electric Company  
Ken-Pin Hwang, PHD, Houston, TX (*Abstract Co-Author*) Nothing to Disclose  
Ryusuke Irie, MD, Tokyo, Japan (*Abstract Co-Author*) Nothing to Disclose  
Tomoko Maekawa, MD, Tokyo, Japan (*Abstract Co-Author*) Nothing to Disclose  
Christina Andica, Shinjuku-ku, Japan (*Abstract Co-Author*) Nothing to Disclose  
Toshiaki Akashi, MD, Sendai, Japan (*Abstract Co-Author*) Nothing to Disclose  
Koji Kamagata, Tyuuouku, Japan (*Abstract Co-Author*) Nothing to Disclose  
Kanao K. Kumamaru, MD, PhD, Tokyo, Japan (*Abstract Co-Author*) Nothing to Disclose  
Michimasa Suzuki, MD, Bunkyo-ku, Japan (*Abstract Co-Author*) Nothing to Disclose  
Akihiko Wada, MD, Tokyo, Japan (*Abstract Co-Author*) Nothing to Disclose  
Shigeki Aoki, MD, PhD, Tokyo, Japan (*Abstract Co-Author*) GE, Toshiba/Canon, Fuji Film, Fuji RI/Toyama Kagaku, Eisai, Daiichi-Sankyo/GE pharma, Medipysics, Siemens, Bayer, Guerbet, Bracco-Eisai, Shimazu

## PURPOSE

Quantitative synthetic MRI enables simultaneous quantification of T1 and T2 relaxation times and proton density as well as synthesis of various contrast-weighted images. However, MR angiography (MRA) was unable to obtain using synthetic MRI. The purpose of this study was to develop a deep learning algorithm for synthetic MRI to generate MR angiography without extra scanning time.

## METHOD AND MATERIALS

10 healthy volunteers and 3 patients with intracranial aneurysms were included in this study. All participants underwent time-of-flight (TOF) MRA sequence and three dimensional (3D) synthetic MRI sequence, namely 3D-QALAS (3D-quantification using an interleaved Look-Locker acquisition sequence with T2 preparation pulse). The 5 raw images of 3D-QALAS were used as inputs to a deep learning network. The proposed network was carefully designed to minimize the risk of generating false objects; each pixel value of the output image is generated by a combination of each corresponding pixel of the input images. A simple linear combination model was prepared for comparison. Three-fold cross-validation was performed. Peak signal-to-noise ratio and normalized root mean square error were calculated for deep learning MRA (DL-MRA) and linear combination MRA (linear-MRA) against TOF-MRA, and compared using non-parametric Wilcoxon signed rank test. Overall image quality and branch visualization in 5-point Likert scale were blindly scored by a neuroradiologist. These visual scores were compared among DL-MRA, linear-MRA, and TOF-MRA using pairwise Dunn-Bonferroni post hoc test.

## RESULTS

Deep learning MRA was successfully obtained in all subjects. The peak signal-to-noise ratio and normalized root mean square error were significantly higher and lower, respectively, in DL-MRA versus linear-MRA (both  $P_s < .05$ ). The overall image quality of DL-MRA was  $4.6 \pm 0.4$ . The branch visualizations were comparable between DL-MRA and TOF-MRA. Linear-MRA failed to depict intracranial aneurysms, whereas DL-MRA successfully visualized in all three patients.

## CONCLUSION

Deep learning for 3D synthetic MRI enabled to visualize major intracranial arteries as efficient as TOF-MRA, with coaligned quantitative maps and various contrast-weighted images.

## CLINICAL RELEVANCE/APPLICATION

Our proposed deep learning algorithm that creates MR angiography can reduce the overall MR scan time and contribute to patient satisfaction, while helping radiologists screen vascular pathology.

## RC205-05 Upstream AI: Using Deep Learning to Improve Image Acquisition Quality and Safety

Monday, Dec. 2 9:30AM - 10:00AM Room: S406B

### Participants

Greg Zaharchuk, MD, PhD, Stanford, CA (*Presenter*) Research Grant, General Electric Company; Research Grant, Bayer AG; Stockholder, Subtle Medical

### For information about this presentation, contact:

gregz@stanford.edu

## LEARNING OBJECTIVES

1) Learn how AI methods can be used to perform image transformation; (2) Compare different AI model architectures for this task; (3) Review several potential use cases of how AI methods can improve imaging efficiency and reduce radiation and contrast dose; (4) Understand the limitations of these models, including the potential for bias; (5) Estimate the impact these methods will have on clinical radiology and nuclear medicine.

## RC205-06 Hot Topic Panel: When is an AI Algorithm Ready for Clinical Practice?

Monday, Dec. 2 10:10AM - 10:40AM Room: S406B

### Participants

Jayashree Kalpathy-Cramer, MS, PhD, Portland, OR (*Presenter*) Research support, General Electric Company; Research support, F. Hoffmann-La Roche Ltd;  
Marc D. Kohli, MD, San Francisco, CA (*Presenter*) Nothing to Disclose  
Linda Moy, MD, New York, NY (*Presenter*) Grant, Siemens AG; Support, Lunit Inc ; Support, iCad, Inc; Support, FAIR Facebook; Advisory Board, Lunit Inc; Advisory Board, iCad, Inc  
Greg Zaharchuk, MD, PhD, Stanford, CA (*Presenter*) Research Grant, General Electric Company; Research Grant, Bayer AG; Stockholder, Subtle Medical

## RC205-07 Infrastructure Needs for Leveraging AI in Radiology

Monday, Dec. 2 10:40AM - 11:10AM Room: S406B

### Participants

Marc D. Kohli, MD, San Francisco, CA (*Presenter*) Nothing to Disclose

### LEARNING OBJECTIVES

1) Describe data needs for AI, and compare and contrast with research prior to AI, and how these affect infrastructure. 2) Explain compute requirements for AI training and inference and how they impact implementation infrastructure. 3) Compare cloud vs. on-prem solutions for training and inference. 4) Discuss transitioning AI research from the lab to clinical implementation.

## RC205-08 Automated Detection of Critical Findings in Multi-Parametric Brain MRI Using a System of 3D Neural Networks

Monday, Dec. 2 11:10AM - 11:20AM Room: S406B

### Participants

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

Benjamin L. Odry, PhD, Princeton, NJ (*Abstract Co-Author*) Employee, Siemens AG

Chen Yang, PhD, New York, NY (*Abstract Co-Author*) Nothing to Disclose

Amish H. Doshi, MD, New York, NY (*Abstract Co-Author*) Speaker, Merit Medical Systems, Inc

Bogdan Georgescu, PhD, Princeton, NJ (*Abstract Co-Author*) Employee, Siemens AG

Nirmal G. Janardhanan, Princeton, NJ (*Abstract Co-Author*) Employee, Siemens AG

Mariappan Nadar, Princeton, NJ (*Abstract Co-Author*) Nothing to Disclose

Dorin Comaniciu, PhD, Princeton, NJ (*Abstract Co-Author*) Employee, Siemens AG

Bernd Stoeckel, PhD, Malvern, PA (*Abstract Co-Author*) Employee, Siemens AG

Thomas Re, Princeton, NJ (*Abstract Co-Author*) Nothing to Disclose

Stefan Huwer, PhD, Princeton, NJ (*Abstract Co-Author*) Employee, Siemens AG

Heinrich von Busch, Princeton, NJ (*Abstract Co-Author*) Employee, Siemens AG

Heiko Meyer, Uttenreuth, Germany (*Abstract Co-Author*) Employee, Siemens AG

David S. Mendelson, MD, Larchmont, NY (*Abstract Co-Author*) Spouse, Employee, Novartis AG; Advisory Board, General Electric Company; Advisory Board, Bayer AG; Advisory Board, Nines; Advisory Board, Maverick AI

Zahi A. Fayad, PhD, Larchmont, NY (*Abstract Co-Author*) Nothing to Disclose

### For information about this presentation, contact:

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### PURPOSE

With rapid growth and increasing use of brain MRI, there has been a significant interest in automated image processing and classification of brain MRI scans to aid human interpretation and improve workflow. In this study we aim to assess the diagnostic accuracy of a 3D neural network in automated identification of critical findings including acute infarction, hemorrhage, and mass effect.

### METHOD AND MATERIALS

A total of 6,123 consecutive clinical brain MRI studies including sagittal T1W (pre and post contrast), axial FLAIR, ADC, B1000, T2W, T2\*W sequences were selected. MRI studies were obtained across multiple MR scanners from two manufacturers (GE and Siemens). Each sequence was reformatted to common resolution to accommodate for differences between vendors. Two board certified neuroradiologists assigned each case to acute infarction, acute hemorrhage, mass effect or none based on the review of clinical report of each case. Acute infarct was diagnosed in 713 (11.6%), acute hemorrhage in 376 (6.1%), and mass effect in 202 (3.3%). A deep learning network was developed to assess up to 7 different contrasts and classify them into critical findings. Training was done with data augmentation (random rotation, translation and added noise at each iteration) in a supervised way. Training and testing sets were randomly defined on a patient basis. Training was performed on 5,505 studies (1,233,120 images) with class weights to address class imbalance. Testing included 618 studies (138,432 images) including patients with acute infarction (n=60), acute hemorrhage (n=44), and mass effect (n=17).

### RESULTS

Receiver operating characteristic (ROC) analysis showed AUC / sensitivity / specificity / overall accuracy of 0.96 / 88% / 89% / 89% for acute infarction, 0.97 / 93% / 94% / 94% for acute hemorrhage, and 0.95 / 88% / 91% / 91% for mass effect. .

### CONCLUSION

Our proposed deep learning 3D network can accurately identify critical findings on individual brain MRIs, while addressing the fact that some MR contrasts might not be available in individual studies.

### CLINICAL RELEVANCE/APPLICATION

Our proposed automated system of 3D neural networks can flag critical findings on routine brain MRI scans, catering available human expertise in interpreting abnormal cases in a timely manner. The information presented in this paper are based on research results that are not commercially available.

## RC205-09 Unsupervised Brain Metastases Detection Based on Introspective Variational AutoEncoders with Structural Similarity Constraints

Monday, Dec. 2 11:20AM - 11:30AM Room: S406B

### Participants

Kazuma Kobayashi, MD, Chuo-ku, Japan (*Presenter*) Nothing to Disclose

Mototaka Miyake, MD, Tokyo, Japan (*Abstract Co-Author*) Nothing to Disclose

Hirokazu Watanabe, MD, Kobe, Japan (*Abstract Co-Author*) Nothing to Disclose



Amina Bolatkan, Chuo-ku , Japan (*Abstract Co-Author*) Nothing to Disclose  
Norio Shinkai, Chuo-ku , Japan (*Abstract Co-Author*) Nothing to Disclose  
Ryuji Hamamoto, MD, Tokyo, Japan (*Abstract Co-Author*) Nothing to Disclose

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**PURPOSE**

Detecting abnormality based on an assumption of 'what is normal' can be formulated as *unsupervised abnormality detection*, which is still technically challenging. Recent progress in deep learning provides a new set of approaches for this problem, especially through adopting deep generative models such as Generative Adversarial Networks (GAN) and Variational AutoEncoders (VAE) to train neural networks to estimate data distributions of 'normal' image appearances. However, there is plenty of room for improvement regarding image resolution that is essential for the detection of small lesions, which considered as more valuable targets to support clinicians rather than large, obvious ones.

**METHOD AND MATERIALS**

To train a model that learns manifold which represents normal anatomical variability, we adopted Introspective VAE (H. Huang et al., 2018), which is an extended model of VAE for synthesizing more realistic images, and added structural similarity constraints to enable pixel-wise perceptual difference estimation between its input and the generated images. To evaluate the performance, a total of 15,994 axial images of size 256 × 256 were obtained from brain magnetic resonance imaging (MRI) of 93 patients, taken as T1-weighted 3D MRI with Gadolinium injection for the treatment planning of stereotactic radiotherapy for brain metastases.

**RESULTS**

Among the dataset, 13,536 images without any gross tumor were used for the training, and the remaining 2,458 images with metastatic lesions were used for the evaluation. After 730,000 iterations, Introspective VAE with structural similarity constraints apparently converged to learn the manifold representing image appearances without any occupational lesion. Consequently, when an anomalous image was mapped to the latent space, a very similar image without any apparent abnormality could be reconstructed. Thus, pixel-wise comparison between its input and the generated images could identify the region of disease. When cut-off values for pixel-wise perceptual differences were set to 95 and 99 percentiles, sensitivity for the tumor detection were 90.0% and 69.9%, respectively.

**CONCLUSION**

Introspective VAE with structural similarity constraints works as a hypothesis-free framework for detecting tumors.

**CLINICAL RELEVANCE/APPLICATION**

Deep neural networks that learn manifold representing normal anatomy can be useful for tumor detection without any manually-labeled reference images.

**RC205-10 What Makes a Good AI Radiology Study?**

Monday, Dec. 2 11:30AM - 12:00PM Room: S406B

**Participants**

Linda Moy, MD, New York, NY (*Presenter*) Grant, Siemens AG; Support, Lunit Inc ; Support, iCad, Inc; Support, FAIR Facebook; Advisory Board, Lunit Inc; Advisory Board, iCad, Inc

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

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**LEARNING OBJECTIVES**

1) To describe study designs that allow for reliable and reproducible assessment of a model and its predictions. 2) To discuss essential elements of an AI study that allow for generalizability of results from complex machine learning methods. 3) To discuss the need for internal validation, external validation and appropriate validation metrics to minimize overfitting and to identify models that make true discoveries.

Printed on: 10/29/20



RC206

## The Basics of Upper Aerodigestive Tract Anatomy and Pathology

Monday, Dec. 2 8:30AM - 10:00AM Room: E451A

HN NR

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

### Sub-Events

#### RC206A Nasopharyngeal Anatomy and Pathology

##### Participants

Nancy J. Fischbein, MD, Stanford, CA (*Presenter*) Nothing to Disclose

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

fischbein@stanford.edu

##### LEARNING OBJECTIVES

1) Provide a refresher on the anatomy of the nasopharynx, with an emphasis on adjacent skull base foramina and neurovascular structures. 2) Consider nasopharyngeal carcinoma: etiology, pathogenesis, epidemiology, imaging. 3) Review imaging appearance of other benign and malignant pathologies of the nasopharynx.

##### ABSTRACT

**Nasopharynx: Anatomy** The nasopharynx is the uppermost part of the upper aerodigestive tract. It has complex anatomy and complex boundaries. The superior boundaries of the nasopharynx are the undersurface of the sphenoid sinus and the upper aspect of the clivus. The inferior boundary of the nasopharynx is the superior surface of the soft palate. The posterior boundaries of the nasopharynx include the lower clivus, the craniovertebral junction (CVJ), and the prevertebral muscles. The anterior boundary is the posterior choana of the nasal cavity. The complex lateral margin includes the Eustachian tube orifice, the torus tubarius, and the fossa of Rosenmüller (lateral pharyngeal recess). The nasopharynx is also in close proximity to multiple important skull base structures and foramina, and these must be carefully assessed for tumor involvement when patients have tumors of the nasopharynx. Nasopharyngeal tumors may extend to the pterygopalatine fossa (PPF), and from there they may access multiple regions by direct or perineural extension. The connections of the PPF include the palatine foramina to the palate inferiorly, the sphenopalatine foramen to the nasal cavity medially, the pterygomaxillary fissure to the infratemporal fossa laterally, the vidian canal toward the carotid canal posteroinferiorly, foramen rotundum to the cavernous sinus posterosuperiorly, and the inferior orbital fissure from the upper PPF to the orbit superiorly. Nasopharyngeal tumors may also extend to foramen lacerum (just inferior to the internal carotid artery) superiorly, and to foramen ovale superolaterally. To some degree, the tough pharyngobasilar fascia limits extension to foramen ovale. Tumors of the inferior nasopharynx often extend posteriorly or posterolaterally to involve the hypoglossal canal and/or the jugular foramen. **Nasopharyngeal Carcinoma (NPC)** NPC is a unique malignant epithelial carcinoma of the head-and-neck region that is most common in endemic regions such as Southeast Asia. There are different histological subtypes, with the undifferentiated carcinoma associated with EBV the most prevalent. A variety of clinical presentations are associated with NPC. Most common is a neck mass (present in 70 to 90% of cases), followed by nasal obstruction or bleeding, hearing loss/otitis/otalgia, headache, and/or cranial neuropathy. Imaging plays an important role in all aspects of diagnosis, staging, treatment planning and follow-up of patients with NPC. MR is the imaging study of choice, as CT does not give adequate information regarding skull base and intracranial extent of disease. We will review the updated staging of NPC and will look at imaging examples of each stage. **Nasopharynx: Other Pathologies** Many other benign and malignant pathologies can affect the nasopharynx. Congenital lesions such as the Tornwaldt cyst may be seen, as may adenoidal hypertrophy and nasopharyngitis. Infiltrative processes such as IgG4-related disease and pseudotumor may occur, as may sarcoidosis and amyloid. Benign tumors such as pleomorphic adenoma and schwannoma may be seen in this location. Other malignancies such as lymphoma, rhabdomyosarcoma (typically in children) and minor salivary gland tumors (notably adenoid cystic carcinoma) may also affect the nasopharynx.

#### RC206B Oropharyngeal Anatomy and Pathology

##### Participants

Richard H. Wiggins III, MD, Salt Lake City, UT (*Presenter*) Nothing to Disclose

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

Richard.Wiggins@hsc.utah.edu

##### LEARNING OBJECTIVES

1) Review important oropharyngeal imaging anatomy. 2) Understand common oropharyngeal pathologies. 3) Recognize important oropharyngeal pathology imaging differentials.

##### ABSTRACT

The oropharynx as the center of the upper aerodigestive tract has complicated anatomy. The nasopharynx above and the hypopharynx below, with the oral cavity anteriorly all border the oropharynx. This anatomy includes the soft palate, palatine tonsils, the lingual adenoidal tissue (or the base of the tongue) and the posterior wall of the pharynx. Pathologies of this region include infectious and inflammatory processes, and neoplasms. Sometimes pathology crosses over these regions from one to the other, and sometimes even more spaces! Both CT and MRI may be used to evaluate the oropharynx. Some people think that oropharynx

rhymes with nasopharynx and hypopharynx, but that is like saying the larynx rhymes with larynx. Does anyone really read these? Please email me if you do at: Richard.Wiggins@hsc.utah.edu , and let me know, i am highly suspicious. This session will review critical anatomy points of the oropharynx on both CT and MRI and discuss imaging techniques to best evaluated this complex region.

#### **RC206C Oral Cavity Anatomy and Pathology**

Participants

Hilda E. Stambuk, MD, New York, NY (*Presenter*) Nothing to Disclose

#### **LEARNING OBJECTIVES**

1) Review the salient anatomic features of the oral cavity. 2) Understand imaging features of benign and malignant diseases of the oral cavity. 3) Describe anatomical pathways of tumor spread in the oral cavity that are important in treatment planning.

#### **RC206D Laryngeal and Hypopharyngeal Anatomy and Pathology**

Participants

Minerva Becker, MD, PhD, Geneva 14, Switzerland (*Presenter*) Nothing to Disclose

#### **LEARNING OBJECTIVES**

1) To review the key anatomic structures of the larynx and hypopharynx and their imaging appearance on CT and MRI. 2) To discuss characteristic patterns of submucosal tumor spread in squamous cell carcinoma. 3) To illustrate the imaging appearance of other benign and malignant lesions of the larynx and hypopharynx. 4) To present a systematic approach for a clinically relevant radiologic report.

#### **ABSTRACT**

The vast majority of laryngeal and hypopharyngeal tumors are squamous cell cancers related to the consumption of tobacco and alcohol, whereas only a minority are caused by infection with the HPV virus or are of non-squamous cell type. The most common indication to perform cross-sectional imaging of the larynx and hypopharynx consists in imaging a biopsy-proven or a suspected tumor. CT, MRI and PET CT play an indispensable complementary role to endoscopic biopsy, because they enable the evaluation of the deep submucosal structures and spaces, all of which guide tumor dissemination. Knowledge of the key structures, regions, spaces and boundaries of the larynx and hypopharynx is of utmost importance for a clinically relevant radiologic report. First, the imaging aspect of the laryngeal and hypopharyngeal subsites, of the pre-epiglottic space, paraglottic space, anterior and posterior commissure, as well as of laryngeal cartilages is discussed with emphasis on the distinction between normal features, variants and abnormal findings. Then characteristic patterns of submucosal invasion in supraglottic, glottic and subglottic squamous cell cancers and in tumors arising from the piriform sinus, retrocricoid region and posterior hypopharyngeal wall are reviewed and the implications of imaging for tumor staging and treatment planning are discussed. The role of MRI in distinguishing between tumor invasion and peritumoral inflammation is highlighted and typical pitfalls of image interpretation on CT, MRI and PET CT are presented. A systematic approach to image interpretation and the use of a check-list style structured report will be presented in order to improve report comprehension by the referring clinician thus facilitating decisions for patient management.

Printed on: 10/29/20



RC207

## Novel Anti-cancer Agents in Genitourinary Malignancies: What Your Reports Should Include

Monday, Dec. 2 8:30AM - 10:00AM Room: S102CD



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

### Participants

Priya R. Bhosale, MD, Bellaire, TX (*Presenter*) Nothing to Disclose

Andrew D. Smith, MD, PhD, Birmingham, AL (*Presenter*) CEO, AI Metrics LLC ; Owner, AI Metrics LLC ; CEO, Radiostics LLC; Owner, Radiostics LLC; CEO, Liver Nodularity LLC ; Owner, Liver Nodularity LLC ; Research Grant, General Electric Company; Speaker, Canon Medical Systems Corporation; Speaker, AlgoMedica, Inc

Atul B. Shinagare, MD, Boston, MA (*Presenter*) Consultant, Arog Pharmaceuticals, Inc; Consultant, VirtualScopics, Inc

### For information about this presentation, contact:

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### LEARNING OBJECTIVES

1) Know the mechanisms of action and rationale behind use of various novel anticancer agents available to treat advanced renal, bladder, prostate and gynecologic malignancies. 2) Identify the typical and atypical patterns of tumor response with the novel anticancer agents using a combination of size-based, morphologic and immune-response criteria, and avoid common pitfalls in response assessment. 3) Detect adverse events and complications associated with the novel anticancer agents including immune-related adverse events, and understand the role of certain adverse events as imaging biomarkers.

### ABSTRACT

Molecular targeted therapies, immune checkpoint inhibitors and hormonal therapies represent three classes of novel anticancer agents with distinct mechanisms of action, response patterns and toxicities. With the burgeoning use of these agents to treat advanced GU malignancies, the role of the radiologist as a key member of the treatment team has evolved. After attending this course, attendees will know how novel anticancer agents change the radiologic assessment of advanced genitourinary cancers, including their typical and atypical response patterns and common toxicities seen on imaging. This knowledge will inform the radiologists how to render appropriate reports of imaging exams and conduct an effective dialogue with the referring physicians about the management of genitourinary cancers.

Printed on: 10/29/20



RC208

## Emergency Cardiothoracic CT Angiography

Monday, Dec. 2 8:30AM - 10:00AM Room: E450B



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

### Participants

Douglas S. Katz, MD, Mineola, NY (*Moderator*) Nothing to Disclose

### Sub-Events

#### RC208A Imaging of Venous Thromboembolism in Obesity: Pitfalls and Pearls

##### Participants

Douglas S. Katz, MD, Mineola, NY (*Presenter*) Nothing to Disclose

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

douglasscottkatzmd@gmail.com

##### LEARNING OBJECTIVES

1) To provide some 'pearls' for accurate interpretation of CT pulmonary angiography performed for suspected pulmonary embolism. 2) To review some potential 'pitfalls' in the interpretation of CT pulmonary angiography for suspected pulmonary embolism, using examples from clinical practice, and to discuss strategies for avoiding falling into these potential pitfalls. 3) To briefly review the relevant imaging literature.

#### RC208B CT Angiography of Acute Aortic Syndrome

##### Participants

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

##### LEARNING OBJECTIVES

1) Review the imaging findings of patients presenting with the acute aortic syndrome. 2) Identify imaging findings in patients with the acute aortic syndrome that can affect prognosis or management. 3) Discuss mimics and confounding imaging findings in cases of suspected acute aortic syndrome.

#### RC208C Emergency Coronary CT Angiography

##### Participants

Jeffrey M. Levsky, MD, PhD, Bronx, NY (*Presenter*) Nothing to Disclose

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

jlevsky@montefiore.org

##### LEARNING OBJECTIVES

1) Identify the landmark studies that form the evidence base for ED coronary CTA. 2) Contrast the levels of evidence supporting CTA use in different settings. 3) Differentiate between proven and speculative benefits and drawbacks of CTA. 4) Assess the appropriateness of development of ED coronary CTA programs.

Printed on: 10/29/20



RC209

### Gastrointestinal Series: Pancreas Imaging

Monday, Dec. 2 8:30AM - 12:00PM Room: E353C

**GI**

AMA PRA Category 1 Credits <sup>™</sup>: 3.00  
ARRT Category A+ Credits: 3.50

**FDA**

Discussions may include off-label uses.

#### Participants

Elizabeth M. Hecht, MD, New York, NY (*Moderator*) Nothing to Disclose  
Eric P. Tamm, MD, Houston, TX (*Moderator*) Institutional Research Grant, General Electric Company  
Desiree E. Morgan, MD, Birmingham, AL (*Moderator*) Institutional Research Grant, General Electric Company; Consultant, General Electric Company  
Koenraad J. Mortele, MD, Boston, MA (*Moderator*) Nothing to Disclose

#### Sub-Events

##### RC209-01 Advances in Pancreatic CT and MR Imaging

Monday, Dec. 2 8:30AM - 8:50AM Room: E353C

#### Participants

Elizabeth M. Hecht, MD, New York, NY (*Presenter*) Nothing to Disclose

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#### LEARNING OBJECTIVES

1) Briefly review the current role of CT and MRI in pancreatic diseases both advantages and limitations. 2) Discuss advances in CT/MR software and hardware technology that can potentially benefit diagnostic pancreatic imaging from scan efficiency and radiation dose reduction to diagnosis and treatment planning.

##### RC209-02 Chemical Exchange Saturation Transfer (CEST) for Pancreatic Ductal Adenocarcinoma (PDAC) Evaluation

Monday, Dec. 2 8:50AM - 9:00AM Room: E353C

#### Participants

Lixia Wang, MD, Beijing, China (*Presenter*) Nothing to Disclose  
Zhengwei Zhou, Los Angeles, CA (*Abstract Co-Author*) Nothing to Disclose  
Nan Wang, Los Angeles, CA (*Abstract Co-Author*) Nothing to Disclose  
Pei Han, Los Angeles, CA (*Abstract Co-Author*) Nothing to Disclose  
Zixin Deng, Los Angeles, CA (*Abstract Co-Author*) Nothing to Disclose  
Srinivas Gaddam, Los Angeles, CA (*Abstract Co-Author*) Nothing to Disclose  
Zhaoyang Fan, West Hollywood, CA (*Abstract Co-Author*) Nothing to Disclose  
Anthony Christodoulou, Los Angeles, CA (*Abstract Co-Author*) Nothing to Disclose  
Tao Jiang, MD, Beijing, China (*Abstract Co-Author*) Nothing to Disclose  
Stephen J Pandol, Los Angeles, CA (*Abstract Co-Author*) Nothing to Disclose  
Debiao Li, Los Angeles, CA (*Abstract Co-Author*) Nothing to Disclose

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

Lixia.wang@cshs.org

#### PURPOSE

To evaluate the feasibility of using a pH-sensitive MR imaging - CEST to differentiate between PDAC, non-tumor pancreas (both upstream pancreas which is the distal end toward the tumor and downstream which is the proximal portion to the tumor), and normal control pancreas.

#### METHOD AND MATERIALS

CEST images from normal volunteers and patients with PDAC were acquired from Dec 1st 2017 to Mar 15th 2019. All PDAC were confirmed with histopathology. The image quality was evaluated, and images with severe motion artifacts were excluded. Regions of interest (ROIs) were determined according to T1-VIBE, T2WI and Diffusion Weighted Imaging (DWI) by an experienced radiologist. APT ratio, i.e., the asymmetric magnetization transfer ratio (MTR) at 3.5 ppm, was measured in PDAC, upstream and downstream pancreas, and normal pancreas. One-way ANOVA and Tukey tests were used to evaluate the differences between groups and within groups. Receiver operating characteristic (ROC) curve was utilized to evaluate CEST in differentiating tumor with non-tumor pancreas.

#### RESULTS

14 PDAC, 11 normal pancreas, 11 upstream pancreas, 11 downstream pancreas, and 11 normal control pancreas were included. The mean APT ratio of PDAC was significantly higher than that of normal pancreas, upstream pancreas, and downstream pancreas ( $p < 0.001$ ).

14 PDAC patients (5 female, median age 65 years (range 46-80 years) and 12 healthy volunteers (5 females, median age 32 years (range 18-66 years) were included in the study. The mean APT ratios ( $\pm$ SD) were  $0.014\pm 0.034$ ,  $-0.041\pm 0.030$ ,  $-0.019\pm 0.027$  respectively in PDAC mass, upstream pancreas and downstream pancreas in the patient group respectively, and  $-0.008\pm 0.024$  in normal pancreas in the volunteer group. Significant differences were found between PDAC and upstream pancreas ( $P < 0.001$ ), and between upstream pancreas and normal control pancreas ( $P = 0.04$ ). Area under curve (AUC) to differentiate PDAC from non-tumor pancreas was 0.857 (95% confidence interval (CI): 0.724-0.991).

## CONCLUSION

pH-sensitive CEST MRI can be used to differentiate PDAC from non-tumor pancreas (upstream and downstream pancreas) as acidic condition is expected in PDAC because of hypoxia. It provides a novel metabolic imaging method in PDAC identification.

## CLINICAL RELEVANCE/APPLICATION

PH-sensitive CEST provides a novel metabolic imaging method in PDAC patients and can be used to differentiating tumor with upstream and downstream pancreas.

### RC209-03 CT Perfusion Combined with Standard Multiphase CT as a Potential Biomarker for Pancreatic Ductal Adenocarcinoma

Monday, Dec. 2 9:00AM - 9:10AM Room: E353C

#### Participants

Ryan O'Malley, MD, Seattle, WA (*Presenter*) Research Grant, General Electric Company  
Erik Soloff, MD, Seattle, WA (*Abstract Co-Author*) Research Grant, General Electric Company  
Janet M. Busey, MS, Seattle, WA (*Abstract Co-Author*) Nothing to Disclose  
Nitin Desai, BS, Seattle, WA (*Abstract Co-Author*) Nothing to Disclose  
Danielle Nacamuli, BS, Seattle, WA (*Abstract Co-Author*) Nothing to Disclose  
Kent M. Koprowicz, Seattle, WA (*Abstract Co-Author*) Research Consultant, Axio Research, LLC  
Achille Mileto, MD, Seattle, WA (*Abstract Co-Author*) Research grant, General Electric Company;  
Carolyn L. Wang, MD, Seattle, WA (*Abstract Co-Author*) Research Grant, General Electric Company

## PURPOSE

To combine perfusion CT with routine multi-phase contrast-enhanced CT on a 256-slice scanner to evaluate the significance of perfusion parameters in patients with pancreatic ductal adenocarcinoma (PDA).

## METHOD AND MATERIALS

CT perfusion was added to routine baseline and follow-up CT scans with fifteen perfusion acquisitions obtained 5-42.5 sec after contrast administration, followed by standard pancreatic arterial and portal venous phases using the same IV contrast injection. Regions of interest (ROIs) were drawn for the center, rim, and entire tumor to generate perfusion maps from which tumor blood volume (BV), blood flow (BF), and permeability surface area product (PS) were calculated using deconvolution algorithms. Tumor size, RECIST 1.1 response, and carbohydrate antigen 19-9 (CA 19-9) were obtained at baseline and follow-up. Pearson correlation coefficients were used to compare perfusion parameters to clinical variables at both timepoints. Radiation dose was recorded, and size specific dose estimate (SSDE) was calculated.

## RESULTS

Twenty-five patients with PDA were included (15 m, 10 f;  $64 \pm 10$  years). Mean baseline tumor BV was  $2.5 \pm 1.5$  ml/100g, BF was  $19.7 \pm 10.1$  ml/100g/min, PS was  $7.9 \pm 7.6$  ml/100g/min. Mean follow-up tumor BV was  $2.3 \pm 1.5$  ml/100g, BF was  $16.4 \pm 9.1$  ml/100g/min, PS was  $7.9 \pm 7.6$  ml/100g/min. Per RECIST 1.1, 3 patients had Partial Response, 12 patients had Stable Disease, and 10 had Progressive Disease. There was a significant negative correlation between mean tumor BV at baseline and follow-up sum of diameters ( $r = -.51$ ,  $p < 0.05$ ), RECIST response ( $r = -0.44$ ,  $p < 0.05$ ), longest tumor diameter ( $r = -0.41$ ,  $p < 0.05$ ) and CA 19-9 ( $r = -0.49$ ,  $p < 0.05$ ). There was also a negative correlation between change in tumor BV from baseline to follow-up but did not reach statistical significance. For the perfusion sequence, CTDIvol was  $41 \pm 5$  mGy and SSDE was  $54 \pm 8$  mGy.

## CONCLUSION

A perfusion sequence added to routine pancreatic CT provides added quantitative information that negatively correlates with other clinical metrics. Lower perfusion parameters at baseline correlated with worse follow-up outcomes, of which tumor BV reached statistical significance. Routinely adding perfusion CT to standard pancreatic CTs could add quantitative information to stratify tumors at baseline and predict treatment response.

## CLINICAL RELEVANCE/APPLICATION

Using CT perfusion in conjunction with routine pancreas CT is a novel way to comprehensively characterize PDA at baseline and add metrics that may be used to predict individual response to therapy.

### RC209-05 Challenges in Pancreatic Cancer Staging

Monday, Dec. 2 9:20AM - 9:40AM Room: E353C

#### Participants

Eric P. Tamm, MD, Houston, TX (*Presenter*) Institutional Research Grant, General Electric Company

## LEARNING OBJECTIVES

1) To be able to identify and describe common challenges encountered in staging pancreatic cancer. 2) To be able to manage these challenges, whether through imaging techniques/modalities or interpretation/reporting. 3) To be able to make recommendations to clinicians.

### RC209-06 Apparent Diffusion Coefficient (ADC) Allows Early Prediction of Response After Prophylactic DC Vaccination for Pancreatic Ductal Adenocarcinoma (PDAC) Prevention

Monday, Dec. 2 9:40AM - 9:50AM Room: E353C

## Participants

Junjie Shangguan, Chicago, IL (*Presenter*) Nothing to Disclose  
Liang Pan, MD, Changzhou, China (*Abstract Co-Author*) Nothing to Disclose  
Matteo Figini, Chicago, IL (*Abstract Co-Author*) Nothing to Disclose  
Chong Sun, Chicago, IL (*Abstract Co-Author*) Nothing to Disclose  
Jia Yang, PhD, Chicago, IL (*Abstract Co-Author*) Nothing to Disclose  
Quanhong Ma, Chicago, IL (*Abstract Co-Author*) Nothing to Disclose  
Aydin Eresen, PhD, Chicago, IL (*Abstract Co-Author*) Nothing to Disclose  
Yu Li, PhD, Chicago, IL (*Abstract Co-Author*) Nothing to Disclose  
Yuri Velichko, PhD, Chicago, IL (*Abstract Co-Author*) Nothing to Disclose  
Zhuoli Zhang, MD, PhD, Chicago, IL (*Abstract Co-Author*) Nothing to Disclose  
Vahid Yaghmai, MD, Orange, CA (*Abstract Co-Author*) Nothing to Disclose

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## PURPOSE

We evaluated ADC as an imaging biomarker for prediction of response to prophylactic DC vaccination in Panc02 inoculated mice, a model of pancreatic ductal adenocarcinoma (PDAC).

## METHOD AND MATERIALS

All animal protocols were approved by the institutional animal care and use committee. 20 mice were randomly assigned to treatment or control groups. Animals underwent 3 intraperitoneal injections of DC vaccines, unpulsed mature DCs, Panc02 lysates, or no treatment. All mice underwent tumor induction by Panc02 cell injection into the pancreas, followed by weekly MRI scans. ADC was calculated from DW-MRI using MatLab.  $\Delta$ ADC is calculated by  $\Delta$ ADC=ADC3w-ADC1w. Tumor tissue was collected for histology. Statistical analysis was performed on GraphPad Prism. Receiver operating characteristic (ROC) was generated with a survival 2 standard deviations higher than average untreated animal survival considered to be positive survival events.

## RESULTS

$\Delta$ ADC of DC-vaccine group was significantly higher than in control groups and correlated with diminished tumor volume, survival, and % interstitial collagen on histology, suggesting that  $\Delta$ ADC had direct correlations with tumor pathology. Prophylactic IP DC-vaccination also induced a strong anti-tumor immune response in vivo, decreased tumor volume, and prolonged survival. For ROC, survival > 49 d was considered positive events. Distance analysis ( $d = 0.316$ ) and Youden indexing (0.6) showed that optimal cutoff values were  $-8.52 \times 10^{-5}$  (specificity = 0.9 and sensitivity = 0.7) and  $-9.24 \times 10^{-5}$  (specificity = 0.7 and sensitivity = 0.9). Diagnostic odds ratio was 2.33.

## CONCLUSION

$\Delta$ ADC can predict response to prophylactic DC vaccination via IP injection in a Panc02 mouse model of pancreatic cancer.

## CLINICAL RELEVANCE/APPLICATION

Here, we showed that ADC is a clinically translatable tool that allows early prediction of response to DC vaccination for PDAC treatment, facilitating timely therapy adjustment in individual patients.

## RC209-07 Imaging Workup of Cystic Pancreatic Lesions

Monday, Dec. 2 10:20AM - 10:40AM Room: E353C

## Participants

Koenraad J. Morteale, MD, Boston, MA (*Presenter*) Nothing to Disclose

## RC209-08 Intraductal Pancreatic Mucinous Neoplasm with Main Duct Involvement: How Ominous are the Current Worrisome Features and High-Risk Stigmata?

Monday, Dec. 2 10:40AM - 10:50AM Room: E353C

## Participants

Alejandro Garcés-Descovich, MD, Boston, MA (*Presenter*) Nothing to Disclose  
Khoschy Schawkat, MD, Boston, MA (*Abstract Co-Author*) Nothing to Disclose  
Elena L. Resnick, MD, Portland, ME (*Abstract Co-Author*) Nothing to Disclose  
Jonathan N. Glickman, Boston, MA (*Abstract Co-Author*) Nothing to Disclose  
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Koenraad J. Morteale, MD, Boston, MA (*Abstract Co-Author*) Nothing to Disclose

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## PURPOSE

To evaluate the "worrisome features" (WF) and "high-risk stigmata" (HRS) of pathologically resected main duct-IPMN (MD-IPMN) and combined duct-IPMN (CD-IPMN) and correlate the imaging features with their clinical presentation, laboratory values, and histopathological features.

## METHOD AND MATERIALS

Of 187 consecutive patients with endoscopic ultrasound and pancreatic surgical resection from February 2004 to July 2017, 101 had histopathologically proven IPMN. Pathological examination revealed 87 cases of MD/CD-IPMN. Thirteen patients were excluded due to unavailability of imaging (n=12), and history of prior surgery (n=1). For the remaining 74 patients (42 women; mean age:  $67.2 \pm 10.4$  years), high-resolution cross-sectional imaging (3 MRI; 26 MRI + MRCP; 45 MDCT imaging) were retrospectively assessed



by three radiologists. Each WF and HRS accordingly to the current IPMN guidelines [International Association of Pancreatology (IAP), American Gastroenterological Association (AGA), and American College of Radiology (ACR)] were assessed in imaging and correlated with pathologic findings for high-grade dysplasia (HGD) and invasive carcinoma (IC). Preoperative growth rate was assessed in 17 patients. Fisher-Exact test was used for the analysis between the guidelines features and dichotomized values of histopathology [1) low/intermediate dysplasia and 2) HGD/IC].

## RESULTS

Of 74 patients, 13 (18%) had HGD and 10 (13%) had IC arising from the MD/CD-IPMN. No significant association between HGD/IC and WF or HRS from any of the three guidelines was found. From the IAP, WF were found in 57 (77%) patients and HRS in 40 (53%) patients ( $p=0.99$  and  $p=0.21$ , respectively). Accordingly to the AGA, HRS were found in 64 (86%) patients ( $p=0.71$ ). Finally, following the ACR guidelines, WF were found in 56 (77%) patients and HRS in 40 (54%) patients ( $p=0.99$  and  $p=0.22$ , respectively). Clinical signs and laboratory values were also insignificant ( $p=0.12$ ).

## CONCLUSION

The radiological WF and HRS from the three most used current guidelines (IAP, AGA, and ACR) for diagnosis and treatment of MD/CD-IPMN do not correlate with histopathological high-grade dysplasia or invasive carcinoma.

## CLINICAL RELEVANCE/APPLICATION

Radiologists, surgeons and gastroenterologists should be aware that the current guidelines (IAP, AGA and ACR) for the management of IPMNs are not applicable to IPMNs with main duct involvement.

### RC209-09 Clinical Feasibility of Abbreviated MR with 3D-Breath Hold Magnetic Resonance Cholangiography for Surveillance of Pancreatic IPMN

Monday, Dec. 2 10:50AM - 11:00AM Room: E353C

#### Participants

Hyo-Jin Kang, MD, Seoul, Korea, Republic Of (*Presenter*) Nothing to Disclose  
Dong Ho Lee, MD, Seoul, Korea, Republic Of (*Abstract Co-Author*) Nothing to Disclose  
Jeongin Yoo, Seoul, Korea, Republic Of (*Abstract Co-Author*) Nothing to Disclose  
Joon Koo Han, MD, Seoul, Korea, Republic Of (*Abstract Co-Author*) Nothing to Disclose

## PURPOSE

To determine the clinical feasibility of abbreviated MRI using breath-hold 3D-MRCP (aMRI-BH) for pancreas IPMN surveillance compared to conventional contrast-enhanced pancreatobiliary MRI (cMRI).

## METHOD AND MATERIALS

This retrospective study includes 123 patients with 159 pancreatic IPMNs (pathologically proven [ $n=74$ ], typical image feature with more than 2-year stability [ $n=85$ ]) who underwent contrast-enhanced pancreatobiliary MRI with conventional and breath-hold 3D-MRCP. Two readers independently evaluated: 1) aMRI-BH, consisted of heavily T2W, BH-3D-MRCP, pre-contrast T1W and DWI, and 2) cMRI, consisted of aMRI-BH plus 2D-MRCP, conventional 3D-MRCP and contrast enhanced dynamic sequences. Diagnostic performance and recommended further management plan were compared by evaluating high-risk stigmata and worrisome features based on revised Fukuoka guideline. A mural nodule  $\geq 5$ mm without enhancement information defined as suspicious finding for high risk stigmata. Inter-protocols and inter-observer agreement of image features using ICC and  $\kappa$  statistics and the ROC curve analysis for diagnostic performance were used.

## RESULTS

The total acquisition time of cMRI and aMRI-BH were  $32.7 \pm 8$  and  $6.5 \pm 2.1$  min, respectively ( $P < 0.01$ ). Among 159 IPMNs, 25 (15.7%) lesions were invasive carcinomas and 7 (4.4%) lesions were high grade dysplasia. Of these 32 malignant lesions, cMRI enabled to present more high risk stigmata than aMRI-BH (75% and 34.3% in each). However, 65.6% lesions further revealed mural nodules  $\geq 5$ mm in aMRI-BH and finally no differences were found for revealing high risk or suspicious high risk stigmata between protocols (75.0% and 76.6% in cMRI and aMRI-BH). Diagnostic performance for detecting malignant IPMN was comparable (AUC, 0.85-0.90 in cMRI and 0.87-0.90 in aMRI-BH,  $P_s > 0.05$ ) with substantial inter-protocols and inter-observer agreements for assessing high risk stigmata and worrisome features (ICC, 0.88-0.95;  $\kappa$ , 0.57-0.95) except thickened cyst wall and lymphadenopathy. All malignant IPMNs evaluated by aMRI-BH were assessed as strongly requiring further work-up.

## CONCLUSION

An aMRI using breath-hold 3D-MRCP showed comparable diagnostic performance in capturing suspicious findings of high risk stigmata for IPMN and in determining the immediate action is needed or not, compared to cMRI.

## CLINICAL RELEVANCE/APPLICATION

An aMRI consist of heavily T2W, BH-3D-MRCP, pre-contrast T1W and DWI might be clinically feasible for pancreatic IPMN surveillance while escaping high time-cost and cumulative CT radiation hazard.

### RC209-10 Pancreatic Neuroendocrine Tumors

Monday, Dec. 2 11:00AM - 11:20AM Room: E353C

#### Participants

Desiree E. Morgan, MD, Birmingham, AL (*Presenter*) Institutional Research Grant, General Electric Company; Consultant, General Electric Company

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## LEARNING OBJECTIVES

1) Identify imaging features of pancreatic endocrine tumors that differentiate it from pancreatic ductal adenocarcinoma. 2)

Compare appearances of pancreatic endocrine tumors on different imaging modalities and specify clinical utility of the different imaging modality choices. 3) Understand updated World Health Organization grading and implications for staging and treatment of pancreatic endocrine tumors.

### **RC209-11 Radiomics Analysis Based on Diffusion Kurtosis Imaging and T2 Weighted Imaging for Differentiation of Pancreatic Neuroendocrine Tumors from Solid Pseudopapillary Tumors**

Monday, Dec. 2 11:20AM - 11:30AM Room: E353C

#### **Participants**

Yan-jie Shi, Beijing, China (*Presenter*) Nothing to Disclose  
Haitao Zhu, PhD, Beijing, China (*Abstract Co-Author*) Nothing to Disclose  
Xiao-Yan Zhang, Beijing, China (*Abstract Co-Author*) Nothing to Disclose  
Ying-shi Sun, MD, PhD, Beijing, China (*Abstract Co-Author*) Nothing to Disclose

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#### **PURPOSE**

To develop and validate a radiomics model of diffusion kurtosis imaging (DKI) and T2 weighted imaging for discriminating pancreatic neuroendocrine tumors (PNET) from solid pseudopapillary tumors (SPT)

#### **METHOD AND MATERIALS**

57 patients with histopathological confirmed PNET (n=25) and SPT (n=32) were enrolled in this study. All the patients underwent T2-weighted and diffusion-weighted imaging at 3T MRI. DW imaging was obtained using single-shot echo-planar imaging with 10 b-values (0, 20, 50, 100, 200, 600, 800, 1000, 1200 and 1500 s/mm<sup>2</sup>). ROIs of tumors were manually drawn on each slice at T2 weighted images and DWI (b=1500 s/mm<sup>2</sup>) independently by two observers. Intraclass correlation coefficients were used to evaluate the interobserver agreement. Mean diffusivity (MD) and mean kurtosis (MK) were derived from DKI approach. The two-sample t test and the least absolute shrinkage and selection operator regression were used for feature selection at DKI and T2 weighted images. Receiver operating characteristic (ROC) analysis was performed and diagnostic accuracy was calculated.

#### **RESULTS**

Satisfactory interobserver agreement was achieved. MD and MK had good diagnostic performance with area under curve (AUC) of 0.732 (95% confidence interval, 0.598-0.841) and 0.650 (95% CI, 0.512-0.772). 10 radiomic features extracted from T2 weighted imaging and DKI showed excellent discrimination performance with AUC of 0.94 (95% CI, 0.844-0.986). The radiomics model had better diagnostic performance than that of MD (Z=3.445, P=0.0006) and MK (Z=3.761, P=0.0002) in 57 patients. The radiomics model, which comprising DKI and T2 weighted imaging, showed excellent differentiation with AUC of 0.950 (95% CI, 0.839-0.993), sensitivity of 94.12% (95% CI, 71.3-99.9%), specificity of 85.19% (95% CI, 66.3-95.8%) in the primary cohort (PNET=17 and SPT=27). Using this model to differentiate PNET and SPT had AUC of 0.925 (95% CI, 0.624 -0.998), sensitivity of 100% (95% CI, 63.1-100%), specificity of 80% (95% CI, 24-99.5%) in the validation cohort (PNET=8 and SPT=5).

#### **CONCLUSION**

Radiomics model based on DKI and T2 weighted imaging may be more valuable than MD and MK for discriminating PNET and SPT. This model could improve the diagnostic accuracy of differentiating PNET and SPT.

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

Radiomics analysis could improve the diagnostic accuracy and contribute to determining an appropriate treatment strategy for pancreatic tumors.

### **RC209-12 Best CNR Curve-Guided keV Selection of Virtual Mono-Energetic Image Reconstruction for Necrosis Depiction in Acute Pancreatitis**

Monday, Dec. 2 11:30AM - 11:40AM Room: E353C

#### **Participants**

Yuan Yuan, Chengdu, China (*Presenter*) Nothing to Disclose  
Zixing Huang, Chengdu, China (*Abstract Co-Author*) Nothing to Disclose  
Zhenlin Li, MD, Chengdu, China (*Abstract Co-Author*) Nothing to Disclose  
Bin Song, MD, Chengdu, China (*Abstract Co-Author*) Nothing to Disclose  
Liping Deng, Chengdu, China (*Abstract Co-Author*) Nothing to Disclose  
Kai Liao, Chengdu, China (*Abstract Co-Author*) Nothing to Disclose  
Xinyue Chen, London, United Kingdom (*Abstract Co-Author*) Nothing to Disclose

#### **PURPOSE**

To investigate the feasibility of using best CNR curve from dual-energy post-processing for necrosis depiction in acute pancreatitis by comparing the conspicuity and image quality with 100kVp, Sn140kVp and mixed imaging that was routinely used for clinical interpretation.

#### **METHOD AND MATERIALS**

48 patients of acute pancreatitis with proven necrosis (24 male and 24 female), who underwent dual-energy (100 kVp and Sn140 kVp) CT acquisition in venous phase between March 2015 and January 2016, were retrospectively enrolled in the study. The median age was 46 years. Three imaging series (100kVp, Sn140kVp and mixed imaging) were reconstructed automatically after acquisition. In addition keV that gives the peak value of CNR demonstrated on the Best CNR curve derived from dual-energy post-processing workstation is used to reconstruct the mono-energetic imaging. Two blinded radiologists evaluated 100kVp, Sn140kVp, mixed imaging and Best CNR based-keV imaging and grading the necrosis conspicuity in 4-point scale on a per-necrosis basis. Image quality (Noise and SNR) was assessed, and overall image preference was ranked as a per-patient basis. Necrosis-to-parenchymal contrast-to-noise ratio (CNR) was compared between 4 imaging series. ANOVA and bonferroni correction were used to do statistic analysis.

## RESULTS

The mean keV suggested by best CNR curve was 75keV (range:74~78keV). The inter-reader agreement was excellent for necrosis conspicuity (ICC: 0.716). Across two readers, the conspicuity rating for Best-CNR curve based mono-energetic imaging was superior to other imaging series ( $p<0.001$ ). Besides its SNR is also significant higher in mono-energetic imaging than other imaging series ( $p<0.0001$ ) with least noise shown as  $9.31\pm 2.96$ . CNR was significant higher in best-CNR based keV mono-energetic imaging ( $9.99\pm 5.86$ ), superior to all the other series ( $p<0.001$ ).

## CONCLUSION

It is demonstrated in the study that the best CNR curve based keV mono-energetic imaging has better conspicuity and imaging quality for necrosis depiction in acute pancreatitis compared to routinely automatically reconstructed imaging series.

## CLINICAL RELEVANCE/APPLICATION

Since the necrosis is illustrated to be the most serious morphologic findings closely relating to mortality, it is crucial to have a correct assessment of it in acute pancreatitis. After the advent of dual-energy CT, best-CNR curve guided selection of keV was validated to be a convenient and feasible way.

## RC209-13 Acute Pancreatitis Reporting

Monday, Dec. 2 11:40AM - 12:00PM Room: E353C

### Participants

Bhavik N. Patel, MD, Fremont, CA (*Presenter*) Speakers Bureau, General Electric Company; Research Grant, General Electric Company

## LEARNING OBJECTIVES

1) Be familiar with different types of acute pancreatitis and their associated complications. 2) Understand the revised Atlanta classification terminology.

Printed on: 10/29/20



RC210

## Thyroid Sonography: At a Tipping Point

Monday, Dec. 2 8:30AM - 10:00AM Room: E351



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

### Sub-Events

#### RC210A Advanced ACR TI-RADS: Rationale, Challenges, and Validation

Participants

Franklin N. Tessler, MD, Birmingham, AL (*Presenter*) Nothing to Disclose

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#### LEARNING OBJECTIVES

1) Understand why ACR TI-RADS was created and how it improves patient care. 2) Be familiar with the main challenges that radiologists face in implementing and using ACR TI-RADS. 3) Know how ACR TI-RADS compares to other risk stratification systems.

#### RC210B TI-RADS: Cases for Aces

Participants

William D. Middleton, MD, Saint Louis, MO (*Presenter*) Nothing to Disclose

#### LEARNING OBJECTIVES

1) Interpret the five sonographic features used in the ACR TI-RADS. 2) Accurately classify thyroid nodules using the ACR TI-RADS. 3) Recommend appropriate management for patients with thyroid nodules.

#### RC210C After TI-RADS: Bethesda Classification and Molecular Studies

Participants

Mary C. Frates, MD, Boston, MA (*Presenter*) Nothing to Disclose

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#### LEARNING OBJECTIVES

1) Describe the utility of the Bethesda classification for cytology interpretation. 2) Compare and contrast the different molecular testing options. 3) Explain how to manage nodules with indeterminate results.

#### RC210D Post-operative Surveillance of Thyroid Cancer

Participants

Mitchell E. Tublin, MD, Pittsburgh, PA (*Presenter*) Nothing to Disclose

#### LEARNING OBJECTIVES

1) Understand the central role of ultrasound in current ATA guidelines for surveillance of differentiated thyroid carcinoma. 2) Review nodal zone classifications, pathways of spread, and ultrasound features of locally recurrent tumor/lateral compartment adenopathy. 3) Review epidemiology of thyroid carcinoma and recent impact of professional (endocrinology, pathology, radiology) society adoption of newer guidelines upon the thyroid carcinoma 'epidemic'.

Printed on: 10/29/20



RC211

## Nuclear Medicine Series: New PET Tracers for Prostate Cancer

Monday, Dec. 2 8:30AM - 12:00PM Room: S505AB

GU NM

AMA PRA Category 1 Credits™: 3.50  
ARRT Category A+ Credits: 4.00

FDA Discussions may include off-label uses.

### Participants

Terence Z. Wong, MD, PhD, Chapel Hill, NC (*Moderator*) Consultant, Lucerno Dynamics, LLC;  
Phillip J. Koo, MD, Phoenix, AZ (*Moderator*) Advisory Board, Bayer AG; Advisory Board, Johnson & Johnson; Consultant, Blue Earth Diagnostics Ltd; Researcher, Progenics Pharmaceuticals, Inc; Speaker, Astellas Pharm Inc; Advisory Board, Pfizer Inc; Consultant, Merck & Co, Inc; Consultant, Advanced Accelerator Applications SA

### Sub-Events

#### RC211-01 Logistics: Incorporating New PET Tracers into Practice

Monday, Dec. 2 8:30AM - 8:55AM Room: S505AB

#### Participants

Nancy M. Swanston, RT, Houston, TX (*Presenter*) Nothing to Disclose

#### RC211-02 Potential Use of Fluciclovine PET/CT as Follow-Up Modality in Patients with Biochemically Recurrent Prostate Cancer

Monday, Dec. 2 8:55AM - 9:05AM Room: S505AB

#### Participants

Yo Sup Kim, BS, Maywood, IL (*Presenter*) Nothing to Disclose  
Petra Lovrec, MD, Wheaton, IL (*Abstract Co-Author*) Nothing to Disclose  
Medhat S. Gabriel, MD, Maywood, IL (*Abstract Co-Author*) Nothing to Disclose  
Robert H. Wagner, MD, Maywood, IL (*Abstract Co-Author*) Nothing to Disclose  
Bitai Savir-Baruch, MD, Atlanta, GA (*Abstract Co-Author*) Research Grant, Blue Earth Diagnostics Ltd; Consultant, Blue Earth Diagnostics Ltd

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### PURPOSE

The feasibility of fluciclovine PET/CT imaging as follow-up modality for biochemically recurrent prostate cancer patients undergoing treatment or surveillance.

### METHOD AND MATERIALS

A retrospective chart review was conducted for biochemically recurrent prostate cancer patients (Pts) who underwent two fluciclovine PET/CT scans between August 2016 and March 2019. Outcomes of follow-up scans were recorded as: Progression (new and/or increased uptake), partial response (combination of decreased and persistent uptake), improved (decreased uptake), and resolved (complete resolution). The PSA changes (%) for each interval outcome were calculated. The maximum standardized uptake values (SUV max) of lesions suspicious for malignancy and their interval changes were collected. Differences in SUV max values in Pts who demonstrated progression of disease were evaluated using the Wilcoxon Rank Sum Test.

### RESULTS

Among 260 Pts who underwent fluciclovine PET/CT, 12 Pts had 2 scans with average interval time ( $\pm$ SD) of 12  $\pm$ 5.2 months. One patient was excluded due to poor management records. In total, 11 Pts with 22 scans were included in the analysis. Types of interval management were: 4 surveillance (S), 1 radiation therapy (RT) + selective lymph node dissection (sLND), 3 initiated androgen deprivation therapy (iADT), 2 continued previously initiated ADT (cADT), and 1 RT. Interval progression was noted in 6 Pts (55%): 4 S, 1 RT + sLND, 1 cADT. Partial response in 1 cADT Pt (9%). Improved outcome in 3 Pts (27%): 2 iADT, 1 RT. Resolution in 1 iADT Pt (9%). PSA level reduced by 86.9%, 86.7%, and 100% in partial response, improved, and resolved outcome scans, respectively. PSA level increased by 223.2% in the progressed outcome scan. Among the progressed outcome scans, average SUV max for positive lesions was 4.4  $\pm$ 1.9 at baseline PET/CT (n=16) and 4.3  $\pm$ 2.2 at follow-up (n=28). Although no statistical significance of uptake difference was noted ( $p>0.05$ ), 12 new lesions were reported overall.

### CONCLUSION

Fluciclovine PET/CT can potentially be used as follow-up for treatment management in Pts with biochemically recurrent prostate cancer.

### CLINICAL RELEVANCE/APPLICATION

The usage of fluciclovine PET/CT scan as a modality to assess response to therapy is not known.

**RC211-03 Preoperative 18F-fluciclovine PET/CT Findings are Predictive of Optimal Post-Operative Prostate-Specific Antigen (PSA) in Patients with Intermediate to High-Risk Prostate Cancer**

Monday, Dec. 2 9:05AM - 9:15AM Room: S505AB

**Awards**

**Trainee Research Prize - Fellow**

**Participants**

Akinyemi A. Akintayo, MD, Atlanta, GA (*Presenter*) Nothing to Disclose  
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Mehrdad Alemozaffar, Atlanta, GA (*Abstract Co-Author*) Nothing to Disclose  
Oladunni O. Akin-Akintayo, MD, MPH, Atlanta, GA (*Abstract Co-Author*) Nothing to Disclose  
Dattatraya Patil, MBBS, MPH, Atlanta, GA (*Abstract Co-Author*) Nothing to Disclose  
Adeboye Osunkoya, MD, Atlanta, GA (*Abstract Co-Author*) Nothing to Disclose  
Martin J. Sanda, MD, Atlanta, GA (*Abstract Co-Author*) Nothing to Disclose  
David M. Schuster, MD, Decatur, GA (*Abstract Co-Author*) Institutional Research Grant, Nihon Medi-Physics Co, Ltd; Institutional Research Grant, Blue Earth Diagnostics Ltd; Institutional Research Grant, Advanced Accelerator Applications SA; Institutional Research Grant, Telix Pharmaceuticals Inc; Consultant, Syncona Ltd; Consultant, AIM Specialty Health, Inc; ;

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**PURPOSE**

To evaluate factors associated with optimal post-operative PSA following fluciclovine PET/CT guided radical prostatectomy and extended pelvic lymph node dissection (RP+EPLND).

**METHOD AND MATERIALS**

35 patients with intermediate to high risk prostate cancer underwent 18F-fluciclovine PET/CT before robotic RP+EPLND. Image interpretation was performed by a board-certified nuclear medicine physician blinded to other clinical and imaging data. Fluciclovine uptake in the prostate and extraprostatic sites were reviewed with the surgeon preoperatively. Histologic assessment was completed and results correlated with the preoperative PET/CT. Post-operative PSA were obtained 52 (range 23-139) days after surgery. Undetectable PSA was considered optimal. Univariate analysis was performed to determine factors associated with optimal post-operative PSA. Patients ineligible for curative surgery were not included in this analysis. Statistical significance was set as  $p < 0.05$ .

**RESULTS**

Local prostate disease was found in 23/35 (65.7%) patients and nodal disease was found in 12/35 (34.3%) patients [7 regional pelvic lymph nodes (N1), 5 non-regional lymph nodes (M1a)] on fluciclovine PET. Optimal post-operative PSA was present in 14/35 (40%) patients. Absence of nodal disease on PET was significantly associated with optimal post-operative PSA (OR 1.64(95%CI 1.03-2.59,  $p=0.04$ ). Also, histologic finding of localized prostatic disease (21/25 patients) was associated with optimal post-operative PSA (OR 2.79(95%CI 1.50-5.19,  $p < 0.01$ ). Though not statistically significant, pre-operative PSA in patients with optimal post-operative PSA was lower than the patients with those who has suboptimal post-operative PSA ( $16.68 \pm 17.13$  vs  $36.14 \pm 40.73$  ng/ml,  $p=0.06$ ). There was no significant difference in the Gleason scores, Grade groups or resection margins between patients who achieved optimal post-operative PSA and those who did not ( $p > 0.05$ ). All patients with non-regional LN metastasis (M1a) on PET ( $n=5$ ) or histology ( $n=5$ ) had sub-optimal post-operative PSA.

**CONCLUSION**

Findings on preoperative fluciclovine PET is predictive of achieving optimal post-operative PSA after RP+EPLND. Fluciclovine PET may have prognostic value in selecting patients that will benefit from surgery and those that may require adjuvant therapy.

**CLINICAL RELEVANCE/APPLICATION**

Findings on preoperative fluciclovine PET/CT is predictive of post-operative PSA. This may be of value in overall treatment planning for patients with high grade prostate cancer.

**RC211-04 18F-Fluciclovine PET/CT for Response Assessment in Patients with Metastatic Castration Resistant Prostate Cancer Treated with Docetaxel**

Monday, Dec. 2 9:15AM - 9:25AM Room: S505AB

**Participants**

Akinyemi A. Akintayo, MD, Atlanta, GA (*Presenter*) Nothing to Disclose  
Mehmet Asim Bilen, MD, Atlanta, GA (*Abstract Co-Author*) Nothing to Disclose  
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David M. Schuster, MD, Decatur, GA (*Abstract Co-Author*) Institutional Research Grant, Nihon Medi-Physics Co, Ltd; Institutional Research Grant, Blue Earth Diagnostics Ltd; Institutional Research Grant, Advanced Accelerator Applications SA; Institutional Research Grant, Telix Pharmaceuticals Inc; Consultant, Syncona Ltd; Consultant, AIM Specialty Health, Inc; ;

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**PURPOSE**

To determine the value of fluciclovine PET/CT in evaluation of response to docetaxel chemotherapy in patients with metastatic castration resistant prostate cancer (mCRPC).

## METHOD AND MATERIALS

Seven patients with mCRPC were evaluated in this study. Each patient had fluciclovine PET/CT prior to commencement, after 1 and 6 cycles of docetaxel. Fluciclovine uptake parameters were recorded in the prostate/bed and up to 5 metastatic bone and soft tissue lesions. The same lesions were evaluated on subsequent scans. Therapy response was assessed using the summed changes in SUVmax between PET scans (PET response) on per patient basis. Decrease in summed SUVmax of  $\geq 30\%$  was considered response, while appearance of new lesions or  $>30\%$  increase in summed SUVmax was considered progressive disease. Prostate specific antigen (PSA) levels were assessed at baseline and before each dose of chemotherapy. Assessment of response was based on recommendations from Prostate Cancer Clinical Trial Working Group 3 for PSA, bone scan and RECIST 1.1. A decrease in PSA of  $\geq 50\%$  was considered response. Results on fluciclovine PET were compared to standard of care bone scan and CT and correlated with PSA response.

## RESULTS

All patients in the study complete the 1st and 2nd fluciclovine PET/CT, while 4/7 patients completed all 3 PET/CT scans. PSA response was seen in 1/7 (14.3%), 4/7 (42.9%) had stable PSA while 2/7 (28.6%) had PSA progression after 1 cycle of docetaxel. After 6 cycles of docetaxel, 3/4 (75%) patients had PSA response, while 1/4 (25%) patient had progression. PET response correlated with PSA response in 3/7 (42.9%) patients after 1 cycle of docetaxel. After 6 cycles of docetaxel, PET response was concordant with PSA response in 3/4 (75%) patients, while bone scan and CT correlated with PSA response in 1/4 (25%) patients. Fluciclovine PET correlated with CT and bone scan in 2/4 (50%) patients.

## CONCLUSION

Fluciclovine PET seems to better correlate with PSA response than CT or bone scan in the assessment of therapy response in patients with mCRPC on docetaxel. Larger studies are required to confirm the value of fluciclovine PET as an imaging biomarker for response assessment.

## CLINICAL RELEVANCE/APPLICATION

Fluciclovine PET may be useful for assessment of treatment response in patients with metastatic castration resistant prostate cancer on docetaxel. Further investigation is warranted.

### RC211-05 Q&A

Monday, Dec. 2 9:25AM - 9:35AM Room: S505AB

### RC211-06 Landscape of New and Future PET Tracers for Prostate Cancer

Monday, Dec. 2 9:35AM - 10:00AM Room: S505AB

#### Participants

Andrei Iagaru, MD, Emerald Hills, CA (*Presenter*) Research Grant, General Electric Company Research Grant, Progenics Pharmaceuticals, Inc Research Grant, Advanced Accelerator Applications SA

## LEARNING OBJECTIVES

1) List some of the molecular imaging targets that are used in prostate cancer. 2) Understand underlying biology and mechanism of action for some of the new PET radiopharmaceuticals in prostate cancer. 3) Discuss patterns of prostate cancer appearance when using some of the new PET radiopharmaceuticals.

## ABSTRACT

Data from the American Cancer Society suggests that prostate cancer will continue to be the leading cancer diagnosis in men with 174,650 estimated new cases and will have the second highest mortality (after lung cancer) with 31,620 estimated deaths for 2019 in the United States. Initial and subsequent treatment of prostate cancer may involve surgery, radiation therapy, hormonal therapy, chemotherapy, or a combination of these. Additional molecular pathways in prostate cancer lead to the identification of new targets that may be amenable to diagnostic and therapeutic intervention with novel agents. Areas of interest for the Nuclear Medicine and Molecular Imaging community include mainly aminoacid analogues (Fluciclovine) and the prostate specific membrane antigen (PSMA), but also gastrin releasing peptide receptors (GRPR).

### RC211-07 Clinical Impact of 68Ga-PSMA-11 PET on Patient Management for Staging Intermediate to High-Risk Prostate Cancer Patients

Monday, Dec. 2 10:00AM - 10:10AM Room: S505AB

#### Participants

Daniela A. Ferraro, MD, Zurich, Switzerland (*Presenter*) Nothing to Disclose  
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## PURPOSE

Accurate staging is of major importance for prognosis assessment and treatment approach for patients with prostate cancer. Positron emission tomography (PET) with prostate specific membrane antigen (PSMA) is a promising technique that already outperformed conventional imaging in the detection of nodal and distant metastasis in previous studies. However, it is still unclear whether this superior sensitivity and specificity of PSMA PET would translate into a significant impact on management. The aim of this study was to assess the detection rate of disease and impact on management of 68Ga-PSMA-11 PET in patients that underwent a 68Ga-PSMA-11 PET scan for staging prostate cancer.

## METHOD AND MATERIALS

In this retrospective analysis, approved by the local ethics committee, from all 137 patients that underwent 68Ga-PSMA-11 PET/CT or 68Ga-PSMA-11 PET/MRI scans for staging intermediate and high-risk prostate cancer between April 2016 and May 2018, 116 patients gave written informed consent for retrospective analysis of their data and were included into the study. The potential 68Ga-PSMA-11 PET impact on patient management was assessed within a simulated multidisciplinary tumour board where clinical and conventional imaging information was used to define treatment option pre-68Ga-PSMA-11 PET and information from the 68Ga-PSMA-11 PET was added to define treatment post-68Ga-PSMA-11 PET.

## RESULTS

The primary tumour was positive on 68Ga-PSMA-11 PET in 113 patients (97%). Nodal metastasis were detected in 27 (23%) and bone metastasis in 14 patients (12%). Compared to clinical staging and conventional imaging, 68Ga-PSMA-11 PET brought new information in 42 of 116 patients (36%), leading to a change in management in 32 (27%) of them. In 15 patients (13%) a new therapy modality was chosen and in 17 patients (14%) the therapy details would be adjusted based on 68Ga-PSMA-11 PET findings (e.g. modification of radiotherapeutic field).

## CONCLUSION

68Ga-PSMA-11 PET changed the management in more than a fourth of intermediate to high-risk prostate cancer patients. Whether tailor-made therapies based on 68Ga-PSMA-11 PET will improve patient outcome will need further investigation.

## CLINICAL RELEVANCE/APPLICATION

68Ga-PSMA-11 PET have an impact on patient management in the staging setting for intermediate and high-risk prostate cancer patients.

### RC211-08 The Impact of 18F-DCFPyL PET-CT Imaging on Staging and Clinical Management of Men with De Novo Prostate Cancer: A First Experience within Veterans Healthcare System

Monday, Dec. 2 10:10AM - 10:20AM Room: S505AB

#### Participants

Neil R. Parikh, MD, MBA, Los Angeles, CA (*Presenter*) Nothing to Disclose  
Carol Bennett, MD, Los Angeles, CA (*Abstract Co-Author*) Nothing to Disclose  
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Ahmad Sadeghi, MD, Santa Monica, CA (*Abstract Co-Author*) Nothing to Disclose  
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Nicholas Nickols, MD, Los Angeles, CA (*Abstract Co-Author*) Research Grant, Johnson & Johnson; Research Grant, Varian Medical Systems, Inc; Research Grant, Bayer AG; Consultant, Genes Sciences Inc; Consultant, Progenics Pharmaceuticals, Inc;  
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## PURPOSE

Positron emission tomography with computed tomography (PET-CT) utilizing novel prostate-specific membrane antigen (PSMA) tracers has shown efficacy in detecting extraprostatic disease not otherwise seen on conventional imaging. Although most published studies with PSMA PET-CT were conducted in the recurrent/salvage setting and utilized a gallium-based probe, this study aimed to evaluate the effect of 18F-DCFPyL PET-CT on staging and clinical management of patients with newly-diagnosed, untreated prostate cancer.

## METHOD AND MATERIALS

From 9/2018 to 3/2019, 39 Veterans with untreated prostate cancer were prospectively enrolled on a single-arm Phase II clinical trial to receive 18F-DCFPyL PET-CT, in addition to conventional imaging, for staging of prostate cancer. Enrollment criteria was defined as: prostate specific antigen greater than 10 ng/mL, Gleason Score 4+3 or higher, or clinical stage T2c or higher. Upon completion of 18F-DCFPyL PET-CT, management recommendations for each case were formulated by a multi-disciplinary physician team consisting of a urologic oncologist, medical oncologist, and radiation oncologist, based upon predetermined recommendations associated with clinic-pathologic criteria and imaging findings in accordance with current guidelines.

## RESULTS

Of the 39 patients initially enrolled, clinic-pathologic features and conventional imaging enabled designation of 5 unfavorable-intermediate cases, 26 high-risk cases, 3 node-positive cases, and 5 metastatic cases. Following 18F-DCFPyL PET-CT, 12 patients were upstaged and 3 were downstaged. Modified treatment recommendations were made to initiate long-term abiraterone in 9 (23%) patients, extend abiraterone duration in 3 (8%) patients, extend ADT course in 12 (31%) patients, boost pelvic nodes in 4 (10%) patients, deliver metastasis-directed therapy (MDT) in 8 (21%) patients, and forgo RT to primary in 1 (3%) patient. Three patients (7.5%) initially thought to have M1 disease were downstaged and no longer recommended to receive abiraterone or MDT.

## CONCLUSION

In conjunction with conventional imaging, 18F-DCFPyL PET-CT appears to significantly alter the staging and management of newly-diagnosed untreated prostate cancer patients.

## CLINICAL RELEVANCE/APPLICATION

Patients with unfavorable-intermediate (or higher) prostate cancer may benefit from upfront 18F-DCFPyL PET-CT to improve



staging and designation of individuals for combination and/or systemic therapy.

### **RC211-09 Interim Analysis Results of a Prospective Study of 68Ga-RM2 PET/MRI in Patients with Biochemically Recurrent Prostate Cancer and Negative Conventional Imaging**

Monday, Dec. 2 10:20AM - 10:30AM Room: S505AB

#### Participants

Lucia Baratto, MD, Stanford, CA (*Presenter*) Nothing to Disclose  
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Andrei Iagaru, MD, Emerald Hills, CA (*Abstract Co-Author*) Research Grant, General Electric Company Research Grant, Progenics Pharmaceuticals, Inc Research Grant, Advanced Accelerator Applications SA

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#### **PURPOSE**

68Ga-RM2 is a synthetic bombesin receptor antagonist targeting gastrin-releasing peptide receptors (GRPr) that are overexpressed in several human tumors, including prostate cancer (PC). We present data from the use of 68Ga-RM2 in patients with biochemically recurrent (BCR) PC and negative conventional imaging (CI).

#### **METHOD AND MATERIALS**

We enrolled 91 men with BCR PC, 53-83-year-old (mean±SD: 68.8±6.3). Imaging started at 40-89 minutes (mean±SD: 53.6±8.8 after injection of 127.5-152.6 MBq (mean±SD: 141.8±5.3) of 68Ga-RM2 using a time-of-flight (TOF)-enabled simultaneous positron emission tomography (PET) / magnetic resonance imaging (MRI) scanner. T1-weighted (T1w), T2-weighted (T2w) and diffusion-weighted images (DWI) were acquired. Standardized uptake value (SUVmax) measurements in up to 6 lesions with highest uptake was collected in 35 patients for this analysis.

#### **RESULTS**

All patients had rising prostate specific antigen (PSA) (range: 0.2-124 ng/mL; mean±SD: 7.6±18.5) and negative CI (CT or MRI, and 99mTc MDP bone scan) prior to enrollment. 68Ga-RM2 PET identified recurrent PC in 64 of the 91 participants, while the simultaneous MRI scan identified findings compatible with recurrent PC in 25 of the 91 patients. PSA velocity (PSAv) values were 0.29±0.44 ng/ml/year (range: 0.03-1.9) in patients with negative PET scans and 2.29±2.01 ng/ml/year (range: 0.13-8.68) in patients with positive PET scans (P: 0.0042). We detected 73 lesions in 35 patients (45 lymph nodes, 9 prostate bed, 5 seminal vesicles, 9 bone, 2 liver and 2 lungs), mean±SD SUVmax was 9.19±11.23.

#### **CONCLUSION**

68Ga-RM2 PET identifies GRPr expression in BCR PC lesions despite negative CI, indicating it is a promising PET radiopharmaceutical in this clinical scenario. 68Ga-RM2 may identify higher risk patients given the highly statistically significant difference PSA velocity values between patients with negative and positive scans.

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

68Ga-RM2 is a promising tracer for assessment of GRPr expression in patients with BCR PC.

### **RC211-10 Automatic Acquired 18F-Choline PET/CT Biomarkers Association with Prognostic Value in High-Risk Prostate Cancer Patients**

Monday, Dec. 2 10:30AM - 10:40AM Room: S505AB

#### Participants

Pablo Borrelli, MD, Goteborg, Sweden (*Presenter*) Nothing to Disclose  
Henrik Kjolhede, Goteborg, Sweden (*Abstract Co-Author*) Nothing to Disclose  
Olof Enqvist, Malmo, Sweden (*Abstract Co-Author*) Nothing to Disclose  
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Mattias Ohlsson, Halmstad, Sweden (*Abstract Co-Author*) Nothing to Disclose  
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#### **CONCLUSION**

Automated deep learning-based measurements of 18F-choline uptake in the prostate gland were significantly associated with prostate cancer specific survival in patients with hormone-naive prostate cancer. This type of deep learning-based methods could be applied to other prostate cancer PET tracers as well, for example PSMA.

#### **Background**

Biomarkers are not routinely used in PET/CT explorations, one of the motives could be that automated quantitative PET/CT assessments are often lacking. Although few research groups are incorporating deep learning in PET/CT management and have successfully used to delineate or identify gross tumoral volume in different malignancies, the use of biomarkers acquired with the aid of deep learning is almost unheard of in 18F-choline PET/CT in prostate cancer.

#### **Evaluation**

The core of the automated segmentation method is a fully convolutional neural network (CNN) taking both the PET and the CT image. The CNN works directly on the three-dimensional images and produces segmentations of the prostate as well as the urinary bladder (Figure 1). Based on these segmentations, prostate volume, lesion volume, SUVmax and total lesion uptake (TLU, defined as the product SUVmean x lesion volume) are calculated. The CNN was trained on a separate training set of manually segmented PET/CT scans. After the training, the method was applied to a separate validation group of patients with prostate cancer who had undergone 18F-choline PET/CT for primary metastasis staging before treatment. Associations between automated deep learning-based PET/CT measurements, age, PSA, Gleason score, T stage, and prostate cancer specific survival were studied using a univariate Cox proportional hazards regression model.

## Discussion

A total of 77 patients were included in the validation group and twelve of them died from prostate cancer during follow-up. Median survival time was 4.9 years (range 1.7-7.0 years) compared to a median follow-up time of 6.6 years (range 1.8-8.5 years) in the remaining patients. TLU ( $p=0.01$ ), prostate volume ( $p=0.02$ ), lesion volume ( $p=0.001$ ), and PSA ( $p=0.03$ ) were significantly associated with prostate cancer specific survival, while SUVmax, age, T stage and Gleason score were not.

## RC211-11 Q&A

Monday, Dec. 2 10:40AM - 10:50AM Room: S505AB

## RC211-12 Clinician's Perspective: Impact and Applications

Monday, Dec. 2 10:50AM - 11:15AM Room: S505AB

### Participants

Steve Cho, MD, Madison, WI (*Presenter*) Research Grant, General Electric Company; Consultant, Advanced Accelerator Applications SA;

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## LEARNING OBJECTIVES

1) Review current and emerging PET radiotracers for prostate cancer. 2) Assess how these new PET imaging radiotracers can address unmet clinical needs in prostate cancer. 3) Address remaining clinical and research questions arising from new PET radiotracers in prostate cancer.

## RC211-13 Prospective Comparison of 18F-DCFPyL PET/CT with 18F-NaF PET/CT for Detection of Skeletal Metastases in Biochemically Recurrent Prostate Cancer

Monday, Dec. 2 11:15AM - 11:25AM Room: S505AB

### Participants

Heying Duan, MD, Stanford, CA (*Presenter*) Nothing to Disclose

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## PURPOSE

18F-DCFPyL is a promising 18F-labeled agent for PSMA PET imaging, available at our institution through a research access program. Here we compared 18F-DCFPyL PET/CT and 18F-NaF PET/CT for the detection of skeletal metastases in patients with biochemically recurrent prostate cancer (BCR PC).

## METHOD AND MATERIALS

We prospectively enrolled 50 patients (52-91 years old,  $71.2 \pm 7.4$  years) who had 18F-DCFPyL PET/CT at BCR PC after definitive treatment with prostatectomy (30 patients) and/or radiation therapy (20 patients). A total of 16 of the 50 patients (63-86 years old,  $73.6 \pm 5.9$  years) also had 18F-NaF PET/CT for identification of bone metastases. Up to 7 bone lesions were recorded per patient for each tracer.

## RESULTS

Three patients did not have bone metastases. A total of 41 skeletal lesions were found. 18F-DCFPyL PET/CT identified 32 bone lesions (78%) and 18F-NaF PET/CT identified 35 lesions (85.4%). Congruent findings between 18F-DCFPyL and 18F-NaF were found in 26/41 (63.4%) lesions. 18F-DCFPyL identified 1 lesion missed on 18F-NaF in 4 participants (4/41, 9.8%). However, 18F-DCFPyL was negative in 2 patients with lesions found on 18F-NaF (4/41 lesions, 9.8%). CT alone identified 21 lesions (51.2%).

## CONCLUSION

The performance of 18F-DCFPyL PET/CT for detecting bone metastases is similar to that of 18F-NaF PET/CT. Taken together with the accuracy of 18F-DCFPyL PET/CT in the detection of non-bone metastases and disease at low PSA presented separately, 18F-DCFPyL PET/CT may be used as a "one stop shop" for evaluation of patients with BCR PC. However, more patients have to be evaluated to support these findings.

## CLINICAL RELEVANCE/APPLICATION

18F DCFPyL PET/CT is a very promising diagnostic tool for evaluating patients with BCR PC.

### RC211-14 Rapid High Definition Na18F Digital PET/CT for Whole-Body Osteoblastic Disease Assessment: A Phase I Intra-Individual Comparison Study

Monday, Dec. 2 11:25AM - 11:35AM Room: S505AB

#### Participants

Chadwick L. Wright, MD, PhD, Columbus, OH (*Presenter*) Nothing to Disclose  
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Jun Zhang, PhD, Columbus, OH (*Abstract Co-Author*) Nothing to Disclose  
Edmund Folefac, Columbus, OH (*Abstract Co-Author*) Nothing to Disclose  
Dayssy A. Diaz-Pardo, Columbus, OH (*Abstract Co-Author*) Nothing to Disclose  
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Michael V. Knopp, MD, PhD, Columbus, OH (*Abstract Co-Author*) Nothing to Disclose

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#### PURPOSE

In this Phase Ib intra-individual comparison study we assess the clinical feasibility of a substantially faster, high-definition whole-body Na18F PET approach using digital photon counting PET detector (dPET) technology in the evaluation of osteoblastic metastatic disease and compare to standard PET image acquisition times (60 - 120 s/bed).

#### METHOD AND MATERIALS

Whole-body Na18F dPET/CT imaging (Vereos, Philips) was performed in 29 male oncologic patients using a target Na18F dose of 185 MBq. At 70 min post injection, dPET acquisitions were performed using a substantially faster acquisition time of 30 s/bed. At 85 min post injection, dPET acquisitions were performed using standard 90 s/bed. All dPET image data sets were reconstructed using Time-of-Flight and high-definition approaches with voxel volume = 2x2x2 mm<sup>3</sup>. A blinded reader panel using an Intellispace Portal workstation to assess background quality, image quality and lesion detectability reviewed the data sets.

#### RESULTS

All patients had evaluable dPET data sets (n = 58) for qualitative assessment of 18F biodistribution and osteoblastic activity. Faster dPET acquisitions demonstrated comparable 18F-avidity in both normal bone and osteoblastic lesion conspicuity when compared to standard acquisitions with no discordant osteoblastic lesions. Average SUV<sub>mean</sub> were comparable for 30 s/bed and 90 s/bed acquisitions for background skeletal muscle (0.8 +/- 0.1 and 0.7 +/- 0.1, respectively) and normal vertebral bone (7.1 +/- 1.6 and 7.6 +/- 1.7, respectively). Average SUV<sub>max</sub> of 48 osteoblastic lesions were also comparable for 30 s/bed and 90 s/bed acquisitions (32.4 +/- 27.9 and 35.9 +/- 30.8, respectively).

#### CONCLUSION

There is an unmet clinical need to reduce PET image acquisition time for patients with symptomatic bony disease. This Phase Ib study demonstrates the clinical feasibility of rapid whole-body high-definition PET imaging with dPET technology.

## CLINICAL RELEVANCE/APPLICATION

Digital PET technology enables substantially faster (3x) whole-body Na18F PET imaging with no loss of lesion detectability, image quality or quantitative accuracy.

### RC211-15 Ga-68-PSMA Activity Optimization Based on List-Mode Phantom and Patient Data

Monday, Dec. 2 11:35AM - 11:45AM Room: S505AB

#### Participants

Jette Wielaard, MSc, Nieuwegein, Netherlands (*Presenter*) Nothing to Disclose  
Jan Habraken, Nieuwegein, Netherlands (*Abstract Co-Author*) Nothing to Disclose  
Peter Brinks, PhD, Nieuwegein, Netherlands (*Abstract Co-Author*) Nothing to Disclose  
Jules Lavalaye, MD, PhD, Nieuwegein, Netherlands (*Abstract Co-Author*) Nothing to Disclose  
Ronald Boellaard, PhD, Amsterdam, Netherlands (*Abstract Co-Author*) Researcher, Koninklijke Philips NV

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#### PURPOSE

A study on optimization of Gallium-68 (68Ga) activity for 68Ga-prostate specific membrane antigen positron emission tomography/computed tomography (68Ga PSMA PET/CT) studies is achieved by finding the highest coefficient of variation (COV) acceptable for reliable image interpretation and quantification.

#### METHOD AND MATERIALS

To obtain images with different COV, lower activities were mimicked by reconstructions with shorter acquisition times. A 20 min/bed (2 bed positions) scan of the NEMA Image Quality phantom is acquired in list mode PET (Philips Gemini PET/CT), of which sphere 1 (d=10mm) is analysed (activity ratio 9:1 for spheres compared to background). First, to evaluate impact on image interpretation, the relationship of COV and contrast-to-noise ratio (CNR) is studied and assuming that the CNR should remain greater than 5 (Rose criterion). Secondly, the effect of COV on the difference between quantification results of two equivalent studies is analysed. Pairs of equivalent images were obtained by reconstruction of two non overlapping parts of list-mode data. Comparison was done by calculating the percentage difference of the SUV<sub>mean</sub>. The maximum allowable percentage difference was set at 20%.

#### RESULTS

Results show that at a COVmax  $\leq$  25% image interpretation (CNR  $\geq$  5) as well as image quantification (percentage difference  $\geq$  20%) are within acceptable limits. The phantom scan with a COV of 25% was acquired with an acquisition time of 114 s and a background activity concentration of 0.71 MBq/kg. This is translated to the clinical protocol by taking into account decay between injection and acquisition time and urine clearance, resulting in a clinical activity regimen of 3.5 MBq/kg\*min at injection. To verify this activity regimen, 16 patients (6 MBq/kg\*min) with a total of 27 lesions are included. Additional reconstructions were made to mimic the proposed activity regimen. Based on the CNR criterion no lesions greater than 10 mm are missed with this proposed activity regimen.

#### **CONCLUSION**

A COVmax of 25% leads to a proposed activity regimen of 3.5 MBq/kg\*min at injection, which indicates that activity can be reduced by almost 50% for diagnostic readings of scans. This is supported by clinical images: none of the included lesions were missed using the newly proposed activity regimen.

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

The injected activity for 68Ga-PSMA imaging studies can be reduced for diagnostic readings of scans.

#### **RC211-16 Panel Discussion**

Monday, Dec. 2 11:45AM - 12:00PM Room: S505AB

#### **Participants**

Nancy M. Swanston, RT, Houston, TX (*Presenter*) Nothing to Disclose

Andrei Iagaru, MD, Emerald Hills, CA (*Presenter*) Research Grant, General Electric Company Research Grant, Progenics Pharmaceuticals, Inc Research Grant, Advanced Accelerator Applications SA

Steve Cho, MD, Madison, WI (*Presenter*) Research Grant, General Electric Company; Consultant, Advanced Accelerator Applications SA;

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#### **LEARNING OBJECTIVES**

1) Discuss questions and issues related to new and emerging PET imaging agents for prostate cancer.

Printed on: 10/29/20



RC212

## Body Imaging Expert Panel: CTA or MRA?

Monday, Dec. 2 8:30AM - 10:00AM Room: S104A

**CT** **MR** **VA**

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

### Participants

Martin R. Prince, MD, PhD, New York, NY (*Moderator*) Patent agreement, General Electric Company; Patent agreement, Hitachi, Ltd; Patent agreement, Siemens AG; Patent agreement, Koninklijke Philips NV; Patent agreement, Nemoto Kyorindo Co, Ltd; Patent agreement, Bayer AG; Patent agreement, Lantheus Medical Imaging, Inc; Patent agreement, Bracco Group; Patent agreement, Mallinckrodt plc; Patent agreement, Guerbet SA; Patent agreement, Toshiba Corporation

### Sub-Events

#### RC212A MRA

##### Participants

J. Paul Finn, MD, Los Angeles, CA (*Presenter*) Nothing to Disclose  
Scott B. Reeder, MD, PhD, Madison, WI (*Presenter*) Nothing to Disclose  
Robert R. Edelman, MD, Evanston, IL (*Presenter*) Research support, Siemens AG; Royalties, Siemens AG

### LEARNING OBJECTIVES

1) Discuss CTA and MRA methods and techniques for optimized vascular imaging in clinical practice. 2) Debate the advantages and disadvantages of CTA and MRA in clinical practice. 3) Recommend the application of CTA or MRA for common challenging clinical scenarios.

#### RC212B CTA

##### Participants

Elliot K. Fishman, MD, Owings Mills, MD (*Presenter*) Institutional Grant support, Siemens AG; Institutional Grant support, General Electric Company; Co-founder, HipGraphics, Inc  
W. Dennis Foley, MD, Milwaukee, WI (*Presenter*) Nothing to Disclose  
Geoffrey D. Rubin, MD, Durham, NC (*Presenter*) Consultant, Fovia, Inc; Advisor, HeartFlow, Inc; Consultant, General Electric Company; Advisor, Boehringer Ingelheim GmbH; Advisor, Siemens AG;

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### LEARNING OBJECTIVES

1) Discuss CTA and MRA methods and techniques for optimised vascular imaging in clinical practice. 2) Debate the advantages and disadvantages of CTA and MRA in clinical practice. 3) Recommend the application of CTA or MRA for common challenging clinical scenarios.

Printed on: 10/29/20



RC213

## Pediatric Series: Chest/Cardiovascular Imaging

Monday, Dec. 2 8:30AM - 12:00PM Room: E353B

CH PD

AMA PRA Category 1 Credits™: 3.25  
ARRT Category A+ Credits: 4.00

FDA Discussions may include off-label uses.

### Participants

Edward Y. Lee, MD, Boston, MA (*Moderator*) Nothing to Disclose

Shi-Joon Yoo, MD, Toronto, ON (*Moderator*) Nothing to Disclose

Dianna M. Bardo, MD, Phoenix, AZ (*Moderator*) Speaker, Koninklijke Philips NV; Consultant, Koninklijke Philips NV; Master Enterprise Agreement, Koninklijke Philips NV; Author, Thieme Medical Publishers, Inc; Research support, Bracco Group; Consultant, Guerbet SA; Consultant, Anderson Publishing, Ltd

Cynthia K. Rigsby, MD, Chicago, IL (*Moderator*) Nothing to Disclose

### Sub-Events

#### RC213-01 Imaging of Pediatric Interstitial Lung Disease

Monday, Dec. 2 8:30AM - 8:50AM Room: E353B

#### Participants

Edward Y. Lee, MD, Boston, MA (*Presenter*) Nothing to Disclose

### LEARNING OBJECTIVES

1) Review new classification system for pediatric interstitial lung disease. 2) Discuss optimal imaging techniques for assessing pediatric interstitial lung disease. 3) Learn characteristic imaging findings of pediatric interstitial lung disease.

#### RC213-02 Low-Dose Computerized Tomography of the Airways to Diagnose Suspected Foreign Body Aspiration in Children

Monday, Dec. 2 8:50AM - 9:00AM Room: E353B

#### Participants

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### PURPOSE

Suspected foreign body aspiration (FBA) in the airways is a common event at the pediatric emergency units, especially in children under 3 years of age. The event can be life threatening if not diagnosed promptly and accurately. The purpose of our study was to introduce a low dose CT protocol using tin filter as first and only diagnostic tool in the diagnosis of airway foreign body aspiration.

### METHOD AND MATERIALS

A retrospective review was conducted to compare diagnostic performance and effective doses for conventional radiographic methods (fluoroscopy and plain radiography in two projections) with low dose CT using a tin filter. Data from 136 children was collected; 75 were examined with conventional radiographic methods and 61 with low dose CT. The following parameters were analyzed; tube voltage, KAP, CTDI, DLP and effective dose. Independent t-test were used for analysis of continuous variables and contingency 2 x 2 tables were elaborated to assess the diagnostic performance of the two investigated diagnostic methods related to laryngo-bronchoscopy outcomes. The accuracy of the methods were also calculated.

### RESULTS

The low dose CT examinations resulted in lower effective doses compared to conventional radiographic methods ( $p < 0.001$ ), with a median dose at CT of 0,04 mSv compared to conventional radiographic methods 0.1 mSv (Fig 1). Sensitivity and specificity was higher for low dose CT (100% and 98%) than for conventional methods (25% and 94%) as was positive and negative predicted values; (90% and 100%) for CT and (40% and 91%) for conventional methods. The accuracy of low dose CT to diagnose suspected FBA in the airways was 98% compared to 88% using conventional methods.

### CONCLUSION

A tailored low dose CT protocol can be used as first and only diagnostic tool in the emergency setting in the diagnosis of suspected FBA in the airways, reducing radiation dose and increasing diagnostic accuracy to avoid a high negative bronchoscopy rate.

## CLINICAL RELEVANCE/APPLICATION

A tailored low dose CT protocol in children with suspected FBA in the airways reduces radiation dose and negative bronchoscopy rate, thereby avoiding unnecessary risks such as laryngospasm and complications from anesthesia.

### RC213-03 Comparison of Radiation Dose and Image Quality of Contrast-Enhanced Dual-Source CT of the Pediatric Chest: Single versus Dual-Energy CT

Monday, Dec. 2 9:00AM - 9:10AM Room: E353B

#### Participants

Juan Carlos Ramirez-Giraldo, PhD, Cary, NC (*Presenter*) Employee, Siemens AG

Marilyn J. Siegel, MD, Saint Louis, MO (*Abstract Co-Author*) Speakers Bureau, Siemens AG Spouse, Consultant, General Electric Company

#### PURPOSE

To compare radiation dose and image quality of single- and dual-energy CT (SECT, DECT) examinations of the pediatric chest on a dual-source CT scanner (DSCT).

#### METHOD AND MATERIALS

Retrospective CT data were collected in pediatric patients (age  $8.0 \pm 6.6$  years, range newborn to 21 years) from September 2014 until September 2018 using dose tracking software. Contrast-enhanced thoracic CT studies were sorted into two categories: SECT (N=264) and DECT (N=291). SECT done at 80, 100 or 120 kVp were included to match DECT range of 80/140 kVp. Size-specific dose estimates (SSDEs) based on body circumference and volume CT dose index (CTDIvol) were calculated. All examinations were performed on a 2nd generation DSCT system (Somatom Flash, Siemens Healthineers). Both SECT and DECT acquisitions used automatic exposure control and iterative reconstruction. Patient data were grouped into one of five body circumferences. The median, 25th and 75th quartile of the SSDEs within each circumference group was calculated. Statistical unpaired comparisons were made between groups. Subjective image quality (scale 1, excellent, to 4, non-diagnostic) of 25 DECT and SECT scans from each circumference group was assessed.

#### RESULTS

For the five effective diameters (< 15cm, 15-19cm, 20-24cm, 25-30 cm and > 30cm), the median SSDE [25th-75th quartile] for DECT were 2.2 [1.8-2.5], 2.8 [2.4-3.2], 4.8 [3.8-5.6], 6.6 [6.1-8.3], 8.6 [6.7-18.6] mGy and for SECT 2.4 [2.0-3.3], 2.2 [1.9-3.0], 5.9 [3.8-7.6], 8.6 [6.8-10.7], 11.4 [9.6-13.5] mGy; respectively. The SSDE for DECT was statistically lower than that of SECT for the 20-24cm group, and non-significantly different from all other groups. Overall, there were no statistical differences in the median [25th-75th quartile] of SSDE values for the DECT and SECT (4.5 [2.8-6.1] vs 4.5 [2.2-8.0],  $P = 0.229$ ). Image quality was also similar for both DECT and SECT. Differences in subjective image quality between the four groups were not statistically significant.

#### CONCLUSION

Contrast-enhanced DECT examinations of the pediatric chest can be performed routinely with second-generation DSCT systems without either increased radiation exposure or decreased image quality compared with SECT acquisition.

## CLINICAL RELEVANCE/APPLICATION

Our results suggest that the DECT mode on DSCT scanners should be implemented in pediatric chest CT which has the advantage of allowing further postprocessing capabilities to improve image quality and differentiation

### RC213-04 Pediatric Chest CT at 100 kVp with Tin Filtration: Comparison of Image Quality with 70 kVp Imaging at Comparable Radiation Dose

Monday, Dec. 2 9:10AM - 9:20AM Room: E353B

#### Participants

Sophie Vivier, Lille, France (*Abstract Co-Author*) Nothing to Disclose

Younes Arous, MD, Lille, France (*Abstract Co-Author*) Nothing to Disclose

Jean-Baptiste Faivre, MD, Lille, France (*Abstract Co-Author*) Nothing to Disclose

Thomas G. Flohr, PhD, Forchheim, Germany (*Abstract Co-Author*) Employee, Siemens AG

Jacques Remy, MD, Mouvaux, France (*Abstract Co-Author*) Research Consultant, Siemens AG

Martine J. Remy-Jardin, MD, PhD, Lille, France (*Presenter*) Research Grant, Siemens AG; Speaker, Siemens AG

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#### PURPOSE

The attention of the medical community has recently been driven to further reduce radiation dose by spectral shaping, i.e., pre-patient filtration of the x-ray beam by additional filters. The low-energy photons of the polyenergetic x-ray beam in an energy range of about 30-50 keV are almost completely absorbed by the anatomical region scanned. As a consequence, these photons increase the radiation dose to the patient without significantly contributing to image formation, at least in CT scans without iodinated contrast agent. The purpose of this study was to investigate the level of noise reduction achievable with tin filtration at 100 kVp in pediatric chest CT in comparison with the standard scanning reference at 70 kVp, with both CT examinations performed at comparable radiation dose.

#### METHOD AND MATERIALS

50 consecutive children (Group 1) underwent noncontrast chest CT examinations on a 3rd-generation dual-source CT system at Sn100kVp and pitch 2. The tube-current time product (mAs) was adjusted to maintain the predicted DLP value at 70 kVp for the respective patient. Each child was then paired by weight and age to a child scanned at 70kVp on the same CT unit (Group 2).

#### RESULTS

The mean image noise was significantly lower in Group 1 compared to Group 2 when measured in the air around the patient

( $p < 0.0001$ ) and inside the aorta ( $p < 0.001$ ). The mean CNR was higher in Group 1 than in Group 2. In Group 1, the mean ( $\pm$ SD) noise reduction was 21.6 % ( $\pm 16.11$ ) (median: 21.3; range: -52.7 to 46.7) around the thorax and 12.0% ( $\pm 32.73$ ) (median: 14.8; range: -141 to 69.8) inside the thorax. There was no significant difference between the two groups with respect to the subjective scores for chest examinations, whether considering scores of the entire examination ( $p = 0.87$ ), or scores of only parenchymal ( $p = 1$ ) or mediastinal structures ( $p = 0.81$ ). CT examinations were always rated with an excellent diagnostic quality both at 100kVp-Sn and 70kVp.

## CONCLUSION

At comparable radiation dose, the image noise was found to be reduced by 21.6% compared to the 70-kVp protocol, providing basis for dose reduction without altering image quality in further investigations.

## CLINICAL RELEVANCE/APPLICATION

With spectral filtration, the image noise can be reduced by 21.6% with an excellent image quality. This provides an objective basis for further dose reduction of pediatric non-contrast scans.

### RC213-05 Clinical Significance of Ancillary Findings on Chest CTA in Performed for Suspected Pulmonary Embolism in Children

Monday, Dec. 2 9:20AM - 9:30AM Room: E353B

#### Participants

Christian A. Barrera, MD, Philadelphia, PA (*Abstract Co-Author*) Nothing to Disclose  
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Angela Ellison, MD, MSc, Philadelphia, PA (*Abstract Co-Author*) Nothing to Disclose  
Summer L. Kaplan, MD, MS, Philadelphia, PA (*Presenter*) Nothing to Disclose

## PURPOSE

The number of chest computed tomography angiograms (CTA) performed in children for suspected pulmonary embolism (PE) has risen in the pediatric emergency department (ED), but the number of PE detected has remained the same. However, CTA exams may provide additional clinically significant information. Number of clinically relevant ancillary findings on CTA negative for PE may affect clinical decision making regarding the risk/benefit ratio of CTA

## METHOD AND MATERIALS

We retrospectively reviewed radiology reports from chest CTA exams performed for suspected PE in patients  $\leq 20$  years old at our tertiary pediatric ED during a 13-year period. In addition to demographic information, we noted whether radiology report was negative for PE and whether ancillary findings were present. We stratified clinical significance of ancillary findings as likely relevant, equivocal, or unlikely relevant. For chest CTA with chest radiographs performed  $< 24$  hours prior, we compared CTA report to radiograph report and categorized CTA findings as new or previously described on radiograph.

## RESULTS

During 13 years, 307 chest CTA exams were performed in our ED for PE, and 84% ( $N = 257$ ) were negative for PE. Of these exams negative for PE, 35% ( $N = 91$ ) had ancillary findings, and 21% ( $N = 54$ ) were likely clinically relevant. However, only 13% ( $N = 34$ ) of exams had a clinically significant finding that was not described on prior radiograph. The most frequent ancillary findings were pneumonia ( $N = 26$ ), pleural effusion ( $N = 11$ ), mosaic attenuation ( $N = 9$ ) and lung nodules ( $N = 7$ ). While the number of chest CTA exams increased 3.6 per year ( $R^2 = 0.89$ ), the number of exams of with clinically relevant ancillary findings increased by 0.4 per year ( $R^2 = 0.81$ ). The percent of chest CTA exams each year that yielded new, clinically relevant information ranged from 0% to 3%.

## CONCLUSION

Chest CTA performed in a pediatric ED to evaluate PE found a new, clinically relevant finding in 13% of cases when PE was negative. An increasing number of CTA per year did not correspond to a similar increase in the number of new clinically relevant ancillary findings.

## CLINICAL RELEVANCE/APPLICATION

When considering chest CTA for children with symptoms of PE, clinicians should consider not only the low probability of PE in these children, but also the low probability of finding a relevant abnormality not identified on prior radiograph.

### RC213-06 Role of MDCT Angiography in Evaluation of Pulmonary Arteries and Collateral Vessels in Children with Cyanotic Congenital Heart Diseases

Monday, Dec. 2 9:30AM - 9:40AM Room: E353B

#### Participants

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## PURPOSE

To compare the efficacy of MDCT Angiography (CTA) with echocardiography (TTE) in evaluation of pulmonary arteries and collateral



vessels (MAPCAs) in children with cyanotic congenital heart diseases (CCHD) and to demonstrate their role in delineation of the extracardiac vascular anatomy including the pulmonary arteries, MAPCAs, and PDA, in the patients of CCHD.

#### **METHOD AND MATERIALS**

The study was a prospective observational study where 32 pediatric patients (18 male, 14 female, age range 2-116 months) with CCHD were included. All patients underwent TTE, CTA and cardiac catheterization angiography (CCA). The findings of CTA in evaluation of pulmonary arteries and collateral vessels were compared with TTE and correlated with CCA findings. McGoon ratio, Nakata index and Z scores of pulmonary arteries were calculated for TTE, CTA and CCA. The output was analyzed in SPSS v20.

#### **RESULTS**

All CTA studies were adequate and assessed the pulmonary artery anatomy in all the cases. Right pulmonary artery (RPA) anatomy was not clear on CCA in 2 cases (6.3%) and were not demonstrated in 2 (6.3%) more cases, whereas CTA was able to demonstrate pulmonary arteries in these cases. In 1 (3.1%) case MPA and RPA were not visualized on any of the three modalities. TTE was inadequate in 11 cases (34.3 %) in evaluation of pulmonary arteries in which one or more pulmonary artery was not clearly visualized. In cases with good pulmonary artery diameter (mean >6 mm), statistically significant ( $P < 0.001$ ) correlation was found between pulmonary artery diameters, McGoon ratio, Nakata index and Z-scores calculated for pulmonary arteries on CTA and CCA as well as between TTE and MDCT. There was concordance between CTA and CCA in assessment of MAPCAs and PDA whereas TTE failed to demonstrate MAPCAs in 6 cases (18.8%) which were later detected on CTA as well as on CCA.

#### **CONCLUSION**

CTA was found to be superior to TTE and CCA for the assessment of pulmonary artery anatomy and MAPCAs. CTA was also found superior to TTE in detection of extracardiac anomalies.

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

Cardiac imaging plays a pivotal role in the pre-operative assessment of pulmonary arteries, MAPCAs, PDA and extracardiac anomalies in patients with CCHD which are main determinants in the surgical outcome of these patients. This study shows CTA to be superior to TTE and CCA in the assessment of pulmonary artery anatomy, MAPCAs, PDA and extracardiac anomalies.

#### **RC213-07 MR Imaging of the Lung with Radial Acquisition at 1.5 T: Comparison of T2- Weighted BLADE and PETRA Sequences in Cystic Fibrosis Patients**

Monday, Dec. 2 9:40AM - 9:50AM Room: E353B

##### **Participants**

Stefania Ghinassi, Rome, Italy (*Abstract Co-Author*) Nothing to Disclose  
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Giovanna Stefania Colafati, MD, Rome, Italy (*Abstract Co-Author*) Nothing to Disclose  
Laura Menchini, MD, Rome, Italy (*Abstract Co-Author*) Nothing to Disclose  
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#### **PURPOSE**

To assess lung magnetic resonance (MR) imaging with a respiratory-gated pointwise encoding time reduction with radial acquisition (PETRA) sequence at 1.5 T and compare it with imaging with T2- Weighted (BLADE) sequence, with extra focus on the visibility of bronchi and the signal intensity of lung parenchyma

#### **METHOD AND MATERIALS**

The study was approved by the local ethics committee, and all subjects gave written informed consent. Twelve Cystic Fibrosis patients were imaged with PETRA and BLADE sequences. For preliminary clinical assessment, 13 young patients underwent both MR imaging and computed tomography (CT). Comparisons were made by using the Wilcoxon signed-rank test for means and the McNemar test for ratios. Agreement between CT and MR imaging disease scores was assessed by using the kappa test.

#### **RESULTS**

PETRA imaging was performed with a voxel size of 0.86 mm<sup>3</sup>. Overall image quality was good, with little motion artifact. Bronchi were visible consistently up to the fourth generation and in some cases up to the sixth generation. Mean CNR and SNR with PETRA were 32.4% ± 7.6 (standard deviation) and 322.2% ± 37.9, respectively, higher than those with BLADE ( $P < .001$ ). Good agreement was found between CT and PETRA cystic fibrosis scores ( $k = 1.0$ ).

#### **CONCLUSION**

PETRA enables silent, free-breathing, isotropic, and submillimeter imaging of the bronchi and lung parenchyma with high CNR and SNR and may be an alternative to CT for patients with Cystic Fibrosis.

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

MR Imaging of the lung, including evaluation of PETRA sequences, is a valid alternative to evaluate specific chronic lung structural abnormalities of Cystic Fibrosis patients without radiation exposure.

#### **RC213-08 Imaging of Pediatric Pulmonary Hypertension**

Monday, Dec. 2 9:50AM - 10:10AM Room: E353B

##### **Participants**

Shi-Joon Yoo, MD, Toronto, ON (*Presenter*) Nothing to Disclose

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#### LEARNING OBJECTIVES

1) To explain common and rare etiologies of pulmonary hypertension in children. 2) To describe plain radiographic findings of various forms of pulmonary hypertension in children. 3) To identify imaging principles, strengths and weaknesses of echocardiography, CT and MRI in the assessment of pulmonary hypertension in children. 4) To assemble the imaging findings to reach the etiologic diagnosis of pulmonary hypertension. 5) To estimate the severity of the disease and predict the short and long term outcomes.

#### RC213-09 Extracardiac Complications of Fontan in the Chest

Monday, Dec. 2 10:20AM - 10:40AM Room: E353B

#### Participants

Dianna M. Bardo, MD, Phoenix, AZ (*Presenter*) Speaker, Koninklijke Philips NV; Consultant, Koninklijke Philips NV; Master Enterprise Agreement, Koninklijke Philips NV; Author, Thieme Medical Publishers, Inc; Research support, Bracco Group; Consultant, Guerbet SA; Consultant, Anderson Publishing, Ltd

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#### LEARNING OBJECTIVES

1) Identify radiographic features of the key pathologies that occur in the thorax due to the Fontan procedure, including: Lymphatic obstruction and its association with protein losing enteropathy, pulmonary embolus and thrombosis of the Fontan circuit, and bronchial casts. 2) Understand the implications of the imaging findings of chronic pleural effusion, acute and chronic Fontan circuit thrombosis and pulmonary embolus, and imaging features of bronchial casts. 3) Be able to discuss the emergent clinical implications of pleural effusion, Fontan circuit thrombosis with pulmonary embolus and bronchial casts.

#### ABSTRACT

Univentricular congenital heart disease is commonly treated with a Fontan shunt. The physiology and often the anatomy resultant remains a surgical and clinical mystery for our referring Cardiologists and Surgeons. It is extremely difficult to predict the manner in which a Fontan circuit should be connected to the branch pulmonary arteries. Goals of this presentation include information regarding scan optimization, patient individualization and optimal review of patient medical records.

#### RC213-10 Dual-Contrast MR Cardio-Lymphangiography in Pediatric Congenital Heart Disease: A Feasibility Study

Monday, Dec. 2 10:40AM - 10:50AM Room: E353B

#### Participants

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Aarti Luhar, MD, Los Angeles, CA (*Abstract Co-Author*) Nothing to Disclose  
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#### PURPOSE

Chylous pleural & pericardial effusions are a growing & potentially debilitating complication of treatment for pediatric congenital heart disease. Recently, dynamic MR lymphangiography (DMRL) with gadolinium based contrast agents (GBCA) has been used successfully for diagnosis & pre-procedural lymphatic pathway mapping. The relatively high dose of GBCA used for DMRL limits use of GBCA for simultaneous evaluation of vascular & cardiac anatomy, which would ideally be performed under a single anaesthesia session. We evaluated the feasibility of combining DMRL with high resolution 4-D cardiac & blood flow imaging using gadobutrol & ferumoxytol.

#### METHOD AND MATERIALS

In this IRB-approved study, 4 patients (age 11 mo-11 y; IQR 8 y 10 mo; 1 male) underwent DC\_MR CL, following infusion of gadavist & ferumoxytol. Breath-held, high resolution, 3D SGE imaging was performed through the chest, abdomen & pelvis during intra-nodal infusion of dilute gadobutrol. Subsequently, ferumoxytol (Feraheme, AMAG Pharmaceuticals) was administered by slow IV infusion, total dose 4 mg/kg. 4-D MUSIC was acquired during uninterrupted positive pressure ventilation. Supplemental 4-D flow imaging was performed in 3 patients. Immediately after MRI, patients were transported to the IR suite - 3 for lymphatic intervention & 1 for right heart cath. 3D processing of DMRL images was performed using MPR, MIP & VR reconstructions. Image processing of 4D MUSIC images was performed on MacOsiriX & Vitrea (Canon Medical) workstations. 4D flow was analyzed on the Arterys Cloud (Arterys.com). 3D DMRL & 4D MUSIC data was fused in 1 patient using Mimics (Materialize, Belgium).

#### RESULTS

All patients underwent technically successful DC-MRCL without adverse events. 100% of vascular segments were of diagnostic quality. The location of lymphatic abnormality was identified on DC-MRL in all patients. Lymphatic intervention was successfully performed in 1. No additional imaging was required prior to a clinical management decision in any of the patients.

#### CONCLUSION

DC-MRCL is feasible in children with CHD under a single anesthesia session & informs management of both lymphatic & cardiovascular disorders.

#### CLINICAL RELEVANCE/APPLICATION

The use of dynamic 3D acquisitions for MR lymphangiography & 4D acquisitions for cardiovascular imaging restricts the total

duration of the MR study to a predictable time window & facilitates planning for subsequent procedures in the catheter laboratory.

**RC213-11 Quantitative Dynamic Thoracic MRI (QdMRI) on Normal Children and Pediatric Patients with Thoracic Insufficiency Syndrome (TIS): Quantitative Evaluation of Vertical Expandable Prosthetic Titanium Rib (VEPTR)-Based Surgery**

Monday, Dec. 2 10:50AM - 11:00AM Room: E353B

**Participants**

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Joseph McDonough, Philadelphia, PA (*Abstract Co-Author*) Nothing to Disclose  
Drew A. Torigian, MD, MA, Philadelphia, PA (*Abstract Co-Author*) Co-founder, Quantitative Radiology Solutions LLC  
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**PURPOSE**

To quantitatively evaluate VEPTR-based TIS treatment via dynamic volumetric parameters derived from QdMRI on TIS patients (pre- and post-operative) and normal children.

**METHOD AND MATERIALS**

27 normal children (10.7±2.3 yrs) and 29 TIS patients (4.8±4.2 yrs/ 6.4±4.3yrs, pre-/post-operative) formed the subject cohort. QdMRI was performed on all subjects based on 4D images constructed from dynamic MRI. Tidal volumes (tv) were computed for the segmented left and right lung components including lung (Ltv), chest wall (CWtv) and hemi-diaphragm (Dtv). Mahalanobis distances (MDs) of tidal volumes between every TIS patient (pre- and post-operative, separately) and the distribution for her/his age-matched normal subjects (age difference < 2 years) were assessed to evaluate closeness to normality.

**RESULTS**

All tidal volumes (Ltv, CWtv, Dtv, left and right, separately), after being adjusted with growth between the pre and post-operative scans, significantly increased for TIS patients after treatment which was illustrated in previous research. MDs for Ltv significantly decreased (suggesting closer to normality) after treatment (P = 0.02), and the average MDs (95% CI) were -0.41(-0.82 - 0.01) and 0.40 (-0.11 - 0.90) pre- and post-operatively. MDs (95% CI) for RDtv were -0.79 (-1.34 - 0.25) and 0.54 (0.09 - 1.00) pre- and post-operatively with P = 0.001. Similarly, MDs (95% CI) for RLtv were -0.59 (-1.18 - 0.01) and 0.34 (-0.11 - 0.79) pre- and post-operatively with P = 0.02. No significant difference in MDs for LLtv, LDtv, LCWtv, or RCWtv was observed.

**CONCLUSION**

VEPTR surgery was associated with post-operative increases in all components of tidal volume (L/R CWtv, L/R Dtv, L/R Ltv). Mahalanobis distance on Ltv, RLtv, and RDtv between patients and age-matched normal children significantly decreased after treatment indicating positive treatment effect from VEPTR.

**CLINICAL RELEVANCE/APPLICATION**

This is the first study to offer a dynamic functional method to assess VEPTR surgery for treating TIS. It opens new avenues to better understand TIS and its treatment and many other conditions like scoliosis that affect thoracic function.

**RC213-12 Accuracy and Precision in Pediatric Chest Radiograph Interpretation: A Comparison of Radiology Subspecialists**

Monday, Dec. 2 11:00AM - 11:10AM Room: E353B

**Participants**

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**PURPOSE**

Small airways disease (SAD) is a common pathology seen in pediatric patients. In suspected cases of SAD/RSV/bronchiolitis, chest radiographs are often ordered to diagnose disease and to rule out other conditions, such as bacterial pneumonia. While SAD and pneumonia have unique radiographic features, the threshold to diagnose such findings may depend on radiologist experience and training background. The purpose of this study is to compare subspecialty radiologist precision and accuracy in diagnosing normal, SAD, and bacterial pneumonia on pediatric chest radiography.

**METHOD AND MATERIALS**

An IRB-approved retrospective review of all stat pediatric chest radiographs obtained in patients aged 6 months to 6 years over a one year period was performed. An emergency radiologist, chest radiologist, and pediatric radiologist at similar stages of their careers assigned a diagnosis of normal, SAD or pneumonia to each of 100 randomly selected qualifying cases. Two to four weeks later, this process was repeated with the 100 cases presented in a different order. Intra-radiologist agreement was then assessed.

**RESULTS**

Overall intra-radiologist agreement held a kappa value of 0.67, indicating "good" agreement. Intra-radiologist precision was 78% for the chest radiologist, 85% for the emergency radiologist, and 79% for the pediatric radiologist. For all cases, accuracy was 68%, 66% and 65.5% for the pediatric, chest and emergency radiologist, respectively.

## CONCLUSION

Our findings demonstrate that there is no statistically significant difference in the precision or accuracy with which radiologists of different subspecialties but similar levels of training interpret pediatric chest radiographs. Nevertheless, both overall precision and accuracy were lower than anticipated, which appears to be primarily due to inconsistency in diagnosing SAD. Future studies comparing radiologists in different stages of their careers and comparing staff and resident radiologists are currently in progress and will allow for more complete characterization of this study's conclusions.

## CLINICAL RELEVANCE/APPLICATION

Mid-career staff radiologists have similar levels of precision and accuracy in basic pediatric chest radiograph interpretation regardless of subspecialty training.

### RC213-13 **Impact of a Second Generation, Whole-Heartmotion-Correction Algorithm on Image Quality of Coronary CT Angiography in Children with Congenital Heart Disease**

Monday, Dec. 2 11:10AM - 11:20AM Room: E353B

#### Participants

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Helene Vernhet-Kovacsik, MD, PhD, Montpellier, France (*Abstract Co-Author*) Nothing to Disclose

## PURPOSE

Assess the improvement in cardiac structure visualization using first and second generation of motion correction algorithm (MCA) and to compare it with conventional monophasic and multiphasic reconstructions.

## METHOD AND MATERIALS

Fifty paediatric patients with coronary artery anomalies underwent a CCTA on a wide-coverage single-beat CT scanner (Revolution CT, GE). Images were reconstructed with first (SSF1) and second (SSF2) generation of MCA (Snapshot Freeze) and compared to conventional monophasic and multiphasic reconstructions. Sixteen coronary segments and six cardiac elements were evaluated using a semi-quantitative scale (4: excellent; 1: non-diagnostic).

## RESULTS

Forty-seven exams could be reconstructed with MCA. Three patients were excluded, due to inadequate field of view, preventing MCA processing. A total of 6900 cardiac structures were assessed. SSF2 reconstructions provided better results than SSF1 or regular monophasic reconstructions in terms of interpretability rates (99.3% vs. 93.5%, respectively, all  $P < 0.05$ ) and proportion of structures with optimal quality (89.5% vs. 66.1% and 55.6%, respectively, all  $P < 0.05$ ). SSF2 provided interpretability rates similar to multiphasic acquisitions (99.6% vs. 99.3%,  $P = 0.05$ ), along with higher proportion of optimal quality structures (89.5% vs. 79.6%,  $P < 0.05$ ).

## CONCLUSION

Snapshot Freeze 2 improves interpretability by reducing motion artefacts and could provide, in a single reconstruction, image quality at least equivalent to a multiphasic acquisition.

## CLINICAL RELEVANCE/APPLICATION

The last generation of motion correction algorithms applied on monophasic acquisitions could provide, in a single cardiac phase, image quality equivalent to a multiphasic acquisition, with potentially significant ionizing radiation dose reduction.

### RC213-14 **Validation and Diagnostic Performance of a Computational Fluid Dynamics Method Based on Multi-Detector Computed Tomography Angiography for Coarctation of Aorta Diagnosis**

Monday, Dec. 2 11:20AM - 11:30AM Room: E353B

#### Participants

Rui Chen, Guangzhou, China (*Abstract Co-Author*) Nothing to Disclose  
Hui Liu, MD, Guangzhou, China (*Abstract Co-Author*) Nothing to Disclose  
Weitao Ye, MD, Guangzhou, China (*Presenter*) Nothing to Disclose

## PURPOSE

The clinical diagnosis of coarctation of the aorta (CoA) constitutes a clinical challenge, with the use of the peak systolic pressure gradient (PSPG) being the reference method. Multi-detector computed tomography angiography (MDCTA)-based computational fluid dynamics (CFD) has been hypothesized to afford accurate and noninvasive PSPG measurement. The aim of this study was the validation of a CFD method that utilizes MDCTA imaging data for CoA diagnosis.

## METHOD AND MATERIALS

The study included 75 pediatric patients divided into a training set ( $n = 50$ ; 25 with CoA and 25 without CoA) and a test set ( $n = 25$ ). Effectiveness of the CFD method for distinguishing between patients with and without CoA was illustrated by using the training set, while the test set was used to analyze the diagnostic performance of CFD. All the patients underwent cardiac catheterization for confirmation of CoA or any other congenital heart disease. The utilized CFD models were developed from MDCTA imaging data. The PSPG determined by CFD (PSPGCFD) was compared with that determined by cardiac catheterization (PSPGCC) to validate the CFD method. The employed diagnostic performance indices included the PSPG, average peak systolic wall shear stress (APSWSS),

and peak systolic velocity (PSV), which were analyzed by receiver operating characteristic (ROC) curves.

## RESULTS

PSPGCFD agreed excellently with PSPGCC in both the training and test sets ( $R^2 = 0.969$  and  $0.900$ , and bias =  $1.152$  and  $0.182$  mmHg, respectively;  $p < 0.001$ ). In addition, PSPGCFD, the CFD-based APSWSS (APSWSSCFD), and the CFD-based PSV (PSVCFD) all exhibited good predictive performance in both the training set (AUC =  $0.987$ ,  $0.978$ , and  $0.931$ , respectively) and test set (AUC =  $0.953$ ,  $0.947$ , and  $0.823$ , respectively).

## CONCLUSION

The noninvasive MDCTA-based CFD method can accurately diagnose CoA.

## CLINICAL RELEVANCE/APPLICATION

The present results demonstrate that the use of CFD models offers an accurate and non-invasive method for the diagnosis of CoA, and can be used to substitute invasive angiography.

### RC213-15 Fetal Cardiac 4D Phase-Contrast MRI Using Doppler Ultrasound Gating to Visualize Fetal Hemodynamics in Utero: Preliminary Results

Monday, Dec. 2 11:30AM - 11:40AM Room: E353B

#### Participants

Fabian Kording, Hamburg, Germany (*Presenter*) Co-founder and Stakeholder, Northh Medical GmbH  
Bjoern Schoennagel, MD, Hamburg, Germany (*Abstract Co-Author*) Co-founder and Stakeholder, Northh-Medical GmbH  
Manuela Tavares de Sousa, Hamburg, Germany (*Abstract Co-Author*) Co-founder and Stakeholder, Northh Medical GmbH  
Jin Yamamura, MD, Hamburg, Germany (*Abstract Co-Author*) Nothing to Disclose  
Daniel Giese, Koln, Germany (*Abstract Co-Author*) Employee, Siemens AG

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## PURPOSE

The use of 4D flow cardiovascular magnetic resonance (CMR) may provide valuable additional information over conventional methods for the assessment of fetal hemodynamics, especially for prenatal diagnosis of fetal coarctation. The aim of this preliminary study was to evaluate the feasibility of 4-D phase contrast magnetic resonance imaging to visualize fetal cardiac hemodynamics with the focus on the fetal aorta.

## METHOD AND MATERIALS

The feasibility to acquire a 4D dataset of the aortic arch and to visualize fetal cardiac hemodynamics was evaluated in 7 fetuses (Gestation week 30 - 35). Cardiac gating was performed using a recently developed Doppler Ultrasound (DUS) device (northh medical GmbH, Hamburg, Germany), similar to ECG gating. Morphologic images of the aorta and fetal heart for planning and orientation were acquired using standard retrospectively gated SSFP cine sequences. Flow values in the aorta descendent were calculated from each 4D dataset and compared to a gated 2D cine phase contrast angiography sequence that was acquired perpendicular to the descending aorta.

## RESULTS

Dynamic PC and 4D datasets were successfully in performed in six fetus. The aortic arch, descending aorta as well as ascending aorta could be clearly visualized and the blood flow from the pulmonary artery into the aorta via the ductus arteriosus could be visualized. The cross-sectional aortic lumen was of  $7.8 \pm 1,2$  mm. The assessed time-velocity curves revealed characteristic biphasic arterial flow waveform patterns with a strong early systolic peak and continuously positive low diastolic blood flow with an average net flow in the descending aorta of  $22 \pm 5$  ml/s (2D) and  $24 \pm 4$  ml/s (4D).

## CONCLUSION

This preliminary study showed the possibility of visualization and quantitative measurements of blood flow in-utero 4D phase contrast imaging and direct fetal cardiac gating using Doppler ultrasound. The acquisition of 4D data may provide a substantial advantage for the evaluation of congenital cardiovascular pathologies as the hemodynamics of the fetal vasculature can be evaluated retrospectively. The technique may be beneficial for visualization and quantification of blood flow for complex congenital cardiovascular malformations.

## CLINICAL RELEVANCE/APPLICATION

Prenatal diagnosis of fetal coarctation is still challenging today. Fetal 4D flow CMR max provides a valuable adjunct in the evaluation of congenital cardiovascular pathologies.

### RC213-16 Ebstein's Anomaly

Monday, Dec. 2 11:40AM - 12:00PM Room: E353B

#### Participants

Cynthia K. Rigsby, MD, Chicago, IL (*Presenter*) Nothing to Disclose

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## LEARNING OBJECTIVES

1) Define Ebstein's anomaly. 2) Describe the imaging features of Ebstein's anomaly. 3) Demonstrate how imaging can be used to manage patients with Ebstein's anomaly.

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RC214

### Interventional Series: Embolotherapy

Monday, Dec. 2 8:30AM - 12:00PM Room: E350

IR

AMA PRA Category 1 Credits™: 3.00  
ARRT Category A+ Credits: 3.50

FDA

Discussions may include off-label uses.

#### Participants

Wael E. Saad, MBBCh, Bethesda, MD (*Moderator*) Speaker, W. L. Gore & Associates, Inc; Consultant, Siemens AG  
Laura K. Findeiss, MD, Atlanta, GA (*Moderator*) Nothing to Disclose

#### LEARNING OBJECTIVES

1) Describe rationale of bariatric embolization. 2) Explain the rationale for approaches to treatment of high flow malformations. 3) Describe the preparation of cyanoacrylates for embolization. 4) List two complications related to embolization. 5) Recognize the significance of Type II endoleaks. 6) Describe approach to treatment of visceral aneurysms.

#### Sub-Events

##### RC214-01 Embolization of Hemorrhoids

Monday, Dec. 2 8:30AM - 8:45AM Room: E350

#### Participants

Vincent Vidal Sr, MD, Marseille, France (*Presenter*) Nothing to Disclose

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#### LEARNING OBJECTIVES

1) Describe the role of rectal arteries in hemorrhoid disease. 2) Describe the various anatomy of rectal arteries. 3) Describe the technical points of rectal artery embolization. 4) List the potential benefits of embolization technique.

##### RC214-02 Transhepatic Rectal Variceal Embolization for Refractory Bleeding Rectal Varices

Monday, Dec. 2 8:45AM - 8:55AM Room: E350

#### Participants

Chad Selph, Aurora, CO (*Presenter*) Nothing to Disclose  
Jonathan D. Lindquist, MD, Aurora, CO (*Abstract Co-Author*) Nothing to Disclose  
Premal S. Trivedi I, MSc, MD, Denver, CO (*Abstract Co-Author*) Nothing to Disclose  
Matthew A. Brown, MD, Aurora, CO (*Abstract Co-Author*) Nothing to Disclose  
Kristofer M. Schramm, MD, Aurora, CO (*Abstract Co-Author*) Nothing to Disclose  
Anjali R. Bagley, MD, Denver, CO (*Abstract Co-Author*) Nothing to Disclose  
Paul J. Rochon, MD, Aurora, CO (*Abstract Co-Author*) Speaker, Penumbra, Inc; Speakers Bureau, C. R. Bard, Inc; Speaker, Cook Group Incorporated; Advisory Board, Medtronic plc ; Speaker, Medtronic plc

#### PURPOSE

Rectal varices are common in the portal hypertensive patient; however, bleeding is a rare occurrence and screening for rectal varices is not routinely performed. Rectal varices are spontaneous portosystemic collateral pathways connecting the inferior mesenteric vein to the internal iliac vein via the superior, middle, and inferior rectal veins. Rectal variceal bleeding can be life threatening, and endoscopic therapies are commonly used to treat associated hemorrhage. When these therapies fail or are contraindicated, endovascular therapies can be lifesaving. Transjugular intrahepatic portosystemic shunt (TIPS) and transjugular variceal embolization have been described, though TIPS alone is often inadequate. Isolated case reports of double balloon-occluded sclerotherapy, percutaneous transhepatic obliteration with sclerosant, and balloon-occluded transvenous obliteration have been described in the Asian literature. We submit the largest known case series of transhepatic rectal variceal embolization.

#### METHOD AND MATERIALS

Retrospective review of cases over the past ten years was performed. All adult patients who had percutaneous transhepatic rectal variceal embolization or sclerosis were included in the analysis. Patients that had concurrent TIPS were excluded. Technical success of the procedure, clinical success, complication rates, and rebleeding within one month were analyzed. In each case, the portal vein was directly punctured percutaneously under ultrasound guidance. The inferior mesenteric vein was catheterized, and sclerosis and/or embolization was performed (Figure 1). Various embolic materials and sclerosants were used at the discretion of the operator. Coil embolization of the tract was performed upon sheath removal.

#### RESULTS

Between August 2015 and January 2018, five patients were treated. Three of these patients failed endoscopic therapies prior to presentation. Procedures were all technically successful. No complications were encountered, and no rebleeding was identified

within one month of the procedure.

## CONCLUSION

This series is in concordance with prior reports, suggesting transhepatic rectal variceal embolization may be a safe and effective means of treating refractory rectal variceal hemorrhage.

## CLINICAL RELEVANCE/APPLICATION

Refractory bleeding rectal varices can be effectively treated with embolization from a transhepatic approach in patients who fail endoscopic therapy and are not candidates for TIPS.

### RC214-03 Advanced Endoleak Treatment

Monday, Dec. 2 8:55AM - 9:10AM Room: E350

#### Participants

Laura K. Findeiss, MD, Atlanta, GA (*Presenter*) Nothing to Disclose

## LEARNING OBJECTIVES

1) Understand the flow dynamics present in type II endoleaks. 2) Recognize different types of endoleaks post EVAR. 3) Apply various approaches and techniques to type II endoleaks, dependent on patient variables.

### RC214-04 AVM Embolization

Monday, Dec. 2 9:10AM - 9:25AM Room: E350

#### Participants

William S. Rilling, MD, Milwaukee, WI (*Presenter*) Consultant, BTG International Ltd; Consultant, Terumo Corporation; Consultant, C. R. Bard, Inc; Research support, Guerbet SA

### RC214-05 Routine Usage of NBCA-Lipiodol Mixture for Bronchial Artery Embolization

Monday, Dec. 2 9:25AM - 9:35AM Room: E350

#### Participants

Ramazan Kutlu, MD, Malatya, Turkey (*Presenter*) Nothing to Disclose  
Ahmet Arslan, MD, Malatya, Turkey (*Abstract Co-Author*) Nothing to Disclose  
Murat Yalcinsoy, MD, Malatya, Turkey (*Abstract Co-Author*) Nothing to Disclose  
Zeynep A. Aytemur, Malatya, Turkey (*Abstract Co-Author*) Nothing to Disclose

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## PURPOSE

To report our experience of routine usage of NBCA-Lipiodol mixture for bronchial artery embolization for hemoptysis.

## METHOD AND MATERIALS

138 patients who underwent bronchial artery angiography at our center due to life threatening hemoptysis between 2010 and 2019 were investigated retrospectively. The technical and clinical results were followed in terms of bleeding control and effect on survival of the procedure.

## RESULTS

Of the 138 patients included in the study, 103 were male and 35 were female. The mean age was 52.6 (range 17-88). 131 patients were treated once, 6 patients twice, and 1 patient three times. 1 patient underwent massive hemoptysis attack and one another patient developed bronchial artery dissection and the procedures could not be completed. Technical success was 98.5%. A total of 143 embolization procedures were performed (93 NBCA-lipiodol, 17 NBCA-Lipiodol and other embolic (8 coils, 1 Amplatzer plug, 3 Gel-foam, 5 PVA) material combination, 33 PVA). Repeat procedures were required in PVA group. 101 of the patients were still alive, and the remaining 37 died from various causes. The average survival of the survivors is 1226.8 days (range 10 days - 3288 days). The mean survival of the expired patients was 423.24 days (range 15 hours -2636 days).

## CONCLUSION

Bronchial artery embolization is a life saving interventional procedure. Routine usage of NBCA-Lipiodol combination for the bronchial artery embolization is a safe and effective treatment method with high technical and clinical success and low complication rate in hemoptysis patients.

## CLINICAL RELEVANCE/APPLICATION

routine usage of NBCA and lipiodol mixture is a rapid and effective mode of treatment for bronchial artery embolization

### RC214-06 Percutaneous Embolization of Non-Catheterizable Splenic Artery Pseudoaneurysm with Glue (NBCA) Injection Coupled with Simultaneous Saline Flush through the Angiography Catheter

Monday, Dec. 2 9:35AM - 9:45AM Room: E350

#### Participants

Pankaj Sharma JR, MBBS, DMRD, Rishikesh, India (*Presenter*) Nothing to Disclose  
Udit Chauhan, MBBS, MD, Haridwar, India (*Abstract Co-Author*) Nothing to Disclose  
Mohit Tayal, MBBS, MD, Rishikesh, India (*Abstract Co-Author*) Nothing to Disclose

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## PURPOSE

Embolization of non catheterizable splenic artery pseudoaneurysm (PSA) by percutaneous injection glue (NBCA) and lipiodol mixture directly into the sac under sonographic and fluoroscopic guidance coupled with simultaneous pressure injection of saline through the angiographic catheter into the splenic artery to prevent any spillage of glue mixture into the parent vessel.

## METHOD AND MATERIALS

After endovascular access from right CFA with a 5F sheath, the celiac trunk was cannulated with SIM -1 catheter. Thereafter an angiogram was done which revealed the (PSA) from the proximal splenic artery. Attempt was made to selectively catheterize the neck of PSA with microcatheter which eventually failed. Thereafter the PSA sac was punctured with a 22G Chiba needle under sonographic guidance. An injection of iodinated contrast was given into the PSA sac to assess for any flow into the splenic artery in addition to requirement of exact volume of glue to be injected. Since no flow was seen into the splenic artery, 33% glue mixed with lipiodol was injected into the PSA. Appx 0.5 ml injection was required for complete opacification of the sac. During the injection normal saline was injected under pressure into the splenic artery through the angiographic catheter in view to prevent any spillage of glue mixture into the pseudoaneurysm sac. Thereafter angiogram was repeated which revealed complete non opacification of PSA with patent splenic artery.

## RESULTS

There was complete embolisation of the PSA with patent splenic artery.

## CONCLUSION

Percutaneous glue embolisation could be offered as a treatment option to non-catheterizable aneurysms with a tiny neck along with rapid pressure injection of normal saline into the main artery through the angiographic catheter to prevent any spillage of glue mixture back into the main artery.

## CLINICAL RELEVANCE/APPLICATION

Meticulous and careful use of glue (NBCA) can be recommended as treatment option to non catheterizable aneurysms with tiny neck

### RC214-07 Embolization in the Trauma Patient

Monday, Dec. 2 9:45AM - 10:00AM Room: E350

#### Participants

Ahmed K. Abdel Aal, MD, PhD, Birmingham, AL (*Presenter*) Consultant, Abbott Laboratories; Consultant, Baxter International Inc; Consultant, C. R. Bard, Inc; Consultant, Boston Scientific Corporation; Consultant, W. L. Gore & Associates, Inc; Consultant, Sirtex Medical Ltd; Consultant, Guerbet SA

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## LEARNING OBJECTIVES

1) Outline the different grades of trauma for the liver, kidney, spleen and pelvis. 2) Describe the various techniques and embolics used in the treatment. 3) Describe the outcomes of treatment.

### RC214-08 Prophylactic Embolization Pre-Y90

Monday, Dec. 2 10:30AM - 10:45AM Room: E350

#### Participants

Matthew M. Niemeyer, MD, Washington Washington, IL (*Presenter*) Nothing to Disclose

### RC214-09 Efficacy of Hypertrophy Induction by Unilobar 90Y Radioembolisation versus Portal Vein Embolization: A Prospective Animal Study

Monday, Dec. 2 10:45AM - 10:55AM Room: E350

#### Participants

Federico Pedersoli, MD, Aachen, Germany (*Presenter*) Nothing to Disclose  
Martin Liebl, MD, Aachen, Germany (*Abstract Co-Author*) Nothing to Disclose  
Anna Tschinaev, Aachen, Germany (*Abstract Co-Author*) Nothing to Disclose  
Markus Zimmermann, MD, Aachen, Germany (*Abstract Co-Author*) Nothing to Disclose  
Maximilian F. Schulze-Hagen, MD, Aachen, Germany (*Abstract Co-Author*) Nothing to Disclose  
Vincent van Den Bosch, Aachen, Germany (*Abstract Co-Author*) Nothing to Disclose  
Paul F. Sieben, Aachen, Germany (*Abstract Co-Author*) Nothing to Disclose  
Emona Barzakova, Aachen, Germany (*Abstract Co-Author*) Nothing to Disclose  
Alexander Heinzl, Aachen, Germany (*Abstract Co-Author*) Nothing to Disclose  
Christiane K. Kuhl, MD, Aachen, Germany (*Abstract Co-Author*) Nothing to Disclose  
Philipp Bruners, MD, Aachen, Germany (*Abstract Co-Author*) Nothing to Disclose  
Peter Isfort, MD, Aachen, Germany (*Abstract Co-Author*) Nothing to Disclose

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## PURPOSE

To compare the hypertrophy induction of the contralateral liver lobe achieved by unilobar radioembolisation (RE) with 90Y resin

microspheres vs portal vein embolization (PVE) in a swine model.

## METHOD AND MATERIALS

After approval by the animal care authorities, we conducted a prospective trial on 20 pigs. After a dose escalation study in the first four animals, 16 consecutive pigs were treated by either unilobar 90Y-RE, or unilobar PVE using lipiodol/cyanoacrylate. Liver volume was measured on contrast-enhanced CT/MRI before treatment and one, three and six months thereafter. After euthanasia, livers were evaluated histopathologically. Independent t-test ( $p < 0.05$ ) was used to compare the hypertrophy rate.

## RESULTS

At one month after the intervention, a significantly different degree of hypertrophy was observed for the PVE-group vs the 90Y-RE group, with a volume gain of +51% (IQR: +47%; +69%) for PVE, compared to +29% (IQR: +20%; +50 %) for 90Y-RE. At follow-up after three and six months, degrees of hypertrophy in the two different groups converged, with a volume gain of +103% (IQR: +86%; +119%) for PVE, vs +82% (IQR: +70%; +96%) for 90Y-RE after three months, and of +115% (IQR: +70%; +146%) for PVE, vs +86% (IQR: +58%; +111%) for 90Y-RE, after six months.

## CONCLUSION

Hypertrophy-inducing effects of unilobar 90Y-RE and of PVE follow a different time course. PVE causes a fast, strong volume gains within 4 weeks after the procedure, followed by a steady-state. Effects of 90Y-RE are slower, but persist until 3 months after the procedure, at which time the hypertrophy is similar to PVE.

## CLINICAL RELEVANCE/APPLICATION

90Y-RE can provide a similar volume gain compared to PVE from three months after the intervention.

### RC214-10 Prostate Embolization: Lessons Learned

Monday, Dec. 2 10:55AM - 11:10AM Room: E350

#### Participants

John T. Cardella, MD, Washington, DC (*Presenter*) Nothing to Disclose

#### LEARNING OBJECTIVES

1) To review the latest literature, technical details and potential complications related to PAE.

### RC214-11 Embolization: New Tools and Techniques

Monday, Dec. 2 11:10AM - 11:25AM Room: E350

#### Participants

D. T. Johnson, MD, PhD, South San Francisco, CA (*Presenter*) Inventor, Thunar Medical, Inc

#### LEARNING OBJECTIVES

1) To describe the currently available embolic materials for chemoembolization and be able to describe the proper uses, advantages, and drawbacks for these treatments.

### RC214-12 Reduced Non-Target Embolization and Increased Targeted Delivery with SEQUIRE Microcatheter Demonstrated in Swine Model

Monday, Dec. 2 11:25AM - 11:35AM Room: E350

#### Participants

Geert Maleux, MD, PhD, Leuven, Belgium (*Presenter*) Nothing to Disclose  
Thierry J. De Baere, MD, Villejuif, France (*Abstract Co-Author*) Consultant, Terumo Corporation; Speaker, Medtronic plc; Consultant, General Electric Company; Consultant, Guerbet SA; Speaker, Nanobiotix  
Fei Sun, Caceres, Spain (*Abstract Co-Author*) Nothing to Disclose  
Nir Holtzman, Rehovot, Israel (*Abstract Co-Author*) Employee, Guerbet SA  
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Daniel Balvay, DiplPhys, Paris, France (*Abstract Co-Author*) Nothing to Disclose  
Thomas Viel, Paris, France (*Abstract Co-Author*) Nothing to Disclose  
Silvia Rizzitelli, Roissy CDG Cedex, France (*Abstract Co-Author*) Employee, Guerbet SA  
Xavier Violas, Aulnay-Sous-Bois, France (*Abstract Co-Author*) Employee, Guerbet SA  
Philippe Robert, Roissy CDG Cedex, France (*Abstract Co-Author*) Employee, Guerbet SA  
Caroline Robic, Roissy CDG Cedex, France (*Abstract Co-Author*) Employee, Guerbet SA  
Aymeric Seron, Roissy CDG, France (*Abstract Co-Author*) Employee, Guerbet SA  
Claire Corot, PhD, Roissy, France (*Abstract Co-Author*) Employee, Guerbet SA

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## PURPOSE

The SEQUIRE microcatheter utilizes fluid dynamics to minimize the risk of nontarget embolization and improve microspheres delivery in targeted arteries. The purpose of this study is to compare, in a swine model, the microspheres embolization outcome of SEQUIRE and a standard end-hole microcatheter

## METHOD AND MATERIALS

Embolization procedures with SEQUIRE microcatheters were compared to a standard microcatheter of the same diameter (Progreat), using radiopaque microspheres. 8 kidneys of pigs were partially embolized with radio-opaque microspheres by positioning the microcatheters either SEQUIRE ( $n = 4$ ) or Progreat (Terumo, Tokyo, Japan) ( $n = 4$ ) in a higher or lower polar artery. An automated pulsatile injection protocol (8mL / min, duration 7.5s) was used to normalize the injections. The first reflux of contrast seen in a

non-targeted vessel served as a criterion for stopping the injection. The quality of the embolization was determined by measuring the volumes of injected microspheres and quantifying the number of enhanced arterial bifurcations as well as the contrast of the segments between two bifurcations embolized from ex vivo  $\mu$ CT images.  $\mu$ CT images were analyzed with InterViewFUSION software and processed with Matlab in order to quantify the embolization parameters

## RESULTS

The SEQUIRE delivered higher microspheres volumes ( $11.5\text{mL}\pm 4.04$ ) into the targeted distal and main branches compared to Progreat ( $8.5\text{mL}\pm 5.4$ ) which only partially filled the targeted main branches. The volume of voxels enhanced (SEQUIRE:target area  $56.8\pm 24.9$  vs non-target  $2.5\pm 3.8$ /Progreat:target area  $32.5\pm 15.5$  vs non-target  $9.5\pm 16.5$ ) demonstrate larger non-target embolization for kidneys embolized with Progreat than with SeQure, although contrast reflux was visible in all cases, and higher amount of microspheres delivered in the target area of injection. The number of branch nodes filled by microspheres, indicating delivery depth, was higher for SEQUIRE ( $1247\pm 791$ ) versus Progreat ( $680\pm 246$ ). The CT enhancement values indicate that SEQUIRE ( $28.8\pm 15.3$ ) can deliver higher density of microspheres into the vessels than Progreat ( $24.2\pm 8.4$ )

## CONCLUSION

The SEQUIRE microcatheter demonstrated superior microspheres delivery in-vivo versus a standard microcatheter, with reduced nontarget embolization and better microspheres delivery into the main targeted branches

## CLINICAL RELEVANCE/APPLICATION

Peripheral embolization for interventional radiology (HCC, UFE, ..)

### RC214-13 Fluid Embolization of Gastroesophageal Varices During Transjugular Intrahepatic Portosystemic Shunt (TIPS) Improves Survival Compared to Coil-Only Embolization

Monday, Dec. 2 11:35AM - 11:45AM Room: E350

#### Participants

Karsten Wolter, MD, PhD, Bonn, Germany (*Presenter*) Nothing to Disclose  
Michael Praktijn, Bonn, Germany (*Abstract Co-Author*) Nothing to Disclose  
Julia Boie, Bonn, Germany (*Abstract Co-Author*) Nothing to Disclose  
Georges Decker, Bonn, Germany (*Abstract Co-Author*) Nothing to Disclose  
Wiebke Keller, PhD, Tübingen, Germany (*Abstract Co-Author*) Nothing to Disclose  
Carsten Meyer, Bonn, Germany (*Abstract Co-Author*) Nothing to Disclose  
Jonel Trebicka, Bonn, Germany (*Abstract Co-Author*) Nothing to Disclose  
Daniel K. Thomas, MD, PhD, Bonn, Germany (*Abstract Co-Author*) Nothing to Disclose

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## PURPOSE

In decompensated cirrhosis portal hypertension leads to complications mainly through development and bleeding from esophageal varices (OV) and / or refractory ascites with consecutive spontaneous bacterial peritonitis. The insertion of a transjugular portosystemic shunt (TIPS) improves survival in these patients, and concomitant embolization of OV at TIPS is considered beneficial. However, different embolization-materials are in use and their effectiveness has not yet been evaluated in this specific setting. The aim of this study was the assessment of effectiveness of coil versus glue embolization regarding treatment failure, complications and survival.

## METHOD AND MATERIALS

In this monocentric study patients receiving TIPS with concomitant of OV and a minimum follow-up of one-year between 2008 and 2017 104 (males: 67) were included. Primary endpoint was overall-survival (6 week; 1 year). Secondary endpoints were treatment failure, acute-on-chronic liver failure (ACLF), variceal rebleeding and hepatic encephalopathy (HE). Survival analysis was performed using Kaplan-Meier analysis utilizing propensity score weighing to adjust for confounders.

## RESULTS

Indications were refractory ascites (n=33) and variceal bleeding (n=71). Embolization was performed using glue with or without coils (n=40) (Group G) or coil-only (n=64) (Group NG). Overall survival has been significantly better in group G (Deaths: G: n=6, NG: n=21; p=0.003). Also 6 Week survival as a surrogate of treatment failure showed a significantly higher mortality in group NG (n=13) compare to group G (n=3) (p=0.001). Development of ACLF was significantly higher in group NG after 6 months (NG=14; G=6; p=0.015), without significant difference after one-year (p=0.481). Rates of HE-episodes were not significantly different (G: n=15, NG: n=22 (p=0.75)). Rebleeding rates (G: n=3; NG: n=6) (p=0.74) were low.

## CONCLUSION

Closure of OV in patients undergoing TIPS utilizing glue embolization material improves overall survival and may be preferable over coil embolization alone.

## CLINICAL RELEVANCE/APPLICATION

Concomitant embolization of oesophageal varices using fluid embolization material should be performed in order to improve overall survival compared to sole coil embolization (p=0.003)

### RC214-14 Anatomy and Basic Technique for BRTO/BATO

Monday, Dec. 2 11:45AM - 12:00PM Room: E350

#### Participants

Wael E. Saad, MBBCh, Bethesda, MD (*Presenter*) Speaker, W. L. Gore & Associates, Inc; Consultant, Siemens AG

## LEARNING OBJECTIVES

1) Learner should understand the basic anatomy and definitions of the Gastric Variceal System. 2) Learner should understand the basic concept of the BRTO-procedure. 3) Learner should understand when to clinically apply the BRTO procedure for bleeding gastric varices and the pros and cons of the procedure. 4) Learner should know the outcomes of BRTO for gastric varices either as a sole procedure or in concert with other procedures. 5) Learner should understand the basic anatomy, definitions, hemodynamics and classification of Ectopic Varices. 6) Learner should understand the basic concept (hemodynamics-based approach) to the Endovascular Management of Ectopic Varices. 7) Learner should understand when to clinically apply the BRTO procedure for bleeding ectopic varices and the pros and cons of the procedure. 8) Learner should know the outcomes and limitations of Endovascular Management Ectopic varices.

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RC215

### Breast Series: MRI

Monday, Dec. 2 8:30AM - 12:00PM Room: Arie Crown Theater



AMA PRA Category 1 Credits™: 3.25  
ARRT Category A+ Credits: 3.75

#### Participants

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Thomas H. Helbich, MD, Vienna, Austria (*Moderator*) Research Grant, Medcor, Inc ; Research Grant, Siemens AG ; Research Grant, C. R. Bard, Inc; Research Grant, Guerbet SA; Research Grant, Novomed GmbH  
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#### Sub-Events

##### RC215-01 MRI: Part 1

##### RC215-02 How Genetics Will Fit Into Your Practice

Monday, Dec. 2 8:30AM - 8:55AM Room: Arie Crown Theater

#### Participants

Elizabeth A. Morris, MD, New York, NY (*Presenter*) Nothing to Disclose

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#### LEARNING OBJECTIVES

1) Understand the impact that genetics will have on the future of screening. 2) Understand the different methods of assessing risk for breast cancer. 3) Assess different algorithms for screening beyond mammography.

##### RC215-03 MRI in Addition to Mammography Screening in Women with Extremely Dense Breasts: Primary Outcome of the Randomized DENSE Trial

Monday, Dec. 2 8:55AM - 9:05AM Room: Arie Crown Theater

#### Participants

Marije F. Bakker, PhD, Utrecht, Netherlands (*Presenter*) Grant, Bayer AG; Software support, Volpara Health Technologies Limited  
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Carla H. van Gils, PhD, Utrecht, Netherlands (*Abstract Co-Author*) Software support, Volpara Health Technologies Limited

#### PURPOSE

To evaluate the effect of supplemental MRI for women with extremely dense breasts within a population-based screening program.

#### METHOD AND MATERIALS

Between 2011-2015, we randomized 40,373 screening participants (aged 50-75) with a negative screening mammography and extremely dense breasts (ACR category 4 by Volpara software) to (an invitation for) supplemental 3.0-T MRI at 8 sites (intervention arm; n=8,061) or mammography screening only (control arm; n=32,312). The difference in interval cancers after the first (prevalent) screening round, during the two-year screening interval, was investigated by intention-to-treat (ITT) analysis, and by complier-average causal effect (CACE) analysis to account for noncompliance. The performance of the incident screening rounds was investigated as well.

#### RESULTS

In the intervention arm, 4,783 (59%) underwent MRI examination. Cancer detection rate was 16.5/1000 screens [95%CI:13.3-

20.5]. For this, 9.5% of women were recalled (6.3% with biopsy). Positive predictive values are 17.4% [95%CI:14.2%-21.2%] (recall) and 26.3% [95%CI:21.7%-31.6%] (biopsy). In the intervention arm, cancers were more frequently stage 0-I than in the control arm (82.8% vs 41.6%,  $p < 0.001$ ). With ITT analysis, the interval cancer rate was 4.98/1000 women in the control arm and 2.48/1000 women in the intervention arm, leading to a reduction of 2.50/1000 women [95%CI:0.98-3.71];  $p < 0.001$ . With CACE analysis, this reduction was 4.22/1000 women [95%CI:2.01-6.43]. Preliminary results of the incident screening rounds showed that 3,548 women had again undergone (at least one) mammographic screening with a negative result. Supplemental cancer detection rate was 5.3/1000 screens [95%CI:3.4-7.7]. For this, 2.8% [95%CI:2.4%-3.4%] of women were recalled for further diagnostic work-up. At the meeting, results on cost-effectiveness will be presented as well.

## CONCLUSION

Supplemental MRI screening in women with extremely dense breasts results in statistically significantly fewer interval cancers. In subsequent rounds, both the cancer detection rate and the false-positive rate decrease.

## CLINICAL RELEVANCE/APPLICATION

There is a heated debate on the value of supplemental screening in women with dense breasts. The DENSE trial is the first randomized trial on supplemental MRI screening that has been performed in women with dense breasts.

### RC215-04 Abbreviated Screening Breast MRI Protocol: Impact on Cancer Detection and Biopsy Rates

Monday, Dec. 2 9:05AM - 9:15AM Room: Arie Crown Theater

#### Participants

Andrew J. Lukaszewicz, MD, Brampton, ON (*Abstract Co-Author*) Nothing to Disclose  
Leslie Lamb, MD, Boston, MA (*Abstract Co-Author*) Nothing to Disclose  
Paul Healey, Ottawa, ON (*Abstract Co-Author*) Nothing to Disclose  
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Jean M. Seely, MD, Ottawa, ON (*Presenter*) Nothing to Disclose

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## PURPOSE

To assess patient outcomes with the implementation of an abbreviated breast magnetic resonance imaging (MRI) protocol for high-risk breast screening.

## METHOD AND MATERIALS

In this IRB-approved study performed at a large academic institution, an abbreviated breast MRI protocol (AP) was implemented for high-risk patients (IBIS lifetime risk  $\geq 25\%$ ) in a population-based high-risk screening program (pre and two post-contrast T1 and T2 sequences). The protocol was evaluated prospectively for 10 months. It was compared to a standard protocol (SP) in the same population during the 12 previous months. MRI scanning times, BI-RADS assessment categories, positive predictive values (PPV3) and cancer detection rates (CDR) were evaluated.

## RESULTS

A total of 1539 patients during the 22-month study period were included. 658 patients underwent 658 AP screening MRIs. Of those, 135 (20.5%) were baseline exams and 523 (79.5%) were prevalent exams. 881 patients underwent 881 SP screening MRIs during the comparison study period. Of those, 230 (26.1%) were baseline exams and 651 (73.9%) were prevalent exams. The AP scanning time was an average of 16.3 minutes (range 12-25), compared to 27 minutes (range 25-30) in the SP. Abnormal interpretation rate with the AP was 12.5% (82/658) compared to 19.1% (168/881) with the SP ( $p < 0.001$ ). The BI-RADS 3 rate for the AP was 6.9% (45/658) compared to 7.2% (63/881) with the SP ( $p = 0.81$ ). Breast biopsies were performed in fewer patients with the AP [8.4% (55/658)] than with the SP [13.7% (121/881)] ( $p = 0.001$ ). PPV3 for the AP was 20.0% (11/55) compared to 12.4% (15/121) for the SP ( $p = 0.19$ ). The CDR was 16.7/1000 (11/658) with the AP and 17.0/1000 (15/881) with the SP ( $p = 0.96$ ).

## CONCLUSION

Using an abbreviated breast screening MRI protocol in high-risk patients led to fewer false positives, and was associated with 5% fewer benign biopsies, while a similar cancer detection rate was maintained.

## CLINICAL RELEVANCE/APPLICATION

Abbreviated breast MRI screening protocols may lead to increased tolerability and MRI capacity while optimizing quality indicators. Further study is required to determine long-term outcomes.

### RC215-05 Radiomics for Prediction of Breast Cancer Prognosis Using Dynamic Contrast-Enhanced Magnetic Resonance Imaging (DCE-MRI)

Monday, Dec. 2 9:15AM - 9:25AM Room: Arie Crown Theater

#### Participants

Seri Kang, Iksan, Korea, Republic Of (*Abstract Co-Author*) Nothing to Disclose  
Hye-won Kim, MD, PhD, Iksan, Korea, Republic Of (*Presenter*) Nothing to Disclose

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## PURPOSE

To evaluate the value of dynamic contrast enhanced magnetic resonance imaging (DCE-MRI) parameters as an imaging biomarker for predicting prognosis in the breast cancer, we analyzed the association with the histopathologic factors of the tumor.

## METHOD AND MATERIALS

A total of 122 invasive ductal carcinomas (IDCs) in 105 women who underwent preoperative breast DCE-MRI on a 3T scanner between November 2017 and December 2018 were enrolled. Twenty-fifth, 50th, 75th percentile and coefficient of variation (CV) of each perfusion parameter (Ktrans, Kep, Ve and Vp) were calculated within each tumor. Histopathologic factors such as estrogen receptor (ER), progesterone receptor (PR), human epidermal growth factor receptor 2 (HER2), Ki-67, p53, epidermal growth factor receptor (EGFR), CK 5/6, histologic grade and lymphovascular space invasion (LVSI) status were assessed. The student's t-test or Mann-Whitney U test were used for comparison of two groups and ANOVA or Kruskal-Wallis test for multiple groups.

## RESULTS

Triple negative breast cancers exhibited higher Ktransmedian, Ktrans75, Kepmedian and Kep75 than luminal cancers ( $p < .05$ ). ER-negative tumors showed higher Ktransmean, Ktransmedian and Ktrans75 than ER-positive tumors ( $p < .05$ ). PR-negative tumors presented higher Ve25, Vemean, Vemedian and Ve75 than PR-positive tumors ( $p < .05$ ). Tumors with higher Ki-67 showed higher Kep25, Kepmean and Kepmedian than tumors with lower Ki-67 ( $p < .05$ ). P53-positive tumors exhibited higher Ktrans25, Ktransmean, Ktransmedian, Ktrans75, Kepmean, Kepmedian and Kep75 than p53-negative tumors ( $p < .05$ ). Higher histologic grade tumors (grade II/III) presented higher Ktrans25, Ktransmean, Ktransmedian, Ktrans75, Kep25, Kepmean, Kepmedian, Kep75, Vp25, Vpmean and Vpmedian ( $p < .04$ ) than grade I tumor. Tumors with LVSI presented higher Ktrans25, Ktransmedian, Ktrans75, Kepmean, Kepmedian and Kep75 than tumors without LVSI ( $p < .05$ ). On the other hand, EGFR, CK 5/6 showed no significant correlation.

## CONCLUSION

We identified breast cancer presenting higher Ktrans and Kep on DCE-MRI was associated with poor prognostic factors. Therefore, DCE-MRI perfusion parameters can be useful imaging biomarkers for prediction of tumor prognosis.

## CLINICAL RELEVANCE/APPLICATION

DCE-MRI may be helpful to predict prognosis of breast cancer through analysis of perfusion parameters.

### RC215-06 Prognostic Factors Associated with Survival in Breast Cancer Patients: Magnetic Resonance Imaging and Clinico-Pathologic Factors Associated with Disease Recurrence

Monday, Dec. 2 9:25AM - 9:35AM Room: Arie Crown Theater

#### Participants

Eunjin Lee, Suwon, Korea, Republic Of (*Presenter*) Nothing to Disclose  
Jeong Min Lee, Seoul, Korea, Republic Of (*Abstract Co-Author*) Nothing to Disclose  
Sung-Hun Kim, MD, Seoul, Korea, Republic Of (*Abstract Co-Author*) Nothing to Disclose  
Bong Joo Kang, Seoul, Korea, Republic Of (*Abstract Co-Author*) Nothing to Disclose  
Heerin Lee, Seoul, Korea, Republic Of (*Abstract Co-Author*) Nothing to Disclose

## PURPOSE

To investigate prognostic factors predicting recurrence of breast cancer, focusing on imaging factors including advanced MR techniques and clinico-pathologic factors.

## METHOD AND MATERIALS

This retrospective study was approved by our institutional review board, and the requirement to obtain informed consent was waived. A total of 267 patients with breast cancer who underwent dynamic contrast-enhanced magnetic resonance imaging (MRI) before surgery from February 2014 to June 2016 was included in the study sample. Imaging parameters of MRI, including morphologic information, perfusion parameters, and texture analysis, were retrospectively reviewed by two breast expert radiologists. Patient clinical pathologic information was also reviewed. Univariable and multivariable Cox proportional hazards regression analyses were used to identify factors associated with cancer recurrence. Using Kaplan-Meier survival analysis, disease-free survival was compared between patients who experienced recurrence and those who did not.

## RESULTS

At a median follow up of 26 months, 23 patients (8%) showed disease: five cases of ipsilateral breast or axilla recurrence, one case of contralateral breast recurrence, 15 cases of distant metastasis, and one case of both ipsilateral breast recurrence and distant metastasis. Increased ipsilateral vascularity, entropy and kurtosis from texture analysis, and multiple perfusion parameters showed significant association with disease recurrence. The Ve 25th percentile value of perfusion parameters had the highest hazard ratio of 4.37 [95% confidence interval (CI): 1.80-11.18]. Pathologic stage, especially if higher than stage II, also showed significant association with disease recurrence, independent of multiple MRI parameters. In addition, higher entropy, higher Kep 25th percentile, higher Ve 25th percentile value, and increased ipsilateral vascularity were associated with short interval time to disease recurrence by Kaplan-Meier survival analysis.

## CONCLUSION

Higher pathologic stage and MRI parameters of texture parameters, perfusion parameters, and increased ipsilateral vascularity are predictors of breast cancer recurrence and may also be predictors of poor survival.

## CLINICAL RELEVANCE/APPLICATION

Multiple parameters of breast MRI including perfusion and texture analysis can predict breast cancer recurrence in addition to the clinico-pathologic factors.

### RC215-07 Diffusion with Very High b-Value in Breast MRI: End of the Contrast Injection?

Monday, Dec. 2 9:35AM - 9:45AM Room: Arie Crown Theater

#### Participants

Hajar Hamri, MD, Paris, France (*Presenter*) Nothing to Disclose  
Zoe Jolibois, Paris, France (*Abstract Co-Author*) Nothing to Disclose  
Elisabeth Weiland, Erlangen, Germany (*Abstract Co-Author*) Nothing to Disclose  
Cedric M. De Bazelaire, MD, PhD, Paris, France (*Abstract Co-Author*) Nothing to Disclose

## PURPOSE

To evaluate diagnostic yield of diffusion weighted imaging (DWI) with very high b-value combined with T2 weighted sequence in breast MRI.

## **METHOD AND MATERIALS**

130 patients were included consecutively in this retrospective study approved by our IRB. All patients underwent breast MRI (MAGNETOM Aera, Siemens 1.5T, 18-channel breast antenna) with a 2D-SS-EPI-SPAIR diffusion sequence (TR / TE: 5200 / 67ms, b 2500s / mm<sup>2</sup>) in addition to the standard protocol with 2D-T1-FSE, 3D-T2-SPAIR and 3D-T1-VIBE-SPAIR -DCE. 2 independent readings were performed by 2 radiologists in consensus: 1) combined analysis of the DWI and T2W sequences and 2) analysis of the standard protocol according to BIRADS lexicon. All findings with hypersignal DWI and low T2 signal were considered as suspicious. All suspicious lesions were biopsied. BIRADS 1-3 lesions had at least 2years follow-up or histological proof. Diagnostic yields were compared using ROC curves.

## **RESULTS**

A total of 180 lesions were analyzed of which 27% were malignant. Similar sensitivity but higher specificity were found with the combined analysis of DWI and T2W sequences compared with T1W, T2W and DCE sequences (92%, 92% vs 96%, 82% respectively). However, the comparison of ROC curves showed no significant difference (AUC= 0.92 vs 0.89 respectively, p= 0,364).

## **CONCLUSION**

Combined analysis of DWI with a b-value of 2500s / mm<sup>2</sup> and T2W sequences could be a reliable alternative to gadolinium injection, particularly for screening in women at high risk of breast cancer.

## **CLINICAL RELEVANCE/APPLICATION**

Diagnosis of breast cancer is possible with combined analysis of DWI with a b-value of 2500s/mm<sup>2</sup> and T2W sequences, even in non-contrast MR imaging.

### **RC215-08 Updates on the Use of Breast MRI in Women with Higher than Average Risk**

Monday, Dec. 2 9:45AM - 10:10AM Room: Arie Crown Theater

Participants

Debra L. Monticciolo, MD, Temple, TX (*Presenter*) Nothing to Disclose

#### **LEARNING OBJECTIVES**

1) To understand which populations at higher than average risk for breast cancer that may benefit from supplemental screening with MRI. 2) To provide an update of the latest ACR recommendations for the use of breast MRI in women of higher risk. 3) To understand the reasoning and data supporting the newest recommendations for high risk women.

### **RC215-09 MRI: Part 2**

### **RC215-10 MRI Biomarkers**

Monday, Dec. 2 10:30AM - 10:55AM Room: Arie Crown Theater

Participants

Julia Camps Herrero, MD, Alzira, Spain (*Presenter*) Nothing to Disclose

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#### **LEARNING OBJECTIVES**

1) To learn about the pathway of an imaging biomarker in its different stages: proof of concept, proof of mechanism, proof of principle and proof of efficacy and effectiveness. 2) To know the different types of MR-derived imaging biomarkers and their current clinical use. 3) To understand how the quantitative MR-phenotypes can be integrated into clinical practice as well as the challenges we face in this implementation.

#### **ABSTRACT**

Breast MRI is the most sensitive modality for high-risk screening and for the diagnosis and characterization of breast lesions. Both qualitative and quantitative imaging biomarkers can be derived from breast MRI that can be associated with a patient's risk to develop a breast cancer, the prognosis of a known breast cancer through data mining of MR-phenotypes or a prediction of response evaluation to neoadjuvant therapies. BM of breast cancer risk that can be analyzed through breast MRI are breast density and background parenchymal enhancement. BC is a heterogeneous disease and the different molecular subtypes that have been described in the last decade have had a tremendous impact on the personalized treatment of the disease. These subtypes have been shown to be predictive of disease free survival and overall survival. Computer extraction or analysis of quantitative imaging features also known as radiomics has been applied to MRI data (tumor morphology, texture and enhancement kinetics) in order to build predictive or prognostic models and correlate MR features with BC molecular subtypes. The correlation of imaging phenotypes with genomic information is also known as radiogenomics through which MR features are correlated with clinically available genomic assays. These MR-phenotypes can serve as surrogate markers of tumor behaviour and survival and speed up drug development as well as personalized therapies. The process of imaging biomarker validation is not easy nor simple, standardisation of imaging processing and analysis and measurement of the MR features is still a challenge.

### **RC215-11 Comparison of Four Radiomics-Based Classification Methods in Diagnosis of Breast Lesions with Multi-b Diffusion-Weighted MR Imaging**

Monday, Dec. 2 10:55AM - 11:05AM Room: Arie Crown Theater

Participants

Kun Sun, Shanghai, China (*Presenter*) Nothing to Disclose



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Dinggang Shen, Chapel Hill, NC (*Abstract Co-Author*) Nothing to Disclose

## PURPOSE

To compare the diagnostic performance of four radiomics-based classification methods in differentiation between benign and malignant breast lesions with multi-b diffusion-weighted MR imaging.

## METHOD AND MATERIALS

Totally, 542 lesions in 542 patients with multi-b diffusion-weighted-images (b values: 0-2500 s/mm<sup>2</sup>) were acquired, where 100 radiomic features (by using Pyradiomics toolbox) were computed with multi-b diffusion-weighted-imaging, as well as mono-exponential (ME) with ME-ADC0-1000 and ME-ADCall-b, bi-exponential (BE) with BE-D, BE-D\*, and BE-f, stretched-exponential (SE) with SE-DDC and SE-a, and diffusion kurtosis imaging (DKI) with DKI-D and DKI-K. Radiomics-based analysis was performed by using four classification methods, including random forest (RF), principal component analysis (PCA), L1 regularization (L1R), and support vector machine (SVM). The dataset is randomly split into the training and testing sets for 100 times to evaluate the performance of all the classification models. The training and testing sets were randomly split into 50% and 50%. The radiomics-based diagnosis was compared to the pathological results. AUCs were used to compare performances of the four classification models.

## RESULTS

The AUCs of RF in the differential diagnosis of breast lesions ranged from 0.80 (BE-D\*) to 0.85 (BE-D), whereas the AUCs of PCA ranged from 0.53 (SE-DDC) to 0.79 (b1500). The AUCs of L1R and SVM ranged from 0.53 (SE-DDC) to 0.83 (ME-ADC0-1000) and from 0.51 (SE-DDC) to 0.82 (b2500), respectively. The top 5 sequences with the highest AUCs by the RF are BE-D (0.85), ME-ADCall-b (0.84), DKI-K (0.84), ME-ADC0-1000 (0.83) and b2500 (0.83). The top 5 sequences with the highest mean AUCs are b2500 (0.82), b2000 (0.81), ME-ADC0-1000 (0.81), b1500 (0.81), and BE-D (0.81). RF attained higher AUCs than L1R, PCA and SVM. However, there was no significant difference among these four classification methods in the top 5 sequences with the highest mean AUCs (all  $P > 0.002$ ).

## CONCLUSION

Radiomics-based analysis with RF model was recommended for the classification of breast lesions. BE-D with the highest AUC by RF model and b2500 with the highest mean AUC were recommended for the diffusion-related radiomic analysis in breast cancer evaluation.

## CLINICAL RELEVANCE/APPLICATION

For radiomic analysis of multi-b diffusion-weighted imaging in the evaluation of breast lesions, RF model is provided to be a reliable classification technique.

## RC215-12 Radiomic Features Derived from Contrast-Enhanced Magnetic Resonance and Diffusion Weighted Imaging for the Assessment of Breast Cancer Molecular Subtypes

Monday, Dec. 2 11:05AM - 11:15AM Room: Arie Crown Theater

### Participants

Doris Leithner, MD, Frankfurt Am Main, Germany (*Presenter*) Nothing to Disclose  
Marius E. Mayerhoefer, MD, PhD, Vienna, Austria (*Abstract Co-Author*) Speaker, Siemens AG; Research support, Siemens AG  
Blanca Bernard-Davila, MPH, MS, New York, NY (*Abstract Co-Author*) Nothing to Disclose  
Maxine S. Jochelson, MD, New York, NY (*Abstract Co-Author*) Speaker, General Electric Company; Consultant, Bayer AG  
Joao V. Horvat, MD, New York, NY (*Abstract Co-Author*) Nothing to Disclose  
Maria Adele Marino, MD, Messina, Italy (*Abstract Co-Author*) Nothing to Disclose  
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Sunitha Thakur, PhD, MS, New York, NY (*Abstract Co-Author*) Nothing to Disclose  
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Katja Pinker-Domenig, MD, New York, NY (*Abstract Co-Author*) Speakers Bureau, Siemens AG ; Advisory Board, Merantix Healthcare GmbH

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## PURPOSE

To evaluate the performance of combined radiomic features extracted from contrast-enhanced magnetic resonance imaging (CE-MRI) and diffusion-weighted imaging (DWI) for the assessment of breast cancer receptor status and molecular subtypes.

## METHOD AND MATERIALS

Ninety-one patients with biopsy-proven breast cancer (luminal A, n=49; luminal B, n=8; HER2-enriched, n=11; triple negative (TN), n=23) who underwent 3T CE-MRI and DWI were included in this IRB-approved HIPAA-compliant retrospective study. Radiomic features (co-occurrence and run-length matrix, absolute gradient, autoregressive model, Haar wavelet transform and lesion geometry) were extracted from manually defined ROIs (total number of features per lesion, n=704) on early CE-MR images and ADC maps. The five best features for the differentiation of molecular subtypes were selected, separately for each technique (i.e. CE-MRI and ADC) using probability of error and average correlation coefficients. A multi-layer perceptron feed-forward artificial neural network (MLP-ANN) was used for radiomics-based classification, with histopathology serving as reference standard. 70% of the cases were used for training, and 30% for validation. The analysis was performed five times each.

## RESULTS

MLP-ANN yielded an overall median area under the receiver operating characteristic curve (AUC) of 0.86 (0.77-0.92) for

MLF-ANN yielded an overall median area under the receiver-operating-characteristic curve (AUC) of 0.88 (0.77-0.92) for separation of TN from all other cancers, with median accuracies of 85.9% in the training and 85.2% in the validation datasets. The separation of luminal A and triple negative cancers yielded an overall median AUC of 0.8 (0.75-0.83), with median accuracies of 74% in the training, and 68.2% in the validation dataset. All other AUCs were below 0.8.

## CONCLUSION

Combination of radiomic features extracted from CE-MRI and DWI may be useful to differentiate triple negative and luminal A breast cancers from other subtypes.

## CLINICAL RELEVANCE/APPLICATION

Combined CE-MRI and DWI radiomic features may potentially provide prognostic indicators derived from the entire tumor, which may be used for tumor monitoring during treatment.

### RC215-13 **Change in Contralateral Parenchymal Enhancement during Neoadjuvant Endocrine Treatment is Associated with Tumor Response in Unilateral ER+/HER2- Breast Cancer Patients**

Monday, Dec. 2 11:15AM - 11:25AM Room: Arie Crown Theater

#### Participants

Max Ragusi, MD, Utrecht, Netherlands (*Presenter*) Nothing to Disclose  
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Bas H. van der Velden, MSc, Utrecht, Netherlands (*Abstract Co-Author*) Nothing to Disclose  
Jelle Wesseling, Amsterdam, Netherlands (*Abstract Co-Author*) Nothing to Disclose  
Regina G. Beets-Tan, MD, PhD, New York, NY (*Abstract Co-Author*) Nothing to Disclose  
Sjoerd G. Elias, MD, PhD, Utrecht, Netherlands (*Abstract Co-Author*) Nothing to Disclose  
Kenneth G. Gilhuijs, PhD, Amsterdam, Netherlands (*Abstract Co-Author*) Nothing to Disclose

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## PURPOSE

To investigate whether contralateral parenchymal enhancement (CPE), a quantitative measure of parenchymal enhancement, is associated with tumor response during neoadjuvant endocrine treatment (NET) of unilateral ER+/HER2- breast cancer.

## METHOD AND MATERIALS

Retrospective single center cohort study of unilateral ER+/HER2- breast cancer patients treated with NET between Jan 2013 and Dec 2017. Pretreatment and response DCE-MRIs (3 and 6 months) were acquired using 1.5T or 3T MRI. The early contrast-enhanced images were acquired after 90s post-contrast injection and the late images after 360-450s. CPE is defined as the mean of the top-10% relative parenchymal enhancement between early and late post-contrast images of the contralateral breast. Tumor response was expressed by the preoperative endocrine prognostic index (PEPI), which identifies three distinct groups based on post-treatment pT, pN, Ki-67 and ER-status. A high PEPI-group is associated with increased risks of relapse and death. We used a linear mixed model to assess log(CPE) during NET in relation to tumor response, using patient-level random intercepts to account for clustered data.

## RESULTS

A total of 39 patients with 79 CPE measurements were available (patients with unavailable PEPI-score [n=2] or MRIs with motion artifacts [n=2] were excluded). Mean age was 61 ( $\pm 11$ ) years. Mean treatment duration was 7.2 ( $\pm 1.4$ ) months. After NET, 12 patients had PEPI-1 score, 15 PEPI-2, and 12 PEPI-3. Pretreatment CPE did not differ between PEPI-groups: difference of 7.8% in PEPI-1 vs 2 (P=.593), 29.9% in PEPI-1 vs 3 (P=.091), and 20.5% in PEPI-2 vs 3 (P=.209). Change in CPE over time depended on tumor response (Pinteraction\*PEPI=.005). CPE increased in PEPI-1 by 5.0% (95% CI= 0.8-9.4%, P=.025) per month, and decreased in the less favorable groups by 2.4% (95% CI= -1.4-6.0%, P=.224) for PEPI-2 and 5.8% (95% CI= -0.1-11.3%, P=.058) for PEPI-3 per month. The difference in CPE over time was significant for PEPI-1 vs 2 (P=.014) and PEPI-1 vs 3 (P=.005), but not for PEPI-2 vs 3 (P=.327).

## CONCLUSION

Change in CPE during NET is associated with tumor response: an increase in CPE over time was associated with a favorable tumor response.

## CLINICAL RELEVANCE/APPLICATION

Contralateral parenchymal enhancement has potential as a prognostic biomarker in breast cancer patients to assess tumor response during neoadjuvant endocrine treatment.

### RC215-14 **DCE-MRI Biomarkers of Changes in Peri-Tumoral and Intra-Tumoral Heterogeneity for Improving Early Prediction of Survival after Neoadjuvant Chemotherapy for Breast Cancer**

Monday, Dec. 2 11:25AM - 11:35AM Room: Arie Crown Theater

#### Participants

Nariman Jahani, Philadelphia, PA (*Presenter*) Nothing to Disclose  
Eric A. Cohen, Philadelphia, PA (*Abstract Co-Author*) Nothing to Disclose  
Susan Weinstein, MD, Philadelphia, PA (*Abstract Co-Author*) Nothing to Disclose  
Nola M. Hylton, PhD, San Francisco, CA (*Abstract Co-Author*) Research support, General Electric Company  
David Newitt, PhD, San Francisco, CA (*Abstract Co-Author*) Nothing to Disclose  
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## PURPOSE

To evaluate changes in peri- and intra-tumoral DCE-MRI heterogeneity as a biomarker for early prediction of recurrence-free survival (RFS) after neoadjuvant chemotherapy (NAC) for breast cancer.

## METHOD AND MATERIALS

We analyzed DCE-MRI scans of 132 women from the I-SPY1 TRIAL acquired before and after the first cycle of NAC. A deformable registration technique was applied to quantify voxel-wise changes during NAC. From that, two groups of feature maps were extracted within peri- and intra-tumoral regions: 1) four features representing deformations in shapes and volumes and 2) four kinetic features indicating changes in enhancement patterns. Also, eight additional features were computed to indicate relative changes between peri- and intra-tumoral heterogeneity. Thus, a total of 24 imaging features were extracted and evaluated in three models: 1) using combinations of peri- and intra-tumor features 2) using only intra-tumoral features 3) using only peri-tumoral features. For a proper comparison, the same number of features (top six RFS-associated features) were selected for each model by Cox regression via five-fold cross-validation. Functional tumor volume (FTV) and established covariates of age, race, and hormone receptor status were considered. The C-statistic was evaluated over the cross-validation loops and the likelihood ratio test was used to compare nested models.

## RESULTS

Significant improvement was achieved when using both peri- and intra-tumoral features (c-statistic=0.77,  $p < 0.05$ ) compared to models using only peri- or intra-tumoral features (c-statistics =0.70 and 0.73, respectively). For the combined model, all selected features including three of relative changes, two intra-tumoral, and one peri-tumoral features had strong associations with RFS ( $p < 0.01$ ). Performance of the combined model was improved further by adding FTV and the established histopathologic and demographic covariates (c-statistic=0.79,  $p_{\text{Likelihood-Ratio}} < 0.001$ ).

## CONCLUSION

Analysis of changes in peri-tumoral heterogeneity features and their relative changes with respect to intra-tumoral heterogeneity may reveal markers from the surrounding tumor tissues that could improve early assessment of RFS for breast cancer NAC.

## CLINICAL RELEVANCE/APPLICATION

Quantification of changes in peri- and intra-tumoral heterogeneity may improve early prediction of patient survival after NAC providing better guidance for personalized cancer treatment.

## RC215-15 Background Parenchymal Enhancement

Monday, Dec. 2 11:35AM - 12:00PM Room: Arie Crown Theater

### Participants

Christoph I. Lee, MD, Mercer Island, WA (*Presenter*) Royalites, The McGraw-Hill Companies; Royalties, Oxford University Press; Royalties, Wolters Kluwer nv;

## LEARNING OBJECTIVES

1) Provide an overview of reporting standards for breast parenchymal enhancement observed on breast MRI. 2) Describe the current evidence regarding breast parenchymal enhancement and associated breast cancer risk. 3) Identify future directions for incorporating breast parenchymal enhancement in cancer risk assessment.

Printed on: 10/29/20



RC216

## Improving Patient Experience through Human Design Thinking (Sponsored by the RSNA Public Information Committee)

Monday, Dec. 2 8:30AM - 10:00AM Room: S403B

LM

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

### Participants

Susan D. John, MD, Houston, TX (*Moderator*) Nothing to Disclose

### For information about this presentation, contact:

laurabancroftmd@gmail.com

### LEARNING OBJECTIVES

1) Apply human design thinking processes to create practical solutions to improve patient experience. 2) Use novel teaching methods to improve empathy and communication between physicians and patients. 3) Implement effective methods of providing equitable care and improving access to imaging.

### ABSTRACT

As patients become increasingly engaged in their medical care, attention to the quality of the patient experience must become a priority in radiology departments and imaging facilities. Human centered design is an approach to problem-solving that uses the patient perspective through all phases of the process. This technique emphasizes human dignity, access, and abilities when developing solutions. Empathetic communication with patients is a key factor in designing patient-centered solutions. This course will introduce the concept of human design thinking and how it can be applied to improve patient experience, access, and communication in radiology.

### Sub-Events

#### RC216A Human Design Thinking: What Is It and How Can You Use it to Improve Patient Experience?

### Participants

Achala S. Vagal, MD, Mason, OH (*Presenter*) Research Grant, Cerovenus

### For information about this presentation, contact:

vagala@ucmail.uc.edu

### LEARNING OBJECTIVES

1) To become familiar with concept of human centered design thinking. 2) To understand the methodology of design thinking for patient experience through a case study example. 3) To learn about the challenges of design thinking in healthcare and radiology.

#### RC216B Teaching Empathetic Communication with Patients and Physicians

### Participants

Ruth C. Carlos, MD, MS, Ann Arbor, MI (*Presenter*) Editor, Journal of the American College of Radiology; Support, Harvey L. Neiman Health Policy Institute; In-kind support, Reed Elsevier;

#### RC216C Equity and Access to Imaging

### Participants

Lucy B. Spalluto, MD, Nashville, TN (*Presenter*) Nothing to Disclose

### For information about this presentation, contact:

lucy.b.spalluto@vumc.org

### LEARNING OBJECTIVES

1) Review concepts of health equity. 2) Summarize current challenges in providing equitable care. 3) Discuss potential methods to improve access to care.

Printed on: 10/29/20



RC217

## Emerging Technology: 3D Joint MR Imaging

Monday, Dec. 2 8:30AM - 10:00AM Room: S504CD

MR MK

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

FDA Discussions may include off-label uses.

### Participants

Avneesh Chhabra, MD, Flowermound, TX (*Moderator*) Consultant, ICON plc; Consultant, Treace Medical Inc; Author with royalties, Wolters Kluwer nv; Author with royalties, Jaypee Brothers Medical Publishers Ltd

### For information about this presentation, contact:

Avneesh.chhabra@utsouthwestern.edu

### LEARNING OBJECTIVES

1) Gain knowledge of techniques of optimal 3D isotropic MRI technique for joint and bone evaluation. 2) Learn how to create meniscus, cruciate and ankle ligament, and rotator cuff specific reconstructions using 3D MRI. 3) Learn 3D evaluation of internal joint derangements and their arthroscopy correlations. 4) Explain the advantages and drawbacks of 3D MSK MRI. 5) Describe new techniques to accelerate 3D MSK MRI. 6) Gain knowledge of the optimal 3D isotropic MRI technique for knee meniscus and bone evaluation. 7) Learn how to create meniscus and cruciate specific reconstructions using 3D MRI. 8) Learn how to evaluate meniscus tears and describe their longitudinal extent with arthroscopy correlations. 9) To apply current techniques and acquisition strategies for isotropic 3D MRI of the ankle joint. 10) To review the diagnostic performance and comparative accuracy of 3D MRI of the ankle joint. 11) To illustrate the strengths and limitations of 3D MRI of the ankle. 12) Define technical elements that allow acquisition of high resolution 3D MR images of the hip. 13) List common clinical indications for 3D MR imaging of the hip. 14) Explain differences between high resolution 3D MRI and conventional MR sequences to referring clinicians. 15) Discuss accuracy of 3D MRI of the hip as compared to conventional MR sequences and MR arthrogram. 16) List pitfalls and list measures to minimize artifacts in using high resolution 3D sequences of the hip. 17) Review the imaging and post-processing techniques used to create 3D MRI shoulder models. 18) Discuss the use of 3D MRI bone models in the evaluation of anterior shoulder instability patients. 19) Discuss the use of 3D MRI soft tissue models in the evaluation of rotator cuff tendon tears.

### Sub-Events

#### RC217A Fast 3D Imaging: Emerging Techniques to Accelerate 3D Acquisitions

##### Participants

Naveen Subhas, MD, Shaker Heights, OH (*Presenter*) Research support, Siemens AG

### LEARNING OBJECTIVES

1) Explain the advantages and drawbacks of 3D MSK MRI. 2) Describe new techniques to accelerate 3D MSK MRI.

#### RC217B 3D MR Imaging of Knee Joint

##### Participants

Avneesh Chhabra, MD, Flowermound, TX (*Presenter*) Consultant, ICON plc; Consultant, Treace Medical Inc; Author with royalties, Wolters Kluwer nv; Author with royalties, Jaypee Brothers Medical Publishers Ltd

### For information about this presentation, contact:

Avneesh.chhabra@utsouthwestern.edu

### LEARNING OBJECTIVES

1) Gain knowledge of the optimal 3D isotropic MRI technique for knee meniscus and bone evaluation. 2) Learn how to create meniscus and cruciate specific reconstructions using 3D MRI. 3) Learn how to evaluate meniscus tears and describe their longitudinal extent with arthroscopy correlations.

#### RC217C 3D MR Imaging of Ankle Joint

##### Participants

Jan Fritz, MD, Baltimore, MD (*Presenter*) Institutional research support, Siemens AG; Institutional research support, Johnson & Johnson; Institutional research support, Zimmer Biomet Holdings, Inc; Institutional research support, Microsoft Corporation; Institutional research support, BTG International Ltd; Scientific Advisor, Siemens AG; Scientific Advisor, General Electric Company; Scientific Advisor, BTG International Ltd; Speaker, Siemens AG; Patent agreement, Siemens AG

### For information about this presentation, contact:

janfritz777@gmail.com

### LEARNING OBJECTIVES

1) To apply current techniques and acquisition strategies for isotropic 3D MRI of the ankle joint. 2) To review the diagnostic

performance and comparative accuracy of 3D MRI of the ankle joint. 3) To illustrate the strengths and limitations of 3D MRI of the ankle.

### **RC217D 3D MR Imaging of Hip Joint**

Participants

Oganes Ashikyan, MD, Dallas, TX (*Presenter*) Nothing to Disclose

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

oganes.ashikyan@utsouthwestern.edu

#### **LEARNING OBJECTIVES**

1) Define technical elements that allow acquisition of high resolution 3D MR images of the hip. 2) List common clinical indications for 3D MR imaging of the hip. 3) Explain differences between high resolution 3D MRI and conventional MR sequences to referring clinicians. 4) Discuss accuracy of 3D MRI of the hip as compared to conventional MR sequences and MR arthrogram. 5) List pitfalls and list measures to minimize artifacts in using high resolution 3D sequences of the hip.

### **RC217E 3D MR Imaging of Shoulder Joint**

Participants

Soterios Gyftopoulos, MD, Scarsdale, NY (*Presenter*) Nothing to Disclose

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

Soterios.Gyftopoulos@nyumc.org

#### **LEARNING OBJECTIVES**

1) Review the imaging and post-processing techniques used to create 3D MRI shoulder models. 2) Discuss the use of 3D MRI bone models in the evaluation of anterior shoulder instability patients. 3) Discuss the use of 3D MRI soft tissue models in the evaluation of rotator cuff tendon tears.

Printed on: 10/29/20



RC218

## Whole Body MRI for Precision Oncology in Malignant Bone Disease

Monday, Dec. 2 8:30AM - 10:00AM Room: S103AB

**BQ** **MR** **MK** **OI**

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

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

### Participants

Evis Sala, MD, PhD, Cambridge, United Kingdom (*Moderator*) Co-founder, Cambridge AI Health; Speakers Bureau, GlaxoSmithKline plc

### LEARNING OBJECTIVES

1) Describe the limitations of current imaging modalities in evaluation of metastatic bone disease. 2) Learn the added value of whole body MRI in evaluation of metastatic bone disease in various malignancies including prostate cancer and multiple myeloma. 3) Understand the role of quantitative whole body MRI in delivering precision medicine in oncology.

### Sub-Events

#### RC218A Imaging of Metastatic Bone Disease: Current Limitations

##### Participants

Hebert Alberto Vargas, MD, Cambridge, United Kingdom (*Presenter*) Nothing to Disclose

### LEARNING OBJECTIVES

1) Discuss the challenges associated with the diagnosis and interpretation of bone findings in patients with metastatic disease.

### ABSTRACT

Conventional imaging of metastatic disease to the bone is notoriously difficult. Unlike soft tissue metastases, significant cortical disruption is required before a bone metastases is visible on CT, and bone scan demonstrates the effect of the metastases on bone, rather than the metastases themselves. MR partially overcomes these limitations, as early bone metastases can be detected. However, even after bone metastases are apparent on imaging, it is difficult to assess their evolution with regards to therapy response.

#### RC218B WB-MRI of Multiple Myeloma: My-RADS

##### Participants

Christina Messiou, MD, BMBS, London, United Kingdom (*Presenter*) Nothing to Disclose

### For information about this presentation, contact:

Christina.Messiou@icr.ac.uk

### LEARNING OBJECTIVES

1) List indications for WB-MRI in multiple myeloma. 2) Describe the core and comprehensive protocols for WB-MRI in multiple myeloma. 3) Apply a systematic approach to reporting WB-MRI in multiple myeloma as outlined in MY-RADS. 4) Review the MY-RADS criteria for assessing disease phenotype, burden and response assessment with case examples.

### ABSTRACT

Acknowledging the increasingly important role of WB-MRI for directing myeloma patient care, a multidisciplinary international expert panel of radiologists, medical physicists and haematologists convened to discuss the performance standards, merits and limitations of WB-MRI in myeloma. The MY-RADS imaging recommendations are designed to promote standardization and diminish variations in the acquisition, interpretation, and reporting of WB-MRI in myeloma both in the clinical setting and within clinical trials. MY-RADS comprehensive disease classification requires validation within clinical trials including assessments of reproducibility.

### Active Handout: Christina Messiou

[http://abstract.rsna.org/uploads/2019/18001096/Messiou\\_Final\\_RSNA\\_2019\\_WB\\_MRI\\_in\\_multiple\\_myeloma.pdf](http://abstract.rsna.org/uploads/2019/18001096/Messiou_Final_RSNA_2019_WB_MRI_in_multiple_myeloma.pdf)

#### RC218C WB-MRI of Metastatic Bone: MET-RADS

##### Participants

Anwar R. Padhani, MD, FRCR, Northwood, United Kingdom (*Presenter*) Advisory Board, Siemens AG; Speakers Bureau, Siemens AG; Speakers Bureau, sanofi-aventis Group; Speakers Bureau, Johnson & Johnson; Speakers Bureau, Astellas Group

### For information about this presentation, contact:

anwar.padhani@stricklandscanner.org.uk

### LEARNING OBJECTIVES

1) MET-RADS measurement protocols distinguishing between tumor detection (core) and response (comprehensive) assessments.

2) To highlight and review the MET-RADS response assessment criteria and their application. 3) To illustrate MET-RADS usage with case examples and to provide efficacy data on MET-RADS use in clinical practise. 4) Outline development steps for MET-RADS.

#### **ABSTRACT**

MET-RADS provides the minimum standards for whole body MRI with DWI regarding image acquisitions, interpretation, and reporting of both baseline and follow-up monitoring examinations of patients with advanced, metastatic cancers. MET-RADS is suitable for guiding patient care in practice (using the regional and overall assessment criteria), but can also be incorporated into clinical trials when accurate lesion size and ADC measurements become more important (the recording of measurements is not mandated for clinical practice). MET-RADS enables the evaluation of the benefits of continuing therapy to be assessed, when there are signs that the disease is progressing (discordant responses). MET-RAD requires validation within clinical trials initially in studies that assess the effects of known efficacious treatments. METRADS measures should be correlated to other tumor response biomarkers, quality of life measures, rates of skeletal events, radiographic progression free survival and overall survival. The latter will be needed for the introduction of WB-MRI into longer term follow-up studies, that will allow objective assessments of whether WB-MRI is effective in supporting patient care

#### **RC218D Quantitative WB-MRI for Promoting Precision Oncology**

Participants

Dow-Mu Koh, MD,FRCR, Sutton, United Kingdom (*Presenter*) Nothing to Disclose

#### **LEARNING OBJECTIVES**

1) To review the quantitative parameters that can be derived from WB-MRI studies. 2) To understand the evolving role of quantitative WB-MRI for the evaluation of metastatic bone disease. 3) To appreciate the application of quantitative WB-MRI for precision oncology in assessing tumour treatment response and disease heterogeneity.

Printed on: 10/29/20





RC220

## Stereotactic Ablative Radiotherapy (SABR) for Oligometastases/Oligoprogression: A New Treatment Paradigm

Monday, Dec. 2 8:30AM - 10:00AM Room: S401CD

RO

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

### Participants

Nina A. Mayr, MD, Seattle, WA (*Moderator*) Nothing to Disclose

### LEARNING OBJECTIVES

1) Understand the new concept of oligo-metastases and oligo-progression in the major cancer types. 2) Understand the role of stereotactic ablative radiotherapy in patients with oligo-metastases from lung, gynecological, prostate and colorectal cancer. 3) Understand the role of stereotactic ablative radiotherapy in patients with oligo-progression of one or more among multiple metastases from lung, gynecological, prostate and colorectal cancer. 4) Understand techniques, outcomes and toxicities of stereotactic ablative radiotherapy for oligo-metastases and oligo-progression.

### ABSTRACT

This session provides a comprehensive and critical review of the role, outcomes and techniques of stereotactic ablative radiotherapy in patients with limited metastases (oligo-metastases) or progression of limited metastases (oligo-progression) in major common tumors: lung, gynecologic, prostate and colorectal cancer. Together these 4 tumor types represent over one third of all cancer diagnoses in the U.S. and have a high propensity for developing metastases. With the continuous advancement of systemic (chemo- and targeted) therapy options, the survival time and tumor control in patients with metastatic cancer has continued to improve. Therapy for local tumor progression of individual metastatic sites therefore becomes critical to contribute to overall cancer control and patients' quality of life. Stereotactic ablative radiotherapy is a novel, emerging technique to address this need.

### Sub-Events

#### RC220A Lung Cancer

##### Participants

Candice A. Johnstone, MD, Milwaukee, WI (*Presenter*) Nothing to Disclose

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

cjohnstone@mcw.edu

#### RC220B Gynecologic Cancer

##### Participants

Eric Leung, MD, FRCPC, Toronto, ON (*Presenter*) Nothing to Disclose

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

eric.leung@sunnybrook.ca

#### RC220C Prostate Cancer

##### Participants

Abhishek A. Solanki, MD, Maywood, IL (*Presenter*) Consultant, Blue Earth Diagnostics Ltd; Advisory Board, Blue Earth Diagnostics Ltd; Research Funded, Blue Earth Diagnostics Ltd; Speaker, DAVA Oncology

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

abhishek.solanki@lumc.edu

#### RC220D Stereotactic Ablative Radiotherapy for Oligometastatic Colorectal Cancer

##### Participants

Suzanne M. Russo, MD, Cleveland, OH (*Presenter*) Nothing to Disclose

Printed on: 10/29/20



RC221

### Innovations in Cone-beam CT

Monday, Dec. 2 8:30AM - 10:00AM Room: E352

**CT** **PH**

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

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

#### Participants

Jeffrey H. Siewerdsen, PhD, Baltimore, MD (*Coordinator*) Research Grant, Siemens AG; Advisory Board, Siemens AG; Research Grant, Medtronic plc; Advisory Board, Carestream Health, Inc; License agreement, Carestream Health, Inc; License agreement, Precision X-Ray, Inc; License agreement, Elekta AB; ; ;

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

jeff.siewerdsen@jhu.edu

#### LEARNING OBJECTIVES

Learn about the range of technologies and clinical applications of cone-beam CT in image-guided interventions (including surgery, interventional radiology, and image-guided radiation therapy) and specialty diagnostic imaging (such as breast imaging and orthopaedic / musculoskeletal imaging). Learn about the diversity of cone-beam CT imaging systems for image-guided interventions, including fixed-room and mobile C-arms, O-arms, and new embodiments. Learn about the image quality challenges in cone-beam CT, including image noise and artifacts. Learn about the methods being developed to address such challenges, including new detector types and 3D image reconstruction algorithms. Learn about the systems and methods being developed to further improve spatial resolution in cone-beam CT, offering to extend imaging performance for applications such as breast imaging (detection of microcalcifications) and orthopaedic imaging (visualization / quantification of fine skeletal detail). Learn about the methods by which cone-beam CT can give quantitative measures of pathophysiology, including quantitative imaging metrics related to musculoskeletal health in high-resolution orthopaedics imaging.

#### Sub-Events

##### RC221A Innovations in CBCT for Image-guided Interventions

#### Participants

Jeffrey H. Siewerdsen, PhD, Baltimore, MD (*Presenter*) Research Grant, Siemens AG; Advisory Board, Siemens AG; Research Grant, Medtronic plc; Advisory Board, Carestream Health, Inc; License agreement, Carestream Health, Inc; License agreement, Precision X-Ray, Inc; License agreement, Elekta AB; ; ;

##### RC221B Innovations in CBCT for Breast Imaging

#### Participants

John M. Boone, PhD, Sacramento, CA (*Presenter*) Board of Directors and Shareholder, Izotropic Imaging Corporation; Co-author with royalties, Wolters Kluwer nv; Patent agreement, The Phantom Laboratory

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

z

#### LEARNING OBJECTIVES

1) To inform the audience of the overall design and use of a dedicated breast CT scanner. 2) To demonstrate the performance of the scanner as assessed using mathematical observers and other quantitative metrics. 3) To further demonstrate the performance of the scanner based upon radiologist-observer studies.

##### RC221C Innovations in CBCT for Musculoskeletal/Orthopedic Imaging

#### Participants

Wojciech Zbijewski, PhD, Baltimore, MD (*Presenter*) Research Grant, Carestream Health, Inc; Research Grant, Siemens AG

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

wzbijewski@jhu.edu

#### LEARNING OBJECTIVES

1) Explain the technology of musculoskeletal (MSK) cone-beam CT (CBCT). 2) Identify key differences between MSK CBCT and other orthopedic imaging modalities. 3) Discuss emerging clinical applications of MSK CBCT.

Printed on: 10/29/20



RC222

## Advanced PET Imaging for Radiotherapy Planning and Response Assessment

Monday, Dec. 2 8:30AM - 10:00AM Room: N229

**BQ** **NM** **PH** **RO**

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

### Participants

Paul E. Kinahan, PhD, Seattle, WA (*Moderator*) Research Grant, General Electric Company Co-founder, PET/X LLC

### Sub-Events

#### RC222A State of the Art in PET Imaging

##### Participants

Paul E. Kinahan, PhD, Seattle, WA (*Presenter*) Research Grant, General Electric Company Co-founder, PET/X LLC

### LEARNING OBJECTIVES

1) Understand the connections between the capabilities of PET imaging and clinical and research uses. 2) Become familiar with recent technical advances in PET imaging and tradeoffs. 3) Gain awareness of initiative in quantitative imaging for clinical trials.

#### RC222B Technical Challenges in the Integration of PET Imaging into Radiotherapy Treatment Planning

##### Participants

Stephen R. Bowen, PhD, Seattle, WA (*Presenter*) Nothing to Disclose

### LEARNING OBJECTIVES

1) Understand the differences between diagnostic and treatment planning PET/CT imaging technical requirements. 2) Become familiar with the source and propagation of technical errors in PET/CT-guided radiation therapy. 3) Gain awareness of technical design elements in PET/CT-guided radiation therapy clinical trials.

Printed on: 10/29/20



RC223

## ACR Accreditation Updates I

Monday, Dec. 2 8:30AM - 10:00AM Room: S502AB

PH

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

### Participants

James M. Kofler JR, PhD, Jacksonville, FL (*Coordinator*) Nothing to Disclose

### LEARNING OBJECTIVES

1) Learn new and updated information for the ACR CT imaging accreditation program. 2) Become familiar with the requirements for the ACR MRI accreditation program. 3) Learn updated information on the ACR Nuclear Medication and PET accreditation program.

### Sub-Events

#### RC223A ACR CT Accreditation Update

##### Participants

Jessica Clements, MS, Los Angeles, CA (*Presenter*) Nothing to Disclose

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

jessicaclements@gmail.com

### LEARNING OBJECTIVES

1) To understand the requirements of the ACR CT accreditation program, including updates to the QC manual and accreditation process.

##### Active Handout: Jessica Clements

<http://abstract.rsna.org/uploads/2019/18001926/2019 Dec 2 RSNA ACR CT Update Handout.pdf>

#### RC223B ACR MRI Accreditation Update

##### Participants

Donna M. Reeve, MS, Silverdale, WA (*Presenter*) Nothing to Disclose

### LEARNING OBJECTIVES

1) Provide an overview of the current ACR MRI and Breast MRI Accreditation Program requirements. 2) Present recent changes to the MRI programs and updates to guidance documents. 3) Present planned changes to both ACR MRI programs.

##### Active Handout: Donna M. Reeve

<http://abstract.rsna.org/uploads/2019/18001927/Active RC223B.pdf>

#### RC223C ACR Nuclear Medicine and PET Accreditation Update

##### Participants

Beth A. Harkness, MS, Detroit, MI (*Presenter*) Nothing to Disclose

### LEARNING OBJECTIVES

1) Describe the requirements of the Nuclear Medicine and PET ACR accreditation programs. 2) Describe physics testing and QC requirements. 3) List common pitfalls in the accreditation process.

### ABSTRACT

The ACR Nuclear Medicine (NM) and PET Accreditation program is a means of demonstrating that the department is performing quality imaging studies. The program itself evolves to address the current state of nuclear and PET imaging and comments from users. This presentation will review the current status of the physics requirements for this process.

##### Active Handout: Beth A. Harkness

<http://abstract.rsna.org/uploads/2019/18001928/Active RC223C.pdf>

Printed on: 10/29/20



RC224

## Requirements for Tumor Biopsies in the Age of Precision Cancer Care

Monday, Dec. 2 8:30AM - 10:00AM Room: S404AB

**ED** **IR**

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

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

### Participants

Sanjay Gupta, MD, Houston, TX (*Moderator*) Nothing to Disclose  
Vikas Kundra, MD, PhD, Houston, TX (*Moderator*) Institutional license agreement, Introgen Therapeutics, Inc; Research Grant, General Electric Company

### For information about this presentation, contact:

laurabancroftmd@gmail.com

### LEARNING OBJECTIVES

1) Specify requirements for lung tumor biopsies from an oncology, pathology and technical perspective. 2) Define clinical requirements for a biopsy to comprehensively diagnose and monitor chest tumors. 3) Identify requirements for tissue collection and processing required for a successful biopsy. 4) Describe technical criteria to perform a successful lung biopsy.

### Sub-Events

#### RC224A Clinical Requirements for Diagnosis and Monitoring (Oncologist)

##### Participants

Vincent Lam, MD, Baltimore, MD (*Presenter*) Advisory Committee, Takeda Pharmaceutical Company Limited; Speaker, Bristol-Myers Squibb Company; Research support, Guardant Health; Research support, Takeda Pharmaceutical Company Limited; Research support, Adaptimmune; ;

#### RC224B Tissue Processing (Pathologist)

##### Participants

Neda Kalhor, MD, Houston, TX (*Presenter*) Consultant, Bristol-Myers Squibb Company; Advisory Committee, Bristol-Myers Squibb Company; Consultant, AbbVie Inc; Advisory Committee, AbbVie Inc; Consultant, Merck & Co, Inc; Advisory Committee, Merck & Co, Inc; Consultant, F. Hoffmann-La Roche Ltd; Advisory Committee, F. Hoffmann-La Roche Ltd; Steering Committee, Merck & Co, Inc

#### RC224C How to Perform Tumor Biopsies

##### Participants

Sanjay Gupta, MD, Houston, TX (*Presenter*) Nothing to Disclose

Printed on: 10/29/20



RC225

## Quantitative Imaging: Image Modality Specific Issues

Monday, Dec. 2 8:30AM - 10:00AM Room: S504AB

**BQ** **PH**

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

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

### Participants

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

### For information about this presentation, contact:

mmcnittgray@mednet.ucla.edu

### LEARNING OBJECTIVES

1) To learn about issues related to quantitative imaging that are specific to CT including image acquisition and reconstruction as well as QA processes. 2) To learn about issues related to quantitative imaging that are specific to PET/CT including image acquisition and reconstruction as well as QA processes. 3) To learn about issues related to quantitative imaging that are specific to DCE MRI including image acquisition and reconstruction as well as QA processes. 4) To understand the current limitations of each modality in quantitative imaging. 5) To understand the role of CT imaging as a biomarker for disease. 6) To describe applications of CT-based quantitative imaging in the clinical and research settings. 7) To appreciate the need for standardization in the extraction of quantitative features from CT scans. 8) To learn issues related to quantitative imaging in PET/CT in single and multi-center setting. 9) To learn about uncertainties related to PET/CT quantification. 10) To learn about ways to increase PET/CT quantification.

### Sub-Events

#### RC225A Quantitative Imaging for Computed Tomography: Applications and Future Directions

##### Participants

Samuel G. Armato III, PhD, Chicago, IL (*Presenter*) Nothing to Disclose

### For information about this presentation, contact:

s-armato@uchicago.edu

### LEARNING OBJECTIVES

1) To understand the role of CT imaging as a biomarker for disease. 2) To describe applications of CT-based quantitative imaging in the clinical and research settings. 3) To appreciate the need for standardization in the extraction of quantitative features from CT scans.

#### RC225B Quantitative Imaging for PET-CT: Applications and Future Directions

##### Participants

Robert Jeraj, PHD, Madison, WI (*Presenter*) Founder, AIQ Solutions

### For information about this presentation, contact:

rjeraj@wisc.edu

### LEARNING OBJECTIVES

1) To learn issues related to quantitative imaging in PET/CT in single and multi-center setting. 2) To learn about uncertainties related to PET/CT quantification. 3) To learn about ways to increase PET/CT quantification.

#### RC225C Quantitative Imaging for DCE-MRI: Applications and Future Directions

##### Participants

Yue Cao, PhD, Ann Arbor, MI (*Presenter*) Nothing to Disclose

### ABSTRACT

1) To understand how to perform QA of acquisition and quantification processes of DCE MRI to derive physiological parameters 2) To understand how to apply quantitative DCE MRI in an adaptive therapy clinical trial 3) To understand how to perform real-time QA of quantitative DCE MRI in a clinical trial

Printed on: 10/29/20



RC227

## Health Policy and Practice Series: Health Policy & Quality-Buy-in, Metrics, and Motivation

Monday, Dec. 2 8:30AM - 12:00PM Room: S501ABC



AMA PRA Category 1 Credits™: 3.25  
ARRT Category A+ Credit: 0

### Participants

Nadja Kadom, MD, Atlanta, GA (*Moderator*) Nothing to Disclose  
Anil N. Kurup, MD, Rochester, MN (*Moderator*) Research Grant, Galil Medical Ltd; Research Grant, EDDA Technology, Inc; Royalties, Wolters Kluwer nv  
Neville Irani, MD, Kansas City, KS (*Moderator*) Nothing to Disclose  
Shlomit Goldberg-Stein, MD, Bronx, NY (*Moderator*) Nothing to Disclose

### For information about this presentation, contact:

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### LEARNING OBJECTIVES

1) Negotiate for buy-in (Goldberg-Stein). 2) Identify and mitigate for diagnostic error (Itri). 3) Apply methods for motivating people. 4) Relate knowledge acquired during this session to a real-world example (Duong).

### ABSTRACT

n/a

### Sub-Events

#### RC227-01 How to Get Buy-in

Monday, Dec. 2 8:30AM - 8:50AM Room: S501ABC

### Participants

Shlomit Goldberg-Stein, MD, Bronx, NY (*Presenter*) Nothing to Disclose

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### LEARNING OBJECTIVES

1) Classify stakeholders according to their stake (power, agency, constituency) and stance (supporters, undecideds, dissenters). 2) Identify sources of power and motivation used to influence stakeholders. 3) Describe four methods to move an undecided stakeholder from inaction to action.

#### RC227-02 Radiology Patient Outcome Measures: Impact of a Multifaceted Departmental Initiative on Key Quality and Safety Performance Indicators

Monday, Dec. 2 8:50AM - 9:00AM Room: S501ABC

### Participants

Sheila S. Enamandram, BS, MBA, Brookline, MA (*Presenter*) Nothing to Disclose  
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Wendy Mar, Boston, MA (*Abstract Co-Author*) Nothing to Disclose  
Cynthia Centerbar, Brookline, MA (*Abstract Co-Author*) Nothing to Disclose  
Giles W. Boland, MD, Wellesley, MA (*Abstract Co-Author*) Nothing to Disclose  
Ramin Khorasani, MD, Roxbury Crossing, MA (*Abstract Co-Author*) Nothing to Disclose

### PURPOSE

To assess impact of a novel, multifaceted implementation of Radiology Patient Outcome Measures (RPOMs) on radiologist performance for key quality issues of reporting timeliness, safety, and peer-learning.

### METHOD AND MATERIALS

This Institutional Review Board-approved retrospective study was performed at a large academic radiology department in an urban tertiary medical center. RPOMs were implemented 10/1/17-9/30/18 (fiscal year 2018, FY2018) measuring report timeliness, critical results communication, and generation of peer-learning communications between radiologists. Department-wide targets were specified, performance was transparently communicated and updated daily on an institutional intranet dashboard, and accountability was financially incentivized quarterly. Primary outcome was change pre-RPOMs (FY2017, 10/1/2016-9/30/2017) versus post-RPOMs (FY2018) in monthly 90th percentile time from scan completion to final report signature (CtoF). Secondary outcomes were distributions of individual radiologists and subspecialty divisions meeting quarterly targets for critical results communication, finalized signature times, and peer-learning communications. Statistical process control (SPC) analysis was performed to assess for temporal trends.

## RESULTS

1,255,771 reports were generated (613,273 pre-RPOMS) across 13 divisions and 142 radiologists during the study period. Monthly 90th percentile CtoF exhibited an absolute decrease of 4.4 hours (21.1-16.7 hours) and 20.9% relative decrease between 10/2016 and 9/2018. SPC analysis demonstrated significant sustained decreases in 90th percentile CtoF starting 10/2017 ( $p < 0.003$ ). Between 95% (119/125, 7/1/18-9/30/18) and 98.4% (126/128, 10/1/17-12/31/17) of radiologists achieved >90% timely closure of critical alerts; >99% radiologists achieved 80th percentile preliminary to final report signature time <6 hours each quarter; and all divisions exceeded target of >90 (range: 97-472) peer-learning communications each quarter after 1/1/18.

## CONCLUSION

Incentivizing departmental performance via RPOMS implementation increased timeliness of radiology report generation and timely critical alert acknowledgement.

## CLINICAL RELEVANCE/APPLICATION

Implementing imaging-related quality and safety measures via a multifaceted, leadership-driven approach can yield synergistic improvements in key indicators of physician and departmental performance.

### RC227-03 Creating and Psychometrically Validating a Radiology-Specific Patient Satisfaction Survey

Monday, Dec. 2 9:00AM - 9:10AM Room: S501ABC

#### Participants

Valerie Ryan, MA, Providence, RI (*Abstract Co-Author*) Nothing to Disclose  
Grayson L. Baird, PhD, Providence, RI (*Presenter*) Nothing to Disclose  
Elizabeth H. Dibble, MD, Barrington, RI (*Abstract Co-Author*) Nothing to Disclose  
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Terrance T. Healey, MD, North Scituate, RI (*Abstract Co-Author*) Nothing to Disclose

#### PURPOSE

We created and implemented a survey tailored to evaluate radiology patients' satisfaction with five dimensions of care. This survey is adapted to identify areas of care that could be improved for radiology practices. The present study psychometrically validates this radiology-specific survey.

#### METHOD AND MATERIALS

We developed a survey to measure five dimensions of care: 1.) attributes of making an appointment, 2.) attributes of arriving at the facility, 3.) attributes of registration, 4.) attributes of the radiology procedure, and 5.) attributes of the facility itself. Each dimension included three to five questions. Each question was answered using a Likert-type seven-point response scale ranging from very dissatisfied to very satisfied. We also collected data on type of procedure, facility, if patients met with a radiologist, how patients would rate their overall health, whether or not the survey was too long, and basic demographics. The survey was implemented at 13 radiology offices using Qualtrics Software (Qualtrics, Provo, UT). Preliminary analyses were conducted using survey responses collected from August 2018 through January 2019, N = 6,968. Validation of our five dimensions of care was accomplished using confirmatory factor analysis (CFA). Internal consistency was examined using Cronbach analysis. Patient satisfaction was analyzed using generalized mixed modeling. Analyses were conducted using SAS Software 9.4.

## RESULTS

The total sample was N= 6,968. The five dimensions of care were confirmed using the confirmatory factor analysis achieving the best fit (as well as very good fit) with the 5-factor model, relative to other factor models, (CFI: .95, SRMR 0.0481, GFI .92). Cronbach Coefficient Alpha was .94, indicating very high internal consistency. Item analysis showed that no applicable items were consistently skipped and 85% of participants said the survey was not too long. We also found that patients reported high satisfaction on all dimensions across imaging modalities and practice offices.

## CONCLUSION

The factor analysis and Cronbach analysis provides evidence for this survey having good psychometric properties: construct validity for the 5 dimensions of care and high internal consistency among the items. This survey is intended to be used for and benefit radiology practices.

## CLINICAL RELEVANCE/APPLICATION

Our radiology-tailored survey achieved good psychometric properties and can be used by other radiology practices.

### RC227-04 Learning from Simulation Models to Balance Resource Utilization and Patient Satisfaction in Diagnostic Radiology in a Hospital Setting

Monday, Dec. 2 9:10AM - 9:20AM Room: S501ABC

#### Participants

Lorraine Kelly, ARRT, RT, Burlington, MA (*Presenter*) Nothing to Disclose  
Patricia A. Doyle, MBA, RT, Burlington, MA (*Abstract Co-Author*) Nothing to Disclose  
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#### PURPOSE

Under constant pressure to cut costs and improve resource utilization, we wanted to assess the quality of our X-Ray (XR) workflow as it relates to patient satisfaction, particularly patient wait times. Specifically we tried to answer the following questions: a) are the current resources sufficient to handle demand (including walk-ins), b) can reduction of resources be justified without compromising patient satisfaction, and c) assess how "unrestricted-same day add" scheduling affects patient wait times and identify improvement opportunities. Patient demand in diagnostic radiology is variable and appetite for resource scheduling in the



clinic setting is low.

## RESULTS

a) Are existing resources sufficient to manage the current demand? The baseline simulation model was tweaked by adding 1% more volume during the hours of operation. This new simulation model showed an increase in patient wait times compared to the baseline, but the changes were not too drastic. In particular, patients who waited 30 minutes or longer after arrival increased by 3% points. It is safe to conclude that the existing resources and workflow can handle a 1% increase in volume over the next three years. b) Can reduction in resources be justified without compromising patient satisfaction? Keeping all else equal (i.e. patient arrival times and exam durations), the baseline simulation model was tweaked by removing one resource. This new simulation model showed a drastic increase in patient wait times. Overall, patients waiting 30 minutes or longer increased by 21.7% points or 21 more patients per day. c) Assess how unrestricted scheduling affects workflow KPIs and identify improvement opportunities. Data from RIS showed that about 40% of patients are un-scheduled (i.e. walk-ins). The remaining 60% of scheduled arrivals are removed and then added back into the data by evenly distributing them between 8am and 5pm. This was done to mimic a more balanced schedule (as opposed to an unrestricted scheduling in the current practice). The simulation model with this new arrival pattern showed an improvement in patient wait times. In particular, the percentage of patients waiting 30 minutes or longer decreased by 8% points. Further, patients seen within 15 minutes of arrival increased by 15% points.

## CONCLUSION

With the existing resources it will be feasible to maintain the current patient satisfaction KPIs even as the volume grows by 1% over the next three years. On the other hand, any reduction in resources can have a detrimental effect on patient satisfaction. Future opportunities for improvement include review of available scheduling template options in our RIS to provide more "balanced scheduling" and consideration of developing a pilot scheduling process with our high volume ordering departments such as Orthopedic Surgery or Rheumatology to evaluate the impact of resource specific scheduling for their patients. Simulating scenarios have been an effective way of assessing quality of service and improvement opportunities without making any disruptive changes to the existing workflow.

## METHODS

We used simulation based scenario modeling to perform quality assessment of our XR resource. Our department has dedicated resources for ED and general internal medicine, as well as, portable XRs for inpatient services. Aside from these dedicated services, there are six resources (i.e. exam rooms) available for general demand (that includes orthopedics, rheumatology etc.). Our focus for this paper is on these six resources only. Data from the first quarter of 2019 was analyzed for the hours of operation on weekdays between 8am and 5pm. Data points such as exam durations and patient arrivals are obtained from RIS (Radiology Information System powered by EPIC). In this time period a total 6,804 exams were performed (40% of these were walk-ins) with an overall resource utilization of 48%. However, depending on the hour of the day and day of the week; it can rise up to 99%. Patient wait times also follow a similar pattern. That is, overall, only 12% of the patients had to wait 30 minutes or longer after arrival to be seen. However, depending on the hour of the day and day of the week, it can increase to 21%. Simulation of the current workflow was modeled and built using FlexSimHC Software [<https://healthcare.flexsim.com/>]. Patient wait time from this simulation model was in good agreement with the empirical data obtained from RIS. The simulation model accurately captured the percentage of patients waiting 30 minutes or longer (11.72% in empirical compared to 11.12% in simulation).

## RC227-05 Radiologists Commit More Errors in Interpreting After-Hours Abdominal CT Studies during Overnight Shifts as Compared to Similar Length and Frequency Daytime Shifts

Monday, Dec. 2 9:20AM - 9:30AM Room: S501ABC

### Participants

Maitray D. Patel, MD, Paradise Valley, AZ (*Presenter*) Nothing to Disclose

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Anika Patel, Paradise Valley, AZ (*Abstract Co-Author*) Nothing to Disclose

C. Daniel Johnson, MD, Scottsdale, AZ (*Abstract Co-Author*) License agreement, General Electric Company License agreement, E-Z-EM, Inc

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## PURPOSE

To analyze whether there is a difference in the rate of clinically significant interpretation errors for CT examinations of the abdomen and/or pelvis ('abdominal CT studies') initially interpreted by board-eligible on-call radiology fellows based on whether the shift was at night or during the day.

## METHOD AND MATERIALS

Between July 2014 and June 2018, 32 board-eligible radiology fellows training in either Body MR, MSK Imaging, or Breast Imaging independently interpreted 10,090 abdominal CT studies during in-house call shifts. On-call shifts on weekends and holidays were either from 07:00-18:00 ("day") or 18:00-07:00 ("night"). On call shifts on weekdays were from 20:00-07:00 ("night"). All fellows had at least 11 hours off prior to the start of any shift; fellows took no more than 5 consecutive call shifts before having at least 48 hours off. Studies and finalized reports were reviewed within 10 hours of initial dictation by a member of the Abdominal Division faculty, and interpretation discrepancies that affected either acute or follow-up care were documented as "affecting care". The rate of errors affecting care were compared for day and night call shifts.

## RESULTS

During day call shifts, interpretation errors affecting care were identified in 58 of 3126 abdominal CT studies (1.9%). During night call shifts, interpretation errors affecting care were identified in 226 of 6964 abdominal CT studies (3.2%). The difference in the error rate is statistically significant. For 19 fellows, the night error rate was  $\geq 1\%$  higher than the day error rate. For 3 fellows, the night error rate was  $\geq 1\%$  lower than the day error rate. For 10 fellows, the night and day error rates were within 1% of each other.

## CONCLUSION

Collectively, radiology fellows committed clinically important abdominal CT interpretation errors at higher rates during night call

shifts as compared to day call shifts, even when rested. Substantially more fellows made more mistakes at night.

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

Abdominal CT studies interpreted at night by radiologists who routinely work during the day merit more quality assurance scrutiny, even when the radiologists have the usual amount of time away from work prior to the start of their shift. Patients may benefit from subspecialty review of studies initially interpreted at night by rotating radiologists even if those radiologists have completed residency training.

#### **RC227-06 Cognitive Load After an 8-Hour Shift in Busy ER Reading Room: How Much Does It Increase After a Shift and Does It Get Worse During the Week?**

Monday, Dec. 2 9:30AM - 9:40AM Room: S501ABC

##### **Participants**

Jason I. Halpern, MD, Providence, RI (*Presenter*) Nothing to Disclose  
Thomas K. Eggin, MD, Providence, RI (*Abstract Co-Author*) Nothing to Disclose  
Shreya Ramayya, Providence, RI (*Abstract Co-Author*) Nothing to Disclose  
Grayson L. Baird, PhD, Providence, RI (*Abstract Co-Author*) Nothing to Disclose

#### **PURPOSE**

Cognitive load has been linked to short-term exhaustion and long-term physician burnout. The purpose of this study is to estimate the degree to which residents' cognitive load increases after an 8-hour shift over the course of a week in a busy, high-volume emergency department reading room. It is hypothesized that cognitive load will increase dramatically after an 8-hour shift compared to before a shift. It is also hypothesized that cognitive load will increase globally as the week continues relative to the beginning of the week. Lastly, it is hypothesized that residents' diagnostic detection performance will diminish after a shift relative to before a shift - due in part to increased cognitive load.

#### **METHOD AND MATERIALS**

A within-subjects randomized block design was used to examine cognitive load in residents before vs. after a night shift over the course of one week. Data were examined using generalized mixed modeling. Cognitive load was examined using the validated *NASA Task Load Index*, where higher scores indicate higher cognitive load. Diagnostic detection performance was measured before and after a shift using neutral stimuli - *Where's Waldo* scenes, where residents were tasked with finding as many characters possible within 3 minutes.

#### **RESULTS**

Cognitive load (*NASA Task Load Index*), increased from 25.0 95% CI [20,31] before a shift to 63.3 95% CI[56, 70] after a shift,  $p < 0.01$ ), though this increase was constant over the course of a week (did not increase as the week progressed,  $P = .1500$ ) (Figure 1). We failed to find a decrease in diagnostic detection performance: residents were able to find all *Where's Waldo* characters 63% of the time before a shift and 60% after the shift,  $p = .4986$

#### **CONCLUSION**

Cognitive load is a well-studied aspect of human performance in many high-demand fields such as air traffic controllers and pilots. However, little research has been done examining cognitive load in radiologists working in high-demand settings. These results indicate that cognitive load increases dramatically after a night-float shift. More research is needed to assess how this increase in cognitive load affects performance and burnout in radiologists, especially in high-volume and high-demand settings.

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

Cognitive load was found to increase dramatically by the end of an 8-hour shift. More research is needed to examine how this increase affects performance and burnout in radiologists.

#### **RC227-07 Diagnostic Error**

Monday, Dec. 2 9:40AM - 10:00AM Room: S501ABC

##### **Participants**

Neville Irani, MD, Kansas City, KS (*Presenter*) Nothing to Disclose

#### **LEARNING OBJECTIVES**

1) Discuss methods to determine diagnostic accuracy. 2) Describe important considerations when implementing metrics related to diagnostic accuracy.

#### **RC227-08 Motivating People**

Monday, Dec. 2 10:20AM - 10:40AM Room: S501ABC

##### **Participants**

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

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#### **LEARNING OBJECTIVES**

1) Describe the central importance of intrinsic motivation in professional work productivity. 2) Explain the advantages and disadvantages of financial incentive programs with respect to individual motivation. 3) Critique their current practice's approach to financial incentives and other strategies for enhancement of professional motivation, and compare it to the various models presented at the session. 4) Apply their understanding toward the development of new approaches they might recommend to enhance professional engagement in their own practices.

**Active Handout: Michael Andrew Bruno**

[http://abstract.rsna.org/uploads/2019/19000130/Active RC227-08.pdf](http://abstract.rsna.org/uploads/2019/19000130/Active_RC227-08.pdf)

### **RC227-09 Feed Patients without Fluoro: A Teaching Hospital Experience**

Monday, Dec. 2 10:40AM - 10:50AM Room: S501ABC

#### **Participants**

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#### **PURPOSE**

An estimated one-third of patients develop malnutrition during their hospital stay. Malnutrition leads to a higher risk of surgical site infection, decubitus ulcer, and readmission. Thus, feeding critically ill patients in a timely fashion is essential for the safety and quality of patient care. At our institution, fluoroscopic-guided feeding tube placement (FgFTP) is performed by the abdominal radiologists. As the volume and complexity of cross-sectional imaging studies increased over the last several years, the abdominal radiology section struggled to accommodate feeding tube placements in a timely manner. In response to this challenge, our hospital implemented the electromagnetic-guided feeding tube placement (EMgFTP) system (Cortrak; Avanos Medical), which can be performed at the bedside using on-screen visualization of the feeding tube tip, in December 2016. In this Quality Improvement storyboard, we share the process that we took to transition from FgFTP to EMgFTP for inpatients using the Value Summary adapted from the Toyota A3 template.

#### **RESULTS**

The annual number of FgFTP decreased from 182 in 2016 to 129 in 2017, corresponding to a 29% reduction after implementation of the EMgFTP system. The number of EMgFTP steadily increased after its introduction with 115 tubes placed in December 2016, 2,232 during 2017, and 1,284 during the first 6 months of 2018 (see figure 1). Furthermore, the average patient radiation dose decreased with decreasing proportion of the feeding tubes being placed with fluoroscopic guidance. Currently, the Cortrak team consists of 14 nurses available 9a-9p daily for inpatient feeding tube placement. The cost to patients decreased with the introduction of the EMgFTP system. The patient is billed \$275.00 for EMgFTP, while the cost of FgFTP (including the use of the fluoroscopic suite as well as radiological interpretation and supervision) is \$1,185.57.

#### **CONCLUSION**

The transition from FgFTP to EMgFTP has made a dramatic improvement of timely feeding to prevent malnutrition for critically ill inpatients. The risk of fall or line misplacement related to patients' transportation is markedly reduced. Furthermore, there has been a more efficient use of healthcare resources leading to a reduction in the internal cost of feeding tube placement to the health care system and decreased strain on the abdominal radiology section. Finally, the average patient radiation dose has also decreased.

#### **METHODS**

A feeding tube task force was formed comprised by members of the nursing staff and radiology department to address the delay in feeding tube placement for inpatients needing enteric nutrition. Using a fishbone diagram, a root cause analysis was performed. The task force produced a proposal to transition from FgFTP to EMgFTP which was supported by the Chief Value Officer Committee and led by the hospital CMO. Inpatient nurses were recruited and trained on the EMg feeding tube placement system using a simulator. Nine inpatient nurses were trained prior to the transition to EMgFTP. For the first 6 months, a portable abdominal radiograph was obtained after EMgFTP to confirm the position of the feeding tube tip and correlate with the image on the Cortrak monitor. Following nearly perfect correlation of the feeding tube tip position on the Cortrak, screen with the abdominal radiograph, a portable abdominal radiograph was obtained after EMgFTP for only anatomically complex cases. FgFTP was reserved for outpatients and inpatients in whom EMgFTP failed.

### **RC227-10 Improving Abdominal Image Quality at Reduced Radiation Dose with a Model-Based Iterative Reconstruction Algorithm**

Monday, Dec. 2 10:50AM - 11:00AM Room: S501ABC

#### **Participants**

Lanxin Zhang, Xianyang, China (*Presenter*) Nothing to Disclose  
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#### **PURPOSE**

Objective: To study the effect of model-based iterative reconstruction (MBIR) algorithm on improving abdominal CT image quality at a reduced radiation dose.

#### **METHOD AND MATERIALS**

Methods: 30 patients with standard dose in abdominal CT (noise index (NI) = 10HU) were used in this study as a control group

(Group A). Group B (n=30) was acquired under a lower dose at NI = 14HU for the abdominal section and was used for comparison. The adaptive statistical iterative reconstruction (ASIR) was used to reconstruct images in Group A and MBIR was used to reconstruct images in Group B. All images were at 0.625 slice thickness. ROI (area about 25 - 250mm<sup>2</sup>) was put on liver, spleen, subcutaneous fat in the anterior abdominal wall and left erector spinae muscle on the axial image containing the left portal vein to measure their CT value, standard deviation (SD) and contrast-to-noise ratio (CNR). Two radiologists with more than 10 years of experience used a 5-point scoring system to evaluate the subjective image quality including the subjective noise and the display of fine structures.

## RESULTS

Result: There was no different in BMI value between the two groups. Group B reduced the CT dose index (CTDI) by 42% (6.93±3.23mGy vs. 11.88±7.58mGy, p<0.05). There was no difference in CT value for all the organs between the two groups. However, the images noise in the MBIR group (Group B) with the reduced radiation dose was significantly reduced compared with that in the ASIR group (Group A) with the routine liver dose. Group B had lower image noise in liver and spleen (11.66±0.94HU and 11.64±1.26HU vs. 18.80±2.97HU and 18.86±3.62HU) and higher CNR (14.83±3.61 and 14.08±3.59 vs. 12.06±3.19, 11.57±2.93) than Group A (all p<0.001). Images in Group B also had higher subjective image quality scores than in Group A.

## CONCLUSION

Conclusion: MBIR reconstruction algorithm improves image quality at 42% lower radiation dose compared with the state of the art ASIR algorithm at routine radiation dose.

## CLINICAL RELEVANCE/APPLICATION

Clinical Relevance: MBIR algorithm can be used clinically to reduce image noise and improve image quality with much reduced radiation dose.

## RC227-11 Emerging Demand for Guideline-Discordant Lung Cancer Screening: Indications Given by Referring Providers

Monday, Dec. 2 11:00AM - 11:10AM Room: S501ABC

### Participants

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## PURPOSE

Growing public awareness of the benefits of lung cancer screening (LCS) with low-dose chest CT (LDCT) for high-risk smokers may lead patients and providers to knowingly request guideline-discordant LCS outside Centers for Medicare and Medicaid Services (CMS) coverage criteria. Here, we examined whether and why providers within our hospital network intentionally order guideline-discordant LDCTs.

## METHOD AND MATERIALS

This is a HIPAA-compliant, IRB-approved retrospective review of LDCTs ordered within a network of academic and community practices over the initial 5-month period after integration of Best Practices Advisory (BPA) alerts into our LDCT electronic medical record-based order entry system (11/2018-3/2019). Alerts trigger when providers order exams outside institutional LCS guidelines, which mirror CMS criteria (current smoker or quit ≤ 15 years, 30 pack-year history, 55-77 years old). Providers can override alerts, enter reason for LCS, and complete the order. Primary variables of interest are number of LDCTs ordered after overriding alerts and reasons given.

## RESULTS

During the study period, 946 LDCTs were performed. For 35 patients, LDCTs were ordered after overriding a BPA alert. Mean age was 61±10.3 years; 51% (18/35) were female. 37% (13/35) were outside age criteria, 34% (12/35) have never smoked, 31% (11/35) smoked < 30 pack-years, and 29% (10/35) quit > 15 years. Reasons for ordering LDCT were: firefighter (17%, 6/35), carcinogen exposure unrelated to firefighting or smoking (17%, 6/35), family history of lung cancer (11%, 4/35), mediastinal radiation (6%, 2/35), secondhand smoke (3%, 1/35), and epidermal growth factor receptor mutation carrier (3%, 1/35). No reason was provided for 43% (15/35). All LDCTs performed were reported using Lung-RADS.

## CONCLUSION

Patients and providers intentionally request screening LDCTs outside recommended guidelines, including for never smokers. The most common indication was carcinogen exposure unrelated to smoking, such as from firefighting. For these specific patient populations, appropriateness of LCS as well as follow-up imaging, procedures, and costs resulting from management of screen-detected findings with Lung-RADS warrant further study.

## CLINICAL RELEVANCE/APPLICATION

Radiologists should be aware of emerging demand for screening LDCTs for guideline-discordant indications and further evaluate LCS appropriateness and management options for these patients.

## RC227-12 Radiology Assistant for Completion of Recommended Imaging Follow-Ups: Return on Investment

Monday, Dec. 2 11:10AM - 11:20AM Room: S501ABC

### Participants

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**PURPOSE**

To quantify the gain in revenue from additional imaging studies attributable to overdue workup reminder notifications sent by a Radiology Assistant.

**METHOD AND MATERIALS**

The IRB approved this HIPAA-compliant study. Informed consent was waived. A RIS search of imaging reports over 2 months in 2016 at our institution for the words 'recommend' or 'advised' was performed, yielding 4,539 studies. Of these, 1,599 patients were studied. Multiple investigators retrospectively reviewed each report and flagged studies with clinically significant findings and 'firm' recommendations. For patients with overdue follow-ups, a Radiology Assistant notified the provider. Imaging studies performed only after notification were credited to the Radiology Assistant, and annual expected volume was extrapolated. Financial rate of return was based on national average CMS reimbursement rates including professional and technical fees.

**RESULTS**

Of 1,599 patients with 'recommend' or 'advised' in their diagnostic imaging reports, 194 patients had clinically significant findings, 'firm' recommendations for follow-up imaging studies and were overdue for work up. Providers for these patients were subsequently notified by the Radiology Assistant. Of the 194 patients, 86 had follow-up imaging studies performed only after notification, 32 were deemed as medically unnecessary by the provider, and 76 were lost to follow-up. Extrapolation of the 86 patients who received imaging follow-up only after notification yields 1,466 additional studies per year (39.5% CT, 3.5% PET, 19.8% MR, 26.7% US, 9.3% radiographs and 1.2% US guided liver biopsy). Using national average CMS physician fee schedule data (professional and technical fees) yields \$361,378/year in additional revenue from studies performed after reminder notifications.

**CONCLUSION**

A Radiology Assistant to remind providers of overdue follow-up studies yields a significant return on investment from additional imaging studies alone, which easily justifies the Assistant's salary many times over. Improved patient outcomes, revenue from treatment of incidentally detected pathology and mitigation of legal exposure are potential benefits that require further study.

**CLINICAL RELEVANCE/APPLICATION**

A Radiology Assistant for reminding providers of overdue recommended imaging findings has a significant financial rate of return, which easily covers an Assistant's salary.

**RC227-13 A Radiology-Led Rapid Diagnostic Clinic for Primary Care Physicians with a 'Gut-Instinct' About Cancer**

Monday, Dec. 2 11:20AM - 11:30AM Room: S501ABC

**Participants**

Imran Siddiqui, MD, Reading, United Kingdom (*Presenter*) Nothing to Disclose  
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**PURPOSE**

Cancer is a leading cause of death in the UK and when benchmarked to other comparable world healthcare systems, UK countries are reporting poorer outcomes for many major cancers. One potential cause is the lack of timely access to diagnostic tests and lengthy times in clinical pathways. Despite accelerated initiatives such as the 2-week-wait (2-WW) and Urgent Suspected Cancer (USC) pathways, which are based on site-specific red flag symptoms, less than 50% of patients diagnosed with cancer come through such routes. A significant proportion of patients have vague symptoms that do not fit these accelerated pathways and consequently patients experience diagnostic delays. We investigated, based on the Danish model, whether primary care physicians 'gut-instinct' could detect cancer in patients with vague symptoms.

**METHOD AND MATERIALS**

A prospective population-based interventional study was undertaken including patients with vague symptoms of cancer and those who did not qualify for an accelerated red-flag diagnostic pathway, over a one-year period. Primary care physicians referred patients to a rapid diagnostic clinic (RDC). Initial consultation, blood tests and a complete examination was performed then appropriate radiological investigations were requested; the majority of patients had a whole body CT which was 'hot reported' by a consultant radiologist during the clinic.

**RESULTS**

We found that over a one-year period, 9.7% of cancers were diagnosed. The most common malignancy was lung cancer. 76% of patients were diagnosed with stage 4 disease. The most common presenting symptom was weight loss (77%). The majority of patients were seen within 2 weeks of referral and average time taken from referral to start of treatment was 30.7 days.

**CONCLUSION**

The 'gut-instinct' of a primary care physician was superior than our conventional red flag pathways at diagnosing cancer (local

The gut-instinct of a primary care physician was superior than our conventional red-flag pathways at diagnosing cancer (local conversion rate 3-8%). A radiology-led diagnostic clinic investigating patients with vague symptoms has significant benefits for rapid cancer diagnosis though further challenges in health promotion are needed to detect cancer at an earlier stage.

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

More than 50% of patients with cancer do not have typical red-flag symptoms but have vague symptoms. A dedicated rapid, radiology-led pathway is useful to help diagnose cancer early and improve access to diagnostic imaging by primary care physicians.

#### **RC227-15 A Practical Example of Buy-in, Metrics, and Motivating**

Monday, Dec. 2 11:40AM - 12:00PM Room: S501ABC

#### **Participants**

Phuong-Anh T. Duong, MD, Atlanta, GA (*Presenter*) Nothing to Disclose

#### **LEARNING OBJECTIVES**

1) Apply methods of obtaining buy-in to a real-world example. 2) Develop a motivating (and achievable) goal. 3) Choose meaningful metrics to drive change.

Printed on: 10/29/20



RC229

## Abbreviated Liver MRI

Monday, Dec. 2 8:30AM - 10:00AM Room: N228

**GI** **MR**

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

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

### LEARNING OBJECTIVES

1) To define the objective of abbreviated MRI protocols from a cost-effectiveness standpoint. 2) To outline a conceptual framework for evaluating the cost-effectiveness of an abbreviated liver MRI protocol. 3) To project how different factors related to the test performance and cost of an abbreviated liver MRI protocol are likely to shape its downstream value. 4) Select patients in whom abbreviated MRI is indicated for quantitative evaluation of diffuse liver disease. 5) Build an abbreviated MRI examination protocol for diffuse liver disease evaluation. 6) Interpret quantitative imaging biomarker maps (fat, iron, and fibrosis) of the liver and generate a clinical report. 7) Explain the essential sequences required within an abbreviated protocol for the detection of liver metastases. 8) Compare the diagnostic performance of an abbreviated protocol versus standard multiparametric liver protocol for the assessment of colorectal liver metastases. 9) Identify pitfalls / challenges for the abbreviated liver protocol. 10) Review current guidelines for liver cancer screening. 11) Review the current options for abbreviated MRI protocol and early results for liver cancer screening.

### Sub-Events

#### RC229A Cost Evaluation of Abbreviated Liver MRI Protocols

Participants

Pari V. Pandharipande, MD, MPH, Chestnut Hill, MA (*Presenter*) Research Grant, Medical Imaging & Technology Alliance

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

pari@mgh-ita.org

### LEARNING OBJECTIVES

1) To define the objective of abbreviated MRI protocols from a cost-effectiveness standpoint. 2) To outline a conceptual framework for evaluating the cost-effectiveness of an abbreviated liver MRI protocol. 3) To project how different factors related to the test performance and cost of an abbreviated liver MRI protocol are likely to shape its downstream value.

#### RC229B Abbreviated Liver Protocol in Diffuse Liver Disease

Participants

Takeshi Yokoo, MD, PhD, Dallas, TX (*Presenter*) Nothing to Disclose

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

Takeshi.Yokoo@UTSouthwestern.EDU

### LEARNING OBJECTIVES

1) Select patients in whom abbreviated MRI is indicated for quantitative evaluation of diffuse liver disease. 2) Build an abbreviated MRI examination protocol for diffuse liver disease evaluation. 3) Interpret quantitative imaging biomarker maps (fat, iron, and fibrosis) of the liver and generate a clinical report.

#### RC229C Abbreviated Liver Protocol in Metastatic Disease

Participants

Angela M. Riddell, MBBS, London, United Kingdom (*Presenter*) Nothing to Disclose

### LEARNING OBJECTIVES

1) Explain the essential sequences required within an abbreviated protocol for the detection of liver metastases. 2) Compare the diagnostic performance of an abbreviated protocol versus standard multiparametric liver protocol for the assessment of colorectal liver metastases. 3) Identify pitfalls / challenges for the abbreviated liver protocol.

#### RC229D Abbreviated Liver Protocol for HCC Screening and Surveillance

Participants

Bachir Taouli, MD, New York, NY (*Presenter*) Research Grant, Bayer AG; Research Grant, Takeda Pharmaceutical Company Limited; Research Grant, Regeneron Pharmaceuticals, Inc; Consultant, Alexion Pharmaceuticals, Inc; Consultant, Bayer AG; ;

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

bachir.taouli@mountsinai.org

### LEARNING OBJECTIVES

1) Review current guidelines for liver cancer screening. 2) Review the current options for abbreviated MRI protocol and early results for liver cancer screening.

#### **ABSTRACT**

Hepatocellular carcinoma (HCC) is the 2nd leading cause of cancer-related death worldwide, and the fastest growing cause of cancer death in the USA. The most important risk factor for HCC is cirrhosis. In this presentation, we will discuss the performance of ultrasound for HCC screening and surveillance and we will review recent developments in the use of abbreviated MRI protocols for HCC screening and surveillance.

#### **RC229E Round Table Discussion**

##### Participants

Pari V. Pandharipande, MD, MPH, Chestnut Hill, MA (*Presenter*) Research Grant, Medical Imaging & Technology Alliance

Takeshi Yokoo, MD, PhD, Dallas, TX (*Presenter*) Nothing to Disclose

Angela M. Riddell, MBBS, London, United Kingdom (*Presenter*) Nothing to Disclose

Bachir Taouli, MD, New York, NY (*Presenter*) Research Grant, Bayer AG; Research Grant, Takeda Pharmaceutical Company Limited; Research Grant, Regeneron Pharmaceuticals, Inc; Consultant, Alexion Pharmaceuticals, Inc; Consultant, Bayer AG; ;

Printed on: 10/29/20





RC231

## Hands-on Musculoskeletal Ultrasound: A Forum for Question and Answer (Hands-on)

Monday, Dec. 2 8:30AM - 10:00AM Room: E258



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

### Participants

Marnix T. van Holsbeeck, MD, Detroit, MI (*Presenter*) Stockholder, Koninklijke Philips NV; Stockholder, General Electric Company; Stockholder, MedEd3D;  
Joseph H. Introcaso, MD, Neenah, WI (*Presenter*) Nothing to Disclose  
Humberto G. Rosas, MD, Madison, WI (*Presenter*) Nothing to Disclose  
Lodewijk J. van Holsbeeck, MD, Lansing, MI (*Presenter*) Nothing to Disclose

### LEARNING OBJECTIVES

1) Recognize and identify pitfalls of scanning that lead to false positive or false negative musculoskeletal ultrasound results. 2) Perform skills for scanning difficult patients. 3) Follow rigorous protocols for the examination of different anatomic regions. 4) Position patients for more complicated musculoskeletal ultrasound examinations. 5) Recognize and integrate the importance of tissue movement in judging the functionality of the extremities.

### ABSTRACT

By means of this Forum on Musculoskeletal Ultrasound, an opportunity will be given to participants to start a written dialogue in advance to RSNA 2019. The electronically submitted questions will be sorted by instructors and organized per topic. A select number of recurrent themes in these questions will be prepared for dialogue on stage. When the questions focus on a particular scanning skill, the authors of the questions will be invited on the examination platform to show problems they encounter in their practice. By using a step-by step approach in solving the scanning issues, all who are present should benefit from the technical interactions on stage. Cameras will project scanning details on large screens. The seating in the class will guarantee close proximity for an enriching interaction between audience and stage.

Printed on: 10/29/20



RC232

## Radiology Practice Under New Healthcare

Monday, Dec. 2 8:30AM - 10:00AM Room: N230B



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

### Participants

N. Reed Dunnick, MD, Ann Arbor, MI (*Moderator*) Nothing to Disclose

### LEARNING OBJECTIVES

1) Appreciate that the cost of healthcare in the United States is among the highest in the world, yet the quality of our healthcare as judged by commonly used metrics is mediocre. 2) Understand that imaging is often considered one of the drivers of healthcare costs. 3) Learn that appropriate imaging may help reduce costs by getting to the appropriate diagnosis earlier, while the disease is easier to treat. 4) Discover approaches that third party payers are taking to reducing payments for medical imaging and image-guided therapy.

### Sub-Events

#### RC232A Challenges of Academic Radiology Practice Under New Healthcare

Participants

N. Reed Dunnick, MD, Ann Arbor, MI (*Presenter*) Nothing to Disclose

#### RC232B Integration of Radiology Practice to Health System: Why and How?

Participants

Satoshi Minoshima, MD, PhD, Salt Lake City, UT (*Presenter*) Consultant, Hamamatsu Photonics KK; Research Grant, Hitachi, Ltd; Research Grant, Nihon Medi-Physics Co, Ltd;

#### RC232C Expanding Radiology Practice to Large Geographic Area

Participants

Vijay M. Rao, MD, Philadelphia, PA (*Presenter*) Nothing to Disclose

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

Vijay.rao@jefferson.edu

### LEARNING OBJECTIVES

1) Understand challenges of expanding radiology practice on a fast track with a limited budget, disparate IT systems and different cultures. 2) Understand how structure, governance and leadership can influence success.

#### RC232D Radiology Practice Under Global Budget

Participants

Karen M. Horton, MD, Baltimore, MD (*Presenter*) Nothing to Disclose

### LEARNING OBJECTIVES

1) Understand Maryland's all-payer global budget program for acute-care hospitals and its impact on Radiology.

Printed on: 10/29/20



RC252

## US-guided Interventional Breast Procedures (Hands-on)

Monday, Dec. 2 8:30AM - 10:00AM Room: E264



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

### Participants

Karen S. Johnson, MD, Durham, NC (*Presenter*) Nothing to Disclose  
Jocelyn A. Rapelyea, MD, Washington, DC (*Presenter*) Speakers Bureau, General Electric Company; ;  
Michael N. Linver, MD, Alexandria, VA (*Presenter*) Medical Advisory Board, Three Palm Software; Scientific Advisory Board, Real Imaging Ltd; Scientific Advisory Board, Seno Medical Instruments, Inc  
Tilden L. Childs III, MD, Fort Worth, TX (*Presenter*) Nothing to Disclose  
Sora C. Yoon, MD, Chapel Hill, NC (*Presenter*) Nothing to Disclose  
Mary S. Soo, MD, Durham, NC (*Presenter*) Nothing to Disclose  
Margaret M. Szabunio, MD, Nicholasville, KY (*Presenter*) Nothing to Disclose  
Jean M. Kunjummen, DO, Atlanta, GA (*Presenter*) Nothing to Disclose  
Evguenia J. Karimova, MD, Memphis, TN (*Presenter*) Research Consultant, Intrinsic Imaging LLC  
Alison L. Chetlen, DO, Hershey, PA (*Presenter*) Consultant, Becton, Dickinson and Company  
Bhavika K. Patel, MD, Phoenix, AZ (*Presenter*) Speaker, Hologic, Inc; Research support, GRAIL, Inc  
Connie E. Kim, MD, Durham, NC (*Presenter*) Spouse, Consultant, ClarVista Medical, Inc; Spouse, Royalties, Leica Biosystems Nussloch GmbH; Spouse, Intellectual property, Leica Biosystems Nussloch GmbH  
Anita K. Mehta, MD, MSc, Washington DC, DC (*Presenter*) Nothing to Disclose  
Roberta M. Strigel, MD, Madison, WI (*Presenter*) Research support, General Electric Company

### For information about this presentation, contact:

achetlen@pennstatehealth.psu.edu

patel.bhavika@mayo.edu

ekarimov@bidmc.harvard.edu

Mary.soo@duke.edu

### LEARNING OBJECTIVES

1) Describe the equipment needed for ultrasound guided interventional breast procedures. 2) Review the basic principles of ultrasound guidance and performance of minimally invasive breast procedures. 3) Practice hands-on technique for ultrasound guided breast interventional procedures.

### ABSTRACT

This course is intended to familiarize the participant with equipment and techniques in the application of US guided breast biopsy and needle localization. Participants will have both basic didactic instruction and hands-on opportunity to practice biopsy techniques on tissue models with sonographic guidance. The course will focus on the understanding and identification of: 1) optimal positioning for biopsy 2) imaging of adequate sampling confirmation 3) various biopsy technologies and techniques 4) potential problems and pitfalls

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## 105<sup>TH</sup> Scientific Assembly and Annual Meeting

December 1-6 | McCormick Place, Chicago

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RC253

### Getting Stuff Done: A Mindful Approach to Personal Productivity

Monday, Dec. 2 8:30AM - 10:00AM Room: S503AB

**IN**

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

#### Participants

Puneet Bhargava, MD, Shoreline, WA (*Moderator*) Editor, Reed Elsevier  
Matthew B. Morgan, MD, Sandy, UT (*Presenter*) Consultant, Reed Elsevier  
Puneet Bhargava, MD, Shoreline, WA (*Presenter*) Editor, Reed Elsevier

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

bhargp@uw.edu

#### LEARNING OBJECTIVES

1) Introduce the concept of 'Getting Things Done.' Learn the concepts of Inbox Zero and other email management techniques. 2) Using tools such as note-taking applications, citation and password managers. 3) Using self-inquiry techniques, review how to make meaningful and powerful changes in how we engage with technology.

Printed on: 10/29/20



RC254

## Integrating the Healthcare Enterprise on Fast Healthcare Interoperability Resources

Monday, Dec. 2 8:30AM - 10:00AM Room: N226

IN

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

### Participants

David S. Mendelson, MD, Larchmont, NY (*Moderator*) Spouse, Employee, Novartis AG; Advisory Board, General Electric Company; Advisory Board, Bayer AG; Advisory Board, Nines; Advisory Board, Maverick AI  
Brad Genereaux, Santa Clara, CA (*Presenter*) Employee, NVIDIA Corporation  
Wyatt M. Tellis, PhD, San Francisco, CA (*Presenter*) Officer, EyePACS, LLC  
Tone Southerland, Durham, NC (*Presenter*) Employee, IQVIA  
Stephen M. Moore, MS, Saint Louis, MO (*Presenter*) Consultant, 3DHISTECH; Consultant, Corista; Consultant, Gestalt; Consultant, Hamamatsu Photonics KK; Consultant, Leica Biosystems Nussloch GmbH; Consultant, Pathcore; Consultant, Koninklijke Philips NV; Consultant, F. Hoffmann-La Roche Ltd; Consultant, Sectra AB; Consultant, Neagen OY;

### For information about this presentation, contact:

wyatt.tellis@ucsf.edu

### LEARNING OBJECTIVES

1) Learn about HL7 FHIR- Fast Healthcare Interoperability Resources- an emerging standard using RESTful web services. 2) Review IHE- profile' guides for using standards to address clinical use cases and workflows. 3) Discuss how FHIR is being incorporated into IHE. 4) Review some specific IHE Profiles which have integrated FHIR. 5) Discuss the DICOMweb RESTful services and how they relate to FHIR and IHE.

### ABSTRACT

RESTful services have become a mainstay of current network-based transaction and communications technologies, often employed in consumer services on the internet. HL7 FHIR is a standard currently in development that uses RESTful services to exchange healthcare data. Over time FHIR is likely to replace legacy versions provided earlier versions of HL7 that are currently widely used. Similarly, DICOM has introduced REST-based services for communicating medical images in its DICOMWeb standards. IHE coordinates the use of standards to provide interoperable solutions that improve communication and workflow. IHE uses HL7, DICOM and other standards in its profiles. We will review the current work to incorporate FHIR in IHE profiles replacing legacy standards where appropriate and introducing new capabilities. We will discuss specific use cases and standards, some from the domain of Radiology but also some from other healthcare domains. Interoperability has become a major focus of the worldwide HIT community and the intelligent incorporation of RESTful services in the standards we use daily is of paramount importance in delivering the highest quality of healthcare services in a cost-effective and robust manner.

Printed on: 10/29/20



RCA21

## An Introduction to Using the NIH/NCI's Cancer Imaging Archive (TCIA) (Hands-on)

Monday, Dec. 2 8:30AM - 10:00AM Room: S401AB



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

### Participants

Justin Kirby, Rockville, MD (*Presenter*) Nothing to Disclose  
Lawrence R. Tarbox, PhD, Little Rock, AR (*Presenter*) Nothing to Disclose  
John B. Freymann, Rockville, MD (*Presenter*) Nothing to Disclose  
Fred W. Prior, PhD, Little Rock, AR (*Presenter*) Nothing to Disclose

### For information about this presentation, contact:

[FWPrior@uams.edu](mailto:FWPrior@uams.edu)

### LEARNING OBJECTIVES

1) Learn how to publish a new collection (data set) on TCIA . We accept a variety of data types including radiology images, pathology images, and clinical data. TCIA also links to other databases which can archive more complex non-image data types such as genomics and proteomics. 2) Learn how to submit 'analysis data' which is derived from existing TCIA collections such as radiologist annotations, segmentations, and computer-extracted radiomic or deep learning features. 3) Review the full scope of TCIA functionality for searching, visualizing and downloading data. 4) Identify support resources that include the TCIA helpdesk, FAQs, and system documentation.

### ABSTRACT

Access to large, high quality data is essential for researchers to understand disease and precision medicine pathways, especially in cancer. However HIPAA constraints make sharing medical images outside an individual institution a complex process. The NCI's Cancer Imaging Archive (TCIA) addresses this challenge by providing hosting and de-identification services which take the burden of data sharing off researchers. TCIA now contains over 100 unique data collections of more than 30 million images. Recognizing that images alone are not enough to conduct meaningful research, most collections are linked to rich supporting data including patient outcomes, treatment information, genomic / proteomic analyses, and expert image analyses (segmentations, annotations, and radiomic / radiogenomic features). This hands-on session will teach the skills needed to fully access our existing data as well as learn how to submit new data for potential inclusion in TCIA.

Printed on: 10/29/20



RCC21

## Core Cybersecurity for Imaging Departments and Imagers: Threats, Vulnerabilities and Best Practices

Monday, Dec. 2 8:30AM - 10:00AM Room: S404CD



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

### Participants

Christopher J. Roth, MD, Raleigh, NC (*Moderator*) Nothing to Disclose

### LEARNING OBJECTIVES

1) Understand the changing environment of network and internet connected devices and software. 2) Be aware of the motivations and tactics of current threat actors. 3) Understand common security issues found in medical devices. 4) Know simple actions that can decrease risk. 5) Understand the vulnerabilities of imaging system modalities to security and privacy breaches. 6) Determine ways to protect and secure imaging systems from internal and external threats. 7) Describe institutional best-practices to maintain protection yet provide necessary accessibility for imaging modalities.

### ABSTRACT

All imaging department devices are potential sites of risk for cybersecurity attack. Such attacks have compromised enterprise data security, modality function, patient health data, and ongoing patient care. This session will describe common insider and outsider threats, and highest yield steps for mitigation at small and large imaging sites.

### Sub-Events

#### RCC21A Sounding the Alarm in Healthcare Cybersecurity: Escalating Threats to Patient Health

### Participants

James Whitfill, MD, Scottsdale, AZ (*Presenter*) President, Lumetis LLC; Spouse, Shareholder, Radiology Partners

### LEARNING OBJECTIVES

1) Understand the changing environment of network and internet connected devices and software. 2) Be aware of the motivations and tactics of current threat actors. 3) Understand common security issues found in medical devices. 4) Know simple actions that can decrease risk. 5) Understand the steps to implement a medical device security program.

### ABSTRACT

Medical devices are increasingly becoming dependent on technology and network connectivity, at a time that the electronic environment is becoming more dangerous. Because of this medical devices and systems can become easy targets for attackers attempting to access PHI, disrupt patient care or even harm a patient. When tested, these devices have been shown to have multiple vulnerabilities. These vulnerabilities range from hardcoded passwords, publically available service passwords and no encryption of patient data. Because of this institutions using these devices need to work with their vendors to improve the security of medical devices and take actions themselves to help protect their environment and patients. There are simple steps to decrease your risk and ways, even with limited resources and skills, to start to evaluate medical devices at your institution.

#### RCC21B The Bare Minimum Cybersecurity Hygiene for Radiologists

### Participants

Christopher J. Roth, MD, Raleigh, NC (*Presenter*) Nothing to Disclose

### LEARNING OBJECTIVES

1) Appreciate the anatomy of a typical healthcare advanced persistent threat cyberattack. 2) Learn the underpinnings and impact of typical protections including anti-malware, multi-factor authentication, personal device managers, firewalls, encryption, password managers, URL and attachment screeners, popup blockers, physical data protections, and identity theft protection. 3) Understand high yield procurement, contingency planning, auditing, training, and hiring next steps. 4) Realize that health care entities will never be completely private or secure, and there is a balance of functionality, efficiency, and care process that must be understood against privacy and security protections.

#### RCC21C Knowing if Your Imaging Systems are Secure and Keeping Them That Way

### Participants

J. Anthony Seibert, PhD, Sacramento, CA (*Presenter*) Nothing to Disclose

### LEARNING OBJECTIVES

1) Appreciate the evolving landscape of cyberthreats to healthcare and Radiology. 2) Understand the different targeting strategies used by cyber attackers. 3) Realize imaging system security weaknesses and everyone's responsibilities to keep systems safe.



MSAS22

**Changing and Developing Roles to Streamline Care: Creating an Effective Team (Sponsored by the Associated Sciences Consortium) (Interactive Session)**

Monday, Dec. 2 10:30AM - 12:00PM Room: S105AB

OT

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

**Participants**

Charlotte Beardmore, MBA, London, United Kingdom (*Moderator*) Nothing to Disclose  
Catherine Gunn, MBA, RT, Halifax, NS (*Moderator*) Nothing to Disclose

**Sub-Events**

**MSAS22A Radiologist Assistant: The Bridge in Radiology**

**Participants**

Thomas W. Carrington, BS, RRA, Dyersburg, TN (*Presenter*) Nothing to Disclose

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

wade.carrington@ira-image.com

**LEARNING OBJECTIVES**

1) History and educational background of Radiologist Assistant. 2) The definition of a Mid-Level Care-givers in Radiology. 3) Roles and Scope of Practice of Radiologist Assistant. 4) Model state licensure. 5) Billing challenges. 6) Radiologist Assistant Schools- location and advantages/disadvantages. 7) The future of Radiologist Assistant profession. 8) Patient Case study.

**ABSTRACT**

The Radiologist Assistant (RA) is an advanced practice Radiologic Technologist who works under the direct supervision of a Radiologist. This presentation will provide a history of the development of the RA, the RA educational background and also define Mid-Level Caregivers in Radiology. The RA roles and scope of practice will be discussed. State licensure efforts will also be explored. Today's challenges and the future of the RA profession will be laid out for the audience. The ending will include a patient case study with audience interaction.

**MSAS22B Journeys of a Reporting Radiographer: Teamwork to Achieve Excellent Patient Care**

**Participants**

Tracy O'Regan, London, United Kingdom (*Presenter*) Nothing to Disclose

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

tracyo@sor.org

**LEARNING OBJECTIVES**

1) List the antecedents to development of the UK reporting radiographer role. 2) Explain the educational requirements of a UK reporting radiographer. 3) Describe progress of the role to date and issues for the future. 4) Apply skills used by reporting radiographers to assess radiographic images.

Printed on: 10/29/20





MSCN22

### Case-based Review of Neuroradiology (Interactive Session)

Monday, Dec. 2 10:30AM - 12:00PM Room: S100AB

HN NR

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

FDA Discussions may include off-label uses.

#### Participants

Pina C. Sanelli, MD, MPH, Manhasset, NY (*Director*) Nothing to Disclose

#### LEARNING OBJECTIVES

1) Identify the application of basic anatomic, pathologic and physiologic principles to specific disease processes and diagnostic and therapeutic procedures in neuroimaging. 2) Analyze Imaging and Therapeutic Techniques and apply this knowledge to protocol development, patient management and safety. 3) Compare indications and contraindications of specific imaging procedures in Neuroradiology.

#### ABSTRACT

This course is designed to highlight the vital role of neuroimaging in the diagnosis, treatment and management of neurologic diseases. A wide range of applications will be covered including brain, spine, head & neck, pediatric and interventional imaging. Our goal is to provide a broad update in the field while addressing new opportunities and challenges for everyday practice.

#### Sub-Events

##### MSCN22A Neck is a Wreck

Participants

Laurie A. Loevner, MD, Philadelphia, PA (*Presenter*) Nothing to Disclose

##### MSCN22B Head & Neck: To Be or Not To Be

Participants

Nandita Guha-Thakurta, MD, Houston, TX (*Presenter*) Nothing to Disclose

##### MSCN22C It is Brain Surgery! Case-based Neurointerventional Treatment of Brain Disease

Participants

Jeremy J. Heit, MD, PhD, Stanford, CA (*Presenter*) Consultant, Medtronic plc; Consultant, Terumo Corporation; Scientific Advisory Board, iSchemaView, Inc; Medical Advisory Board, iSchemaView, Inc

##### MSCN22D Pediatric Posterior Fossa: Something for Everyone

Participants

Andrea Rossi, MD, Genova, Italy (*Presenter*) Nothing to Disclose

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

andrearossi@gaslino.org

Printed on: 10/29/20



MSMC22

**Cardiac CT Mentored Case Review: Part II (In Conjunction with the North American Society for Cardiovascular Imaging) (Interactive Session)**

Monday, Dec. 2 10:30AM - 12:15PM Room: S406A



AMA PRA Category 1 Credits™: 1.75  
ARRT Category A+ Credits: 2.00

**Participants**

Jacobo Kirsch, MD, Miami, FL (*Moderator*) Nothing to Disclose

**LEARNING OBJECTIVES**

1) Identify cardiac and coronary artery anatomy. 2) Recognize cardiac disease processes, including coronary atherosclerosis, as diagnosed on CT. 3) Understand methods of cardiac CT and coronary CT angiography post-processing.

**Sub-Events**

**MSMC22A Coronary Atherosclerosis I**

Participants

Geoffrey D. Rubin, MD, Durham, NC (*Presenter*) Consultant, Fovia, Inc; Advisor, HeartFlow, Inc; Consultant, General Electric Company; Advisor, Boehringer Ingelheim GmbH; Advisor, Siemens AG;

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

grubin@duke.edu

**MSMC22B Coronary Atherosclerosis II**

Participants

Karin E. Dill, MD, Atlanta, GA (*Presenter*) Nothing to Disclose

**MSMC22C Valves and Cardiac Function**

Participants

Suhny Abbara, MD, Dallas, TX (*Presenter*) Royalties, Reed Elsevier; Institutional research agreement, Koninklijke Philips NV; Institutional research agreement, Siemens AG

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MSMI22

## Molecular Imaging Symposium: Oncologic MI Applications

Monday, Dec. 2 10:30AM - 12:00PM Room: S405AB

**BQ** **GU** **MR** **MI** **OI**

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

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

### Participants

Peter L. Choyke, MD, Rockville, MD (*Moderator*) License agreement, Koninklijke Philips NV; Researcher, Koninklijke Philips NV; License agreement, ScanMed; License agreement, Rakuten Medical; Researcher, Rakuten Medical; Researcher, General Electric Company; Researcher, Progenics Pharmaceuticals, Inc; Researcher, Novartis AG; ; ; ;  
Vikas Kundra, MD, PhD, Houston, TX (*Moderator*) Institutional license agreement, Introgen Therapeutics, Inc; Research Grant, General Electric Company

### For information about this presentation, contact:

pchoyke@mail.nih.gov

vkundra@mdanderson.org

### LEARNING OBJECTIVES

1) To understand current advances in PET molecular imaging and clinical applications. 2) To understand new applications of advanced MRI techniques. 3) To improve understanding of theranostic agents based on targeted imaging agents. 4) To improve understanding of imaging delivered gene expression.

### Sub-Events

#### MSMI22A Hyperpolarized MRI of Cancer

##### Participants

Daniel B. Vigneron, PhD, San Francisco, CA (*Presenter*) Research Grant, General Electric Company;

### For information about this presentation, contact:

dan.vigneron@ucsf.edu

#### MSMI22B Imaging of Delivered Gene Expression

##### Participants

Vikas Kundra, MD, PhD, Houston, TX (*Presenter*) Institutional license agreement, Introgen Therapeutics, Inc; Research Grant, General Electric Company

### For information about this presentation, contact:

vkundra@mdanderson.org

### LEARNING OBJECTIVES

1) To improve understanding of imaging of delivered gene expression. 2) Multiple modalities and reporter systems will be discussed.

#### MSMI22C PSMA Imaging in Prostate Cancer

##### Participants

Peter L. Choyke, MD, Rockville, MD (*Presenter*) License agreement, Koninklijke Philips NV; Researcher, Koninklijke Philips NV; License agreement, ScanMed; License agreement, Rakuten Medical; Researcher, Rakuten Medical; Researcher, General Electric Company; Researcher, Progenics Pharmaceuticals, Inc; Researcher, Novartis AG; ; ; ;

### For information about this presentation, contact:

pchoyke@mail.nih.gov

### LEARNING OBJECTIVES

1) To understand the basic biology of PSMA and its role in prostate cancer. 2) To describe the sensitivity of PSMA PET with regard to other PET agents for prostate cancer. 3) To demonstrate potential pitfalls and unexpected findings with PSMA PET imaging.

### ABSTRACT

PSMA PET imaging is a highly sensitive method of detecting prostate cancer. It can be used in the initial diagnosis and staging, for recurrence and to assess metastatic disease. PSMA is expressed in aggressive cancers but not in low grade or highly undifferentiated cancers. It is superior to all other PET agents in terms of sensitivity especially in the recurrence setting. It can be used to determine if lesions seen on CT or MRI are related to prostate cancer. Pitfalls include false negatives in highly aggressive disease, the diagnosis of additional malignancies and false positives in the cisterna chyli and fibrous dysplasia. PSMA PET will have a

profound impact on the management of prostate cancer.

### **MSMI22D Gastrin Releasing Peptide Receptors: When in the Course of Prostate Cancer Will They Be Useful?**

#### Participants

Andrei Iagaru, MD, Emerald Hills, CA (*Presenter*) Research Grant, General Electric Company Research Grant, Progenics Pharmaceuticals, Inc Research Grant, Advanced Accelerator Applications SA

#### **LEARNING OBJECTIVES**

1) List some of the radiopharmaceuticals targeting gastrin-releasing peptide receptors that are used in prostate cancer. 2) Understand underlying biology and mechanism of action for the radiopharmaceuticals targeting gastrin-releasing peptide receptors in prostate cancer. 3) Discuss patterns of prostate cancer appearance when using the radiopharmaceuticals targeting gastrin-releasing peptide receptors.

#### **ABSTRACT**

Various radiopharmaceuticals targeting different molecules have been studied in prostate cancer (PC). One recent class of tracers are the gastrin releasing peptide (GRP) analogs. Bombesin (BBN) is analog to the mammalian GRP, and it binds with high affinity to its transmembrane receptors, the GRP receptors (GRPR). Preclinical evaluation in PC cells and animal models have reported encouraging results; therefore, they are currently investigated as targets both for PC imaging and therapy. Increases in GRPR expression have been shown in 63-100% of intraprostatic PC, and 50-80% of nodal and osseous metastases. High density expression of GRPR has been reported in primary PC in contrast to surrounding healthy tissues and hyperplastic prostate, allowing for detection of early neoplastic events in the prostate with high specificity.

### **MSMI22E Iron Oxide Enhanced MR Imaging in GU Malignancies**

#### Participants

Baris Turkbey, MD, Bethesda, MD (*Presenter*) Research support, Koninklijke Philips NV; Royalties, Invivo Corporation; Investigator, NVIDIA Corporation

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

turkbeyi@mail.nih.gov

#### **LEARNING OBJECTIVES**

1) Understand mechanism of iron-oxide enhanced MRI. 2) Understand imaging findings of iron-oxide enhanced MRI. 3) Understand pitfalls and limitations of iron-oxide enhanced MRI.

#### **ABSTRACT**

n/a

Printed on: 10/29/20



MSRO22

### BOOST: CNS-Case-based Multidisciplinary Review (Interactive Session)

Monday, Dec. 2 10:30AM - 12:00PM Room: S103AB

NR OI RO

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

FDA Discussions may include off-label uses.

#### LEARNING OBJECTIVES

1) Review latest advances in imaging for assessment of gliomas before, during, and after therapy in the context of WHO 2016 molecular/genetic classification gliomas. 2) Discuss challenges and strategies for accurate imaging characterization of gliomas following therapy in a case based format. 3) Recognize the need to incorporate molecular/genetic features and types of therapy in imaging assessment of gliomas.

#### Sub-Events

##### MSRO22A Rapid Fire Tumor Board Case Review

Participants  
Soonmee Cha, MD, San Francisco, CA (*Presenter*) Nothing to Disclose

#### LEARNING OBJECTIVES

1) Simulate a tumor board environment by presenting ten cases of patients with brain tumor and present important elements of discussion relevant to patient care in each case. 2) Discuss latest advances in brain tumor therapy including immunotherapy, convection-enhanced delivery, and molecularly targeted agents and their implications for post-therapy imaging interpretation. 3) Apply structural and advanced imaging methods to differentiate active tumor growth and treatment related changes and recognize imaging pitfalls and limitations.

##### MSRO22B Updates in Primary and Recurrent GBM

Participants  
Roger Stupp, MD, Chicago, IL (*Presenter*) Spouse, Employee, Novartis AG; Research Consultant, Celgene Corporation; Research Consultant, AbbVie Inc; Research Consultant, Boehringer Ingelheim GmbH

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

roger.stupp@northwestern.edu

##### MSRO22C Role of Immunotherapy in GBM

Participants  
Clark C. Chen, MD, PhD, Minneapolis, MN (*Presenter*) Nothing to Disclose

##### MSRO22D Updates in Diffuse Gliomas

Participants  
Christina I. Tsien, MD, Washington, DC (*Presenter*) Advisory Board, Blue Earth Diagnostics Ltd; Advisory Board, NovoCure Ltd; Speakers Bureau, Varian, Inc; Speakers Bureau, Merck & Co, Inc

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## 105<sup>TH</sup> Scientific Assembly and Annual Meeting

December 1-6 | McCormick Place, Chicago

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MSRO26

### **BOOST: Gynecologic-Anatomy and Treatment Planning (Interactive Session)**

Monday, Dec. 2 10:30AM - 12:00PM Room: S103CD



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

#### **Participants**

Stephanie Markovina, MD, PhD, Saint Louis, MO (*Presenter*) Nothing to Disclose  
Aoife Kilcoyne, MBBCh, Boston, MA (*Presenter*) Author, Wolters Kluwer nv  
Marcela G. del Carmen, MD, Boston, MA (*Presenter*) Nothing to Disclose  
Wui-Jin Koh, MD, Plymouth Meeting, PA (*Presenter*) Nothing to Disclose

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

[smarkovina@wustl.edu](mailto:smarkovina@wustl.edu)

#### **LEARNING OBJECTIVES**

1) Describe the appropriate indication and use of pre treatment imaging in the management of patients with endometrial, cervical and vulvar cancer. 2) Describe updates in the primary surgical treatment of patients with endometrial and cervical cancer. 3) Describe the appropriate use of radiation therapy in the treatment of patients with uterine, cervical and vulvar cancer.

#### **ABSTRACT**

At the conclusion of this session, attendees will be able to describe updates in the pre treatment imaging of patients with endometrial, cervical and vulvar cancer. Participants will also be able to describe updates in the surgical and radiation treatment of patients with endometrial, cervical and vulvar cancer.

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## 105<sup>TH</sup> Scientific Assembly and Annual Meeting

December 1-6 | McCormick Place, Chicago

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RCA22

### Getting Stuff Done: A Hands-on Technology Workshop to Enhance Personal Productivity (Hands-on)

Monday, Dec. 2 10:30AM - 12:00PM Room: S401AB

**IN**

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

#### Participants

Puneet Bhargava, MD, Shoreline, WA (*Moderator*) Editor, Reed Elsevier  
Puneet Bhargava, MD, Shoreline, WA (*Presenter*) Editor, Reed Elsevier  
Matthew B. Morgan, MD, Sandy, UT (*Presenter*) Consultant, Reed Elsevier  
Amanda Lackey, MD, Springfield, MO (*Presenter*) Nothing to Disclose  
Tarun Pandey, MD, FRCR, Little Rock, AR (*Presenter*) Nothing to Disclose

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

bhargp@uw.edu

#### LEARNING OBJECTIVES

1) Introduce the concept of 'Getting Things Done.' Learn the concepts of Inbox Zero and other email management techniques. 2) Using tools such as note-taking applications, citation and password managers. 3) Using self-inquiry techniques, review how to make meaningful and powerful changes in how we engage with technology.

Printed on: 10/29/20



RCC22

## Novel Discoveries Using the NCI's Cancer Imaging Archive (TCIA) Public Data Sets

Monday, Dec. 2 10:30AM - 12:00PM Room: E353A

AI IN OI

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

### Participants

Justin Kirby, Rockville, MD (*Moderator*) Nothing to Disclose

### LEARNING OBJECTIVES

1) Gain a general understanding about the scope and mission of The Cancer Imaging Archive (TCIA). 2) Obtain a detailed understanding of how to leverage several of TCIA's most popular data sets. 3) Learn about some of the major scientific discoveries which have resulted from these data.

### ABSTRACT

This didactic session will highlight popular data sets and major projects utilizing TCIA with presentations from leading researchers and data contributors. Attendees will also learn about a number of new, major NIH data collection initiatives that are ongoing or coming in the near future which they can leverage in their own research.

### Sub-Events

#### RCC22A An Introduction to the Cancer Imaging Archive

Participants

Justin Kirby, Rockville, MD (*Presenter*) Nothing to Disclose

### LEARNING OBJECTIVES

1) Understand the scope and mission of The Cancer Imaging Archive. 2) Gain a high level understanding of TCIA services and functionality. 3) Learn about new NIH data collection initiatives that will be generating high-value research resources for the imaging community.

### ABSTRACT

This session will provide a brief introduction to The Cancer Imaging Archive (TCIA) to set the stage for more detailed presentations from the remaining speakers about popular data sets stored in TCIA and the novel discoveries that have resulted from them.

#### RCC22B ECOG-ACRIN Clinical Trial Data Sharing

Participants

Paul E. Kinahan, PhD, Seattle, WA (*Presenter*) Research Grant, General Electric Company Co-founder, PET/X LLC

### LEARNING OBJECTIVES

1) Learn about the image and meta data sets acquired by ECOG-ACRIN collected during clinical trials. 2) Gain a general understanding about the methods and constraints in collecting and disseminating archived images and meta data sets from clinical trials. 3) Learn about the specific ECOG-ACRIN data sets transferred to TCIA.

#### RCC22C Imaging Proteogenomics in Ovarian Cancer

Participants

Evis Sala, MD, PhD, Cambridge, United Kingdom (*Presenter*) Co-founder, Cambridge AI Health; Speakers Bureau, GlaxoSmithKline plc

### LEARNING OBJECTIVES

1) Learn how quantitative imaging can unravel tumour heterogeneity in ovarian cancer. 2) Understand how tumour heterogeneity on imaging may relate to biological heterogeneity. 3) Discuss the added value of integrating imaging with proteogenomics in ovarian cancer for better outcome prediction.

#### RCC22D Crowds Cure Cancer

Participants

Jayashree Kalpathy-Cramer, MS, PhD, Portland, OR (*Presenter*) Research support, General Electric Company; Research support, F. Hoffmann-La Roche Ltd;

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

kalpathy@nmr.mgh.harvard.edu

### LEARNING OBJECTIVES

1) Learn about the crowds cure cancer crowdsourcing activity. 2) Learn how annotations from the crowds cure cancer effort can be used to develop machine learning algorithms.



**RCC22E      Registration of CT and Digitalized Pathology Images in Lung Cancer**

Participants

Mirabela Rusu, DPhil, MENG, Stanford, CA (*Presenter*) Nothing to Disclose

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

mirabela.rusu@stanford.edu

**LEARNING OBJECTIVES**

1) General principles for image registration for multi-modal alignment. 2) Challenges in registering radiology and pathology images. 3) Approaches for registering multi-modal data. 4) Evaluation of registration methods. 5) Case study: Radiology Pathology fusion in pulmonary ground glass nodules.

Printed on: 10/29/20



SPAI21

### RSNA AI Deep Learning Lab: Beginner Class: Classification Task (Intro)

Monday, Dec. 2 10:30AM - 12:00PM Room: AI Showcase, North Building, Level 2, Booth 10342

AI BR CH CT GI HN IN MR NR

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

#### Participants

Bradley J. Erickson, MD, PhD, Rochester, MN (*Presenter*) Board of Directors, VoiceIt Technologies, LLC; Stockholder, VoiceIt Technologies, LLC; Board of Directors, FlowSigma, LLC; Officer, FlowSigma, LLC ; Stockholder, FlowSigma, LLC

#### Special Information

In order to get the best experience for this session, it is highly recommended that attendees bring a laptop with a keyboard and decent-sized screen. Having a Gmail account will be helpful. Here are instructions for [creating](#) and [deleting](#) a Gmail account. Here are instructions for [creating](#) and [deleting](#) a Gmail account.

#### ABSTRACT

This class will focus on basic concepts of convolutional neural networks (CNNs) and walk the attendee through a working example. A popular training example is the MNIST data set which consists of hand-written digits. This course will use a data set we created, that we call 'MedNIST', and consists of images of 6 different classes: Chest X-ray, Chest CT, Abdomen CT, Head CT, Head MR and Breast MRI. The task is to identify the image class. This will be used to train attendees on the basic principles and some pitfalls in training a CNN. • Intro to CNNs • Data preparation: DICOM to jpeg, intensity normalization, train vs test • How do we choose the labels? Inconsistencies... Use Fast.AI routines to classify; Validation of results: Are the performance metrics reliable? 'Extra Credit': if there is time, explore data augmentation options, effect of batch size, training set size.

Printed on: 10/29/20



SPCP21

## India Presents: Indian Radiology-Serving a Billion Population

Monday, Dec. 2 10:30AM - 12:00PM Room: E351

OT

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

FDA

Discussions may include off-label uses.

### Sub-Events

#### SPCP21A Cultural Program

#### SPCP21B Introduction: Radiology in India

##### Participants

Hemant T. Patel, MD, Ahmedabad, India (*Presenter*) Nothing to Disclose

#### SPCP21C Radiology of Infectious Diseases: What Have We Learnt?

##### Participants

Amarnath Chellathurai, MD, FRCR, Chennai, India (*Presenter*) Nothing to Disclose

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

amarrd02@yahoo.co.in

##### LEARNING OBJECTIVES

1) Examine the myriad presentations of tuberculosis. 2) Recommend various imaging advancements that obviate the need for tissue diagnosis in tuberculosis. 3) Compare and contrast the spectrum of opportunistic infections in immunocompromised as in HIV-TB. 4) Apply imaging during outbreak situations as in dengue and swine flu.

#### SPCP21D Imaging Trends in Oncology Practice: Where Are We?

##### Participants

Anirudh Kohli, MD, Mumbai, India (*Presenter*) Nothing to Disclose

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

dranirudhkohli@gmail.com

##### LEARNING OBJECTIVES

1) Imaging trends in detection staging especially multiparametric and hybrid techniques using molecular imaging. 2) Response assessment to therapy especially utilising functional techniques. 3) Therapeutic role in curative and palliation utilising percutaneous ablation, chemo/radio embolisation and pain management. 4) Role in detection of complications of therapy especially immunosuppression.

##### ABSTRACT

The traditional role of Radiologist in oncology has been to detect and stage. With technologic advancements especially hybrid and molecular imaging this role has been enhanced significantly. Emerging roles for radiologists are in response assessment to therapy especially using functional techniques to assess response prior to anatomical changes thus ineffective therapy may be modified an early stage in the therapeutic course. Radiology is making a significant impact as a primary therapeutic modality as well as a palliative modality using percutaneous ablation, regional chemotherapy utilising chemo/radio embolisation. Radiology continues to be very effective in radiation therapy planning as well as in detecting complications as a result of therapy especially immunosuppression.

#### SPCP21E Transplant Imaging: Updates from a World-class Transplant Center

##### Participants

Nitin P. Ghonge, MD, New Delhi, India (*Presenter*) Nothing to Disclose

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

dmitinpghonge@gmail.com

##### LEARNING OBJECTIVES

1) To update the status of Solid organ transplant program at Indraprastha Apollo Hospitals, New Delhi with emphasis on Transplant Imaging in India. 2) To review the imaging work-up of donors and recipients of Living-related Donor Liver transplantation and in Living donor Renal transplantation.

##### ABSTRACT

In recent times, transplant Imaging has evolved as major sub-speciality in Radiology. Imaging-based pre-transplantation donor

evaluation, surgical planning and post-transplant surveillance are integral parts of solid organ transplant programs across the globe and Radiologist has now become a vital member of team transplantation. The presentation will review the status of Transplant Imaging in India. Living-related donor Liver transplantation [LDLT] is a challenging procedure, which requires detailed donor work-up in terms of appropriate donor selection and operative technique. The primary objective is to ensure intra-operative safety and optimal liver functions in donor and the recipients. Laparoscopic Donor Nephrectomy (LDN) offers several advantages for the donor such as lesser post-operative pain, fewer cosmetic concerns and faster recovery time as compared to open nephrectomy. Comprehensive pre-LDN donor evaluation includes detailed assessment of renal morphology including pelvi-calyceal and vascular system for precise surgical planning. Liver and Renal Transplant recipients often require imaging evaluation during the early and late post-operative period for diagnosis of graft complications. This presentation will provide brief overview of the imaging work-up of potential donors and the transplant recipients in Liver and Renal transplant programs in India.

#### **SPCP21F Breast Imaging - IRIA Outreach Programs in India**

Participants

Bijal B. Jankharia, MD, Mumbai, India (*Presenter*) Nothing to Disclose

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

bijal@jankharia.com

#### **LEARNING OBJECTIVES**

To learn how the Indian Radiology & Imaging Association (IRIA) is making a difference towards reducing breast cancer related morbidity and mortality by conducting Outreach programs across the length and breadth of the country.

#### **ABSTRACT**

Breast cancer is the commonest female cancer killer in India. Early detection in asymptomatic patients and better management of symptomatic patients, reduces morbidity and mortality. Radiologists play a key role in both these. Breast imaging is a neglected subspeciality in India. Many in the big metros learn via fellowships abroad, but women radiologists in tier II and tier III cities have fewer opportunities and have to perform breast imaging as part of their duties as general radiologists. It was the vision of the President of The Indian Radiology & Imaging Association (IRIA) to take Breast Imaging knowledge to smaller towns and cities in the form of an Outreach program with the hope that teaching and training radiologists will go a long way in reducing the morbidity and mortality of breast cancer. The design of the Outreach program therefore includes lectures on Techniques, BIRADS reporting and Workshops on breast intervention, keeping in mind the challenges faced by the local radiologists. Since March 2019, the Outreach program has been successfully conducted in twenty tier II and tier III cities in different corners of India, with a total participation of 1893 radiologists. Four more programs are planned before this RSNA lecture and a few more till the IRIA National Conference in January 2020.

#### **SPCP21G Radiology Practice in Rural India: Best Out of Limited Resources**

Participants

Pankaj Sharma JR, MBBS, DMRD, Rishikesh, India (*Presenter*) Nothing to Disclose

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

pankajrad7477@yahoo.com

#### **LEARNING OBJECTIVES**

1) Improve basic knowledge and skills relevant to clinical practice. 2) Highlight problems faced by Radiologists working in rural India and how they utilize limited resources available to them.

#### **ABSTRACT**

Radiology in India has seen a evolutionary change from single X Ray machines, with dark room processing and dripping films to digital radiography and cross sectional imaging techniques like CT and MRI. Indian Radiological and Imaging Association (IRIA) is non-profit Professional Association with 16,000 members and more than 70% of these Radiologists primarily do Ultrasound in Diagnostic Centre/Private/Government Institutions. In Rural India, Radiology Practice is primarily done by Single Radiologist running small clinics with X Ray facilities and Sonography units. These small set ups do basic preliminary imaging, are patient friendly, doctor friendly, easily accessible and cater to needs of family physicians. Due to Economical reasons, in rural practice, still more than 50% centers have analog system. If these small centers in remote small towns start using Digital Technology, then Teleradiology will be useful. But, this will take a long time, as the priorities in our country are different. PC PNDT Act was introduced with good intention in India. But, Radiologists are facing a lot of problems due to this Act and IRIA is striving hard to help Radiologists by collaborating with Authorities. Moreover, IRIA has now started Raksha Program to save the Girl Child and to change public perception about Radiologists in India. Radiology Practice in Rural India has its own Challenges. But, Radiologists are working hard to bring forth best out of Limited Resources in India.

#### **SPCP21H Status of Radiology Practice in Corporate Hospitals in India**

Participants

Deepak Patkar, MD, Mumbai, India (*Presenter*) Nothing to Disclose

#### **LEARNING OBJECTIVES**

1) Understand the evolution of radiology practice in a developing country like India. 2) Identify the expected role of the radiologist in clinical management and patient treatment in the Indian scenario. 3) Compare the difference in radiology practice in government, private and corporate setups. 4) Understand the advantage of working as a team in a corporate setup as a radiologist in India. 5) Identify the challenge and various medico-legal intricacies of being a radiology consultant in a corporate setup. 6) Get an idea about the future and scope of radiology in India with ongoing advances in technology and the upcoming role of Artificial intelligence.

#### **SPCP21I Evolution of Fetal Radiology: Our Challenges, Our Achievements**

Participants

Bhupendra Ahuja, MD, Agra, India (*Presenter*) Nothing to Disclose

#### **LEARNING OBJECTIVES**

1) List the Ultrasound markers for Aneuploidy in 1st Trimester. 2) Approach to detect foetal structural abnormalities & Pitfalls of Foetal ultrasound in 2nd Trimester will be demonstrated. 3) Differentiate between foetus with adequate growth & growth-restricted fetuses in early 2nd trimester scan.

#### **SPCP21J MRGFUS: Status in India**

Participants

Shrinivas B. Desai, MD, Mumbai, India (*Presenter*) Nothing to Disclose

#### **LEARNING OBJECTIVES**

1) Understand the organisation of Radiology Education in India and how it is implemented in the Government sector and Private sector. 2) How a developing country like India provides Post Graduate Education in Radiology and how it translates in the objective of providing health care to more than a billion population. 3) How the Indian experience in Radiology training can be emulated by similarly placed Nations.

#### **SPCP21K Artificial Intelligence in Indian Radiology: We Are All Set!**

Participants

Harsh Mahajan, MD, MBBS, New Delhi, India (*Presenter*) Director, Mahajan Imaging Pvt Ltd; Research collaboration, General Electric Company; Research collaboration, Koninklijke Philips NV; Research collaboration, Qure.ai; Research collaboration, Predible Health

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

hm@mahajanimaging.com

#### **LEARNING OBJECTIVES**

1) Get an overview of AI algorithms available in India. 2) The various deployment strategies and use-cases of AI algorithms in India. 3) Learn how to implement AI algorithms in their department using various tools. 4) Be able to identify challenges with implementing AI, especially in the developing world. 5) Get an overview of how AI algorithms developed and implemented in India, can help in the developed parts of the world.

#### **SPCP21L Closing Remarks**

Participants

Valerie P. Jackson, MD, Tucson, AZ (*Presenter*) Nothing to Disclose

#### **SPCP21M National Anthem: India (vocal)**

Printed on: 10/29/20



SSC01

## Cardiac (CT: Fractional Flow Reserve)

Monday, Dec. 2 10:30AM - 12:00PM Room: S402AB

CA CT

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

FDA Discussions may include off-label uses.

### Participants

Satinder P. Singh, MD, Birmingham, AL (*Moderator*) Nothing to Disclose  
Smita Patel, FRCR, MBBS, Ann Arbor, MI (*Moderator*) Nothing to Disclose  
Jadranka Stojanovska, MD, Ann Arbor, MI (*Moderator*) Nothing to Disclose

### Sub-Events

#### SSC01-01 CAD-RADS in the Era of FFR-CT - An Observational Study in an Acute Chest Pain Population

Monday, Dec. 2 10:30AM - 10:40AM Room: S402AB

### Participants

Dante Giovagnoli, MMedSc, MS, Charleston, SC (*Presenter*) Nothing to Disclose  
Simon S. Martin, MD, Charleston, SC (*Abstract Co-Author*) Institutional Research support, Siemens AG  
Richard Bayer, Charleston, SC (*Abstract Co-Author*) Institutional Research support, Bayer AG; Institutional Research support, HeartFlow, Inc; Institutional Research support, Siemens AG  
Robert Steinbach, Charleston, SC (*Abstract Co-Author*) Nothing to Disclose  
Todd Hudson, MS, Charleston, SC (*Abstract Co-Author*) Nothing to Disclose  
U. Joseph Schoepf, MD, Charleston, SC (*Abstract Co-Author*) Research Grant, Astellas Group; Research Grant, Bayer AG; Research Grant, Bracco Group; Research Grant, Siemens AG; Research Grant, Heartflow, Inc; Research support, Bayer AG; Consultant, Elucid BioImaging Inc; Research Grant, Guerbet SA; Consultant, HeartFlow, Inc; Consultant, Bayer AG; Consultant, Siemens AG; ;  
Marly van Assen, MSc, Charleston, SC (*Abstract Co-Author*) Nothing to Disclose  
Akos Varga-Szemes, MD, PhD, Charleston, SC (*Abstract Co-Author*) Research Grant and Travel Support, Siemens AG Research Consultant, Elucid Bioimaging  
Joseph W. Golden, MD, Charleston, SC (*Abstract Co-Author*) Nothing to Disclose  
Thomas J. Vogl, MD, PhD, Frankfurt, Germany (*Abstract Co-Author*) Nothing to Disclose  
Andrew J. Matuskowitz, MD, Charleston, SC (*Abstract Co-Author*) Nothing to Disclose

### For information about this presentation, contact:

schoepf@musc.edu

### PURPOSE

CAD-RADS (Coronary Artery Disease Reporting and Data System) is increasingly used to communicate findings at coronary computed tomography angiography (CTA) in a standardized fashion. The aim of this study was to investigate the impact of fractional flow reserve (FFR-CT) derived from CTA on CAD-RADS stratifications in patients presenting with acute chest pain.

### METHOD AND MATERIALS

This observational, retrospective study was approved by the institutional review board. FFR-CT analysis was included in the diagnostic workup of 42 patients (mean age  $63.6 \pm 11.2$  years) who presented to the emergency department (ED) with acute chest pain and were referred for CTA. We evaluated the rate of CAD-RADS reclassifications from initial interpretation of the CTA study alone to until after FFR-CT (HeartFlow, Redwood City, CA) results were revealed. Other recorded data included downstream resource use and 90-day clinical outcomes.

### RESULTS

Four patients (10%) were initially classified as CAD-RADS 2 (i.e., mild stenosis not warranting further work-up), 29 (69%) as CAD-RADS 3 (i.e., moderate stenosis requiring functional assessment), and 9 (21%) as CAD-RADS 4 (i.e., severe stenosis requiring intervention), based on CTA alone. CAD-RADS 2 classifications (4 of 4) all remained concordant between CTA alone and with FFR-CT results added. Similarly, only limited reclassification (11%) occurred in CAD-RADS 4 patients, where CTA and FFR-CT results agreed in 8/9 patients. However, in patients with CAD-RADS 3, 55% (18/29) were reclassified to CAD-RADS 4 or CAD-RADS 2 after FFR-CT results were revealed. This assessment may have decreased the rate of additional diagnostic testing by 45%. No clinical events occurred in the group of patients with FFR-CT > 0.80 within 90 days.

### CONCLUSION

Adding FFR-CT analysis in patients presenting with acute chest pain substantially decreases equivocality in CTA interpretation, drastically reduces CAD-RADS 3 classifications, and has potential to obviate unnecessary downstream testing. One should consider an update to the CAD-RADS classification to account for the availability of FFR-CT.

### CLINICAL RELEVANCE/APPLICATION

Adding FFR-CT analysis in patients presenting with acute chest pain rationalizes patient management and has potential to obviate unnecessary downstream testing.

## SSC01-02 Diagnostic Performance of a Machine Learning FFRct Prototype Across Multiple CT Vendors

Monday, Dec. 2 10:40AM - 10:50AM Room: S402AB

### Participants

Joshua Bodrero, DO, Albuquerque, NM (*Presenter*) Nothing to Disclose  
Chengcheng Hu, Tucson, AZ (*Abstract Co-Author*) Nothing to Disclose  
Chris Schwemmer, Erlangen, Germany (*Abstract Co-Author*) Employee, Siemens AG  
Heiko Schmiedeskamp, PhD, Malvern, PA (*Abstract Co-Author*) Employee, Siemens AG  
Ashish Pershad, MD, Phoenix, AZ (*Abstract Co-Author*) Nothing to Disclose  
Michael F. Morris, MD, Scottsdale, AZ (*Abstract Co-Author*) Speakers Bureau, Medtronic plc

### PURPOSE

Recent studies have demonstrated that a prototype machine learning based computed fractional flow reserve (ML-FFR) algorithm significantly boosts the diagnostic performance of coronary computed tomography (CCTA). However, this data is based on results from a single CT vendor, limiting generalizability. We sought to determine the diagnostic performance of a prototype ML-FFR algorithm on CCTA datasets acquired from multiple CT vendors.

### METHOD AND MATERIALS

This was a multicenter retrospective study of patients in a large integrated health system undergoing both CCTA and invasive FFR/iFR within 45 days. The study cohort consisted of 110 patients and a total of 120 vessels. Measurement of ML-FFR was performed using workstation-based software, with blinding to the invasive FFR/iFR results. CT scanners were dichotomized as either 'premium' or 'standard.' The 'premium' CT scanners included GE Revolution (n=18), Siemens Flash (n=17), and Siemens Force (n=8). The 'standard' CT scanners included Toshiba Aquilion 64 (n=56), Toshiba Prime 160 (n=2), and GE Lightspeed VCT (n=1).

### RESULTS

Baseline characteristics of patients did not significantly differ between 'premium' and 'standard' CT scanners. Per-vessel ML-FFR results obtained on 'premium' CT scanners demonstrated significantly higher sensitivity ( $p=0.02$ ) compared to ML-FFR from 'standard' CT scanners (Figure 1). There were no significant differences in the specificity ( $p=0.32$ ) or accuracy ( $p=0.83$ ) of ML-FFR between 'premium' and 'standard' CT scanners.

### CONCLUSION

The sensitivity of a prototype ML-FFR algorithm performed on 'premium' CT scanners is significantly greater than 'standard' CT scanners, with overall similar specificity and accuracy. Future studies with larger number of patients should be performed to determine the reproducibility of these results.

### CLINICAL RELEVANCE/APPLICATION

A prototype ML-FFR algorithm demonstrates significantly improved accuracy compared to standard coronary CTA. The sensitivity of the prototype ML-FFR algorithm performed on 'premium' CT scanners is significantly greater than 'standard' CT scanners.

## SSC01-03 CTCA-Based Coronary FFR, Plaque Progression Prediction and Virtual Stenting: An All-Inclusive On Cloud Decision Support System for CAD Management

Monday, Dec. 2 10:50AM - 11:00AM Room: S402AB

### Participants

Antonis Sakellarios, Ioannina, Greece (*Abstract Co-Author*) Nothing to Disclose  
Alberto Clemente, Massa, Italy (*Presenter*) Nothing to Disclose  
Panagiotis Siogkas, Ioannina, Greece (*Abstract Co-Author*) Nothing to Disclose  
Savvas Kyriakidis, Ioannina, Greece (*Abstract Co-Author*) Nothing to Disclose  
Vassiliki Kigka, Ioannina, Greece (*Abstract Co-Author*) Nothing to Disclose  
Nenad Filipovic, Sestre Janjica, Serbia (*Abstract Co-Author*) Nothing to Disclose  
Dante Chiappino, Massa, Italy (*Abstract Co-Author*) Nothing to Disclose  
Danilo Neglia, Pisa, Italy (*Abstract Co-Author*) Nothing to Disclose  
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### PURPOSE

A comprehensive on cloud platform for clinical decision support (CDS) in stable coronary artery disease (CAD) has been developed within SMARTool EU funded project, including several models and tools based on CT coronary angiography (CTCA) imaging.

### METHOD AND MATERIALS

CTCA images are processed using an in-house 3D reconstruction tool which provides automatically the lumen, outer wall, calcified and non-calcified plaque of the coronary tree. The geometries are used for the non-invasive calculation of SmartFFR index. The pathologic SmartFFR is taken as a marker of obstructive CAD requiring revascularization and the stenosed arteries are used for real-time virtual stenting simulation. Additionally, the reconstructed segments are used in a prognostic model including CTCA and computational modeling features as well as non-imaging patient data to predict patient/plaque-specific CAD progression.

### RESULTS

The above implemented methodologies have been validated in SMARTool clinical trial (263 stable CAD patients recruited at two time points with an interscan period of  $6\pm 1$  years). Data from 27 patients were used for the validation of 3D reconstruction comparing results with manual annotations. The DICE coefficient and the Hausdorff distance are  $0.72\pm 0.08$  and  $1.95\pm 0.45$ , respectively. The

SmartFFR methodology was validated using 88 coronary segments where invasive FFR was available ( $r=0.86$ ,  $P<0.0001$ ). Diagnostic performance of SmartFFR has 90.9, 88.9, 91.8, 82.8 and 94.9 for Accuracy, Sensitivity, Specificity, PPV and NPV, respectively. Virtual stenting methodology has also been proved to accurately simulate inflation and re-expansion of the stenotic segments, while the prognostic model based on the analysis of 480 coronary segments from 187 patients has 80% accuracy for plaque progression prediction.

## CONCLUSION

The CTCA imaging-based models developed in SMARTool on cloud CDS empower current management of stable CAD patients. This work is partially funded by the European Commission: Project SMARTOOL, 'Simulation Modeling of coronary ARtery disease: a tool for clinical decision support - SMARTool' [GA number: 689068].

## CLINICAL RELEVANCE/APPLICATION

SMARTool CDS is expected to enhance the diagnostic and prognostic yield of CTCA imaging and support stent implantation planning.

### SSC01-04 Comparison of Invasive FFR, CT-FFR, and Benchtop FFR Using 3D Printed Patient Specific Coronary Phantoms

Monday, Dec. 2 11:00AM - 11:10AM Room: S402AB

#### Participants

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## PURPOSE

Diagnosis tools based on computational fluid dynamics, have been proposed to predict fractional flow reserve (FFR) in patients with coronary artery disease. These tools use segmented 3D geometry obtained via CT-angiography and various boundary conditions for flow. Regardless of the approach or computational particularities, tool validation and optimization is done using a reference standard invasive FFR. This development approach can be lengthy due to incomplete knowledge of all factors affecting the human physiology complexity. In this study we propose to determine whether it is feasible to use patient specific 3D printed patient specific coronary phantoms to validate a CT-FFR software.

## METHOD AND MATERIALS

Using multi-material 3D printing capabilities, we built 33 patient specific cardiac phantoms from CCTA scans in patients who underwent clinically indicated elective invasive coronary angiography. Each phantom was used in a controlled flow system where patient specific flow conditions were provided by a programmable cardiac pump. Flow parameters were adjusted such that the aortic pressures were 100-120 mmHg and coronary total flow was 500mL/min. Each phantom had pressure sensors embedded in the main coronary arteries and the flow rate was monitored. The benchtop FFR was recorded between the aorta and distal to the stenosis. Benchtop FFR was compared with the invasive FFR and a CT-FFR research software (Canon Medical Systems).

## RESULTS

The AUC for benchtop FFR and CT-FFR compared with invasive FFR as the 'gold standard' was 0.72 and 0.83, respectively, with less than or equal to FFR of 0.8 being true for diseased.

## CONCLUSION

3D printed patient specific coronary phantoms can be used to replicate the human arterial anatomy as well as blood flow conditions. Above all they offer the unique opportunity to control and precisely measure physiological conditions which can be used to optimize and validate diagnostic software.

## CLINICAL RELEVANCE/APPLICATION

Benchtop flow testing using 3D printed patient specific coronary phantoms provide precise and cost effective tools which could accelerate effectiveness and accuracy studies for image based diagnostic technologies.

### SSC01-05 Diagnostic Performance of a Machine-Learning-Based Fractional Flow Reserve Derived from Coronary Computed Tomography Angiography for the Detection of Functionally Obstructive Coronary Artery Disease

Monday, Dec. 2 11:10AM - 11:20AM Room: S402AB

#### Participants

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#### **PURPOSE**

To evaluate the diagnostic performance of a novel machine learning approach for computed tomography (CT) angiography-based fractional flow reserve (FFRCT), using different scanner profiles, in the detection of functionally obstructive coronary artery disease (CAD) assessed by invasive FFR (FFRi).

#### **METHOD AND MATERIALS**

This retrospective study comprised patients clinically referred to CT and subsequently to invasive coronary angiography with FFRi measurement for CAD assessment at Sirio-Libanês Hospital, Sao Paulo, Brazil. CT acquisitions were performed using two scanner profiles: Siemens Somatom Definition Flash (75ms/0.30mm) and AS+ (150ms/0.30mm). On a dedicated software (cFFR version 3.0.0, Siemens Healthineers, Forchheim, Germany) installed in a standard desktop, FFRCT and the minimum luminal area (MLA) were calculated. Obstructive CAD was defined as CT with stenosis >50% and functionally obstructive CAD as FFRi ≤0.8.

#### **RESULTS**

Ninety-three consecutive patients (152 vessels) were included. Bland-Altman analysis showed high agreement between FFRCT and FFRi, with mild systematic overestimation of FFRCT values (bias:-0.02; limits of agreement: 0.14-0.09) (Figure 1A). Images acquired in different CT's did not modify the relationship between FFRCT and FFRi values (p for interaction=0.73) (Figure 1B). Compared with visual anatomically obstructive CAD by CT, both ALM (AUC 0.75 vs. 0.61, p<0,001) and FFRCT (AUC 0.93 vs. 0.61, p<0,001) demonstrated a higher performance. The best cutoff point using a Youden index was 0.84 for FFRCT (Sens 87%, Spec 85%, PPV 73%, NPV 93%), leading to a 70% reduction of false-positive when compared to obstructive CAD by CT.

#### **CONCLUSION**

FFRCT based on a machine learning algorithm can accurately identify patients with flow-limiting stenosis. This new tool is available for standard PC and seems to have consistent results even in CT with different profiles.

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

FFRCT based on machine learning algorithms promises to speed up the clinical implementation of non-invasive functional CAD assessment. Given its reproducibility and diagnostic accuracy, it allows users to install dedicated software on a standard desktop, reducing post-processing time and providing functional information.

#### **SSC01-07 Incremental Value of Coronary Artery Assessment from 70 kVp Stress Dynamic Myocardial CT Perfusion Data: Validation by Invasive Fractional Flow Reserve**

Monday, Dec. 2 11:30AM - 11:40AM Room: S402AB

#### **Awards**

##### **Trainee Research Prize - Resident**

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#### **PURPOSE**

To investigate the diagnostic performance of 70 kVp stress dynamic myocardial CT perfusion as an innovative low-dose, one-stop cardiac CT examination in clinical application.

#### **METHOD AND MATERIALS**

Consecutive symptomatic patients were prospectively recruited and scanned with ATP-stress dynamic myocardial CTP using third-generation dual-source CT. The image quality (IQ) and diagnostic confidence of CTP were analyzed using a 4-point score for each myocardial segment based on the AHA model. The CTP phase with the best enhancement of the coronary arteries was selected and extracted as the CTP-derived single-phase coronary CTA (SP-CTA). The diagnostic performance of CTP and CTP+SP-CTA for functionally significant coronary artery disease were assessed. Invasive coronary angiography and fractional flow reserve (ICA/FFR) were used as the reference standard for the myocardial ischemia evaluation. The effective radiation dose of CTP were recorded.

#### **RESULTS**

In total, 71 patients (43 men and 28 women; 63.61±8.77 years) underwent the stress dynamic myocardial CTP examination. According to ICA/FFR, 63 vessels (36.2%) from 42 patients (59.2%) were identified as causing ischemia. The average score of segment-based IQ and diagnostic confidence of the CTP images was 1.11± 0.34. On a per-vessel basis, the sensitivity, specificity, PPV, NPV and diagnostic accuracy were 77.78%, 93.69%, 87.50%, 88.14%, 87.93% and 84.13%, 93.69%, 88.33%, 91.23%, 90.23%, respectively, for CTP and CTP+SP-CTA. The area under the receiver operating characteristic curve of CTP+SP-CTA (AUC=0.963,95%CI: 0.938-0.989) was significantly superior to that of CTP (AUC=0.922,95%CI: 0.880-0.964) and that of SP-CTA (AUC=0.833,95%CI: 0.765-0.900) alone (all P<0.01). The mean radiation dose of the CTP examination was 3.85±1.35 mSv.

#### **CONCLUSION**

CTP-derived SP-CTA improved the diagnostic value of CTP. With a promising performance of myocardial ischemia detection and

advanced techniques allowing low radiation dose, the innovative low-dose, one-stop CTP examination is clinically feasible for patients who need to receive a myocardial perfusion assessment.

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

The CTP-derived SP-CTA improved the diagnostic value of CTP alone, which makes it clinically feasible to be applied as an innovative one-stop cardiac CT examination for patients with intermediate to high CAD risk, providing the convenience in clinical procedure and the advantage of dose and contrast media saving.

#### **SSC01-08 CT-FFR Profiles in Patients without Coronary Artery Disease**

Monday, Dec. 2 11:40AM - 11:50AM Room: S402AB

##### **Participants**

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##### **PURPOSE**

To evaluate the effect of measurement location and lumen area changes on CT-FFR values in patients without coronary artery disease (CAD).

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

Patients who underwent calcium scoring (CACS) and CCTA with CT-FFR were retrospectively included. Patients were excluded if their CACS was not zero, there were elevated troponin levels, or any cardiac abnormality on the CCTA studies. On-site CT-FFR based on an artificial intelligence, deep-learning algorithm (Siemens Healthineers) was computed for each coronary artery at proximal, mid, and distal segments. At each measurement location, the lumen area and Hounsfield Unit (HU) value was measured. CT-FFR was considered positive with values  $<0.75$ . The relationship between lumen areas, HU values, and CT-FFR was evaluated for each coronary artery and each location. Ratios between mid and distal values compared to proximal values for lumen and HU parameters were calculated.

##### **RESULTS**

A total of 106 patients were included. In 39 (37%) patients, the LAD had CT-FFR values  $<0.75$ , with a decrease in CT-FFR from 0.97 (SD 0.04) proximally to 0.62 (SD 0.10) distally in the abnormal patients. The Cx showed a limited number of patients with CT-FFR values  $<0.75$  ( $n=16$ , 15%), with a decrease in CT-FFR values from 0.96 (SD 0.04) proximally to 0.65 (SD 0.09) distally in those patients. The RCA had 36 (34%) patients with CT-FFR  $<0.75$ , with distal CT-FFR values of 0.61 (SD 0.12) and proximal CT-FFR values of 0.98 (SD 0.02). 12 abnormal CT-FFR values were measured at mid segment, while all others were measured at distal segments. Lumen area was not significantly different between the abnormal and normal CT-FFR groups, while both HU and HU ratios were significantly lower in the abnormal CT-FFR group for all three major coronary arteries.

##### **CONCLUSION**

CT-FFR values in patients without coronary artery disease can become abnormal at a distal location without indicating flow-limiting stenosis, which depends strongly on HU values.

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

CT-FFR values measured distally should always be interpreted in combination with the CCTA images in order to avoid false positives and over treatment.

#### **SSC01-09 Coronary Computed Tomography Angiography and CT-Fractional Flow Reserve for Heart Team Decision-Making in Multivessel Coronary Artery Disease: Syntax III Score**

Monday, Dec. 2 11:50AM - 12:00PM Room: S402AB

##### **Participants**

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##### **PURPOSE**

Coronary computed tomography angiography (CTA) has emerged as a non-invasive complex coronary artery disease remains to be

investigated. The present study sought to determine the agreement between separate heart teams on treatment decision-making based on either coronary CTA or conventional angiography.

## **METHOD AND MATERIALS**

Separate heart teams composed of a cardiologist, a cardiac surgeon, and a radiologist were randomized to assess the coronary artery disease with either coronary CTA or conventional angiography in patients with de novo left main or three-vessel coronary artery disease. Each heart team quantified the anatomical complexity using the SYNTAX score and integrated clinical information using the SYNTAX Score II to provide a treatment recommendations based on mortality prediction at 4 years. The primary endpoint was the agreement between heart teams on the revascularization strategy. The secondary endpoint was the impact of fractional flow reserve derived from coronary CTA (FFRCT) on treatment decision and procedural planning. Overall, 223 patients were included.

## **RESULTS**

A treatment recommendation of CABG was made in 28% of the cases with coronary CTA and in 26% with conventional angiography. The agreement concerning treatment decision between coronary CTA and conventional angiography was high (Cohen's kappa 0.82, 95% confidence interval 0.74-0.91). The heart teams agreed on the coronary segments to be revascularized in 80% of the cases. FFRCT was available for 869/1108 lesions (196/223 patients). Fractional flow reserve derived from coronary CTA changed the treatment decision in 7% of the patients

## **CONCLUSION**

In patients with left main or three-vessel coronary artery disease, a heart team treatment decision-making based on coronary CTA showed high agreement with the decision derived from conventional coronary angiography suggesting the potential feasibility of a treatment decision-making and planning based solely on this non-invasive imaging modality and clinical information.

## **CLINICAL RELEVANCE/APPLICATION**

The addition of coronary CTA to standard medical therapy leads to an incremental benefit; in particular, reducing invasive angiography demonstrating no obstructive CAD and allowing for the appropriate immediate targeting of revascularisation strategies. To aid this process, a heart-team approach and clinical tools such as the Syntax Scores are advocated to objectively quantify CAD burden and clinical co-morbidity.

Printed on: 10/29/20



SSC02

## Cardiac (Nonischemic Cardiomyopathies)

Monday, Dec. 2 10:30AM - 12:00PM Room: S401CD

CA MR

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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### Sub-Events

#### SSC02-01 The Left Ventricular Flow Patterns and Trabecular Complexity in Hypertrophic Cardiomyopathy: Assessment with Multi-Modality Cardiac Magnetic Resonance

Monday, Dec. 2 10:30AM - 10:40AM Room: S401CD

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### PURPOSE

This paper aims to assess left ventricular flow patterns and trabecular complexity of obstructive hypertrophic cardiomyopathy (HOCM) and non-obstructive hypertrophic cardiomyopathy (NOHCM) patients using multi-modality cardiac magnetic resonance (CMR) including 4D Flow, fractal analysis and feature tracking.

### METHOD AND MATERIALS

CMR was performed in 76 HCM patients stratified into HOCM (22-65 years; males, n=25) and NOHCM group (26-59 years; males, n=24) based on LV outflow tract obstruction ( $\geq 30$  mmHg) and 30 healthy subjects (21-65 years; males, n=18). Fast imaging employing steady state acquisition (FIESTA) images and 4D flow were acquired at 3.0T MRI. All data was evaluated by the postprocessing software (cvi42, Circle Cardiovascular Imaging, v. 5.6, Calgary, AB, Canada). The LV blood flow path lines were separated into four different components: Direct Flow, Retained Inflow, Delayed Ejection Flow and Residual Volume. The degree of LV trabeculation was assessed by fractal dimension (FD), a dimensionless measure of trabeculation complexity. Myocardial deformation was evaluated by feature tracking.

### RESULTS

The Retained Inflow, Delayed Ejection Flow and Residual Volume of LV showed significant differences between the HOCM group and the NOHCM group ( $18.48 \pm 8.37$  VS.  $9.59 \pm 4.68$ ,  $P = 0.038$ ;  $14.39 \pm 6.63$  VS.  $28.30 \pm 10.23$ ,  $P = 0.021$ ;  $57.11 \pm 7.26$  VS.  $46.65 \pm 8.84$ ,  $P = 0.047$ ). Mean global FD of the left ventricle was higher in the HOCM and the NOHCM group than in the healthy group ( $1.304 \pm 0.038$  VS.  $1.292 \pm 0.039$  VS.  $1.236 \pm 0.024$ ,  $P = 0.433$ ,  $P < 0.001$ ,  $P < 0.001$ ). Max apical FD was higher in the HOCM group than the NOHCM group ( $1.400 \pm 0.077$  VS.  $1.338 \pm 0.067$ ,  $P = 0.001$ ). Myocardial deformation analysis showed that increased global FD was associated with changed myocardial deformation across global strain value (circumferential:  $r = 0.567$ ,  $P < 0.001$ ; radial:  $r = -0.622$ ,  $P < 0.001$ ; and longitudinal:  $r = 0.535$ ,  $P < 0.001$ ).

### CONCLUSION

Our results demonstrate that LV retained blood remains more in HOCM patients, and the degree of the apical trabecular complexity is increased compared with NOHCM.

### CLINICAL RELEVANCE/APPLICATION

The trabecular complexity and retained blood flow in the left ventricular are promising to be remarkable risk factors for assessment in sudden cardiac death, and guide the clinical management for hypertrophic cardiomyopathy.

#### SSC02-02 Magnetic Resonance Fingerprinting for Multiparametric Quantitative Assessment in Hypertrophic Cardiomyopathy: Comparison with Conventional Cardiac Relaxometry

Monday, Dec. 2 10:40AM - 10:50AM Room: S401CD

### Participants

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**PURPOSE**

The objective of this study is to evaluate cardiac magnetic resonance fingerprinting (MRF) in the assessment of myocardial relaxation times compared to standard relaxometry.

**METHOD AND MATERIALS**

64 Pts (55m,56+/-12.3y) with suspicion/known HCM underwent CMR at 3T. Midventricular SAX T1/T2 values were evaluated with pre-(5(3)3) and post-contrast (4(1)3(1)2) modified Look-Locker inversion recovery (MOLLI) and T2-prep fast low-angle shot (FLASH) techniques. MRF was performed at identical SAX slice position pre-/post-contrast (15 heartbeats). Post-contrast imaging was done >10min after injection of Gadobutrol (0.15mmol/kg). Inline motion correction with pixel-wise fitting was performed for MOLLI/T2-prep FLASH based T1/T2 maps. Acquired MRF raw data was reconstructed off-line for creation of T1/T2 maps. All maps were visually assessed for general image quality using a 5-point Likert scale (1=non-diagnostic/5=excellent). Quantitative Map evaluation was performed using dedicated software and extracellular volume fraction (ECV) calculated with patients' hematocrit. Statistical analysis was performed including Wilcoxon rank-sum test and Spearman's correlation. Data presented as median and IQR.

**RESULTS**

Image quality of MOLLI T1 was superior to MRF T1 in pre- (5 vs. 4;p=.0029) and post-contrast data (5 vs. 4;p=.0004). T2 FLASH showed better image quality than MRF T2 (5 vs 4;p<.0001). MRF T1 values were significantly longer than MOLLI T1 in pre-contrast (1385ms [IQR:1336/1437ms] vs. 1250ms [IQR:1220/1290ms];p<.0001) and post-contrast (514ms [IQR:458/542ms] vs. 485ms [IQR:435/523ms];p<.0001) settings. MOLLI T1 based ECV values (23% [IQR:21/27%]) were significantly lower than MRF T1 based data (27% [IQR:23/31%]) (p<.0001). MRF T2 values were significant different to T2 FLASH data (32.5ms [IQR:30.2/35.2ms] vs. 39.9ms [IQR:38.6/41.8ms];p<.0001). Significant correlations between MRF and standard cardiac relaxometry were found for all evaluated parameters (figure).

**CONCLUSION**

Single breath-hold MRF allows for simple and faster quantitative multiparametric evaluation of the myocardium than conventional fitting based relaxometry with significant correlations. Automatic co-registration of MRF maps may provide further benefits.

**CLINICAL RELEVANCE/APPLICATION**

MRF allows robust single breath-hold multiparametric mapping with intrinsic co-registration. Thus, it may allow improved distinction/differential diagnosis of various cardiomyopathies including HCM.

**SSC02-03 Antimalarial-Induced Cardiomyopathy Resembles Fabry Disease on Cardiac MRI**

Monday, Dec. 2 10:50AM - 11:00AM Room: S401CD

**Participants**

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**PURPOSE**

Antimalarials (AM) are frequently used in the treatment of patients with systemic lupus erythematosus (SLE). AM-induced cardiomyopathy (AMIC) is associated with high mortality and is likely under-recognized in clinical practice. The purpose of this study was to evaluate cardiac magnetic resonance imaging (MRI) findings in AIMC.

**METHOD AND MATERIALS**

Cardiac MRI studies were compared between 11 SLE patients with AMIC (63.0±7.8 years, 90.9% female) and 32 SLE patients without AMIC (42.8±16.5 years, 90.3% female). The diagnosis of AMIC was confirmed by endomyocardial biopsy and/or autopsy in 4 patients and presumed based on concordant history and abnormal cardiac biomarker levels that improved after AM cessation in 7 patients.

**RESULTS**

Patients with AMIC were significantly older (p<0.001) and had longer AM treatment duration (26.1±11.7 years vs. 5.4±6.9 years, p<0.001) compared to those without. There were no significant differences in left ventricular (LV) end-diastolic volumes and ejection fraction between groups (p=0.515 and p=0.489, respectively). However, indexed LV mass was significantly higher and concentric LVH was more common in patients with AMIC compared to those without (68.9±17.4 g/m<sup>2</sup> vs. 52.3±11.0 g/m<sup>2</sup>, p=0.001 and 80.0% vs. 26.7%, p=0.007, respectively). Late gadolinium enhancement (LGE) was present in all 10 patients with AMIC who had undergone LGE imaging (vs. 22.6% of those without AMIC, p<0.001). In patients with AMIC, the pattern of LGE was most commonly mid-wall located at the basal to mid inferior lateral segment (90.0%). Native T1 values outside areas of LGE were low in patients with AMIC who had undergone T1 mapping (1062 ms at 3T and 997 ms at 1.5T).

**CONCLUSION**

To our knowledge this is the largest cardiac MRI study in AMIC to date. Typical cardiac MRI findings in AMIC include concentric LVH, LGE at the basal to mid inferior lateral segment and low native T1 values. This cardiac MRI appearance is similar to Fabry

disease (a lysosomal storage disease). The resemblance is striking given previously described histopathological similarities between AMIC and Fabry disease and supports the hypothesis that AMIC may be caused by reversible inhibition of myocyte lysosomal activity.

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

These results may allow for earlier detection of AMIC, and support the necessity for future larger studies to evaluate the prognostic significance of MRI findings and correlation with histopathology.

#### **SSC02-04 Role of Cardiac MRI in Identification of Myocardial Fibrosis in Patients of Non-Ischemic Dilated Cardiomyopathy**

Monday, Dec. 2 11:00AM - 11:10AM Room: S401CD

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##### **PURPOSE**

To study the prevalence of myocardial scar and its quantification on Cardiac MRI (CMRI) and its utility in predicting clinical outcomes in patients of non-ischemic dilated cardiomyopathy (NIDCM)

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

In this prospective observational study we enrolled 88 consecutive patients of clinically diagnosed NIDCM. Routine CMR sequences was done including black blood imaging T1W and T2W, Steady state free precession Cine images, first pass perfusion images at rest and post contrast (10-15 minutes) 2D segmented inversion recovery gradient recalled echo (GRE) imaging during diastole, inversion time set to null normal myocardium. Myocardial scar was defined as late gadolinium enhancement (LGE) and its extent was quantified using visual scoring method. Patients were followed-up for major adverse cardiac events (MACE), including cardiovascular death, aborted sudden death and heart failure for a mean period of 12 months. ROC curve was generated to know the accuracy of LGE extent in predicting MACE.

##### **RESULTS**

Of 88 patients (median age: 42 years, 66% male), mainly presenting with congestive heart failure symptoms (79%) and palpitations (16%). On CMR 50% of patients showed LGE of variable pattern out of which mid myocardial enhancement was most frequent. The percentage of LGE in these patients ranged from 1.4% to 88%, with a median of 25%. With LGE cut off of 26%, MACE can be predicted with 70% sensitivity and 73.5% specificity (AUROC=0.75). During 12 months follow-up, 16 patients developed MACE, out of which 10 were LGE+ and 6 were LGE-ve. The higher event rate was observed in patients with LGE volume of >26% compared to LGE <26% (43.6% vs 10.7%).

##### **CONCLUSION**

In NIDCM, presenting with heart failure or ventricular arrhythmias, presence of myocardial scar and its extent gives additional prognostic information compared to left ventricular ejection fraction (LVEF) and other traditional risk factors. Even though the final diagnosis is uncertain in NIDCM, extensive amount of LGE should be considered as a sign of poor prognosis.

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

Risk stratification depending solely on LVEF in NIDCM patients may be fallacious, as most patients who experience sudden cardiac death (SCD) did not have severely reduced LVEF. Identification and quantification of myocardial fibrosis could be used as an adjunct for more accurate risk stratification in these patients.

#### **SSC02-05 Chemotherapy Induces Left Ventricular Hypertrophy and Increases T1 Relaxation Times in Female Patients with Breast Cancer**

Monday, Dec. 2 11:10AM - 11:20AM Room: S401CD

##### **Participants**

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

## PURPOSE

To detect and monitor cardiomyopathy by cardiac magnetic resonance (CMR) in female patients with first-time radiochemotherapy treatment of breast cancer.

## METHOD AND MATERIALS

39 female patients (51 ±11 years) with newly diagnosed breast cancer underwent serial 3 Tesla CMR (Ingenia, Philips Medical Systems). Baseline (BL) CMR was performed 10 ±9 days before the start of therapy. First follow-up (FU1) CMR was 13 ±12 days and second follow-up (FU2) 8 ±2 months after completion of chemotherapy. SSFP cine sequences were performed to determine cardiac volumes and function. T1 mapping CMR was performed using a 5s(3s)3s MOLLI sequence. CMR data were analyzed using the commercially available software cmr42 (Circle Cardiovascular Imaging Inc., Calgary, Alberta, Canada). LV end-diastolic and end-systolic volumes were obtained from cine-CMR short-axes to calculate LV stroke volumes (LVSV) as well as LV ejection fraction (LVEF).

## RESULTS

The mean dose of chemotherapeutic agents used was as follows: epirubicin 663 ±60 mg/m<sup>2</sup>, cyclophosphamid 4421 ±398 mg/m<sup>2</sup> and paclitaxel 1646 ±275 mg/m<sup>2</sup>. High sensitive Troponin T increased on FU1 (5 ±4 vs. 8 ±4 pg/ml, P<0.05) and remained high at FU2 (8 ±11 pg/ml, P=0.845). Creatine kinase remained unchanged at FU1 (68 ±29 vs. 78 ±51 pg/ml, P=0.189) and increased at FU2 (97 ±33 pg/ml.) NT-proBNP remained unchanged throughout the observation period. LVEF was constant between FU1 (61 ±5 vs. 62 ±6%, P=0.712) and FU2 (60 ±6%, P=0.094). LV mass increased at FU1 (48 ±5 vs. 52 ±7%, P<0.01) and remained high at FU2 (52 ±7%, P<0.01). T1 relaxation times were increased at FU1 (1258 ±31 vs. 1283 ±44 ms, P<0.01) and declined at FU2 (1269 ±26 ms, P=0.123). ECV did not show any differences between BL and FU2 (28 ±2 vs. 29 ±2%, P=0.519).

## CONCLUSION

Chemotherapy treatment in breast cancer patients can lead to myocardial hypertrophy, which is stable on a 8 month follow-up. Increase in T1 relaxation times of LV myocardium can be detected immediately after completion of radiochemotherapy, but subside on a 8 month follow-up.

## CLINICAL RELEVANCE/APPLICATION

Increase in LV mass and T1 relaxation times of myocardium might be used as early indicators of subclinical cardiomyopathy in asymptomatic patients with breast cancer undergoing chemotherapy.

## SSC02-06 Correlation Between Quantitative Left Ventricular Myocardial Scar Volume and Left Ventricular Ejection Fraction in Cardiac Sarcoidosis

Monday, Dec. 2 11:20AM - 11:30AM Room: S401CD

### Participants

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## PURPOSE

The purpose of this study was to utilize cardiac MRI (cMRI) to determine if there is an association between quantitative left ventricular myocardial scar volume and left ventricular function, as measured by left ventricular ejection fraction (LVEF), in patients with suspected cardiac sarcoidosis.

## METHOD AND MATERIALS

IRB approval was obtained for this HIPAA compliant study. cMRIs of 355 cases with a clinical suspicion for cardiac sarcoidosis were reviewed by 2 cardiothoracic imaging trained radiologists. cMRI based LVEF, and quantitative myocardial scar volume were calculated for all cases and compared between patients with and without cMRI findings suggestive of cardiac sarcoidosis. Correlation between LVEF and myocardial scar volume was assessed with Pearson Correlation Coefficient test. Significance was set at P value=0.05.

## RESULTS

A total of 355 patients with a clinical suspicion of cardiac sarcoidosis were included in this study (mean age 58.0 +/- 12.2). Ninety (25.4%) patients demonstrated cMRI imaging findings suggestive of cardiac sarcoidosis (mean age 60.0 +/- 12.6; 26.7% female, 73.3% male; 47% African American, 50% Caucasian). Myocardial scar volume determined by cMRI was significantly higher in sarcoid positive cases (11.9% +/- 10.8% vs. 2.7% +/- 6.7%, P<0.001) vs sarcoid negative cases. LVEF was significantly lower in the sarcoid positive group when compared to the sarcoid negative group (46.7% +/- 16.1 vs. 54.8 +/- 13.4, P<0.001). Additionally, in those with cMRI findings suggestive of cardiac sarcoidosis, myocardial scar mass volume was significantly correlated (P<0.001) to the left ventricular ejection fraction with Pearson Correlation Coefficient of R= -0.630. In those with cMRI findings suggestive of cardiac sarcoidosis, African Americans demonstrated larger quantitative scar volumes and greater reduction in MRI LVEF than Caucasians (14.1% vs. 9.95; 41.7% vs. 51.4%).

## CONCLUSION

In patients with cMRI findings of sarcoidosis, left ventricular myocardial quantitative scar volume was negatively correlated with left ventricular ejection fraction. In patients with cMRI findings of sarcoidosis, African Americans demonstrated a greater scar volume and a higher decline in ejection fraction when compared to Caucasians.

## CLINICAL RELEVANCE/APPLICATION

Quantitative myocardial scar volume may be a useful quantitative parameter for prediction of LVEF in patients with suspected

Quantitative myocardial scar volume may be a useful quantitative parameter for prediction of LVEF in patients with suspected myocardial sarcoidosis.

### **SSC02-07 The Effects of Left Ventricular Remodeling, Myocardial Perfusion and Tissue Characteristic on Cardiac Motion in Diabetic Cardiomyopathy: A Multimodal Cardiac Magnetic Resonance Study**

Monday, Dec. 2 11:30AM - 11:40AM Room: S401CD

#### Participants

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#### PURPOSE

This study was to determine the effects of left ventricular(LV) remodeling, myocardial perfusion and tissue characteristic on cardiac motion in type 2 diabetes mellitus(T2DM), and to explore the risk factors affecting systolic and diastolic functions, based on a multimodal cardiovascular magnetic resonance (CMR) study.

#### METHOD AND MATERIALS

A total of 85 clinically diagnosed T2DM patients and 39 healthy controls underwent CMR examination. The CMR parameters including morphological structure (LV mass and remodeling index), motion (peak strain(PS), peak systolic strain rate, and peak diastolic strain rate), perfusion (upslope, MaxSI, TTM, and perfusion-index), T1 mapping and T2 mapping were analyzed and compared between controls and T2DM patients. The univariable and multivariable analysis was performed to identify the imaging and clinical variables affecting motion functions.

#### RESULTS

Compared with controls, T2DM patients presented significantly decreased motion function in radial, circumferential and longitudinal direction (PS radial,  $32.16 \pm 8.80$  vs.  $39.32 \pm 9.51$ ,  $p=0.001$ ; PS circumferential,  $-19.67 \pm 3.83$  vs.  $-21.00 \pm 3.35$ ,  $p=0.036$ ; and PS longitudinal,  $-11.93 \pm 3.50$  vs.  $-15.85 \pm 3.79$ ,  $p=0.000$ ), decreased perfusion function (perfusion index,  $0.11 \pm 0.04$  vs.  $0.13 \pm 0.03$ ,  $p=0.010$ ), increased myocardial fibrosis (extracellular volume fraction,  $31.36 \pm 7.83$  vs.  $27.52 \pm 3.05$ ,  $p=0.000$ ), increased myocardial edema ( $41.88 \pm 5.12$  vs.  $40.34 \pm 2.67$ ,  $p=0.044$ ) and increased LV mass ( $59.46 \pm 17.49$  vs.  $42.57 \pm 10.38$ ,  $p=0.000$ ). With univariable and multivariable analysis, myocardial perfusion function is related to both systolic and diastolic motion, while LV remodeling, myocardial fibrosis and edema significantly affected diastolic motion.

#### CONCLUSION

The cardiac motion, perfusion, tissue characteristic and remodeling of T2DM patients are impaired. Both systolic and diastolic motion were related to myocardial perfusion function, while diastolic dysfunction is more susceptible to LV remodeling and myocardial fibrosis and edema.

#### CLINICAL RELEVANCE/APPLICATION

Cardiac motional disorder is the final path of all cardiac pathophysiological changes and is the driving factor of heart failure. Diabetes mellitus and its associated risk factors contribute to cardiac motional disorder by causing damage to different pathophysiological processes in the heart. However, the relationship between cardiac pathophysiological changes and cardiac motion has rarely been studied.

### **SSC02-08 Relation of Regional Myocardial Perfusion and Systolic Strain in Hypertrophic Cardiomyopathy and Cardiac Amyloidosis: A Cardiovascular Magnetic Resonance Analysis**

Monday, Dec. 2 11:40AM - 11:50AM Room: S401CD

#### Participants

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#### PURPOSE

To investigate the microvascular dysfunction and its relation with myocardial strains in cardiac amyloidosis (CA) and hypertrophic cardiomyopathy (HCM) with increased wall thickness.

#### METHOD AND MATERIALS

We included 25 biopsy-proven CA ( $65.4 \pm 10.7$  years, 54% female) and 35 patients with HCM ( $65.4 \pm 10.7$  years, 59% female). Segments with a wall thickness (WT)  $>12$ mm were considered thickened. Perfusion parameters including slope, time to maximum signal intensity (TTM) and time to 50% maximum signal intensity (50%TTM) were obtained from the myocardial signal intensity-time



curve. Myocardial strain indices including circumferential (CS) and longitudinal (LS) strain were derived from the tissue tracking model on cine images. The AHA 16-segment model was used for regional perfusion and strain analyses.

## RESULTS

In total, 169 thickened segments in CA and 228 in HCM with WT >12mm (WT  $14.7 \pm 2.2$  mm in CA vs.  $16.4 \pm 3.9$  mm in HCM,  $p < 0.05$ ) were evaluated. Thickened CA segments demonstrated more impaired myocardial strain and microvascular function compared with HCM segments. Multivariable linear regression analysis showed that CS had association with slope [beta 0.8, 95% confidence interval (CI) 0.3-1.3;  $P < 0.001$ ], wall thickness and hypertrophic phenotype (HCM or CA) ( $P < 0.001$  for both). The ROC analyses demonstrated that 50%TTM performed best in differentiating CA from HCM (AUC 0.92, sensitivity 81.7%, and specificity 91.7%, cut-off value 22.3).

## CONCLUSION

Our results demonstrated that amyloid infiltration impairs the regional microvascular system and systolic function more seriously than HCM characterized with cellular hypertrophy. Regional myocardial mechanics are significantly influenced by microvascular function.

## CLINICAL RELEVANCE/APPLICATION

Amyloid infiltration causes more severe myocardial perfusion disorder and systolic dysfunction. Myocardial perfusion parameters have great performance in differentiating cardiac amyloidosis from hypertrophic cardiomyopathy.

## SSC02-09 Diagnostic Value of Quantitative Tissue-Tracking Cardiac Magnetic Resonance of Myocardium Deformation in Hypertrophic Cardiomyopathy

Monday, Dec. 2 11:50AM - 12:00PM Room: S401CD

### Participants

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## PURPOSE

To explore the diagnostic value of quantitative tissue-tracking cardiac magnetic resonance (CMR) of left ventricular global myocardium deformation in hypertrophic cardiomyopathy (HCM).

## METHOD AND MATERIALS

18 cases of essential HCM (HCM group, 13 males, 5 females, aged 25~72 years with a mean of  $40.89 \pm 15.13$ ) and 19 cases of normal subjects (control group, 16 males, 3 females, aged 21~71 years with a mean of  $39.58 \pm 13.57$ ) were enrolled. All patients were subjected to CMR. The CMR bright blood cine sequences were including short-axis, long-axis and four-chamber of left ventricle (Balance turbo field echo, B-TFE). All DICOM images were performed with the Circle Cardiovascular software (cvi42 version 5.10.1, Calgary, Alberta, Canada) to get left ventricular muscle mass (LVMM), left ventricular end-diastolic volume (LVEDV), left ventricular end-systolic volume (LVESV), stroke volume (SV), cardiac output (CO) and left ventricular ejection fractions (LVEF) in the Short 3D modular, get left atrial minimal volume (LAVmin) and left atrial maximal volume (LAVmax) in the Biplanar LAX modular, and get global peak radial strain (GPSR), global peak circumferential strain (GPSC) and global peak long strain (GPSL) of left ventricle in the Tissue Tracking modular.

## RESULTS

1. There were no significant differences in the clinical profiles (gender, age) between the HCM group and control group ( $P > 0.05$ ). 2. LVMM in the HCM group were significantly greater than in the control group [ $(193.74 \pm 44.68)$ g,  $(125.18 \pm 29.34)$ g,  $P = 0.00$ ]. LAVmin and LAVmax in the HCM group were significantly greater than in the control group. [ $(40.25 \pm 20.64)$ ml,  $(18.63 \pm 8.65)$ ml,  $P = 0.00$  and  $(71.66 \pm 27.98)$ ml,  $(47.69 \pm 12.53)$ ml,  $P = 0.05$ ]. 3. In correlation analysis in HCM group, LVMM did not correlate significantly with GPSR, GPSC and GPSL. 4. The area under ROC curve of GPSR, GPSC and GPSL in diagnosis of HCM were 0.199, 0.807 and 0.857, and the area under ROC curve of GPSL was the largest.

## CONCLUSION

CMR feature tracking technology can quantitatively evaluate cardiomyopathy deformation of HCM. The ventricular diastolic dysfunction of HCM is earlier than that of systolic dysfunction. Left ventricular myocardial mass is not significantly correlated with myocardial deformation. GPSC and GPSL have favorable effective functions for the diagnosis in HCM.

## CLINICAL RELEVANCE/APPLICATION

CMR feature tracking technology can quantitatively evaluate cardiomyopathy deformation of HCM.

Printed on: 10/29/20



SSC03

## Chest (Radiomics - Malignancy)

Monday, Dec. 2 10:30AM - 12:00PM Room: E451A

AI CH CT OI

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

FDA Discussions may include off-label uses.

### Participants

Mark L. Schiebler, MD, Madison, WI (*Moderator*) Stockholder, Stemina Biomarker Discovery, Inc; Stockholder, HealthMyne, Inc;  
John P. Lichtenberger III, MD, Bethesda, MD (*Moderator*) Author, Reed Elsevier

### Sub-Events

#### SSC03-01 Impact of Interobserver Variability in Manual Segmentation of Non-Small Cell Lung Cancer (NSCLC) on Computed Tomography

Monday, Dec. 2 10:30AM - 10:40AM Room: E451A

### Participants

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### PURPOSE

Discovery of predictive and prognostic radiomic features in cancer is currently of great interest to the radiologic community. Since there is no reliable automated means of segmenting lung cancer, tumor labeling is typically performed by imaging analysts, physician trainees and attending physicians. Here we examine the impact of level of specialty training on interobserver variability in manual segmentation of non-small cell lung cancer (NSCLC).

### METHOD AND MATERIALS

A public dataset of computed tomography (CT) imaging (NSCLC-Radiomics-Genomics- LUNG3) which contains 88 patients (61 males and 28 females) with NSCLC (adenocarcinoma (n=42), squamous cell carcinoma (n=32), and other NSCLC (n=12)). For each CT, tumors were labeled in 3D using ITkSnap (ver 3.6.0). Segmentation was performed by three raters with differing levels of radiologic experience: an imaging analyst (BY; no formal experience), a radiology trainee (MH; 5 yrs.) and a specialty-trained thoracic radiologist (SK; 18 yrs.). For each tumor segmentation, 429 radiomic features (including grey-level intensity, co-occurrence, run-length, binary patterns, and wavelet features) were extracted. Principal component analysis was further performed on the extracted features. Interobserver variability in radiologic features between the 3 raters was then examined using the senior radiologist as the ground truth (GT). The Sørensen-Dice (SD) coefficient was used to evaluate spatial agreement of segmentations and the Pearson correlation was estimated between the first principal components of the extracted features from each rater's segmentations.

### RESULTS

The SD coefficient between the BY-SK(GT) and MH-SK(GT) segmentations was indicated 0.894 (STD: ±0.25) and 0.839 (STD: ±0.20), respectively, showing high agreement. The corresponding PCs were also highly correlated with Pearson's correlations of 0.88 and 0.92, respectively.

### CONCLUSION

Routine interobserver variability in tumor segmentation may not result in substantial spatial disagreement of 3D tumor delineation, while subsequently extracted radiomic features are also highly correlated.

### CLINICAL RELEVANCE/APPLICATION

Radiomic feature extraction may be robust to interobserver variability in tumor segmentation from lung CT data, resulting in robust prognostic and predictive biomarkers of NSCLC.

#### SSC03-02 Deep Learning Algorithm for Reducing CT Slice Thickness: Effect on Reproducibility of Radiomics in Lung Cancer

Monday, Dec. 2 10:40AM - 10:50AM Room: E451A

#### Participants

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#### PURPOSE

To retrospectively assess the effect of CT slice thickness on the reproducibility of radiomic features (RFs) of lung cancer, and to investigate if convolutional neural network (CNN)-based super-resolution (SR) algorithms can improve the reproducibility of RFs obtained from different slice thicknesses.

#### METHOD AND MATERIALS

CT images from 100 pathologically proven lung cancers acquired between July 2017 and December 2017 were evaluated, including 1, 3, and 5 mm slice thicknesses. CNN-based SR algorithms using residual learning were developed to convert thick-slice images into 1 mm slices. Lung cancers were semi-automatically segmented and a total of 702 RFs (tumor intensity, texture, and wavelet features) were extracted from 1, 3, and 5 mm slices, as well as the 1 mm slices generated from the 3 and 5 mm images. The stabilities of the RFs were evaluated using concordance correlation coefficients (CCCs).

#### RESULTS

All CT scans were successfully converted to 1 mm slice images at a rate of 2.5 s/slice. The mean CCCs for the comparisons of original 1 vs 3 mm, 1 vs 5 mm, and 3 vs 5 mm images were 0.41, 0.27, and 0.65, respectively (all,  $P < 0.001$ ). Tumor intensity features showed the best reproducibility and wavelets the lowest. The majority of RFs failed to reach reproducibility ( $CCC \geq 0.85$ ; 3.6%, 1.0%, and 21.5%, respectively). In terms of nodule type, GGNs had better reproducibility than solid nodules in all RF classes and in all slice-thickness pairings ( $P < 0.001$  for 1 vs 3 mm and 1 vs 5 mm, and  $P = 0.002$  for 3 vs 5 mm). After applying CNN-based SR algorithms, the reproducibility significantly improved in all three pairings (mean CCCs: 0.58, 0.45, and 0.72; all,  $P < 0.001$ ). This improvement was also observed in the subgroupings based on the classes of RFs and nodule types. The reproducible RFs also increased (36.3%, 17.4%, and 36.9%, respectively).

#### CONCLUSION

The reproducibility of RFs in lung cancer is significantly influenced by CT slice thickness, which can be improved by the CNN-based SR algorithms.

#### CLINICAL RELEVANCE/APPLICATION

On the basis of the findings of our study, the comparisons of radiomics results derived from CT images with different slice thicknesses may be unreliable. As our convolutional neural network-based image conversion algorithm is easily applicable and reliable, this algorithm may be used for enhancing reproducibility of radiomic features when the CT slice-thicknesses are different.

#### SSC03-03 Correlation-Incorporated Hierarchical Clustering of High-Dimensional Radiomic Features for Prognostic Phenotype Identification of EGFR-Mutated Non-Small Cell Lung Cancer

Monday, Dec. 2 10:50AM - 11:00AM Room: E451A

#### Participants

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#### PURPOSE

We propose a correlation-incorporated unsupervised hierarchical clustering algorithm and evaluate it in identifying computed tomography (CT) radiomic phenotypes of EGFR-mutated non-small cell lung cancer (NSCLC) in association with patient overall survival.

#### METHOD AND MATERIALS

The NSCLC-*radiogenomic* dataset publicly available from the National Cancer Institute's Cancer Imaging Archive (TCIA) was analyzed, including 204 patients (age range: 69 [ $\pm 11$ ], male/female: 132/72, event: death [41], adenocarcinoma/squamous cell carcinoma/unspecified: 166/34/4, EGFR mutation status: wild-type/mutant/unknown: 125/42/37). Tumor regions were verified by an experienced radiologist and segmented in 3D using the *ITKSnap* semi-automated toolkit. A total of 429 radiomic features were extracted (grey-level intensity, co-occurrence, run-length, binary patterns, and wavelets) using the *pyRadiomics* toolkit. An unsupervised method was applied based on a correlation-incorporated hierarchical clustering algorithm (CHCA) to determine the truncation distance in the resulting dendrogram and assign features to robust cluster groups. Low-rank dimensionality reduction

was further performed by principal component analysis (PCA) to estimate the first principal component (PC) of each feature cluster and create a radiomic signature for each tumor. Differences between radiomic signature scores and EGFR mutation status was evaluated using Student's t-test. Survival probabilities across the extracted PCs were evaluated using Kaplan-Meier curves, and a Cox proportional hazards (CPH) model was fitted based on the estimated PCs.

## RESULTS

Using CHCA, dimensionality was reduced from 429 to 67 PCs for a dendrogram truncation distance of 0.1. Three significant radiomic phenotypes were identified, which were associated with EGFR mutation status (p-value < 0.05). The best multivariable CPH model had a C-statistic of 0.71 based on the 67 PCs. Combining radiomic signatures with all available clinical covariates (age, sex, histology, EGFR mutation) yielded a C-statistic of 0.78.

## CONCLUSION

CHCA effectively reduces the high dimensionality of radiomic features while allowing for robust identification of CT-based phenotypes of EGFR-mutated NSCLC that are associated with patient survival.

## CLINICAL RELEVANCE/APPLICATION

Radiomic phenotypes of EGFR-mutated NSCLC, efficiently extracted by CHCA, could aid in identifying NSCLC patients likely to benefit from targeted EGFR inhibitor therapy.

### SSC03-04 Radiomics-Based Prognostic Nomogram for the Prediction of Progression-Free Survival in Stage IV Non-Small Cell Lung Cancer Treated with Platinum-Based Chemotherapy

Monday, Dec. 2 11:00AM - 11:10AM Room: E451A

#### Participants

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Zaiyi Liu, MD, Guangzhou, China (*Abstract Co-Author*) Nothing to Disclose

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## PURPOSE

We aimed to establish an effective radiomics-based prognostic nomogram for the prediction of progression-free survival (PFS) in stage IV non-small cell lung cancer (NSCLC) treated with platinum-based chemotherapy.

## METHOD AND MATERIALS

A total of 308 stage IV NSCLC patients without an EGFR-sensitizing mutation or ALK gene rearrangement were enrolled and divided into a discovery cohort (n=159) and a validation cohort (n=149). All patients had received at least 2 cycles of platinum-based chemotherapy as first-line treatment. 1182 radiomics features were extracted from pre-treatment CT images of each patient. Then, radiomics signature was constructed using LASSO Cox regression analysis based on discovery cohort, and was validated in validation cohort. Furthermore, an individualized prognostic nomogram incorporating the radiomics signature and clinicopathologic risk factors was proposed.

## RESULTS

The established signature consisted of 14 features showed good discrimination for classify patients with high-risk and low-risk progression treated by platinum-based chemotherapy. On the multivariable Cox regression, independent factors for PFS were radiomics signature, PS, and N stage, which were all selected into the nomogram. The calibration curve for probability of PFS showed good satisfactory. The C-index of the nomogram for predicting PFS was 0.721(95%CI:0.713-0.729), which was statistically higher than clinicopathologic-based model (C-index: 0.641, 95%CI:0.631-0.651). Decision curve analysis revealed that the nomogram significantly outperformed the clinicopathologic-based model in terms of clinical usefulness.

## CONCLUSION

This study establishes a radiomics-based prognostic nomogram that can be conveniently used to achieve individualized prediction of PFS probability for stage IV NSCLC patients treated with platinum-based chemotherapy, which holds promise of guiding the personalized pre-therapy of stage IV NSCLC.

## CLINICAL RELEVANCE/APPLICATION

The developed radiomics-based prognostic nomogram could be conveniently used to achieve individualized prediction of PFS probability for stage IV NSCLC patients treated with platinum-based chemotherapy.

### SSC03-05 A Primary Study of Predicting Spread through Air Space in Lung Adenocarcinoma Using a CT-Base Radiomics Model

Monday, Dec. 2 11:10AM - 11:20AM Room: E451A

#### Participants

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## PURPOSE

Spread through air space (STAS), a novel invasive pattern of lung adenocarcinoma, is a risk factor for recurrence and worse prognosis of patients with early stage adenocarcinoma who underwent limited resection. Therefore, preoperative prediction of STAS in lung adenocarcinoma can facilitate surgeons' treatment decision making. The aim of this study is to develop and validate a CT-based radiomics model for preoperative prediction of STAS in lung adenocarcinoma.

## METHOD AND MATERIALS

This retrospective study was approved by institutional review board and included 437 patients with pathological confirmed lung adenocarcinoma, which consisted of 186 males and 251 females with a mean age of 58.2 years. Two experienced radiologists retrospectively reviewed the tissue sample slices in consensus to determine whether there was STAS in lung adenocarcinomas. Two experienced radiologists segmented and extracted radiomics features on preoperative thin-slice CT images using the 3D Slicer with Pyradiomics extension ([www.slicer.org](http://www.slicer.org)) independently. Intra-class correlation coefficients (ICC) and Pearson's correlation were used to roll out those low reliability (ICC<0.76) and redundant ( $r>0.9$ ) features. Univariate logistic regression was used to select radiomics features and clinical metrics which were associated with STAS. Multivariate logistic regression analysis was used to develop a predictive model. The diagnostic performance of the model was measured by area under curve (AUC) of receiver operating characteristic (ROC) and calibrated with five-fold cross-validation.

## RESULTS

STAS was identified by the pathologists in 85 patients (19.5%). At univariate analysis, 26 radiomics features and age were found to be associated with STAS. Multivariate logistic regression showed that age and one radiomics feature (Skewness) were independent predictors for STAS. The CT-base radiomics model achieved a AUC of 0.81 with a sensitivity of 0.737 and a specificity of 0.838 for predicting STAS (Figure. 1).

## CONCLUSION

CT-base radiomics model can preoperatively predict STAS in lung adenocarcinoma with high diagnosis performance, which provide guides for patients therapeutic decision making.

## CLINICAL RELEVANCE/APPLICATION

The result of present study showed CT-based radiomics model could preoperatively predict STAS in lung adenocarcinomas with high diagnosis performance which could facilitate surgeons' operation decision making.

## SSC03-06 Can DECT Quantitative and Radiomics Features Differentiate Benign and Malignant Lymphadenopathy?

Monday, Dec. 2 11:20AM - 11:30AM Room: E451A

### Participants

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## PURPOSE

Dual Energy CT tumor analysis prototype (DE-TA, eXamine, Siemens) was developed to evaluate DECT quantitative and DECT radiomics features. We assessed the accuracy of these features for differentiating benign and malignant lymph nodes on DECT of the chest and abdomen using histology as reference.

## METHOD AND MATERIALS

With IRB approval, we identified 80 adult patients (mean age  $62 \pm 15$  years; 42 men, 38 women) from our Radiology Information System who had lymph nodes  $> 1$  cm in short axis and had a tissue biopsy of the lymph nodes. All patients had contrast enhanced, dual-source DECT (SOMATOM Flash or Force, Siemens) of the chest ( $n = 70$ ) and abdomen ( $n = 10$ ). DECT images were de-identified and exported to the DE-TA. Lymph nodes were identified and delineated and segmented into 4 inner peels and 4 outer rims. For each segment, DECT quantitative metrics and 585 radiomics features (including first and higher order statistics) were derived. Logistic regression, receiver operating characteristics and random forest classification were performed.

## RESULTS

We observed a significantly higher volume, RECIST diameter and WHO area for the malignant nodes ( $13.9 \pm 12.5$  ml,  $25.3 \pm 9.4$  mm,  $500.9 \pm 469.0$  mm<sup>2</sup>) as compared to the benign nodes (mean values- $2.3 \pm 3.0$ ,  $18.8 \pm 6.3$  mm,  $271.7 \pm 177.0$  mm<sup>2</sup>) ( $p < 0.02$ ). Malignant nodes had a greater iodine uptake and concentration as compared to the benign nodes (AUC 0.83 ;  $p = 0.001$ ). A total of 1643 radiomics parameters were significantly different between benign and malignant nodes (AUC=0.87 ;  $p = 0.00008-0.04$ ). Rim 3 (the peel before the outermost segment) showed the largest number of statistically significant radiomics parameters for differentiating benign and malignant lesions ( $p < 0.02$ ). Random forest classification revealed an AUC of 0.85 ( $p = 0.002$ ) for differentiating benign and malignant lymph nodes.

## CONCLUSION

Dual-energy quantitative and radiomics features enable accurate differentiation of benign and malignant lymph nodes on contrast-enhanced chest and abdomen CT.

#### CLINICAL RELEVANCE/APPLICATION

DECT quantitative and radiomics features can help in accurate lymph nodal staging for neoplastic diseases of chest and abdomen.

#### SSC03-07 Development of Predictive Models for Lymph Node Metastasis in Pre-Surgical Stage IA Patients with Non-Small Cell Lung Cancer

Monday, Dec. 2 11:30AM - 11:40AM Room: E451A

##### Participants

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Haoyue Yao, Shijiazhuang, China (*Abstract Co-Author*) Nothing to Disclose

##### PURPOSE

To develop and validate predictive models by use of clinical/CT findings, radiomics features and combination of the both for lymph node metastasis (LNM) in pre-surgical stage IA patients with a non-small cell lung cancer (NSCLC).

##### METHOD AND MATERIALS

This retrospective study included 649 pre-surgical stage IA patients with NSCLC from September 2017 to January 2019 in our hospital. All patients had a thin-section venous CT scan before surgery. There were 138 (21%) of the 649 patients who had LNM after surgery. A training group included 455 patients (97 with and 358 without LNM) and a test group included 194 patients (41 and 153, respectively). Clinical/CT features (such as age, gender, smoking status, size, vacuole sign, marginal spiculation, marginal lobulation, and pleural indentation) were identified by a study radiologist, selected by Mann-Whitney U test and  $\chi^2$  test, and used to develop a clinical model. A total of 396 radiomics features were extracted from venous CT scans. Mann-Whitney U test and univariate analysis of variance were used for radiomics feature dimension reduction. The least absolute shrinkage and selection operator (LASSO) algorithm was used for radiomics feature selection. Three models (a clinical model, a radiomics model, and a combined model) were developed to predict LNM in the early-stage NSCLC. The receiver operating characteristic (ROC) curve was used to evaluate the performance in LNM classification by use of the three models.

##### RESULTS

The area under the curve (AUC) value of radiomics model based on seven best features in predicting LNM was 0.898 (95% CI, 0.890-0.906) in the training group, compared with 0.851 in the test group. The AUC values of the clinical model (main based on size and spiculation) were 0.739 (95% CI, 0.725-0.753) and 0.614, respectively, in the training and test group. The AUC values of the radiomic-clinical model were 0.911 (95% CI, 0.904-0.918) and 0.860, respectively, in the two groups.

##### CONCLUSION

A radiomics-clinical model in venous CT was superior for predicting LNM in pre-surgical Stage IA patients with NSCLC than that models developed by radiomics and clinical features only.

#### CLINICAL RELEVANCE/APPLICATION

Approximately 20% of pre-surgical Stage IA patients with NSCLC may have LNM; a radiomics-clinical model has the potential to predict the LNM and may help to improve treatment plans.

#### SSC03-08 CT-Derived Prognostic Radiomics Phenotype of Tumor Habitat is Closely Associated with Interaction of Tumor Infiltrating Lymphocytes (TILs) and Cancer Nuclei on H&E Tissue as Well as PD-L1 Expression in NSCLC

Monday, Dec. 2 11:40AM - 11:50AM Room: E451A

##### Participants

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##### PURPOSE

While radiomic analysis of lung nodules to predict outcome has been increasingly prevalent, the underlying tumor morphology that these features highlight is often not understood or explored. In this multi-modality analysis, we discovered unique radiomic-histologic-molecular phenotypes for early-stage non-small cell lung cancer (ES-NSCLC) patients which could successfully stratify patients based on their disease-free survival (DFS).

##### METHOD AND MATERIALS

After retrospective chart review, we trained a radiomic model to predict recurrence for 316 ES-NSCLC pts. using 124 radiomic textural features from the Gabor, Laws, Laplace, Haralick, and Collage feature families extracted from a 0-3 mm annular ring immediately adjacent to the nodule-Peritumoral(PT) features. The radiomics model had an AUC=0.74( $p<0.01$ ) in predicting recurrence. Among 70 pts in this cohort, we had available tissue derived PD-L1 expression as well as H&E stained Whole slide images (WSIs). In order to build the radiomic-histologic-molecular phenotype of the tumor habitat, we also extracted 242 Quantitative Histomorphometric (QH) features related to the nuclear shape, texture, orientation, spatial architecture of TILs and features quantifying TI-cancer nuclei interaction. Unsupervised clustering of the top 20 most discriminative features from 0-3mm outside the tumor was done, and correlations of the clusters were calculated for QH and PDL-1 expression.

## RESULTS

We obtained two significant clusters corresponding to high-risk and low-risk patients based on their risk of recurrence. The two clusters had significant disease-free survival(DFS) differences based on Kaplan-Meier analysis( $p<0.05$ ). The two clusters were also correlated with nuclear morphology features( $p<0.05$ ) and spatial architecture of TIL patterns ( $p<0.05$ ) as well as PD-L1 expression( $p<0.001$ ). We found that the high-risk cluster had increased PD-L1 expression and increased intensity of the QH features

## CONCLUSION

We built a radio-histo-molecular phenotype of the tumor habitat stratified according to the risk of recurrence in ES-NSCLC. We found that radiomic tumor habitat features were strongly correlated with TIL-cancer nuclei interaction and PD-L1 expression.

## CLINICAL RELEVANCE/APPLICATION

The prognostic usefulness of radiomics of the tumor habitat can be complemented by understanding the underlying morphology in the tissue patterns which lead to the expression of these features, which we have shown in this work.

## SSC03-09 CT-Based Analysis Using Radiomics for Predicting Pathological Response after Preoperative Chemotherapy in Patients with Locally Advanced Esophageal Cancer

Monday, Dec. 2 11:50AM - 12:00PM Room: E451A

### Participants

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## PURPOSE

To investigate the application of radiomics in a group of patients with locally advanced esophageal cancer (LAEC) and distinguish those who will respond to preoperative chemotherapy from those who will not, using histopathologic results as the reference standard.

## METHOD AND MATERIALS

For this retrospective study, a radiomics model was developed based on a primary cohort of 133 patients with LAEC, who underwent contrast-enhanced CT from October 2013 to November 2018, followed by preoperative chemotherapy. All patients underwent surgery after chemotherapy and were divided into two groups based on the pathological evaluation of surgically resected specimens; a poor response group (Grade 0/1) and a good response group (Grade 2/3). A total of 1409 quantitative imaging features were extracted from the CT images using Radcloud platform. We used variance threshold, SelectKBest and LASSO algorithm methods to gradually select the most optimal features and reduce their dimensionality. Six machine learning algorithms (KNN, SVM, XGBoost, RF, LR, DT) were adopted to establish a radiomics nomogram. The predictive performances of the radiomics signature were evaluated by ROC curve analysis in both cohorts: training ( $n=99$  VOIs) and validation ( $n=41$  VOIs).

## RESULTS

Out of 1409 features, 6 optimal ones were selected using the LASSO method. The area under the ROC curve (AUC) of the XGBoost model used for predicting the good response in a group was 0.893 (95% CI; 0.79 - 0.99) in the training cohort and 0.761 (95% CI; 0.65 - 0.87) in the validation cohort.

## CONCLUSION

A radiomics model derived from CT imaging could be potentially useful for predicting the effect of preoperative chemotherapy in patients with LAEC.

## CLINICAL RELEVANCE/APPLICATION

CT-based radiomics features could provide additional quantitative information on disease progression and may help to improve clinical decision making for the preoperative management of LAEC patients.

Printed on: 10/29/20



SSC04

## Science Session with Keynote: Emergency Radiology (Imaging Algorithms and Technique)

Monday, Dec. 2 10:30AM - 12:00PM Room: S102CD

AI CT ER

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

FDA Discussions may include off-label uses.

### Participants

Aaron D. Sodickson, MD, PhD, Boston, MA (*Moderator*) Institutional research agreement, Siemens AG; Speaker, Siemens AG; Speaker, General Electric Company  
Krystal Archer-Arroyo, MD, Decatur, GA (*Moderator*) Nothing to Disclose  
Savvas Nicolaou, MD, Vancouver, BC (*Moderator*) Institutional research agreement, Siemens AG; Stockholder, Canada Diagnostic Centres

### Sub-Events

#### SSC04-01 Emergency Radiology Keynote Speaker: Acute Care - Why Care for Algorithms and Technique?

Monday, Dec. 2 10:30AM - 10:50AM Room: S102CD

#### Participants

Krystal Archer-Arroyo, MD, Decatur, GA (*Presenter*) Nothing to Disclose

#### SSC04-03 Reducing the Incidence of Venous Air Embolism in Contrast-Enhanced CT Angiography Using Preflushing of the Power Injector

Monday, Dec. 2 10:50AM - 11:00AM Room: S102CD

#### Participants

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### PURPOSE

To evaluate the incidence of venous air embolism (VAE) incidence with or without implementation of preflushing before connecting a power injector to a patient's catheter, aiming to reducing the VAE in contrast-enhanced CT angiography (CTA)

### METHOD AND MATERIALS

The control group underwent the conventional injection procedure. In the preflushing group, the injector tubes were flushed at high speed (10 ml/s) with saline before being connected to the patients' indwelling catheters. The locations, number and sizes of VAE were analyzed. The difference in the incidence of VAE between the 2 groups was compared.

### RESULTS

A total of 4900 adults (control/preflushing, 2190/2710) were included. A total of 228 (4.65%) patients were found to have 318 VAEs (285 bubbles and 33 gas-liquid plane VAEs). The incidence of VAE in the preflushing group (3.21%) was lower than that in the control group (6.44%); a similar trend was observed for multiple VAEs ( $P < 0.05$ ). VAEs occurred in the following locations from high to low frequency: right atrium > pulmonary artery trunk > superior vena cava > right ventricle > left brachial vein > right brachial vein. There was no significant difference in the location, shape or diameters ( $P = 0.19$ ) of VAEs between the two groups.

### CONCLUSION

The proposed preflushing procedure is simple yet effective in reducing the incidence of VAE by 50.16% in patients with CTA thus improving safety during power injection.

### CLINICAL RELEVANCE/APPLICATION

The first reported effective measure of preflushing power injector tubing at a high flow rate with saline can significantly reduce the incidence of VAE.



## **SSC04-04 Combination of Rapid Scanning with Wide-Detector and Adaptive Statistical Iterative Reconstruction-V Algorithm in Low Dose Chest CT for Unconscious Patients**

Monday, Dec. 2 11:00AM - 11:10AM Room: S102CD

### **Participants**

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### **PURPOSE**

To explore the value of combining rapid scanning with wide-detector and new adaptive statistical iterative reconstruction (ASIR-V) in low dose chest CT for unconscious patients.

### **METHOD AND MATERIALS**

Prospectively randomized 46 unconscious patients for chest CT into 2 spiral-scan groups: Group A (n=23) with 80mm collimation and 0.28s gantry rotation speed; Group B (n=23) with 40mm collimation and 0.5s speed to simulate conventional scan protocol. Both groups used the 120kV and AutoMA technique (10-500mA) and 50% pre-ASIR-V to obtain a noise index of 14HU. The 0.625mm images were reconstructed with 50%ASIR-V and different kernels. Standard deviations of the antero-subcutaneous fat and back muscle of different scan modes and reconstructions were measured and compared with LSD-t test. The maximum diaphragmatic displacements were measured on sagittal images of the lung-kernel reconstruction and compared. Two radiologists performed 4-level subjective assessments of image quality and motion artifact. The Wilcoxon test and Kappa test was used for image goodness and score consistency, respectively.

### **RESULTS**

The mean scan time in Group A was 1.17s, 70% faster than the conventional protocol (3.91s) resulting in better overall image quality and no measurable diaphragmatic displacement in Group A, compared with the 4.70±5.29mm in Group B (p<0.05). There was no difference in radiation dose (1.33 vs. 1.48mSv) and image noise between the two scan groups.

### **CONCLUSION**

The combination of fast scanning with 80mm collimation, 0.28s rotation speed and ASIR-V significantly reduces motion artifacts and image noise in low-dose chest CT for unconscious or uncooperative patients.

### **CLINICAL RELEVANCE/APPLICATION**

The use of 80mm wide-detector and fast rotation speed combined with ASIR-V can significantly reduce motion artifacts and maintain image quality at low radiation dose, and is more suitable for the chest CT examination for unconscious or uncooperative patients.

## **SSC04-05 Comparison of Baseline, Bone-Subtracted, and Edge-Enhanced Chest Radiographs for Detection of Pneumothorax**

Monday, Dec. 2 11:10AM - 11:20AM Room: S102CD

### **Participants**

Fatemeh Homayounieh, MD, Boston, MA (*Presenter*) Nothing to Disclose  
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### **PURPOSE**

To assess detectability of pneumothorax on unprocessed baseline (Up), bone-subtracted (B-), and edge-enhanced (E+) frontal chest radiographs (CXR).

### **METHOD AND MATERIALS**

Our retrospective IRB approved study included 202 patients (mean age 53 ± 24 years; 132 men, 70 women) who underwent frontal CXR and had trace (<5mm), moderate (≥5mm, <3cm), large (≥3cm), or tension pneumothorax. All patients (except those with tension pneumothorax) had concurrent chest CT performed within 1-7 days of CXR for clinically indicated reasons. Two radiologists reviewed the CXR and chest CT for pneumothorax on Up CXR (ground truth). All Up CXR were processed to generate B- and E+ images (ClearRead X-ray, Riverain Inc). Two separate thoracic radiologists (R1, R2) sequentially assessed the Up, B- and E+ images and separately recorded the presence of pneumothorax (side, size and confidence for detection) for each image type. Area under the curve (AUC) was calculated with ROC analyses to determine the accuracy of pneumothorax detection.

### **RESULTS**

There were 120 right, 95 left, and 13 bilateral pneumothoraces with 53 trace, 87 moderate, 29 large, and 46 tension pneumothoraces. B- images had the lowest accuracy for detection of pneumothorax compared to Up and E+ images ( $p < 0.01$ ). With B-, the sensitivity dropped from 91% to 84% on the right side and 83% to 77% on the left for R1 but remained relatively unchanged for R2 (87% vs 86%). Highest detection rates, and confidence was noted for the E+ images (empiric AUC for R1 and R2 0.95-0.99). No false positive pneumothorax was noted on either B- or E+ images.

## CONCLUSION

Enhanced CXRs are superior to bone subtraction and unprocessed radiographs for detection of pneumothorax.

## CLINICAL RELEVANCE/APPLICATION

Enhanced CXRs improve detection of pneumothorax over unprocessed images; bone subtracted images must be cautiously reviewed to avoid false negatives.

## SSC04-06 FFR-CT in the Evaluation of Acute Chest Pain - Concepts and First Experiences

Monday, Dec. 2 11:20AM - 11:30AM Room: S102CD

### Participants

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## PURPOSE

Fractional flow reserve derived from coronary CTA (FFR-CT) is becoming rapidly established in the evaluation of patients with chronic stable angina in an elective setting. However, the utility of FFR-CT in the work-up of patients presenting to the Emergency Department (ED) with acute chest pain (ACP) is insufficiently studied. We evaluated the hospital course and treatment decisions along with the 30-day rate of major adverse cardiovascular events (MACE) in ACP patients undergoing cCTA and FFR-CT in the ED.

## METHOD AND MATERIALS

Patients between the ages of 18-95 years who presented to our ED with ACP and underwent clinically indicated cCTA and FFR-CT were included, if their cCTA interpretation showed coronary artery stenosis between 30-90% luminal narrowing. cCTA was acquired using 3rd generation dual-source CT and FFR-CT was performed using the commercially available computational fluid dynamics approach (HeartFlow®, Redwood City, CA). Subjects were evaluated for patient management decisions, 30 day MACE, repeat presentation to the ED, and 30 day additional testing for evaluation of chest pain. They were subsequently compared to a control group of patients who also presented to the ED with ACP, but underwent alternative evaluation strategies.

## RESULTS

The average turnaround time for completing FFR-CT analyses was 3h 22min. 16/31 patients (52%) with stenosis grade of 30-90% by cCTA had negative FFR-CT ( $> 0.80$ ), of whom 9 (56%) were discharged from the ED and 2 of whom underwent invasive coronary angiography (ICA) during the index ED visit, with 1 being revascularized. In comparison, 10/15 patients with FFR-CT  $< 0.80$  underwent ICA. Out of the 16 patients without functionally significant coronary artery disease (CAD) by FFR-CT, 15 (93%) did not undergo revascularization and did not experience MACE during the 30-day follow-up. One patient was referred for ICA in the setting of severe stenosis on cCTA, albeit with negative FFR-CT, where ICA showed severe multivessel disease prompting subsequent revascularization. Conversely, 3 patients with FFR-CT  $< 0.80$  experienced MACE during follow-up. Within 30-days 2 patients with FFR-CT  $< 0.80$  were readmitted, versus none in the FFR-CT  $> 0.80$  group. Overall, a negative FFR-CT analysis translates into a high negative predictive value to exclude 30-day MACE occurrence of 94% in this preliminary cohort.

## CONCLUSION

These preliminary data suggest that FFR-CT could be utilized for a more rational risk stratification and disposition of patients who present to the ED with ACP than with cCTA alone, helping to differentiate those who would benefit from admission and further invasive management versus those who could be safely discharged. While prior studies have demonstrated utility in the stable chest pain population, to our knowledge this represents the first reported experience in the ACP, ED setting.

## CLINICAL RELEVANCE/APPLICATION

cCTA with subsequent FFR-CT demonstrate potential for accurate and safe evaluation of CAD in patients presenting to the ED with ACP.

## SSC04-07 Comparison of ASPECTS by Human Observers and Automated ASPECTS in Prediction of Final Infarct Volume in Anterior Circulation Emergent Large Vessel Occlusion

Monday, Dec. 2 11:30AM - 11:40AM Room: S102CD

### Participants

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#### **PURPOSE**

To compare human non-contrast CT ASPECTS, human CT angiography ASPECTS and automated ASPECTS as predictors of final infarct volume in emergent large vessel occlusion in anterior circulation

#### **METHOD AND MATERIALS**

CT studies at presentation of consecutive patients (n=98) presenting with emergent large vessel occlusion in the anterior circulation (terminal ICA, M1, proximal M2) were reviewed. ASPECTS readings were made by two radiologists on non-contrast CT and CT angiography studies independently in a blinded fashion. The observers were blinded from each other, other imaging studies and clinical and patient data. Automated ASPECTS readings were recorded from a research based software package. The observers later made consensus ASPECTS readings on follow-up CT or MRI performed within 7 days of presentation. Spearman's rank correlation was performed. Kappa statistic was calculated to test inter-observer agreement among the human readers.

#### **RESULTS**

Substantial correlation with final ASPECTS was found for human NCCT ASPECTS ( $r=0.713$ ,  $p<0.001$ ) and human CTA ASPECTS ( $r=0.718$ ,  $p<0.001$ ) readings. The correlation was good for automated ASPECTS ( $r=0.543$ ,  $p<0.001$ ). Good interobserver agreement was seen for NCCT ASPECTS ( $\kappa = 0.628$ ) and CTA ASPECTS ( $\kappa = 0.611$ ).

#### **CONCLUSION**

Compared to automated ASPECTS, the ASPECTS by human observers correlates better with final infarct volume in anterior circulation emergent large vessel occlusion. NCCT ASPECTS and CTA ASPECTS show good agreement among the human observers.

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

ASPECTS is a valuable prognostic marker and important tool to make clinical decisions in acute ischemic stroke. Ongoing validation of machine learning based research applications is important.

#### **SSC04-08 Unsupervised Detection of Various Intracranial Diseases on Brain CT Using Generative Adversarial Networks (GANs)**

Monday, Dec. 2 11:40AM - 11:50AM Room: S102CD

#### **Participants**

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#### **PURPOSE**

The main obstacles in applying supervised learning to imaging diagnosis are limited number of abnormal images and effort to annotate training set. In this study, we aim to assess value of simplified AnoGAN (anomaly detection with generative adversarial networks) model in detecting various intracranial disease on brain CT in an unsupervised manner.

#### **METHOD AND MATERIALS**

We trained a Progressive Growing of GAN (PGGAN) to generate realistic artificial CT images, using the training set of 1,159 normal brain CT scans (37,324 slices). Test set consisted of total 200 axial slices of brain CT images (100 abnormal images and 100 normal images). Using our simplified AnoGAN model, PGGAN-trained generator yields a corresponding realistic fake image to a given test image by minimizing mean square error between the fake and the test images. The differences between the fake and the test image on attention maps can detect and localize abnormal findings. For evaluation of the detection performance, we classified various intracranial diseases into 4 groups: intracranial hemorrhage, acute infarction including hypoxic brain injury, tumor including primary brain tumor and metastasis, and other diseases. If the attention map partially included the abnormal lesions, it was considered a positive detection.

#### **RESULTS**

Total per-slice sensitivity was 89.0% (89/100) and total per-lesional sensitivity was 87.2% (102/117). For each disease group, sensitivity was 91.3% (21/23) for hemorrhage, 85.2% (23/27) for acute infarction, 96.8% (30/31) for tumor and 78.9% (15/19) for other diseases. Evaluation for other performance characteristics was limited due to difficult quantification and calculation of non-pathologic false positive detections.

#### **CONCLUSION**

We suggest that unsupervised learning of GANs using healthy dataset can be used to detect various intracranial diseases on unseen data and has high sensitivity to detect anomalies.

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

We propose that this model can be useful for screening and triaging emergency patients with various intracranial diseases by detecting anomalies on CT.

#### **SSC04-09 Color-Coded Virtual Non-Calcium Dual-Energy CT for the Depiction of Bone Marrow Edema of the Calcaneus in Patients with Acute Tarsal Trauma: A Multireader Diagnostic Accuracy Study**

Monday, Dec. 2 11:50AM - 12:00PM Room: S102CD

## Participants

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## PURPOSE

To evaluate the diagnostic accuracy of a dual-energy computed tomography (CT) virtual non-calcium (VNCa) technique for the depiction of traumatic bone marrow edema of the calcaneus.

## METHOD AND MATERIALS

Data from 62 patients with acute tarsal trauma who had undergone third-generation dual-source dual-energy CT and 3-T magnetic resonance imaging (MRI) within seven days between January 2017 and July 2018 were retrospectively analyzed. Five radiologists, blinded to clinical and MRI information, independently assessed conventional grayscale dual-energy CT series for the presence of fractures; after at least eight weeks, readers re-evaluated all cases using color-coded VNCa reconstructions for the presence of bone marrow edema for four calcaneal regions. Quantitative analysis of CT numbers on VNCa reconstructions was performed by a sixth radiologist. Two additional experienced radiologists (32 and 20 years of experience in musculoskeletal imaging), blinded to clinical and CT information, assessed MRI series in consensus to define the reference standard. Sensitivity, specificity and the area under the curve (AUC) were the primary indices for diagnostic accuracy.

## RESULTS

MRI revealed a total of 62 areas with focal posttraumatic bone marrow edema in 39 patients. Fractures were present in 11 patients. In the qualitative analysis, VNCa showed high overall sensitivity (286/310 [92%]), specificity (899/930 [97%]), positive predictive value (286/317 [90%]), negative predictive value (899/923 [97%]) and accuracy (1185/1240 [96%]) for the depiction of bone marrow edema. Inter-reader agreement was excellent ( $\kappa=0.84$ ). CT numbers obtained from VNCa were significantly different in areas with or without edema ( $p<.001$ ). The overall AUC was 0.98. A cut-off value of -53 Hounsfield units (HU) provided a sensitivity of 82 % (51/62) and specificity of 95% (176/186) for differentiating bone marrow edema.

## CONCLUSION

In both quantitative and qualitative analyses, dual-energy CT VNCa reconstructions show excellent diagnostic accuracy for the depiction of traumatic calcaneal bone marrow edema compared to MRI by enabling direct color-coded visualization.

## CLINICAL RELEVANCE/APPLICATION

Bone marrow edema may be visualized using color-coded VNCa reconstructions during dual-energy CT performed for detection of fracture in patients with acute tarsal trauma, potentially replacing MRI in patients with contraindications.

Printed on: 10/29/20



SSC05

## Gastrointestinal (Hepatocellular Carcinoma)

Monday, Dec. 2 10:30AM - 12:00PM Room: N228



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

### Participants

Mustafa R. Bashir, MD, Cary, NC (*Moderator*) Research Grant, Siemens AG; Research Grant, NGM Biopharmaceuticals, Inc; Research Grant, Madrigal Pharmaceuticals, Inc; Research Grant, Metacrine, Inc; Research Grant, Pinnacle Clinical Research; Research Grant, ProSciento Inc; Research Grant, Carmot Therapeutics; Research Grant, 1Globe Health Institute; Research Consultant, ICON plc; Kristin K. Porter, MD, PhD, Baltimore, MD (*Moderator*) Stockholder, Pfizer Inc; Advisory Board, Bracco Group  
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### Sub-Events

#### SSC05-01 How Frequently Does HCC Develop in At-Risk Patients with a Negative Liver MRI Examination?

Monday, Dec. 2 10:30AM - 10:40AM Room: N228

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### PURPOSE

Guidelines for hepatocellular carcinoma (HCC) screening typically recommend imaging surveillance at 6 month intervals. For patients who undergo US screening and have a liver MRI for other reasons, or are screened with MRI due to poor quality US (obesity or hepatic steatosis), a longer interval after may be appropriate. The purpose of this study was to determine the rate of development of significant liver lesions after a negative MRI in a screening population.

### METHOD AND MATERIALS

This retrospective study included patients from 2013 at risk of developing HCC, who underwent MRI surveillance, with follow up CTs or MRIs for at least 12 months read using the Liver Imaging and Reporting Data System (LI-RADS)[3]. Patients with baseline focal liver lesions categorized not LR-1, history of primary liver cancer, prior treatment of a liver lesion, or liver transplant were excluded. All available CTs and MRIs that were compliant with the LI-RADS technical guidelines were included in the follow-up assessment. Follow-up examinations were classified as negative (no lesions or only LR-1 lesions) or positive (at least one observation of any category other than LR-1). Time to first positive examination and observation types were recorded.

### RESULTS

204 patients (mean age 58 ± 11 years, 128 women, 168 patients with cirrhosis, most with non-alcoholic steatohepatitis (n=117), were included. Median follow up duration was 28 (range 12-60) months. 5.9% (12/204) of patients developed a lesion at follow-up ("became positive"). At 6-9 months, one patient (0.5%, 1/204) became positive, with new LR-3 nodules measuring up to 11 mm. At 12±3 months, three additional patients (cumulative 2%, 4/204) became positive: a 12 mm LR-3 nodule, a 10 mm LR-4 nodule, and a 29 mm LR-M nodule. By two years, two additional patients became positive with LR-3 nodules.

### CONCLUSION

Clinically significant (LR-4, LR-5, LR-M) liver nodules develop in a minority (1%) of patients in the first year following negative MRI. While ongoing surveillance is necessary, after a negative MRI it may be reasonable to perform the screening imaging at 1 year.

### CLINICAL RELEVANCE/APPLICATION

In patients at risk for HCC with a negative MRI, the next imaging surveillance for HCC could be delayed until one year after the MRI

#### SSC05-02 Hepatobiliary Phase Hypointense Nodule without Arterial Phase Hyperenhancement on Gadoteric Acid-Enhanced MRI: Risk of HCC Intrahepatic Distant Recurrence after Radiofrequency Ablation or

## Hepatectomy: A Systematic Review and Meta-Analysis

Monday, Dec. 2 10:40AM - 10:50AM Room: N228

### Participants

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### PURPOSE

To perform a systematic review and meta-analysis to determine intrahepatic distant recurrence (IDR) risk of hepatobiliary phase (HBP) hypointense nodules without arterial phase hyperenhancement (APHE) on pretreatment gadoxetic-acid enhanced MRI in patients with hepatocellular carcinoma (HCC) treated with either hepatectomy or radiofrequency ablation (RFA).

### METHOD AND MATERIALS

Pubmed and EMBASE databases were searched up to April 6th 2019. We included studies that evaluated HBP hypointense nodules without APHE as risk factors for IDR in HCC patients treated with either hepatectomy or RFA. Hazard ratios (HR) were meta-analytically pooled using random-effects model. Subgroup analyses stratified to clinicopathologic variables were performed to explore heterogeneity. Methodological quality of included studies was assessed using Quality in Prognostic Studies (QUIPS) tool.

### RESULTS

Eight studies with 842 patients were analyzed. The overall pooled HR for IDR was 2.44 (95% CI, 1.99-2.98) and were (2.14 (95% CI, 1.66-2.76) and 3.07 (95% CI, 2.19-4.31) for patients that underwent hepatectomy and RFA, respectively. No significant heterogeneity was present ( $I^2 = 0\%$ ). The presence of these nodules was consistently shown to be significant factors for IDR in other subgroups (HR = 1.74-3.07). Study quality was generally moderate.

### CONCLUSION

HBP hypointense nodules without APHE are risk factors for IDR in HCC patients treated with either RFA or hepatectomy. Stratification of patient management with regard to performing additional tests or treatment for these nodules and modification of proper follow-up strategies may be required in patients with HCC who have these nodules on pretreatment gadoxetic acid-enhanced MRI.

### CLINICAL RELEVANCE/APPLICATION

HBP nodules without APHE in pretreatment gadoxetic acid-MR should be recognized as a significant risk factor for increased IDR after curative treatment for HCCs and therefore, it may require stratification of patient management with regard to deciding whether to perform additional pathologic test or treatment to these nodules and modification of proper follow-up strategies after curative treatment for HCCs in patients who harbor these nodules.

## SSC05-03 Prospective Intraindividual Comparison of CT, MRI with Extracellular Contrast and Gadoxetic Acid for Diagnosis of HCC

Monday, Dec. 2 10:50AM - 11:00AM Room: N228

### Participants

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### PURPOSE

We prospectively evaluated the diagnostic performance of computed tomography (CT), magnetic resonance imaging (MRI) with extracellular contrast agents (ECA-MRI), and MRI with hepatobiliary agents (HBA-MRI) for the diagnosis of hepatocellular carcinoma (HCC) using the Liver Imaging Reporting and Data System (LI-RADS) with pathological confirmation.

### METHOD AND MATERIALS

Between November 2016 and February 2019, we enrolled 125 patients with chronic liver disease who underwent CT, ECA-MRI, and HBA-MRI within one month before surgery for initial hepatic nodules detected via ultrasound. Two radiologists evaluated the presence of major and ancillary HCC features and assigned LI-RADS categories (v2018) based on CT and MRI. We then compared the diagnostic performance for LR-5 for each modality alone and in combination.

### RESULTS

In total, 163 observations (124 HCCs, 13 non-HCC malignancies, and 26 benign lesions; mean size, 20.7 mm) were identified. ECA-MRI showed a higher rate of identifying arterial phase hyperenhancement (16.1% and 8.1%), washout (5.6% and 6.5%), and enhancing capsule (51.6% and 44.4%) compared with CT and HBA-MRI, respectively. ECA-MRI showed better sensitivity and

accuracy (83.1% and 86.5%) than either CT (63.7% and 71.8%) or HBA-MRI (69.4% and 76.1%), while all imaging modalities achieved 97.4% specificity. When combining CT with ECA-MRI or HBA-MRI, sensitivity (89.5% and 83.1%) and accuracy (91.4% and 86.5%) were increased compared with CT alone.

## CONCLUSION

ECA-MRI showed better sensitivity and accuracy than CT or HBA-MRI for the diagnosis of HCC with LI-RADS. We achieved better diagnostic performance when applying CT in combination with one of the two MRI compared with CT alone.

## CLINICAL RELEVANCE/APPLICATION

Our study confirms that significant discrepancy of HCC imaging features across the imaging modality, and clinicians need to select the appropriate imaging modality for their preferred sensitivity/specificity trade off.

## SSC05-04 Long-Term Evolution of Hepatocellular Adenomas at MR Imaging Follow-Up

Monday, Dec. 2 11:00AM - 11:10AM Room: N228

### Awards

#### Trainee Research Prize - Fellow

#### Participants

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## PURPOSE

Hepatocellular adenomas (HCAs) are rare benign liver tumors. Guidelines recommend continued surveillance for patients diagnosed with HCAs, but these recommendations are mainly based on uncontrolled studies or experts' opinion. The aims of this study were to analyze the long-term course of evolution of HCAs including solitary and multiple lesions, and to identify predictive features of progression.

## METHOD AND MATERIALS

In a retrospective cohort study performed at a tertiary care hospital, we included 118 patients (mean 40±10 years old) with HCAs proven at biopsy or surgery: 41 patients had solitary HCAs and 77 patients had multiple HCAs. Imaging follow-up with MR was analyzed and tumor evolution was evaluated using the Response Evaluation Criteria in Solid Tumors (RECISTv1.1) thresholds.

## RESULTS

Median follow-up of the entire study population was 5.0 years. Overall, 37/41 (90%) solitary HCAs and 55/77 (71%) patients with multiple HCAs showed stable or regressive disease (i.e. >30% size decrease). After resection of solitary HCAs, new lesions appeared only in 2/29 (7%) patients, both with HCAs at-risk of malignancy. In the multiple HCAs cohort, HNF-1A inactivated HCAs showed a higher rate of progression compared to inflammatory HCAs (11/26 [42.3%] vs. 7/37 [18.9%],  $p = 0.043$ ), lower use of oral contraceptives (28/32 [87.5%] vs. 45/45 (100%),  $p = 0.027$ ) and lesser duration of oral contraception intake (mean 12.0 years ± 7.5 vs. 19.2 years ± 9.2,  $p = 0.001$ ).

## CONCLUSION

Seventy-eight percent of HCAs showed long-term stability or size regression. After resection of solitary HCAs, tumor progression occurred only in HCAs at-risk of malignancy. Patients with multiple HCAs were more likely to show progressive disease, with HNF-1A inactivated HCAs being the most common subtype showing progression.

## CLINICAL RELEVANCE/APPLICATION

This is the first study demonstrating the long-term evolution of hepatocellular adenomas (HCAs). In patients with resected solitary HCAs, surveillance may be potentially discontinued after resection, except in case of  $\beta$ -catenin mutated HCAs or foci of malignancy within the tumor. In patients with multiple HCAs, progressive disease may occur in up to 31% of cases, and, therefore, continued surveillance is suggested regardless of surgery.

## SSC05-05 Clinical Outcomes of Patients with Elevated Alpha-Fetoprotein Level but Negative CT or MRI Findings in the Post-Treatment Surveillance After Curative-Intent Surgery or Radiofrequency Ablation for Hepatocellular Carcinoma

Monday, Dec. 2 11:10AM - 11:20AM Room: N228

#### Participants

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## PURPOSE

To evaluate the outcomes of patients with elevated alpha-fetoprotein (AFP) but negative CT or MRI findings in the post-treatment surveillance after curative-intent surgery or radiofrequency ablation (RFA) for hepatocellular carcinoma (HCC) and to determine predictive factors for subsequent detectable recurrence.

#### **METHOD AND MATERIALS**

This single-center retrospective study analyzed 76 patients who presented elevated AFP ( $\geq 20$  ng/mL) without detectable recurrence on concurrent CT or MRI during surveillance after receiving curative-intent surgery or RFA. Time to imaging progression (development of detectable recurrence) after initial event of AFP elevation was estimated by the Kaplan-Meier method and was compared using univariate Cox regression analysis according to following parameters: surgery versus RFA, AFP elevation  $>50$  ng/mL, prior post-treatment AFP  $<20$  ng/mL, and negative imaging results on CT versus MRI.

#### **RESULTS**

In patients with post-treatment AFP elevation but without detectable recurrence on concurrent CT or MRI, the median time to imaging progression was 7.0 months (95% confidence interval: 6.0~9.0 months). Of the 76 patients enrolled, 57 patients (75.0%) developed either intra-hepatic (n=55) or extra-hepatic (n=2) recurrence detected on the average 2.6th follow-up CT or MRI studies after a mean of 7.9 months, whereas the other 19 patients (25.0%) did not develop any recurrence during average 4.4th CT or MRI studies for a mean follow of 15.9 months. Patients with prior post-treatment AFP  $<20$  ng/mL showed significantly shorter time to imaging progression than those without (median 6.0 versus 16.0 months,  $P=0.001$ ), while no significant differences were found according to prior treatment options, AFP elevation degrees, and imaging modalities showing negative results ( $P_s > 0.05$ ).

#### **CONCLUSION**

Elevated AFP ( $\geq 20$  ng/mL) but negative CT or MRI findings in the post-treatment surveillance for HCC was frequently associated with subsequent imaging detectable recurrence in a short-term period. In addition, interval increment of post-treatment AFP from  $<20$  to  $\geq 20$  ng/mL was a significant risk factor for early recurrence.

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

Elevated AFP after HCC treatment requires intensive follow-up to timely detect tumor recurrence, even if imaging studies show negative results at the time of initial AFP elevation.

#### **SSC05-06 Intra Individual Prospective Comparison of Extracellular and Hepatobiliary MR Contrast Agent for the Diagnosis of HCC**

Monday, Dec. 2 11:20AM - 11:30AM Room: N228

##### **Participants**

Anita Paisant, Angers, France (*Presenter*) Nothing to Disclose  
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#### **PURPOSE**

Hepato-biliary (HB) contrast agent became part of international guidelines for the non-invasive diagnostic of hepatocellular carcinoma (HCC). The aim of this study was to compare performances of MRI with extra-cellular contrast agent (ECA-MRI) to HB contrast agent (HBA-MRI) for the diagnostic of small HCCs in a face to face comparison.

#### **METHOD AND MATERIALS**

All patients gave written informed content and this prospective study was approved by IRB. Between August 2014 and October 2017, 172 patients with cirrhosis, each 1 to 3 nodules from 1 to 3 cm large, were included in 8 centers. All patients had both ECA-MRI and HBA-MRI within a month. The non-invasive diagnostic of HCC was made when nodule was hyper-vascularized at arterial phase (HA) with wash-out at portal phase (PP) and/or delayed phase for ECA-MRI, or PP and/or HB phase (HBP) for HBA-MRI. The Gold Standard was defined by a composite algorithm previously published (CHIC study).

#### **RESULTS**

225 nodules, among them 153 HCCs and 72 not HCCs, were included. Both MRI sensitivities were similar (71.2%). Specificity was 83.3% for ECA-MRI and 68.1% for HBA-MRI. Concerning HCCs: on ECA-MRI, 138 were HA, 84 had wash-out at PP and 104 at DP; on HBA-MRI, 120 were HA, 79 had wash-out at PP and 105 at HBP. For nodules from 2 to 3 cm, sensitivity and specificity were similar with respectively 70.9% and 75.0%. For nodules from 1 to 2 cm, specificity drop down to 66.1% for HBA-MRI vs 85.7% for ECA-MRI.

#### **CONCLUSION**

HBA-MRI specificity is lower than HCA-MRI for the diagnostic of small HCC on cirrhotic patients. These results must question about the proper use of HBA-MRI in algorithm for the non-invasive diagnostic of small HCCs.

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

The use of HBA-MRI in international guidelines for the non-invasive diagnostic of HCC should be used with caution.

#### **SSC05-07 Can Baseline MR Imaging Biomarkers Enhance Survival Prediction of Hepatocellular Carcinoma (HCC) Patients?**

Monday, Dec. 2 11:30AM - 11:40AM Room: N228

##### **Participants**

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**PURPOSE**

To evaluate role of baseline ADC and tumor margin as independent predictors of overall survival (OS) in HCC patients and assess how incorporating these variables to current staging systems may enhance survival prediction in these group of patients.

**METHOD AND MATERIALS**

In a retrospective IRB approved study clinical, laboratory and imaging parameters of 273 randomly selected HCC patients were collected. Cox regression model was utilized to identify parameters that were significantly related to survival. Patients were stratified based on BCLC and CLIP. Recursive partitioning test were applied on a test set of patients (70%) to identify the optimal cutoff of ADC in stratifying patient based on difference in survival. The estimated cutoff was validated on the validation set of patients. Binary ADC value (above or below the cutoff) and tumor margin were integrated in to BCLC and CLIP. Kaplan- Myer curves were drawn and overall survival was measured for patients based on BCLC, CLIP, combined model of BCLC + ADC + margin and CLIP + ADC + margin. Predictive performance of each model was measured and compared using C statistical analysis.

**RESULTS**

At baseline, patients with Low tumor ADC and well- defined tumor margin (favorable imaging biomarkers) had longer survival compared with those with high ADC and ill-defined tumor margin (unfavorable imaging biomarkers) (median OS of 63 months and 6 months, respectively). Tumor ADC and tumor margin remained as the two strong independent predictors of survival in HCC patients after adjustment for other clinical variables. Incorporating ADC (at cutoff of  $1390 \times 106\text{mm/s}$ ) and tumor margin into BCLC and CLIP improved performance of survival prediction by 10% in BCLC group (0.63 Vs 0.73;  $p < 0.001$ ) and 7% in CLIP group (0.68 vs 0.75;  $p < 0.001$ ), Table 1. Regardless of BCLC and CLIP stage patients with unfavorable ADC and TM had significantly shorter OS compared to patients with both favorable ADC and TM ( $p < 0.001$ ), Figure 1.

**CONCLUSION**

Incorporating ADC and tumor margin to currently used staging systems for HCC significantly improve prediction performance of these criteria. Also, it could potentially change prediction of OS regardless of patient clinical status.

**CLINICAL RELEVANCE/APPLICATION**

ADC and tumor margin are two imaging biomarkers that can improve prediction performance of current staging systems, help to better stratify patients at baseline and define optimized treatment plan for them

**SSC05-08 Comparison of the Diagnostic Performance of Imaging Criteria for Early-Stage Hepatocellular Carcinoma on Gadoxetate Disodium-Enhanced MRI**

Monday, Dec. 2 11:40AM - 11:50AM Room: N228

**Participants**

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**PURPOSE**

We aimed to compare the diagnostic performance of imaging criteria for early-stage hepatocellular carcinoma (HCC) on gadoxetate disodium-enhanced MRI.

**METHOD AND MATERIALS**

We retrospectively evaluated 570 nodules (440 HCCs, 25 other malignancies, 105 benign nodules) of 3.0 cm or smaller from 418 patients at risk for HCC who underwent gadoxetate disodium-enhanced MRI from July 2015 to December 2016. Final diagnosis was assessed histopathologically or clinically (marginal recurrence after treatment or change in lesion size on follow-up imaging). We compared the sensitivity and specificity for diagnosing HCC among the latest versions of four imaging criteria, including Liver Imaging Reporting and Data System (LI-RADS), European Association for the Study of the Liver (EASL), Asian Pacific Association for the Study of the Liver (APASL), and Korean Liver Cancer Association-National Cancer Center (KLCA-NCC), using the generalized estimating equations.

**RESULTS**

For  $\geq 10$  mm nodules, APASL showed the highest sensitivity (85.0%), significantly higher than LI-RADS category 4 or 5 (75.9%), LI-RADS category 5 (64.2%), and EASL (63.4%) ( $P \leq .001$ ). Regarding the specificity, LI-RADS category 5 was highest (94.7%), significantly higher than KLCA-NCC (83.0%) and APASL (78.7%) ( $P < .001$ ). For  $< 10$  mm nodules, the sensitivity and specificity of LI-RADS category 4 or 5 were 17.1% and 97.2%, respectively, and those of APASL were 73.2% and 83.3%, respectively ( $P < .001$  for sensitivity, and  $P = .1$  for specificity). For histopathologically confirmed lesions, the results of subgroup analysis were similar to

those of all lesions.

## CONCLUSION

Of the four international imaging criteria, APASL had the highest sensitivity and LI-RADS category 5 showed the highest specificity for diagnosing early-stage HCC in high-risk patients on gadoxetate disodium-enhanced MRI.

## CLINICAL RELEVANCE/APPLICATION

To improve diagnostic performance of gadoxetate disodium-enhanced MRI for early-stage HCC, it is important to understand the differences of various imaging criteria for HCC.

## SSC05-09 Hepatobiliary Phase Hypointensity as Predictor of Progression to Hepatocellular Carcinoma for Intermediate-High Risk Lesions

Monday, Dec. 2 11:50AM - 12:00PM Room: N228

### Participants

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Daniele Marin, MD, Durham, NC (*Abstract Co-Author*) Research support, General Electric Company

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## PURPOSE

To determine the prognostic performance of hepatobiliary phase hypointensity, and Liver Imaging Reporting and Data System (LI-RADS) major imaging features in the prediction of progression to hepatocellular carcinoma (HCC) in LR-3 and LR-4 hepatic lesions with arterial phase hyperenhancement (APHE) measuring  $\geq 10$  mm in patients at high risk of HCC.

## METHOD AND MATERIALS

This retrospective dual-institution study included 160 LR-3 and 26 LR-4 lesions measuring more than 10 mm and having APHE in 136 consecutive patients (mean age(SD), 57 (11) years old; mean lesion size (SD), 14 (4) mm). A composite reference standard of pathologic analysis and imaging follow-up was used. The prognostic performance (sensitivity and specificity) of hepatobiliary phase hypointensity and LI-RADS version 2018 major imaging features other than APHE for the prediction of probability of progression to HCC and time to progression to HCC was assessed and compared by means of Log-rank test, Cox-regression and Kaplan-Meier curves.

## RESULTS

Hepatobiliary phase hypointensity was a predictor of progression to HCC at univariate ( $p < 0.0001$ ) and multivariate ( $p < 0.0001$ ) analysis, with an odds ratio of 20.6. Median time to progression to HCC was 284 days [95%CI: 266-363]. In LR-3 and LR-4 lesions  $\geq 10$  mm with APHE that progressed to HCC, the presence of hepatobiliary phase hypointensity, nonperipheral washout or enhancing capsule did not predict time to progression to HCC.

## CONCLUSION

Hepatobiliary phase hypointensity is an independent predictor of progression to HCC in intermediate-high risk lesions measuring  $\geq 10$  mm and having APHE in patients at risk for HCC.

## CLINICAL RELEVANCE/APPLICATION

Intermediate and high risk lesions not fulfilling definitive imaging criteria for HCC account for about 40% of observations during interpretation of CT and MR imaging studies. Natural history of these lesions may be extremely variable. The prognostic information provided by hepatobiliary phase hypointensity in terms of prediction of progression to HCC allows for more tailored management.

Printed on: 10/29/20



SSC06

## Gastrointestinal (Advanced Response Evaluation)

Monday, Dec. 2 10:30AM - 12:00PM Room: N230B

**BQ** **GI** **OI**

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

### Participants

Daniele Marin, MD, Durham, NC (*Moderator*) Research support, General Electric Company  
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### Sub-Events

#### SSC06-01 Immunotherapy Response Evaluation with Magnetic Resonance Elastography (MRE) in Advanced HCC

Monday, Dec. 2 10:30AM - 10:40AM Room: N230B

### Participants

Aliya Qayyum, MD, MBBS, Houston, TX (*Presenter*) Nothing to Disclose  
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### PURPOSE

To determine whether stiffness change on magnetic resonance elastography (MRE) can detect immunotherapy response in advanced HCC.

### METHOD AND MATERIALS

This was a prospective study of 15 patients with advanced HCC who were treated with anti-PD-1 therapy, (Pembrolizumab). All patients had a standard of care liver MRI with MRE, and liver biopsy at baseline and after 6 weeks of therapy. HCC stiffness was measured on MRE elastograms. Increase in HCC stiffness was compared with a decrease in HCC ADC, size and enhancement on MRI. Change in HCC stiffness was compared with the time to disease progression, overall survival, and the total number of intratumoral T lymphocytes (CD3+ positive by immunohistochemistry) on targeted liver biopsy. Analysis was performed using descriptive statistics and Spearman correlation (R); p-value <0.05 was considered statistically significant.

### RESULTS

Nine evaluable patients (6 men; 3 women) were analyzed. Median age was 71 years (range, 54-78). Etiology of liver disease was HCV (n=4), HBV (n=1) and NASH (n=4). HCC was well-differentiated in 2 of 9 patients, moderately differentiated in 6 and poorly differentiated in 1. Average HCC size was 4 cm (range, 1.5 - 8.5), and change in size at 6 weeks was -0.32 (range, - 2.2 - 0.4). Median time to progression (TTP) was 13 weeks (range, 9-48) and overall survival (OS) was 44 weeks (range, 16-70). Average baseline HCC stiffness and change in HCC stiffness were 5.0 kPa (range, 2.4 -9.1) and 0.12 kPa (range, [-2.1] - 2.8), respectively. Increase in HCC stiffness on MRE correlated significantly with a decrease in ADC (p=0), but there was no correlation with change in HCC size (p=0.5) or enhancement (p=1). HCC stiffness correlated significantly with intratumoral T lymphocytes on biopsy (R = 0.79, p = 0.007). Change in HCC stiffness at 6 weeks correlated significantly with TTP (R = 0.88 and OS (R = 0.81), p <0.01. Baseline non-tumor liver stiffness and HCC size tended toward inverse correlation with overall survival (p < 0.055).

### CONCLUSION

Increased HCC stiffness on MRE was associated with longer time to disease progression and survival in advanced HCC and may be useful as a biomarker of early immunotherapy response.

### CLINICAL RELEVANCE/APPLICATION

Development of noninvasive functional MRI biomarkers of early immunotherapy response would improve therapeutic management in advanced hepatocellular carcinoma.

#### SSC06-02 Role of Tumor Morphology and ADC Change in Defining the Need for Additional TACE after Initial

## Treatment in Patients with Unresectable HCC

Monday, Dec. 2 10:40AM - 10:50AM Room: N230B

### Participants

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### PURPOSE

To evaluate the survival benefit of sequential transarterial chemoembolization in different subgroups of patients with unresected hepatocellular carcinoma

### METHOD AND MATERIALS

For this IRB approved, HIPPA compliant retrospective cohort study, our institutional database was searched for patients with hepatocellular carcinoma diagnosed during 2005-2016. Patients who had MR imaging, received transarterial chemoembolization (TACE), and did not undergo liver resection or transplantation were included. Data on baseline liver function, number of TACE, and survival status was retrieved from our clinical database. Lesions were categorized to well-defined or ill-defined for subgroup analysis. Baseline tumor volume and volumetric apparent diffusion coefficient (ADC) of tumors at baseline and after first TACE were measured. After adjustment for demographics, baseline liver function, and tumor volume, the correlation between number of TACE and OS was tested using multiple Cox regression in different subgroups of patients.

### RESULTS

A total of 159 patients met the inclusion criteria. 52 patients had well-defined and 107 patients had ill-defined HCC tumors. The median number of TACE sessions was comparable between groups ( $p=0.35$ ). Tumor volume was larger in patients with ill-defined lesions, as compared to well-defined lesions ( $p=0.001$ ). The median OS was 340 days for all patients, 663 days for those with well-defined lesions, and 257 days for those with ill-defined lesions ( $HR=1.64$ ,  $p<0.001$ ). After adjusting for confounders including the tumor size, Cox model showed that patients with ill-defined lesions take survival benefit from an increase in number of TACE sessions ( $HR=0.86$ ,  $p=0.020$ ). Higher number of TACE did not improve OS in patients with well-defined lesions ( $HR=0.91$ ,  $p=0.173$ ). In patients with well-defined tumors, a cutoff value of  $\geq 25\%$  increase in ADC after first TACE was shown to predict better OS ( $p=0.023$ ). When categorizing these patients based on this cutoff value, a higher number of TACE did not show any survival benefit ( $HR=1.12$ ,  $p=0.422$ ) in patients with  $\geq 25\%$  ADC increase (responders). In patients with  $<25\%$  ADC increase (non-responder to first TACE), an increase in the number of subsequent TACE sessions was shown to significantly improve patients' OS ( $HR=0.73$ ,  $p=0.031$ ).

### CONCLUSION

Survival benefit of sequential TACE is different for ill- vs well-defined HCC. This benefit is limited in lesions that respond well to first treatment by  $\geq 25\%$  increase in ADC. Patients with ill-defined or non-responding well-defined lesions would benefit from additional TACE.

### CLINICAL RELEVANCE/APPLICATION

Patients with ill-defined HCC or well-defined lesions with  $<25\%$  ADC-increase after first TACE will benefit from additional TACE. This benefit is limited in those with adequate response to first TACE.

### SSC06-03 Early Survival Prediction Using 3D Quantitative Tumor Response Analysis on MRI in Patients with Advanced Stage Hepatocellular Carcinoma Undergoing Systemic Therapy with Sorafenib

Monday, Dec. 2 10:50AM - 11:00AM Room: N230B

### Participants

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## PURPOSE

To compare uni- (1D) and three-dimensional (3D) quantitative tumor response criteria on multi-parametric magnetic resonance imaging (mpMRI) in patients with hepatocellular carcinoma (HCC) that underwent systemic therapy with sorafenib and to evaluate their ability to predict overall survival (OS) outcomes.

## METHOD AND MATERIALS

This IRB-approved retrospective, single-institution analysis included twenty-three patients with advanced stage HCC who received sorafenib for at least 60 days. All patients underwent baseline (BL) and Follow-Up (FU) MRI 19- 140 days after initiation of therapy (median 65 days, standard deviation  $\pm 33.58$ ). Response to sorafenib was assessed in 37 target lesions using 1D criteria such as Response Evaluation Criteria in Solid Tumors (RECIST) and modified RECIST (mRECIST). In addition, a segmentation-based 3D quantification of enhancing lesion volume (volumetric quantitative European Association for the Study of the Liver, vqEASL) was performed on arterial-phase MRI, and the enhancement fraction of total tumor volume (percentage-based qEASL, pqEASL) was calculated. Accordingly, patients were stratified into groups of Disease Control (DC, which included Complete Response, Partial Response, and Stable Disease) and Disease Progression (DP, included Progressive Disease). Overall survival was evaluated using Kaplan-Meier curves with log-rank test.

## RESULTS

The survival analysis showed that stratification of patients in DC vs. DP according to vqEASL was successfully predicted (DC n=22, DP n=15) and stratified overall survival (median OS of 15.4 months for DC, 10.7 months for DP;  $p=0.01$ , see Figure 1). Stratification according to RECIST (DC n=20, DP n=17), mRECIST (DC n=27, DP n=10) and pqEASL (DC n=36, DP n=1) did not correlate with OS ( $p=0.2416$ ,  $p=0.6945$  and  $p=0.8055$ , respectively).

## CONCLUSION

The study identified vqEASL as an accurate predictor of overall survival early after initiation of sorafenib treatment. This data provides early evidence for potential advantages of 3D quantitative tumor response analysis over conventional techniques regarding early identification of response to or failure of sorafenib.

## CLINICAL RELEVANCE/APPLICATION

The use of 3D quantitative vqEASL may optimize clinical decision making and provide more personalized therapeutic algorithms in patients undergoing systemic therapy of advanced stage HCC.

## SSC06-04 Multi-Parametric DECT Assessment of Therapeutic Response to Neo-Adjuvant Chemoradiation in Pancreatic Cancer Patients to Determine Surgical Resectability

Monday, Dec. 2 11:00AM - 11:10AM Room: N230B

### Participants

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## PURPOSE

To study if iodine quantification and CTTA can detect histologic response in pancreatic cancer following neoadjuvant chemoradiation

## METHOD AND MATERIALS

This IRB approved study prospectively included patients with borderline resectable or locally advanced pancreatic ductal adenocarcinoma (PDAC) undergoing neo-adjuvant chemoradiation (NACT/RT) prior to surgical resection. Patients underwent multiphase abdominal dual energy (DECT) at baseline and a presurgical DECT within 2 weeks of completion of NACT/RT. Based on post-surgical pathology the patients were divided into good histologic response and poor histologic response. The tumor morphology (RECIST 1.1), Iodine quantification and CT texture analysis (CTTA) were compared between these two groups using student t-test and Mann Whitney U test. Multiple regression was used to identify the strongest independent predictor of histological response.

## RESULTS

Final patient cohort included 25 patients of which 13 had good histologic response and 12 had poor histologic response. Morphological response by RECIST 1.1 was associated with good histologic response (5/13 vs 0/12 respectively,  $p=0.039$ ). CTTA parameters were significantly different between the good and poor histologic response groups at baseline, but more frequently after NACT/RT (Figure). On multivariate analysis, CTTA was a strong ( $r_{\text{partial}}=0.68$ ;  $p=0.007$ ) and independent predictor of histological response after NACT/RT. There was no significant difference in the quantitative iodine values at baseline, early treatment and after completion of chemoradiation both in the arterial/pancreatic phase and portal venous phase.

## CONCLUSION

CT texture analysis performed on post processed DECT images is a strong marker for assessing and predicting histologic response after neoadjuvant chemoradiation in pancreatic and outperforms morphologic features of tumor size and vascular involvement.

## CLINICAL RELEVANCE/APPLICATION

The detection of post NACT/RT treatment effects in PDAC is very challenging and can not be reliably assessed on conventional imaging. This study shows that CTTA can reliably predict and assess the histologic response.

## **SSC06-05 Yttrium-90 Radioembolization for Hepatocellular Carcinoma: Outcome Prediction with MRI Derived Fat-Free Muscle Area**

Monday, Dec. 2 11:10AM - 11:20AM Room: N230B

### Participants

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### PURPOSE

Sarcopenia is associated with adverse outcomes in gastrointestinal malignancies and liver cirrhosis. We aimed at investigating the utility of magnetic resonance imaging (MRI) derived fat-free muscle area (FFMA) to predict clinical outcome in patients receiving yttrium-90 radioembolization (RE) for treatment of hepatocellular carcinoma (HCC).

### METHOD AND MATERIALS

Consecutive patients with unresectable HCC and pre-interventional liver MRI undergoing salvage RE between December 2007 and October 2014 were retrospectively evaluated. Using axial T2-weighted turbo spin echo sequences, FFMA was calculated by subtraction of the intramuscular adipose tissue area from the total cross-sectional area of paraspinal skeletal muscles at the superior mesenteric artery level. FFMA values lower than 3582 mm<sup>2</sup> in male and 2301 mm<sup>2</sup> in female patients were defined as low FFMA. Main outcomes were progression-free survival (PFS) and overall survival (OS). For outcome analysis, the Kaplan-Meier method with log rank test and multivariate cox regression analysis were used.

### RESULTS

Fifty-eight patients (13 female, mean age 68±12 years) were included. Mean time from pre-interventional MRI to RE was 27 ± 20 days. Median OS and PFS after RE were 250 (range: 21-1230 days) and 156 days (range: 21-674 days), respectively. Patients with low FFMA showed significantly reduced OS (197 vs. 294 days, P=0.024) and tended to have shortened PFS (109 vs. 185 days, P=0.068). Low FFMA (HR 2.675; P=0.011), estimated liver tumor burden (HR 4.058; P=0.001), and Eastern Cooperative Oncology Group (ECOG) performance status (1.763; P=0.009) were independent predictors of OS on multivariate analysis.

### CONCLUSION

FFMA might represent a promising new biomarker for survival prognosis in patients undergoing RE for treatment of unresectable HCC.

### CLINICAL RELEVANCE/APPLICATION

In this study, we offer an easy applicable MRI-based measurement of lean muscle mass as a measure of sarcopenia which is capable to predict outcome in patients receiving RE for treatment of unresectable HCC.

## **SSC06-06 Early Tumor Viability Prediction Following Y90 Radioembolization Segmentectomy for Hepatocellular Carcinoma Using Automated 3D Tumor Sub-Volume Segmentation and Texture Analysis**

Monday, Dec. 2 11:20AM - 11:30AM Room: N230B

### Participants

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### PURPOSE

Tumor viability (TV) after radioembolization segmentectomy (RS) is often not definitive on follow-up MRI until several months later.

Given an array of available treatment options for early and advanced HCC, sooner determination of RS efficacy is needed to facilitate optimal disease management.

## METHOD AND MATERIALS

83 patients with initial RS 1/1/14 - 12/31/17 were retrospectively reviewed. Patients with prior TACE, TARE, systemic therapy or target lesion (TL) retreatment after first follow-up (FU1) and before second follow-up (FU2) were excluded. All FU MRIs were assessed using mRECIST criteria. Tumor viability (TV) was defined as PR, SD or PD. Using Slicer's GrowCut tool duplicate tumor and normal parenchymal segmentations were made on T1 arterial phase (T1 AP) and ADC on pre-RS and FU1 MRI. Automated calculation of 3D hypo- and hyperintense sub-volumes and first order texture features were performed using SimpleITK, Numpy and PyRadiomics. Segmentation time and intraclass correlation (ICC) of segmentations was assessed. Metrics were compared to TV at FU2 and time to TL TV. Univariate Mantel-Cox time to event, logistic regression and ROC analysis were performed using R and Prism.

## RESULTS

47 patients were selected with a mean age of 70 (66% male). 5, 27, 10 and 5 were BCLC 0, A, B, and C. Mean TL size (mm) and dose (mCi) were 26 (SD19) and 49 (SD27), respectively. Pre-RS MRI was performed a mean 44 (SD 13) days before treatment. FU1 and FU2 MRIs were performed a mean 51 (SD 15) and 136 (SD 38) days after intervention. 373 tumor segmentations were made taking a mean 3.4 (SD 2.1) minutes each with ICC of 0.83 (95CI 0.78-0.88). At FU2 36 and 11 had CR and tumor viability, respectively. Median overall survival was 30 months. On logistic regression analysis, difference in T1 AP and ADC kurtosis between pre-RS and FU1 were significantly predictive of TV on FU2 with AUC 0.77 ( $p<0.05$ ) and 0.76 ( $p<0.05$ ). There were no significant differences on median-split, univariate time to TV for all measures.

## CONCLUSION

On early follow-up MRI after RS hyper- and hypointense sub-volume sizes do not appear correlated with TV, however, 3D tumor texture analysis do appear to be predictive of TV.

## CLINICAL RELEVANCE/APPLICATION

Texture analysis may provide insight into tumor viability earlier than mRECIST. If validated prospectively, adoption of routine tumor segmentation and MR-based quantitative analyses may hasten and improve HCC treatment decision making.

## SSC06-07 Dual-Energy CT Vital Iodine Tumor Burden as a Quantitative Response Parameter in Patients with GIST Undergoing Tyrosine-Kinase-Inhibitor Therapy - A Comparison to Standard CT and FDG-PET Criteria

Monday, Dec. 2 11:30AM - 11:40AM Room: N230B

### Participants

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## PURPOSE

o determine whether dual-energy CT (DECT) vital iodine tumor burden (VITB) allows reliable response assessment in patients with a Gastrointestinal Stromal Tumor (GIST) undergoing Tyrosine-Kinase Inhibitor therapy (TKI), compared to established CT and [18F] fluorodeoxyglucose (FDG) positron emission tomography (PET) criteria.

## METHOD AND MATERIALS

An anthropomorphic phantom equipped with spherical GIST lesions of 3 different iodine concentrations (1, 2 and 5mg/mL) and a non-enhancing central necrotic core (40HU at 120kVp) was scanned on a second generation dual-source DECT platform. 40 patients with 15 metastatic GIST lesions underwent a portal phase DECT on the same platform. Each patient had a pre-treatment and a 3-4-months follow-up DECT and FDG-PET after TKI-treatment. Up to 5 target lesions were selected using mRECIST 1.1 guidelines. Tumor burden was assessed using different tumor response criteria, including mRECIST 1.1, mChoi, VTB, and VITB. Standardized uptake value (SUVmax) on the FDG-PET datasets, which is the current reference standard for metabolic response assessment in patients with GIST. Progression-free survival (PFS) in responders (complete, partial response and stable disease) and non-responders (progressive disease) according to each response criteria was compared by using the Cox proportional hazard ratio (HR).

## RESULTS

The anthropomorphic phantom revealed a cut-off of 0.5mg/mL (15HU on the iodine image) to differentiate necrotic from vital tumor tissue. The median PFS was significantly different between non-responders and responders and comparable among the SUVmax criteria (632days; HR=4.6; 95%CI:2.2-10.1;  $p<0.001$ ), the VITB criteria (521days; HR=28.4; 95%CI:7.8-184.9;  $p<0.001$ ) and VTB criteria (501days; HR=8.1; 95%CI:3.4-21.2;  $p<0.001$ ). VITB allowed a significant better differentiation between non-responders and responders compared to mRECIST 1.1 (414days; HR=2.5; 95%CI:1.3-5.0;  $p<0.010$ ). and mChoi criteria (151days; HR=1.1; 95%CI:0.5-2.1;  $p<0.001$ ).

## CONCLUSION

The VITB criteria showed comparable performance to FDG-PET criteria for response assessment of patient with GIST under TKIs while outperforming mRECIST 1.1 and mChoi criteria.

## CLINICAL RELEVANCE/APPLICATION

VITB is a quantitative DECT imaging biomarker that captures the effects of TKI therapy and predicts tumor response (PFS) in

patients with GIST and could be used to guide treatment management.

### **SSC06-08 Dynamic Control of Chelation Therapy in Transfusion Dependent and Non-Transfusion Dependent Patients Using Hepatic MRI and DECT**

Monday, Dec. 2 11:40AM - 11:50AM Room: N230B

#### Participants

Anna M. Titova, Saint Petersburg, Russia (*Presenter*) Nothing to Disclose

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#### PURPOSE

To show the possibilities of DECT as well as MRI in the diagnostic of iron overload (IOL) and monitoring of chelation therapy. To determine sufficient time intervals between dynamic hepatic DECT and MRI in controlling of chelation therapy results in Transfusion Dependent (TD) and Non-Transfusion Dependent (NTD) patients with IOL.

#### METHOD AND MATERIALS

We examined 75 patients with suspected IOL. 14 of them were NTD, the other 61 - TD. We conducted T2\* MRI study of the liver by 1.5T scanner for assessment of liver iron concentration (LIC) and performed DECT procedures with 80kV and 140kV on the limited area of the liver of the same patients with the slice thickness of 5mm and calculation of Dual Energy indicators. Chelation therapy was prescribed for all examined patients in doses depending on body weight. 6 and 12 months later, we repeated the same procedures to the earlier examined patients who received iron chelators. For various reasons, only 26 of them were able to undergo CT and MRI studies at appointed times.

#### RESULTS

We calculated IOL severity for the examined patients. Using correlation and regression analysis, it was found that the calculation of the dual-energy difference (HU) gives high correlation coefficient ( $r=0.93$ ) with IOL severity, it means that the predicted values of IOL by CT fall into all ranges of IOL according to MRI. Using the data of 26 patients after 6 and 12 months chelation, in all DECT-results we also established the conformity of our findings to the MRI data. In both control CT and MRI study of NTD patients with HH ( $n=9$ ), degree of LIC decrease significant - average 12% in 6 months, and 33% in a year. When analyzing similar control MRI data in TD patients ( $n=17$ ), we had extremely slow dynamics of reducing the LIC (average 2,75% in 6 months, 7% in a year). MRI data show that there is some dynamic, while DECT data demonstrate no significant dynamic either in 6 or in 12 months of treatment (less than 1% decreasing).

#### CONCLUSION

DECT, like MRI, is a useful technique for controlling chelation therapy. However, such studies in NTD patients should be more frequent to avoid hyper-chelation. The use of DECT for the annual control of chelation therapy in TD patients is not justified.

#### CLINICAL RELEVANCE/APPLICATION

Recommended to undergo hepatic MRI or DECT for NTD patients no less than every 6 months to control chelation therapy results, especially with light or moderate IOL severity, to avoid over-chelation.

### **SSC06-09 Post-TACE Changes in the Mean Value and Kurtosis of Apparent Diffusion Coefficient Histograms are Independent Predictors of Overall Survival in Patients with Hepatocellular Carcinoma**

Monday, Dec. 2 11:50AM - 12:00PM Room: N230B

#### Participants

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#### PURPOSE

To identify MR imaging parameters that can be used for evaluating early tumor response and overall survival (OS) after transarterial chemoembolization in patients with hepatocellular carcinoma

#### METHOD AND MATERIALS

In this IRB approved, HIPAA compliant retrospective cohort study, our institutional database was searched for patients with confirmed HCC, diagnosed during 2005-2016. Imaging data were reviewed by a radiologist and patients with well-defined tumors were recruited initially ( $n=151$ ). Patients with available apparent diffusion coefficient (ADC) map at baseline and 3-4 weeks after first TACE were included ( $n=99$ ). Demographic data, HCC etiology, baseline Child score, treatment modalities, and survival status were retrieved from clinical database. Volumetric MRI metrics including tumor volume, mean ADC, skewness and kurtosis of ADC were measured at baseline and 1 month post-TACE. Change in variables was calculated by subtracting baseline values from post-TACE measures. Univariate and multiple Cox models were used to test the independent role of change in imaging parameters to predict OS.  $p<0.05$  was considered significant.



## RESULTS

In unadjusted survival model, baseline tumor volume, changes in ADC and ADC-kurtosis were potential imaging predictors of survival. After adjusting for baseline liver function, tumor volume, number of TACE sessions, and treatment modality, incremental percent change in ADC was an independent predictor of better OS (HR=0.98, p=0.020). In overall, a decremental change in ADC-kurtosis (increase in heterogeneity) showed a strong trend in predicting better prognosis (HR=0.92, p=0.051). Categorizing patients to responders ( $\geq 25\%$  ADC increase) and non-responders ( $< 25\%$  ADC increase) based on change in mean ADC provided a good prediction of OS (c-index: 0.791). Responders had the best survival profile (HR=0.42, p=0.021). Subgroup analysis showed that in non-responders, change in ADC-kurtosis ( $\Delta$  kADC) as an indicator of change in tissue homogeneity, could distinguish between poor and fair prognosis (cutoff=0.5). It was not a measure of difference among responders (p=0.86). Non-responder patients with  $\Delta$  kADC  $\geq 0.5$  (homogeneous post-TACE tumor) had the worst prognosis (HR=3.03, p=0.007), as compared to responders and those of non-responders who had  $\Delta$  kADC  $< 0.5$  (log-rank p=0.203).

## CONCLUSION

A  $\geq 25\%$  increase in ADC demonstrated favorable response to TACE in patients with HCC. In non-responder patients, an increase in tumor heterogeneity, as measured by ADC-kurtosis, could distinguish patients with relatively better prognosis from those with the worst survival profile.

## CLINICAL RELEVANCE/APPLICATION

Change in mean ADC and ADC-kurtosis, as a measure of change in tissue heterogeneity, can be used to monitor early response to TACE in well-defined HCC and to identify patients with treatment failure and poor prognosis

Printed on: 10/29/20



SSC07

## Science Session with Keynote: Genitourinary (Prostate MRI in Biopsy, Therapy, and Surveillance)

Monday, Dec. 2 10:30AM - 12:00PM Room: E260

**GU** **MR** **OI**

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

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

### Participants

Aytekin Oto, MD, Chicago, IL (*Moderator*) Research Grant, Koninklijke Philips NV; Research Grant, Guerbet SA; Research Grant, Profound Medical Inc; Medical Advisory Board, Profound Medical Inc; Consultant, IBM Corporation; ; ;  
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Ronaldo H. Baroni, MD, Sao Paulo, Brazil (*Moderator*) Nothing to Disclose

### Sub-Events

#### SSC07-01 Genitourinary Keynote Speaker: Next Generation Prostate Imaging

Monday, Dec. 2 10:30AM - 10:40AM Room: E260

### Participants

Daniel J. Margolis, MD, New York, NY (*Presenter*) Consultant, Blue Earth Diagnostics Ltd

### PURPOSE

Prostate imaging has transformed over the past decade, with the advent of iterations on multiparametric MRI in addition to small-molecule PET agents targeting the extracellular domain of prostate specific membrane antigen (PSMA) and high-resolution ultrasound. These innovative magnetic resonance imaging techniques both facilitate new treatment methods, and more importantly, allow for assessment of the efficacy of these new treatments. From MRI-ultrasound image fusion targeted biopsy and ablation to quantitative assessment of treatment response of medical and ablative therapies, the field of prostate imaging is rife with novel applications. These techniques individualize patient care through more accurate identification of the location and stage of prostate cancer so that only significant cancers receive treatment, and then monitor the response to directed therapies. Perhaps most intriguing is the application of artificial intelligence, which augments the radiologist's acumen, improving the value we deliver to our patients. We stand on the cusp of the age of radiologist-driven prostate cancer management.

#### SSC07-02 MR-US Fusion Prostate Biopsy: The Added Value of Systematic Core Biopsy to MR-Targeted Cores for Prostate Cancer Grading

Monday, Dec. 2 10:40AM - 10:50AM Room: E260

### Participants

Sohrab Afshari Mirak, MD, Los Angeles, CA (*Presenter*) Nothing to Disclose  
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Anthony Sisk, DO, Los Angeles, CA (*Abstract Co-Author*) Nothing to Disclose  
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### PURPOSE

To investigate the value of the systematic core biopsy (S-Bx) to MR-US fusion targeted core biopsy (MR-F Bx) for detection and grading of prostate cancer (PCa) using whole mount histopathology (WMHP) as reference.

### METHOD AND MATERIALS

This IRB approved, HIPAA compliant observational study cohort comprises 295 patients with 716 pathology PCa lesions, who underwent MR-F bx prior to radical prostatectomy, between 7/2010-2/2019. All patients had MR-F Bx and S-Bx. The pathology reports of all of the cores were evaluated and the characteristics of patients with higher reported Gleason score (GS) for S-Bx as compared to MR-F bx were assessed.

### RESULTS

Mean patient age and PSA were 62.9±6.3 years and 8.9±10.5 ng/ml, respectively. Mean PCa lesion number on WMHP was 2.4 (1-6). Mean S-Bx and MR-F bx cores were 11.4 (6-16) and 5.3 (1-10), respectively. Mean positive cores for S-Bx was 3 (0-12) and for MR-F Bx was 3.3 (0-10). The per-patient performance of S-Bx and MR-F Bx for PCa detection were 82.4% (243/295) and 95.6% (282/295), respectively. Overall, 37.6% (111/295), 48.8% (144/295) and 13.6% (40/295) of cases had similar GS in S-Bx and MR-F Bx, higher GS in MR-F Bx and higher GS in the S-Bx, respectively. In 4.1% (12/295) of all cases, S-Bx cores upgraded PCa from GS 6 to GS>6. Among cases with higher GS in S-Bx, 32.5% (13/40) cases had benign findings on MR-F bx. 82.5% (33/40) of the higher GS cases in S-Bx were taken from the same lesion as MR-F Bx as a result of wider sampling and the characteristics of these lesions

were as follows: 51.5% (17/33) PIRADSV2 score 3, 33.3% (11/33) score 4 and 15.2% (5/33) score 5; 14.5% (15/33) in apex, 33.3% (11/33) in midgland and 21.2% (7/33) in base; 42.4% (14/33) in a different sextant for the same lesion in contralateral side (3/14) or a different level (11/14). In 22.5% (9/40) of all cases with higher GS in S-Bx and in 8.3% (1/12) of upgraded cases from GS 6 to >6 in S-Bx, the report of the higher GS was false considering WMHP.

## CONCLUSION

Although S-Bx at the time of MR-F Bx can slightly improve PCa grading, however, in almost one quarter of the cases, we found false upgrading. The true rate of upgrading with S-Bx is minimal and significant portion of the upgraded lesions are ipsilateral to the target.

## CLINICAL RELEVANCE/APPLICATION

PCa treatment selection depends on the results of the prostate biopsy. S-Bx improves diagnostic yield only slightly for clinically significant disease over MR-F Bx.

### SSC07-03 Manual Adjustment in mpMRI-Guided Prostate Biopsy Significantly Improves the Detection Rate of Prostate Cancer: Experience in 400 Patients

Monday, Dec. 2 10:50AM - 11:00AM Room: E260

#### Participants

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## PURPOSE

to compare the results of software-guided sampling with those obtained after manual adjustment in multiparametric MRI-guided prostate biopsy (mpMRI-PB) and to evaluate whether manual adjustment improves the detection rate of prostate cancer (PCa).

## METHOD AND MATERIALS

We enrolled 400 consecutive patients between November 2014 and February 2018, who underwent mpMRI-PB of the target lesion visible on previous mpMRI (average 11.6 mm, range 4-40mm). All mpMRI-PBs were performed on a 1.5T MR scanner (Magnetom Avanto, Siemens Healthineers, Germany) using a commercially available MR transrectal biopsy device (DynaTRIM, Invivo, USA). After calibration of the biopsy device, the first sample was obtained using the coordinates provided by the device software to guide the needle along a trajectory to the target lesion. The trajectory was then manually adjusted to improve localization to the target lesion for further biopsy samples.

## RESULTS

225 out of 400 patients were positive for PCa after mpMRI-PB, with PCa diagnosed in 55/62 PI-RADS 5 (88.7%), 136/188 PI-RADS 4 (72.3%), 33/127 PI-RADS 3 (25.9%) and 1/23 PIRADS 2 lesions (4.3%). The first sample was positive for PCa in just 117 cases. After manual adjustment, an additional 108 positive biopsies were obtained, corresponding to an increase in the detection rate of 92.3% ( $p < 0.0001$ ; McNemar's Test). The core involvement averaged 50.3% (range 1-100%). To date, 101 of the 225 PCa patients have undergone surgery, with an average lesion diameter in the surgical specimen of 15.7 mm (range 5-40mm).

## CONCLUSION

Manual adjustment of needle trajectory significantly improves the detection rate of PCa when performing mpMRI-PB.

## CLINICAL RELEVANCE/APPLICATION

mpMRI guided prostate biopsy is associated with an improvement of detection rate of prostate cancer after manual adjustment of needle trajectory.

### SSC07-04 Deep Learning-Based Automated Segmentation of Prostate Cancer on Multiparametric MRI: Comparison with Experienced Uroradiologists

Monday, Dec. 2 11:00AM - 11:10AM Room: E260

#### Participants

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## PURPOSE

To compare the performance of deep learning based prostate cancer (PCa) segmentation with manual segmentation of experienced urologists.

#### **METHOD AND MATERIALS**

From 2011 Jan to 2018 Apr, 350 patients who underwent prostatectomy for prostate cancer were enrolled retrospectively. To collect histopathological ground truth, pathologic slides of whole resected prostate were scanned and PCa lesions were drawn by a uropathologist with 25 years' experience. With reference to the histopathological lesion, radiological ground truth of PCa was drawn on the T2 weighted image by a urologist with 19 years' experience. A U-Net type deep neural network, in which the encoder part has more convolution blocks than the decoder, was trained for segmentation. Four different MR sequences including T2 weighted images, diffusion weighted images ( $b = 0, 1000$ ), and apparent diffusion coefficient (ADC) images, were used as input images after affine registration. Besides the automatic segmentation by the deep neural network, two experienced urologists marked suspected sectors of PCa among 39 sectors provided by PIRADS-v2 after reviewing same images of four MR sequences. The manual segmentation performance of urologists was measured using the number of sectors that coincided with the ground truth PCa lesion.

#### **RESULTS**

The dice coefficient scores (DCSs) achieved by two urologists were 0.490 and 0.310 respectively. The DCS was calculated based on the number of sectors. The DCS of automatic segmentation by a deep neural network was 0.558 (calculated by the number of pixels) which is slightly better than the average (0.40) DCSs of urologists.

#### **CONCLUSION**

Automated segmentation of PCa on multiparametric MR based on histopathologically confirmed lesion label achieved comparable performance with experienced urologist.

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

The automated segmentation of prostate cancer using a deep neural network not only reduce time consuming work but also provide reliable location and size information required for treatment decision.

#### **SSC07-05 Multiparametric MRI Can Exclude Prostate Cancer Progression in Patients Under Active Surveillance**

Monday, Dec. 2 11:10AM - 11:20AM Room: E260

##### **Participants**

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#### **PURPOSE**

To assess the ability of multiparametric MRI (mp-MRI) of the prostate to exclude prostate cancer (PCa) progression in patients under active surveillance.

#### **METHOD AND MATERIALS**

One hundred and forty-seven consecutive patients under active surveillance with known PCa with a Gleason score of 3+3=6 or 3+4=7a were initially enrolled and received mp-MRI (T2WI, DWI, DCE-MRI) of the prostate at 3T. Of these patients, fifty-five received follow-up MRI after a minimum interval of 12 months with subsequent targeted MR/US fusion-guided (FUS-GB) plus systematic transrectal ultrasound-guided (TRUS-GB) biopsy. Primary endpoint was negative predictive value (NPV) of the follow-up mp-MRI to exclude tumor progression. Secondary endpoints were positive predictive value (PPV), sensitivity, specificity, and cancer upgrade after initial mp-MRI.

#### **RESULTS**

Of 55 patients 28 (51%) had a Gleason score upgrade in the re-biopsy. All of the 28 patients showed findings in the follow-up mp-MRI that were suspicious of tumor progress. 16 of 55 patients (29%) showed signs of tumor progress in the follow-up MRI but had a stable re-biopsy. 11 of 55 patients (20%) showed no signs of progress in follow-up MRI and none of these patients had a Gleason score upgrade in the re-biopsy. NPV was 100%. PPV was 64%. Sensitivity was 100% and specificity 59%.

#### **CONCLUSION**

MP-MRI can reliably exclude PCa progression in patients under active surveillance. Over 60% of the patients with signs of tumor progress in follow-up mp-MRI had a Gleason score upgrade in repeat biopsy.

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

Patients under active surveillance should receive follow-up MRI to monitor tumor progress. Standard re-biopsy protocols might be waived if follow-up mp-MRI is stable.

#### **SSC07-06 Post-ablation Prostate Imaging Reporting and Data System (PAPI-RADS): Preliminary Results at 12 Months After Whole-Gland MRI-Guided Transurethral Ultrasound Ablation (TULSA)**

Monday, Dec. 2 11:20AM - 11:30AM Room: E260

##### **Participants**

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**PURPOSE**

PI-RADS v2 criteria do not specifically address evaluation of the prostate gland after non-surgical treatment. We present a modified scoring system for MRI detection of prostate cancer (PCa) in the post-ablation setting (PAPI-RADS), comparing the preliminary diagnostic performance of PAPI-RADS and PI-RADS v2 against histopathology.

**METHOD AND MATERIALS**

PAPI-RADS was defined by consensus among radiologists participating in an IRB-approved, HIPAA-compliant 13-center pivotal trial of whole-gland MRI-guided transurethral ultrasound ablation (TULSA) in 115 men with PCa. The proposed system uses a 5-point likelihood score for residual/recurrent PCa, with the same MRI acquisition parameters recommended by PI-RADS v2. PAPI-RADS criteria give emphasis to focal early enhancement on dynamic contrast-enhanced images, over abnormal T2-weighted hypointensity or diffusion restriction. We present the interpretation by 13 on-site radiologists, in addition to a separate blinded central radiologist who scored all 12-month MRIs according to PI-RADS v2 and PAPI-RADS. Diagnostic accuracy was assessed against histopathology obtained at 12-month post-ablation 10-core biopsy.

**RESULTS**

At time of this submission, local PI-RADS v2 was available for 111/111 men with 12-month MRI and biopsy, central PI-RADS v2 for 76/111. At 12 months, local and central radiologists identified PI-RADS v2 score  $\geq 3$  and  $\geq 4$  lesions in 28/111 (25%) and 13/111 (12%) men, vs. 23/76 (30%) and 15/76 (20%) men, respectively. Local and central PAPI-RADS was available for 55/111 and 29/55 men, with score  $\geq 3$  and  $\geq 4$  lesions identified in 12/55 (22%) and 9/55 (16%) of men, vs. 7/29 (24%) and 5/29 (17%). Preliminary diagnostic performance of both criteria against 10-core biopsy (median sampling density 1.0 cores/cc) are listed in Table 1, with higher negative predictive values for PAPI-RADS (local: 96% vs. 89% for score  $\geq 4$ , central: 92% vs. 90%). Results from all patients will be available in December.

**CONCLUSION**

Preliminary results of 12-month post-ablation mpMRI with the proposed PAPI-RADS scoring system provided improved diagnostic performance for detection of prostate cancer over PI-RADS v2.

**CLINICAL RELEVANCE/APPLICATION**

PI-RADS v2 was designed for treatment-naïve prostates. The proposed modified post-ablation MRI criteria improves accuracy by addressing prostate tissue changes following ablative therapy for PCa.

**SSC07-07 Pivotal Trial of MRI-Guided Transurethral Ultrasound Ablation (TULSA) in Patients with Localized Prostate Cancer**

Monday, Dec. 2 11:30AM - 11:40AM Room: E260

**Participants**

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**PURPOSE**

MRI-guided transurethral ultrasound ablation (TULSA) is an incision-free method for customized prostate ablation using directional ultrasound under MRI thermometry feedback control. We report 12-month (12mo) outcomes from the TULSA-PRO Ablation Clinical Trial (TACT) Pivotal study.

**METHOD AND MATERIALS**

TACT enrolled 115 men with localized prostate cancer at 13 sites. Treatment intent was whole-gland ablation sparing the urethra and urinary sphincter. Primary endpoints were adverse events and proportion of men with PSA reduction  $\geq 75\%$ . Secondary endpoints included 12mo 10-core biopsy, mpMRI, prostate volume reduction, and quality of life.

**RESULTS**

Median (IQR) age was 65 (59-69) years and PSA 6.3 (4.6-7.9) ng/ml. Pre-treatment, 72/115 (63%) men had Grade Group 2 (GG2) disease. PI-RADSv2 score  $\geq 3$  lesions were present in 98/115 (85%) men,  $\geq 4$  in 77 (67%). Ablation times were 51 (39-66) min for targeted prostate volumes of 40 (32-50) cc. MRI thermometry during treatment indicated 98% (95-99%) thermal coverage with ablation precision of  $\pm 1.4$  mm, confirmed qualitatively by post-treatment CE-MRI. Grade 3 adverse events occurred in 8% of men (all resolved), with no rectal injuries or Grade  $\geq 4$  events. At 12mo, 1% of men were incontinent ( $>1$  pad/day), and 69/92 (75%) maintained erections sufficient for penetration (IIEF Q2  $\geq 2$ ). PSA reduction  $\geq 75\%$  was achieved in 110/115 (96%), with median reduction of 95% and nadir of 0.34 ng/ml. Median perfused prostate volume decreased from 41 to 4 cc at 12mo MRI. Of 68 men with baseline GG2 disease, 54 (79%) were free of GG2 on 12mo biopsy. Overall, 72/111 (65%) had no evidence of any cancer. Of 98 men with PI-RADSv2  $\geq 3$  at baseline, 26 had MRI lesions at 12mo, 11/26 with biopsy-confirmed GG2 (negative predictive value, NPV 93%). Multivariate predictors of residual GG2 included intraprostatic calcifications at screening, MRI thermal coverage of target volume, and PI-RADSv2  $\geq 3$  at 12mo ( $p < 0.05$ ).

**CONCLUSION**

The TACT Pivotal study of MRI-guided TULSA for whole-gland ablation in men with localized prostate cancer met its primary PSA endpoint in 96% of patients, with low rates of severe toxicity and residual GG2 disease. MRI at 12mo detected residual disease with NPV of 93%.

**CLINICAL RELEVANCE/APPLICATION**

Whole-gland ablation using MRI-guided TULSA achieves predictable PSA and prostate volume reduction. Multiparametric MRI is promising for post-TULSA follow-up.

**SSC07-08 Early Diffusion and Perfusion Changes of Prostate Cancer on IVIM MR Imaging after ADT Therapy**

Monday, Dec. 2 11:40AM - 11:50AM Room: E260

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**PURPOSE**

To investigate the usefulness of intravoxel incoherent motion (IVIM) MR in early detection of therapeutic changes from androgen deprivation therapy (ADT) in prostate cancer patients.

**METHOD AND MATERIALS**

MR examinations in 22 patients with advanced prostate cancer were performed before and three months after ADT treatment, using a 3.0T system (Ingenia, Philips Healthcare) equipped with a 16-channel body coil. The imaging protocol included axial T1WI, axial T2WI, coronal T2WI and axial IVIM. The IVIM was performed at 11 b values of 0, 10, 20, 30, 50, 75, 100, 250, 500, 750 and 1000s/mm<sup>2</sup>. T2WI and IVIM images were qualitatively reviewed by an experienced radiologist. The prostate-specific antigen (PSA) levels were also assessed. The diffusion coefficients (D), perfusion fractions (f) and the perfusion-related diffusion Coefficient (D\*) values were quantitatively measured in the prostate cancer area and bone metastasis. Changes in these IVIM measurements between pre- and post-treatment timepoints were evaluated using a paired Student t test.  $P < 0.05$  indicated a significant difference.

## RESULTS

Prostate and tumor volume of the patients showed different degrees of reduction after ADT therapy except for 3 patients. T2-weighted images signal was diffusely reduced after therapy. The signal intensities of most cancerous and non-cancer areas were visually similar. The mean PSA level was significantly reduced. At 3 months after treatment, the D value of cancer area  $((0.902 \pm 0.118) \times 10^{-3} \text{ mm}^2/\text{s})$  was significantly increased as compared with the pretreatment value  $((0.585 \pm 0.142) \times 10^{-3} \text{ mm}^2/\text{s})$ , ( $p < 0.001$ ). The f value of cancer area  $(0.299 \pm 0.074)$  was significantly increased compared with the pretreatment one  $(0.254 \pm 0.064)$  ( $P < 0.05$ ). The D and f value of bone metastases was significantly increased after treatment ( $P < 0.05$ ). D\* showed no significant changes before and after treatment.

## CONCLUSION

T2WI images after ADT therapy are of little value for determining the location and boundary of the tumor. The IVIM MR allows non-invasive quantitative characterization of biological changes (both diffusion and perfusion fraction) of prostate cancer after treatment. This technique may potentially be useful for the evaluation of therapeutic effect and risk for recurrence.

## CLINICAL RELEVANCE/APPLICATION

It may have potential technique in the evaluation of therapeutic effect and early prediction of efficacy.

## SSC07-09 Baseline Multiparametric MRI Characteristics of Exceptional Pathologic Response to Neoadjuvant Enzalutamide for High-Risk, Localized Prostate Cancer

Monday, Dec. 2 11:50AM - 12:00PM Room: E260

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## PURPOSE

To assess multiparametric MRI (mpMRI) characteristics of high-risk prostate cancer patients demonstrating minimal residual disease (MRD) at radical prostatectomy (RP) after neoadjuvant androgen deprivation therapy (ADT) + enzalutamide.

## METHOD AND MATERIALS

Patients with untreated high risk prostate cancer enrolled on a clinical trial evaluating neoadjuvant ADT + enzalutamide (160mg/day), receiving mpMRI at baseline and 6-months post-treatment followed by RP. RP specimens were sectioned in same plane as MR using a patient-specific 3D printed mold. Fixed tissue sections of baseline biopsy and tumor on RP specimens were stained, laser capture microdissected, and analyzed using whole exome sequencing to define clonally independent tumors. Non-responding tumors were pathologically defined by residual tumor burden  $>0.05 \text{ cc}$ , measured by an expert GU pathologist. All mpMRI imaging was interpreted by a single expert radiologist. Regions encompassing suspected lesions were contoured at baseline and follow-up. Quantitative characteristics including volume, Apparent Diffusion Coefficients (ADC), and perfusion (Ktrans; calculated using a two compartment Tofts model with standardized arterial input function) were collected. Association between metrics and residual disease was evaluated using appropriate nonparametric statistical testing.

## RESULTS

31 patients completed all imaging and RP, with 49 lesions detected on baseline mpMRI, of which 39 remained measurable at 6-month follow-up imaging. Two patients had at least 2 clonally independent lesions distinguishable on baseline imaging showing differential response at RP assessment. Lesion burden at both mpMRI timepoints was strongly associated with residual cancer (N=16) on pathology ( $p=0.002$  vs  $p=0.003$ , respectively). Baseline summary diffusion (ADC) and perfusion (Ktrans) characteristics showed modest association to residual disease, further enhanced when assessing heterogeneity of signal intensity (ADCentropy 0.003, Ktrans,entropy 0.056).

## CONCLUSION

While quantitative mpMRI metrics have shown correlation to Gleason grading and disease burden in untreated cases, distinct features also correlate with likelihood of residual cancer burden after intensive neoadjuvant therapy.

## CLINICAL RELEVANCE/APPLICATION

Selection of patients based on these parameters may improve overall responses to treatment in subsequent clinical trials.



SSC08

## Informatics (Artificial Intelligence: Bleeding Edge)

Monday, Dec. 2 10:30AM - 12:00PM Room: E450A

IN AI

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

FDA Discussions may include off-label uses.

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### Sub-Events

#### SSC08-01 MULAN: Multitask Universal Lesion Analysis Network for Joint Lesion Detection, Tagging, and Segmentation in CT Images

Monday, Dec. 2 10:30AM - 10:40AM Room: E450A

### Participants

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### PURPOSE

We present and validate an integrated algorithm which can detect, predict multiple tags (attributes), and segment a variety of lesions on CT images.

### METHOD AND MATERIALS

When reading medical images such as a CT scan, radiologists generally search across the image to find lesions, characterize and measure them, and then describe them in the report. We aim to automate this process with an end-to-end framework. We propose a multitask universal lesion analysis network (MULAN) for joint detection, tagging, and segmentation of lesions in a variety of body parts. MULAN is based on an improved Mask R-CNN with a backbone CNN and three head branches. In the backbone, we adopt DenseNet-121 and use the feature pyramid strategy to encode fine-level detail information. We also propose a 3D feature fusion strategy to add 3D context information in the backbone. The detection branch and segmentation branch are similar to those in Mask R-CNN. In the tagging branch, we predict scores for 185 tags describing the body part, type, and attributes of the lesions. We also propose a score refinement layer in MULAN to fuse the detection and tagging scores since they are correlated. To train MULAN, we use the DeepLesion dataset which contains 32K lesions in a variety of body parts on CT. We extract tags from DeepLesion's associated radiology reports to train the tagging branch. The long and short axes of the RECIST diameters in DeepLesion are used to generate pseudo-masks to train the segmentation branch.

### RESULTS

In the test set of DeepLesion, MULAN achieved a detection sensitivity of 84.83% at 1 false positive per image, whereas the previous state-of-the-art is 73.37%. For lesion tagging, MULAN's AUC is 96.01%. We also computed the lesions' RECIST diameters based on the segmentation results and got an absolute error of 1.97+-2.24mm. We further analyzed the interaction between the three tasks and discovered that: 1) Tag predictions improved detection accuracy via the score refinement layer; 2) The detection task improved tagging accuracy but impaired segmentation performance.

### CONCLUSION

We proposed an algorithm for joint lesion detection, tagging, and segmentation in diverse CT images with good accuracy.

### CLINICAL RELEVANCE/APPLICATION

The proposed framework is helpful for radiologists to find, characterize, and measure lesions in CT images.

#### SSC08-02 AUC and Enriched Datasets are Not Good Enough Anymore: Presenting an Alternative Metric to Evaluate Radiology AI Models



#### Participants

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#### PURPOSE

Area under receiver operating curve (AUC) is commonly used to evaluate and select artificial intelligence (AI) models for radiology. Artificially balanced/enriched datasets are also usually used to estimate AUC to maximize confidence interval to sample size ratio. In this work, we show that such evaluation of model performance has reached saturation and propose alternate performance evaluation schemes.

#### METHOD AND MATERIALS

Receiver operating curve (ROC) is a curve where false positive rate (1 - specificity) and sensitivity of model at different thresholds are plotted on x and y-axes respectively. Similarly, precision recall curve (PRC) is plotted with recall (sensitivity) and precision (positive predictive value) on x and y-axes respectively. AUC is defined as area under ROC while average precision (AP) is defined as area under PRC. To illustrate the proposed evaluation scheme, two different high-performance models to detect fractures from head CT scans were created. In addition, two datasets were created by uniformly sampling scans and artificially enriching scans with fractures respectively. AUCs and APs were computed for the model-dataset pairs. We propose that AP computed on uniformly sampled dataset is more useful for model selection than other options.

#### RESULTS

AUCs for all four (model, dataset) pairs were >92%. For both the datasets, difference in AUCs between the models was less than 3%. APs on enriched dataset were high for both models (95% & 92% respectively). However, APs on uniformly sampled dataset were lower than expected (80% & 69% respectively). The difference in models' performance was the highest (difference of 11%) when performance was measured using AP on uniformly sampled dataset.

#### CONCLUSION

AUC, although a commonly used performance metric for models, saturates early. Therefore, it is not suitable for model selection among high performance models (i.e. AUC > 0.9). Similarly, model selection using artificially enriched datasets is not a good practice as both AUC and AP saturate early. Average precision measured on a uniformly sampled dataset shows the deficiencies in models' performance well and therefore, is a better metric for model selection.

#### CLINICAL RELEVANCE/APPLICATION

Average precision and uniformly sampled datasets should be used to evaluate artificial intelligence models in radiology instead of AUC and enriched datasets.

### SSC08-03 Effectiveness of Multi-Class Pretraining to Improve Performance of Deep Learning Models for Radiography

Monday, Dec. 2 10:50AM - 11:00AM Room: E450A

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#### PURPOSE

To compare the performance of deep learning models initialized with 2 pretraining strategies: 1) with general object classification ImageNet and 2) with acuity and body part prediction on RhodyNet.

#### METHOD AND MATERIALS

The RhodyNet database consisted of 285,565 radiographs across 136,761 studies performed at 3 hospitals for any indication. CNNs were trained to predict both a radiologist-assigned acuity score and the body region imaged. We evaluated the DenseNet121 (D121) and InceptionV3 (IV3) architectures on 2 tasks with publicly available datasets: pneumonia detection (RSNA) and musculoskeletal abnormality detection (MURA). All models were trained using the same training schedule, with data augmentation and early stopping on a held-out validation set. The standard area under the receiver operating characteristic curve (AUC) was used to compare model performance for pneumonia and musculoskeletal abnormality detection. To study the data efficiency of each initialization strategy, for each task we randomly sampled the training set at progressively larger sizes, doubling after each trial from n=100 up to n=X, the size of the training set, and compared model performance when trained with each sampled training set.

#### RESULTS

Pneumonia detection: When less than 3200 training examples are provided, for D121 and IV3 RhodyNet weights outperformed

ImageNet weights by 2.0-7.0% and 1.8-6.3%, respectively. With at least 6400 examples, ImageNet weights outperformed RhodyNet weights by 0.3-0.6% (D121) and 0.7-1.4% (IV3). Musculoskeletal abnormality detection: For D121, RhodyNet weights outperformed ImageNet weights up to n=6400 by 0.4-14.6%, after which a 0.3-2.1% decline was observed. For IV3, RhodyNet weights outperformed ImageNet weights by 0.7-17.0%, except for n=1600 (-0.1%) and n=3200 (-0.6%).

## CONCLUSION

Models initialized with RhodyNet weights outperformed their ImageNet counterparts at lower training set sizes for the pneumonia and musculoskeletal abnormality detection tasks. As the training set increased, the performance gap decreased, shifting slightly in favor of ImageNet weights. Our RhodyNet weights and experiments will be made publicly available.

## CLINICAL RELEVANCE/APPLICATION

Multi-class learning on clinical images can substantially boost performance of clinical deep learning models with smaller training sets.

### SSC08-04 Can Machine Learning Algorithm Detect and Classify Specific Abnormalities on Frontal Chest Radiographs?

Monday, Dec. 2 11:00AM - 11:10AM Room: E450A

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## PURPOSE

To assess accuracy of machine learning (ML) algorithm for detection and classification of abnormalities on frontal chest radiographs (CXR).

## METHOD AND MATERIALS

The ML prototype (DNetLoc, not commercially available) was trained for detection and classification of chest radiographic findings on 112,120 frontal projection CXR from the NIH CXR14 data and 185,421 frontal CXR from the Prostate, Lung, Ovarian, and Colon Cancer (PLCO) data. Then, we processed separate 689 de-identified CXR from adult patients. The ML generated scores and prediction statistics and heat maps for mass, nodule, atelectasis, consolidation, pleural effusions and enlarged cardiac silhouette. Two thoracic radiologists assessed all 689 CXR in a blinded fashion for presence or absence of these findings. Descriptive statistics and free-choice receiver operating characteristics analyses were performed.

## RESULTS

About 51% (350/689), 25% (172/689) and 24% (167/689) CXR had no, single and multiple findings, respectively. Distribution of findings was: pleural effusion (130/689, 19%), enlarged cardiac silhouette (117/689, 17%), atelectasis (149/689, 22%), nodule (102/689, 15%), consolidation (62/689, 9%), and mass (44/689, 6%). The area under the curve (AUC), sensitivities and specificities with optimized cut-off prediction scores were: pleural effusion (0.94, 0.93, 0.81), enlarged cardiac silhouette (0.93, 0.88, 0.84), atelectasis (0.83, 0.73, 0.82), consolidation (0.85, 0.81, 0.76), mass (0.86, 0.89, 0.68) and nodule (0.77, 0.62, 0.81).

## CONCLUSION

The ML algorithm accurately detects and classifies CXR abnormalities with higher accuracy for pleural effusion and cardiac silhouette than the pulmonary findings.

## CLINICAL RELEVANCE/APPLICATION

The ML algorithm has high accuracy for evaluation of CXR abnormalities and can serve as a second reader for radiologists to improve their accuracy.

### SSC08-05 Predicting Outcomes After Uterine Fibroid Embolization with Deep Learning Based on Magnetic Resonance Imaging

Monday, Dec. 2 11:10AM - 11:20AM Room: E450A

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**PURPOSE**

To develop and validate a deep learning model based on routine pre-procedure magnetic resonance imaging to predict volume reduction and clinical outcome of uterine fibroid embolization.

**METHOD AND MATERIALS**

Clinical data were collected on patients treated with uterine artery embolization for fibroids at a large academic center from 2007 to 2018. Only patients with both pre and post-procedure magnetic resonance imaging were included. The fibroids for each patient was manually segmented by an abdominal radiologist on T2-weighted and post-contrast T1-weighted sequence of pre and post-procedure magnetic resonance imaging, and fibroid size reduction was calculated as percentage change in fibroid volume after uterine fibroid embolization. A residual convolutional neural network model to predict fibroid volume reduction and clinical outcome was trained using pre-procedure magnetic resonance images.

**RESULTS**

The inclusion criteria were met by 727 fibroids in 409 patients. The average clinical follow up time was 116 days. Of the 727 fibroids, 76.2% (n=554) had a volume reduction of 10% or more, and 23.8% (n=173) had a volume reduction under 10% or increased in size. At clinical follow-up, 85.6% (n=350) of the 409 patients (590 of 727 fibroids, 81.1%) experienced symptom resolution or improvement, and 14.4% (n=59) patients (137 of 727 fibroids, 18.9%) no improvement or worsening symptom. The final ensemble model combining T2-weighted images, post-contrast T1-weighted images and clinical variables achieved a test accuracy of 78.1%, F1 score of 0.875, and area under the precision-recall curve of 0.865 in predicting volume reduction and a test accuracy of 84.7%, F1 score of 0.912, and area under the precision-recall curve of 0.916 in predicting clinical outcome.

**CONCLUSION**

Deep learning based on routine pre-procedure magnetic resonance imaging has potential in predicting outcomes post uterine fibroid embolization. This will help clinicians identify patients who benefit the most from this therapy.

**CLINICAL RELEVANCE/APPLICATION**

Deep learning based on routine pre-procedure MRI has potential in predicting outcomes post uterine fibroid embolization and help clinicians identify patients who benefit the most from this therapy.

**SSC08-06 Thyroid Nodule Classification by Ultrasound Images Based on Clinical-Experience Guided Network**

Monday, Dec. 2 11:20AM - 11:30AM Room: E450A

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**PURPOSE**

Deep neural network models are currently facing problems in medical image analysis due the weak interpretability of predicted results, which is important in evidence-based medicine. Therefore, an interpretable classification model based on clinical-experience guided loss function is proposed in this paper.

**METHOD AND MATERIALS**

In order to incorporate clinical knowledge into the classification model, we propose a multitask model. One task is the classification of benign and malignant tumor of thyroid (carcinoma classification task); and the other one is clinical features classification (TI-RADS task) based on Thyroid Imaging, Reporting and Data System (TI-RADS) such as irregular, hyperechoic, etc. We take turns in training in two groups of datasets: pathological labeled (benign or malignant) group and clinical features labeled group. The pathological labeled datasets was used to train both carcinoma classification task and TI-RADS task. Clinical features label is absent in pathological labeled datasets. Objective functions of TI-RADS task was minimizing the distance between the predicted value of carcinoma classification task ( $P_{\text{malignant}}$ ), and predicted value of TI-RADS task ( $P_{\text{tirads}}$ ). The  $P_{\text{tirads}}$  was defined as the  $\sum_{k \in \text{set } C} P_k + \sum_{k \in \text{set } C} (1 - P_k)$ , where  $C = \{k_1, k_2, \dots, k_n\}$  is a combination of clinical features under which the output TI-RADS grad is most similar to  $P_{\text{malignant}}$  (the best combination). The candidate combinations is determined based on clinical knowledge. The clinical features labeled dataset was used to train TI-RADS task only and was seriously unbalanced. Therefore, a rotation training was proposed for TI-RADS task.

**RESULTS**

A multicenter dataset consisting of 14,867 images from 5,131 patients (14,420 for training dataset and 647 for test dataset) was

analyzed. The clinical-experience guided model offered significantly improved performance (accuracy: 0.821), compared to a clinical feature detection model without pathological labeled datasets (accuracy: 0.753), and radiologists' diagnosis (average accuracy: 0.764).

## CONCLUSION

In this paper, we propose a novel clinical-experience guided model for thyroid nodules classification based on ultrasound images. It was an effective interpretable classification method for clinical application.

## CLINICAL RELEVANCE/APPLICATION

The research proposed an interpretable machine learning model, which makes the machine learning model suitable for the evidence-based medicine.

### SSC08-07 Detection of Lung Cancer in subjects with Positive Screening CT Scans in the National Lung Screening Trial (NLST) Dataset by Leveraging the Lung Image Database Consortium (LIDC-IDRI) Dataset

Monday, Dec. 2 11:30AM - 11:40AM Room: E450A

#### Participants

Pritam Mukherjee, PhD, Stanford, CA (*Presenter*) Nothing to Disclose

Anna Brezhneva, Menlo Park, CA (*Abstract Co-Author*) Technical Product Manager

Sandy Napel, PhD, Stanford, CA (*Abstract Co-Author*) Medical Advisory Board, Fovia, Inc; Scientific Advisor, EchoPixel, Inc; Scientific Advisor, RADLogics, Inc

Olivier Gevaert, PhD, Stanford, CA (*Abstract Co-Author*) Nothing to Disclose

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## PURPOSE

To develop a model for non-invasive determination of the likelihood of lung cancer among NLST subjects with positive CT screening exams with lung nodules > 4 mm in diameter based on current and previous CT scans only.

## METHOD AND MATERIALS

Among the 7096 patients who screened positive at the first screening time-point T0 with lung nodules > 4 mm in diameter from the CT arm of the NLST, we selected a cancer-positive (C+) cohort of 620 subjects (M: 357, F: 263, ages 64±5 yrs) who were diagnosed with cancer during the study, and a cancer-negative (C-) cohort of 620 (M: 357, F: 263, ages 64±5 yrs) subjects who were never diagnosed with cancer during the study but were demographically matched to the cancer-positive cohort. Excluding patients with unavailable or low-quality CT scans, we had 553 and 585 subjects in the C+ and C- cohorts, respectively. Next, we built a two-stage Machine Learning (ML) model for cancer prediction using CT images in three ways by using one, two and three screening time-points, respectively. The first ML stage, common to all three models, is a Convolutional Neural Network (CNN) for detecting nodules and predicting malignancy scores, trained on a subset of the LIDC-IDRI dataset. The second ML stage uses Xgboost to predict cancer probability using the locations and malignancy scores of the subject's lung nodules predicted by the first stage. We used a 50:50 train-test split for training and evaluating the Xgboost model. We repeated this for 1000 random splits to obtain robust performance estimates for cancer prediction.

## RESULTS

The areas under the receiver operating characteristics curves improved significantly ( $p < 0.01$ ) from 0.75 ( $\pm 0.03$ , 95% CI) when predicting based on CT scans from one time-point to 0.80 ( $\pm 0.03$ ) when predicting based on scans from two time-points, to 0.85 ( $\pm 0.02$ ) when predicting on scans from all three time-points in the NLST.

## CONCLUSION

It is possible to predict whether a subject with lung nodules > 4 mm has or will develop cancer in subsequent years based on screening lung CT scans only. Further, the prediction performance improves if CT imaging data from multiple screening time-points are incorporated into the model.

## CLINICAL RELEVANCE/APPLICATION

CT screening for lung cancer has a high false positive rate leading to unnecessary follow-up procedures. Our model may reduce the numbers of false positive screens, resulting in less cost and risk for patients with screen-detected lung cancer.

### SSC08-08 Accelerating Whole-Body Diffusion-Weighted MRI with Artificial Intelligence

Monday, Dec. 2 11:40AM - 11:50AM Room: E450A

#### Participants

Konstantinos Zormpas-Petridis, London, United Kingdom (*Presenter*) Nothing to Disclose

Nina Tunariu, MD, Sutton, United Kingdom (*Abstract Co-Author*) Nothing to Disclose

Christina Messiou, MD, BMBS, London, United Kingdom (*Abstract Co-Author*) Nothing to Disclose

Dow-Mu Koh, MD, FRCR, Sutton, United Kingdom (*Abstract Co-Author*) Nothing to Disclose

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## PURPOSE

Whole-body diffusion-weighted imaging (WBI) is the current state-of-the-art for monitoring patients with metastatic bone disease. Scans last approximately 30 minutes as 9-12 repeat acquisitions (NEX=9-12) are needed to overcome inherent low signal-to-noise ratio (SNR). We show that artificial intelligence (AI) can be used to improve image quality of NEX=1 images, considerably reducing

WBI acquisition times.

## METHOD AND MATERIALS

WBI was acquired in 17 patients with metastatic prostate cancer at  $b=50/600/900$  s/mm<sup>2</sup> at 1.5T (NEX=1): 160-200 axial images covered skull-base to mid-thigh. This was repeated 9 times to derive the arithmetically averaged standard clinical images for each slice location (NEX=9). We trained a deep network (U-Net with linear activation function in final layer and mean absolute error cost function) to approximate NEX=9 (target) images from NEX=1 (input) images. We randomly selected 3 patients as an independent test set (15120 images) and trained the network on the remaining 14 patients (59400 images). An expert radiologist (>10 years' experience) blindly scored test images for SNR, contrast-to-noise ratio, tumor detection, image artefacts, and overall image quality (Likert scale: 1-poor to 5-excellent). The mean apparent diffusion coefficient (ADC) of bone disease (segmented on test NEX=9 images) was compared between the NEX=1, NEX=9 and AI-generated images.

## RESULTS

The AI method radiologically outperformed NEX=1 and NEX=9 images in all test patients (average Likert score across all 5 criteria 3.73 [3.6-4.0] vs 1.6 [1.2-1.8] and 2.53 [2.4-2.6] respectively), thus improving image quality. Mean ADC values measured within bone disease from AI-generated images deviated from mean disease ADC calculated from NEX=9 images by an average of 2.4% [0.6-4.5] (within previously reported repeatability limits for mean ADC measurements).

## CONCLUSION

AI can be used to improve WBI image quality and reduce acquisition times from ~30 minutes to ~5 minutes. Estimates of mean ADC within bone disease calculated from AI-generated WBI images may be sufficiently robust for monitoring treatment response.

## CLINICAL RELEVANCE/APPLICATION

Using AI can lead to better and faster WBI studies, reducing scanning costs, rendering WBI appropriate for screening studies and sparing patient time and/or discomfort.

## SSC08-09 Prediction of Future Healthcare Expenses from Chest Radiographs Using Deep Learning

Monday, Dec. 2 11:50AM - 12:00PM Room: E450A

### Awards

#### Trainee Research Prize - Medical Student

#### Participants

Yixin Chen, Ames, IA (*Presenter*) Nothing to Disclose  
Dmytro Lituiev, San Francisco, CA (*Abstract Co-Author*) Nothing to Disclose  
Thienkhai H. Vu, MD, PhD, San Francisco, CA (*Abstract Co-Author*) Nothing to Disclose  
Jae Ho Sohn, MD, San Francisco, CA (*Abstract Co-Author*) Nothing to Disclose  
Benjamin L. Franc, MD, San Francisco, CA (*Abstract Co-Author*) Nothing to Disclose  
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## CONCLUSION

We showed that our deep learning model can predict order-of-magnitude 5-year health care expenditure as well as identify top healthcare spenders with reasonable performance using chest radiographs. This suggests that our model is able to extract useful healthcare cost-associated indicators from chest radiographs.

## Background

As healthcare reimbursement models change, hospitals and healthcare providers are taking on greater risk. In negotiating contracts with payers, healthcare entities need tools to estimate healthcare expenses that their populations will incur annually; the healthcare requirement of any population can vary substantially and 50% of the total population account for about 97% of total US healthcare expenditures. We hypothesize that chest radiographs capture many general health indicators and thus may be utilized to predict future medical costs. In addition, the prediction harnessed from chest radiographs could be used for proactive preventive care for high-risk groups. To test this hypothesis, we trained two computer vision models based on chest radiographs in order to predict worth of medical treatment and identify top 50% spenders within 5 years after the chest radiographs were taken.

## Evaluation

We used 16,533 anterior-posterior chest radiographs from a single institution paired with the corresponding patient's total spending within the following 5 years. The training set, consisting of 13775 images, was augmented by random adjustment of brightness, inversion, and rotation. For both classification and regression, a Resnet152 model, initialized with weights pretrained on ImageNet was used for feature extraction. For classification, cross-entropy loss function is used. For regression, two more affine layers were added before the mean squared loss (MSE). After hyperparameter tuning and training, the models were validated against a test set consisting of 1877 samples.

## Discussion

Using our regression model we were able to predict 5-year expenditures with Spearman R of 0.67 (p-value < 1e-16) and Pearson R of 0.67 (p-value < 1e-16) in log-transformed test data. We were able to identify top-50% spenders with ROC-AUC of 0.8476, mean average precision of 0.7157, and F1 score of 0.7744.

Printed on: 10/29/20



SSC09

## Musculoskeletal (Body Composition)

Monday, Dec. 2 10:30AM - 12:00PM Room: E450B

AI MK

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

FDA Discussions may include off-label uses.

### Participants

Robert D. Boutin, MD, Davis, CA (*Moderator*) Nothing to Disclose  
Ronnie A. Sebros, MD, PhD, Boston, MA (*Moderator*) Nothing to Disclose

### Sub-Events

#### SSC09-01 Utilizing Artificial Intelligence to Determine Bone Mineral Density via Chest CT

Monday, Dec. 2 10:30AM - 10:40AM Room: E450B

### Participants

Rock Savage, Charleston, SC (*Presenter*) Nothing to Disclose  
Marly van Assen, MSc, Charleston, SC (*Abstract Co-Author*) Nothing to Disclose  
Simon S. Martin, MD, Charleston, SC (*Abstract Co-Author*) Institutional Research support, Siemens AG  
Pooyan Sahbaee, Mount Pleasant, SC (*Abstract Co-Author*) Employee, Siemens AG  
Parkwood Griffith, Charleston, SC (*Abstract Co-Author*) Nothing to Disclose  
Dante Giovagnoli, MMedSc, MS, Charleston, SC (*Abstract Co-Author*) Nothing to Disclose  
Jonathan I. Sperl, Forchheim, Germany (*Abstract Co-Author*) Employee, Siemens AG  
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U. Joseph Schoepf, MD, Charleston, SC (*Abstract Co-Author*) Research Grant, Astellas Group; Research Grant, Bayer AG; Research Grant, Bracco Group; Research Grant, Siemens AG; Research Grant, Heartflow, Inc; Research support, Bayer AG; Consultant, Elucid BioImaging Inc; Research Grant, Guerbet SA; Consultant, HeartFlow, Inc; Consultant, Bayer AG; Consultant, Siemens AG; ; ;

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### PURPOSE

To validate the efficacy of an artificial intelligence (AI) prototype application in determining bone mineral density (BMD) from chest computed tomography (CT) as compared to dual-energy X-ray absorptiometry (DEXA).

### METHOD AND MATERIALS

In this IRB-approved study, we analyzed data of 65 patients (57 female, mean age: 67.4 years) who underwent both DEXA and chest CT (mean time between scans: 1.31 years). From the DEXA studies, T-scores for L1-L4 (lumbar vertebrae 1-4) were recorded. Patients were then divided based on their T-scores into normal control, osteopenic, or osteoporotic groups. An AI algorithm based on wavelet features, AdaBoost, and local geometry constraints independently localized thoracic vertebrae from chest CT studies and automatically computed average Hounsfield Unit (HU) values with kVp-dependent spectral correction. Pearson's correlation evaluated the correlation between the T-scores and HU values. Mann-Whitney U test was implemented to compare the HU values of normal control versus osteoporotic patients.

### RESULTS

Overall, the DEXA-determined T-scores and AI-derived HU values showed good correlation ( $r = 0.55$ ;  $p < 0.001$ ). The patient population was divided into three subgroups based on their T-scores. The mean T-scores for the three subgroups (normal control, osteopenic, osteoporotic) were  $0.77 \pm 1.50$ ,  $-1.51 \pm 0.04$ , and  $-3.26 \pm 0.59$ , respectively. The mean DEXA-determined L1-L4 BMD measures were  $1.13 \pm 0.16$  g/cm<sup>2</sup>,  $0.88 \pm 0.06$  g/cm<sup>2</sup>, and  $0.68 \pm 0.06$  g/cm<sup>2</sup>, respectively. The mean AI-derived attenuation values were  $145 \pm 42.5$  HU,  $136 \pm 31.82$  HU, and  $103 \pm 16.28$  HU, respectively. Using these AI-derived HU values, a significant difference was found between the normal control patients and osteoporotic group ( $p = 0.045$ ).

### CONCLUSION

Our results show that this AI prototype can successfully determine BMD in good correlation with DEXA. Combined with other AI algorithms directed at evaluating cardiac and lung diseases, this prototype may contribute to future comprehensive preventative care based on a single chest CT.

### CLINICAL RELEVANCE/APPLICATION

This AI prototype may be able to successfully screen for osteoporotic disease using chest CT.

## SSC09-02 Significance of Acquisition Parameters for Adipose Tissue Quantification on Computed Tomography

Monday, Dec. 2 10:40AM - 10:50AM Room: E450B

### Participants

Amelie S. Troschel, Boston, MA (*Presenter*) Nothing to Disclose  
Fabian M. Troschel, Boston, MA (*Abstract Co-Author*) Nothing to Disclose  
George Fuchs, Berlin, Germany (*Abstract Co-Author*) Nothing to Disclose  
Jan P. Marquardt, Boston, MA (*Abstract Co-Author*) Nothing to Disclose  
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### PURPOSE

To evaluate the effect of tube current, kVp, intravenous contrast and slice thickness on computed tomography (CT) adipose tissue measurements.

### METHOD AND MATERIALS

Cross-sectional area (CSA) and mean attenuation of subcutaneous (SAT), intermuscular (IMAT) and visceral adipose tissue (VAT) were measured with threshold-based segmentation (-190 to -30 HU) on 244 axial CT images. Images were obtained at the level of the third lumbar vertebral body in 105 adult patients on the same day and on the same scanner, and varied only with regards to one parameter, either tube current (diagnostic vs. low dose), tube potential (100kVp vs. 150kVp), presence of intravenous contrast (non vs. portal-venous phase) or slice thickness (2mm vs. 5mm). Differences were evaluated using mean or median differences, paired t-tests or Wilcoxon signed rank tests, as applicable, and the Bland Altman approach. Intra- and inter-reader agreement was assessed.

### RESULTS

Diagnostic scans had a median effective mAs of 313.5 (IQR 274-348.25) and low dose scans had a median effective mAs of 33 (IQR 33-90), both at 120kVp. Compared to diagnostic scans, low dose technique significantly affected adipose tissue CSA (SAT -3.2%; VAT -12.55%; IMAT +58.8%; all  $p<0.001$ ) and attenuation (-2.4% to -8.7%; all  $p<0.001$ ). Higher tube potential also significantly affected CSA (IMAT +8.8%;  $p=0.006$ ; SAT -5.6%;  $p<0.001$ ; VAT -2.8%;  $p=0.001$ ) and attenuation (+6.2% to +20.8%; all  $p<0.001$ ). Presence of intravenous contrast significantly reduced CSA (SAT -0.7%  $p=0.04$ ; IMAT -9.3%  $p<0.001$ ; VAT  $p>0.05$ ) while increasing attenuation (+0.8% to +1.1%; all  $p<0.05$ ). Thinner slices significantly increased CSA compared to thicker slices (IMAT +17.3%  $p<0.001$ ; VAT +1.3%  $p=0.02$ ; SAT  $p>0.05$ ) and significantly decreased attenuation (-1.0% to -5.4%; all  $p<0.001$ ). Intra- and inter-reader agreement were excellent (>99% for all compartments).

### CONCLUSION

Acquisition parameters significantly and critically affect adipose tissue CSA and attenuation measurements on CT. Body composition studies need to be conducted with consistent CT scan protocols to avoid systematic error. Creation of protocol-dependent reference values should be considered.

### CLINICAL RELEVANCE/APPLICATION

The effect of mAs, kVp, IV contrast and slice thickness on CT adipose tissue measurements needs to be considered for body composition study design and data interpretation to avoid systematic error.

## SSC09-03 3T CSE-MRI Identifies Variation in Fatty Acid Composition in Subcutaneous Fat, Muscle, and Bone Marrow in Subjects with SLE, GIO, and Primary Osteoporosis

Monday, Dec. 2 10:50AM - 11:00AM Room: E450B

### Participants

Dimitri Martel, New York City, NY (*Presenter*) Nothing to Disclose  
Amit Saxena, New York, NY (*Abstract Co-Author*) Nothing to Disclose  
Michael Belmont, New York, NY (*Abstract Co-Author*) Nothing to Disclose  
Stephen Honig, MD, New York, NY (*Abstract Co-Author*) Nothing to Disclose  
Benjamin Leporq, MS, Villeurbanne, France (*Abstract Co-Author*) Nothing to Disclose  
Gregory Chang, MD, New York, NY (*Abstract Co-Author*) Nothing to Disclose

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### PURPOSE

Advances in Chemical Shift Encoded-MRI (CSE-MRI) allow assessment of the quantity and composition of adipose tissue, which permits investigation of the role of amount of fat (PDFF), saturated (SFA), poly/mono-unsaturated (PUFA/MUFA) fatty acids metabolism in diseases such as osteoporosis, muscular dystrophy, obesity, and other metabolic disorders. Our purpose was to quantify and compare the FA profile in in subcutaneous adipose tissue (SAT), muscle (MUS), and bone marrow fat (BMF) in three groups: subjects with systemic lupus erythematosus (SLE), glucocorticoids users with secondary osteoporosis and SLE (GIO), and subjects with postmenopausal osteoporosis (OP)

### METHOD AND MATERIALS

This study had institutional review board approval and written informed consent was obtained. A multi gradient echo sequence at 3T (scan time = 3:32min) was used to acquire images of the pelvis in post-menopausal women with osteoporosis (n= 20, 50.5y+/-15.6), in subjects with SLE (n=10, 52.6y+/-11.2) and in glucocorticoids users (n=13, 45.2y+/-15.4, 10 to 40mg prednisolone equivalent during at least 24 months use due to SLE). A dedicated reconstruction workflow for CSE-MRI was used to reconstruct

parametric maps and regional AT in SAT, MUS, and BMF were semi-automatic segmented by active contours and k-mean clusters. Intergroup comparisons were carried out using Kruskal-wallis test to assess differences between groups.

## RESULTS

Results Within SAT, subjects with SLE had higher SFA compared to those with GIO (+17%,  $p < 0.05$ ). Within MUS, subjects with SLE had lower SFA (-49.1%), MUFA (-47.8%), and PUFA (-57%) compared to subjects with GIO and they had lower PUFA (-72.5%) ( $p < 0.01$  for all) compared to subjects with OP. Within MUS, subjects with GIO compared to OP had higher SFA (+41%) higher MUFA (+45%) ( $p < 0.01$  for both). In addition, MUS volume of SLE subjects was lower than that of GIO subjects (-74%,  $p < 0.05$ ). Within BMF no significant difference was assessed.

## CONCLUSION

CSE-MRI can separate SAT, BMF and MUS and detect regional variation and differences in fat composition and quantity in clinically feasible scan times.

## CLINICAL RELEVANCE/APPLICATION

Chemical Shift Encoded MRI allows assessment of fatty acids in subcutaneous tissues, muscle, and bone marrow and the identification of disease-specific lipid profiles for osteoporosis and lupus.

### SSC09-04 Opportunistic CT-Imaging for Assessment of Fat-Free Muscle Fraction Predicts Outcome in Patients Undergoing Transcatheter Aortic Valve Implantation

Monday, Dec. 2 11:00AM - 11:10AM Room: E450B

#### Participants

Julian A. Luetkens, MD, Bonn, Germany (*Presenter*) Nothing to Disclose  
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Helena Lara Geissler, Bonn, Germany (*Abstract Co-Author*) Nothing to Disclose  
Alois Martin Sprinkart, MSc, Bonn, Germany (*Abstract Co-Author*) Nothing to Disclose  
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Jan-Malte Sinning, Bonn, Germany (*Abstract Co-Author*) Nothing to Disclose  
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## PURPOSE

Sarcopenia is strongly interrelated with frailty, which is considered a major risk factor for poor outcomes in patients undergoing Transcatheter Aortic Valve Implantation (TAVI). We aimed at investigating the predictive value of amount and quality of skeletal muscles, measured from preinterventional computed tomography (CT), in patients undergoing TAVI.

## METHOD AND MATERIALS

A total of 937 consecutive patients (mean age:  $81.10 \pm 6.21$  years, mean EuroSCORE II:  $6.75 \pm 6.34$  %) undergoing TAVI were retrospectively investigated. Amount and quality of skeletal muscles (including assessment of fat-free muscle fraction (FFMF)) and abdominal adipose tissue compartments were quantified from pre-interventional CT using dedicated software. 1-year survivors had a significantly higher FFMF compared to non-survivors ( $45.72 \pm 15.29\%$  vs.  $40.38 \pm 14.89\%$ ,  $P < 0.001$ ). According to their FFMF values, patients were divided into tertiles and were defined to have high ( $> 51.76\%$ ), medium ( $51.76-37.29\%$ ), and low FFMF ( $< 37.29\%$ ), respectively.

## RESULTS

Following TAVI, low FFMF was related to major bleedings (6.4% vs. 2.2% vs. 1.6%;  $P = 0.001$ ) as well as increased 1-year (20.8% vs. 14.7% vs. 9.3%,  $P < 0.001$ ), 2-year (27.2% vs. 20.4% vs. 15.7%;  $P = 0.004$ ), and 3-year mortality (30.8% vs. 24.0% vs. 19.2%;  $P = 0.009$ ). On multivariate Cox regression analysis, low FFMF (hazard ratio (HR), 2.450;  $P = 0.001$ ), medium FFMF (HR, 1.879;  $P = 0.019$ ) and EuroSCORE II (HR, 1.039;  $P < 0.001$ ) were identified as independent prognosticators of 1-year mortality.

## CONCLUSION

In this study, we propose the opportunistic determination of FFMF as a promising new imaging parameter to predict outcome in patients undergoing transcatheter aortic valve replacement. FFMF was shown to be strongly related to dismal outcomes following TAVI and was identified as an independent and strong prognosticator of 1-year mortality, outperforming several established factors for survival prognosis. The potentially outstanding value of FFMF as a biomarker of frailty is underscored by the fact that it can be easily and objectively assessed from routine preinterventional CT and therefore may have the potential to substantially improve risk stratification in patients receiving percutaneous aortic valve replacement for treatment of severe, symptomatic aortic stenosis.

## CLINICAL RELEVANCE/APPLICATION

FFMF is a strong predictor of dismal outcomes in patients undergoing TAVI. It can be easily assessed from pre-interventional CT and may be a promising new imaging parameter for outcome prediction.

### SSC09-05 ACR Database Evaluation of 67,392 Accreditation Examinations: Implications for Opportunistic CT Diagnosis of Osteoporosis

Monday, Dec. 2 11:10AM - 11:20AM Room: E450B

#### Participants

Robert D. Boutin, MD, Davis, CA (*Presenter*) Nothing to Disclose  
Andrew Hernandez, PHD, Sacramento, CA (*Abstract Co-Author*) Nothing to Disclose  
J. Anthony Seibert, PhD, Sacramento, CA (*Abstract Co-Author*) Nothing to Disclose  
Dustin Gress, MS, Reston, VA (*Abstract Co-Author*) Nothing to Disclose



Leon Lenchik, MD, Winston-salem, NC (*Abstract Co-Author*) Nothing to Disclose  
John M. Boone, PhD, Sacramento, CA (*Abstract Co-Author*) Board of Directors and Shareholder, Izotropic Imaging Corporation; Co-author with royalties, Wolters Kluwer nv; Patent agreement, The Phantom Laboratory

## PURPOSE

With the increased use of opportunistic CT, there is an unmet need for multisite assessment of quantitative biomarker integrity across imaging platforms. Our purpose is to investigate if there is a systematic bias in reported attenuation (CT number, HU) among four CT manufacturers.

## METHOD AND MATERIALS

American College of Radiology (ACR) CT accreditation phantom (Gammex model 464, module 1) data were collected retrospectively in a blinded fashion for four CT manufacturers (A: n=8,500; B: n=18,575; C: n=8,278, D: n=32,039) between January 2011 and August 2018. For each manufacturer, an adult abdomen CT technique (with typical acquisition parameters of 120 kV, 240 mA, 50-cm FOV, standard reconstruction algorithm, 5-mm reconstruction width) was used to analyze the CT number of three materials: water, acrylic (surrogate for trabecular bone), and teflon (surrogate for cortical bone). Extreme outliers (HU values > 1.5 x interquartile range) were excluded, representing < 4% of the HU measurements averaged across all manufacturer and material combinations. Comparisons were made to assess for systematic differences using a linear fixed effects regression model.

## RESULTS

The CT number of water ranged from a mean of -0.3 to 2.7 HU, with mean differences between manufacturers that were small but highly significant ( $p < 0.001$ ). For the trabecular bone surrogate, mean differences in CT numbers across all manufacturers were small but highly significant ( $p < 0.001$ ), with mean values [standard deviation, SD] of 120.9 [3.5], 124.6 [3.3], 126.9 [4.4], and 123.9 [3.4] for manufacturers A, B, C, and D, respectively. For the cortical bone surrogate, highly significant mean differences in CT numbers also were observed across all manufacturers ( $p < 0.001$ ), with mean values [SD] of 939.0 [14.2], 874.3 [13.3], 897.6 [11.3], and 912.7 [13.4] for manufacturers A, B, C, and D, respectively.

## CONCLUSION

CT number measurements between manufacturers have a systematic offset when compared to each other. Knowledge of these offsets may be useful in order to harmonize HU values across platforms for optimizing the accuracy of opportunistic diagnosis of osteoporosis.

## CLINICAL RELEVANCE/APPLICATION

CT scanners made by different manufacturers show systematic HU offsets. The small offsets relating to trabecular bone HU supports the integrity of CT for the opportunistic diagnosis of osteoporosis.

## SSC09-06 Patients with Type 2 Diabetes Exhibit a More Mineralized Deep Cartilage Layer Compared to Nondiabetic Controls: A Pilot Study

Monday, Dec. 2 11:20AM - 11:30AM Room: E450B

### Awards

#### Trainee Research Prize - Fellow

#### Participants

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Walid K. Ashmeik, BA, San Francisco, CA (*Abstract Co-Author*) Nothing to Disclose  
Joe Darryl Baal, BS, San Francisco, CA (*Abstract Co-Author*) Nothing to Disclose  
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Claudio E. Von Schacky, Munich, Germany (*Abstract Co-Author*) Nothing to Disclose  
Michael Carl, Menlo Park, CA (*Abstract Co-Author*) Researcher, General Electric Company  
Roland Krug, PhD, San Francisco, CA (*Abstract Co-Author*) Nothing to Disclose  
Gabby B. Joseph, San Francisco, CA (*Abstract Co-Author*) Nothing to Disclose  
Thomas M. Link, MD, PhD, San Francisco, CA (*Abstract Co-Author*) Research Grant, General Electric Company; Research Consultant, General Electric Company; Research Consultant, InSightec Ltd; Research Grant, InSightec Ltd; Consultant, Springer Nature; Research Consultant, Pfizer Inc;

## PURPOSE

The aims of our study were (i) to assess differences in biochemical composition of the deep cartilage layer in subjects with type 2 diabetes mellitus (T2DM) and nondiabetic controls using UTE T2\* mapping and (ii) to investigate the association of vascular health and deep cartilage layer UTE T2\* measurements.

## METHOD AND MATERIALS

Ten subjects with T2DM were recruited for our study and matched for age, sex and body mass index (BMI) with ten non-diabetic controls. A 3D multiecho UTE sequence with 6 echo times was acquired in all subjects using 3T MRI of the knee. For UTE T2\* analysis, the deep cartilage layer was segmented and analyzed in five compartments (patella, medial and lateral femur and tibia). The Ankle Brachial Index (ABI) was obtained in all subjects as a measure of vascular health. Linear regression analyses were used to assess associations of T2DM and UTE T2\* relaxation times and to assess the associations of ABI measurements and UTE values.

## RESULTS

Both study groups were similar in age (53.7 vs. 51.8 years;  $p=0.431$ ), BMI (29.5 vs. 28.9 kg/m<sup>2</sup>;  $p=0.712$ ) and sex ( $p=1.000$ ). Compared to nondiabetic controls, T2DM subjects had significantly lower mean T2\*-UTE in the patella (mean difference 4.87 msec [95% confidence interval (CI) 1.09, 8.65];  $p=0.015$ ), the lateral tibia (mean difference 2.26 msec [95% CI 0.06, 4.45];  $p=0.045$ ), and the lateral femur (mean difference 4.96 msec [95% CI 0.19, 9.73];  $p=0.043$ ). Averaged over all compartments, the mean T2\*-UTE was significantly lower in those with T2DM compared to nondiabetic controls (mean difference 3.24 msec [95% CI 0.36, 6.12];  $p=0.030$ ). Moreover, independent of diabetic status, subjects with higher ABI values, indicating better vascular health, had higher T2\*-UTE of the patella (coefficient: 15.2; 95% CI: 3.3-21.4;  $p=0.017$ ), the medial tibia (coefficient: 9.8; 95% CI: 1.0-18.6;  $p=0.031$ ), and the lateral femur (coefficient: 18.8; 95% CI: 3.3-34.3;  $p=0.021$ ) compared to subjects with lower ABI values.

## CONCLUSION

T2\*-UTE measurements of the deep cartilage layer were consistently lower in subjects with T2DM and in subjects with impaired vascular health, likely indicating increased mineralization of this layer.

## CLINICAL RELEVANCE/APPLICATION

More mineralization of the deep cartilage layer could be an important pathophysiological pathway contributing to degeneration by inhibiting the subchondral bone - cartilage flow of nutrients.

## SSC09-07 MRI Evaluation of Skeletal Muscle Mass and Fat Fraction for the Assessment of Sarcopenia in Psoriatic Patients: Preliminary Results of a Pilot Case-Control Study

Monday, Dec. 2 11:30AM - 11:40AM Room: E450B

### Participants

Federico Bruno, MD, L'Aquila, Italy (*Presenter*) Nothing to Disclose  
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## PURPOSE

Quantitative MRI evaluation of muscle quality and adipose tissue has recently emerged as a research topic of great interest to evaluate sarcopenia induced by several chronic metabolic and inflammatory diseases. The purpose of our study was to evaluate the correlation between clinical features and skeletal muscle characteristics (area and fat fraction) as instrumental MR imaging index of sarcopenia in patients affected by psoriasis

## METHOD AND MATERIALS

In this cross-sectional case-control study we enrolled 31 psoriatic patients (18 M, 13 F, mean age 44.6 years, range 24-63) with mean disease duration of 15.3 years (range 2-37), not under systemic medical treatments and without other known conditions able to influence muscle composition. Clinical evaluation included assessment of patient characteristics, disease severity with PASI score and blood-chemistry investigations. Instrumental MRI evaluation was performed with standard axial T2 sequences and chemical shift encoding-based water-fat sequences with fat fraction mapping acquired at the level of L3 and with segmentation of paraspinal and abdominal muscles for the evaluation of MSI (Skeletal Muscle Mass Index) and skeletal muscle fat fraction. We also enrolled 30 healthy subjects, matched by sex and age, used as a control.

## RESULTS

Mean skeletal muscle mass index values were 47.08 cm<sup>2</sup> in psoriatic patients and 46.23 cm<sup>2</sup> in healthy controls. Fat fraction analysis showed fat fraction values of 18.6% in psoriatic patients and 16.4% in healthy controls. There was no statistically significant difference in terms of skeletal muscle features between study population and controls. Considering patients with psoriasis, statistical analysis showed a significant correlation between the presence of psoriasis, its severity (PASI score) and inflammation markers (CRP) with muscle fat fraction ( $p < 0.005$ ).

## CONCLUSION

These preliminary results suggest a qualitative change in muscle composition in patients with psoriasis, mainly correlated with disease severity and inflammation grade.

## CLINICAL RELEVANCE/APPLICATION

The chronic low-grade inflammation status induced by the disease could be a predisposing factor for the development of sarcopenia. Further long term studies on a larger study population are needed to corroborate our findings and evaluate the possible prognostic role of quantitative skeletal muscle MRI as a marker of sarcopenia in the risk stratification of psoriatic patients

## SSC09-08 Psoas Volume and Fat Fraction in Cancer Patients: Dynamics and Association with Severity of Cachexia Progression

Monday, Dec. 2 11:40AM - 11:50AM Room: E450B

### Participants

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Ernst J. Rummeny, MD, Muenchen, Germany (*Presenter*) Nothing to Disclose  
Dimitrios C. Karampinos, Munich, Germany (*Abstract Co-Author*) Research Grant, Koninklijke Philips NV

## PURPOSE

Cancer cachexia, characterized by weight loss due to skeletal muscle wasting with or without fat loss, is associated with increased morbidity and mortality. Despite its high clinical significance, approaches in stratifying the risk for developing cachexia are sparse. The purpose of this study was to evaluate how the magnetic resonance imaging (MRI)-based proton density fat fraction (PDFF) of skeletal muscle correlates with cachexia development and evolves during the course of the disease.

## METHOD AND MATERIALS

Thirty patients (24 male, mean age 63 years) with different tumor entities received a 3T-MRI using a 6-echo multi-echo gradient echo sequence of abdomen/pelvis for PDFF-mapping. 9 patients underwent between 1 and 4 follow-up scans (range of time interval: 49-335 days), resulting in 14 follow-up scans. Psoas muscle was segmented manually on one slice at the level of the 4th lumbar vertebra bilaterally. Psoas volume and PDFF were extracted. Body mass index (BMI) was calculated as weight (kg)/height (m)<sup>2</sup>. Linear regression analysis was used to evaluate associations between the parameters.

## RESULTS

Mean baseline values were: BMI 25.3±4.6 kg/m<sup>2</sup>, psoas PDFF 9.2±3.6%, psoas volume 13.2±4.2 cm<sup>3</sup>. In the follow-ups, mean relative changes compared to baseline were: BMI -8±8%, PDFF 19±25%, volume -12±16%. At baseline, PDFF correlated with age (R<sup>2</sup>=0.21, p=0.01) and volume correlated with BMI (R<sup>2</sup>=0.2, p=0.01). In patients with follow-up scans, baseline PDFF correlated with the maximum change (i.e., in cases with >1 follow-up the highest relative change) in volume (R<sup>2</sup>=0.81, p<0.001) and tended to correlate with the maximum change in BMI (R<sup>2</sup>=0.38, p=0.08).

## CONCLUSION

The present study demonstrates that in cancer patients, psoas volume correlated with BMI, while psoas PDFF correlated with age at baseline. Higher initial psoas PDFF was strongly associated with the severity of psoas volume loss and tended to correlate with the severity of loss of BMI, which is in line with previous studies reporting on muscle attenuation in computed tomography being a predictor of cancer outcome. These findings point to psoas PDFF representing a potential biomarker for predicting the severity of body composition changes during the course of the disease in cancer patients.

## CLINICAL RELEVANCE/APPLICATION

Psoas muscle PDFF could represent a biomarker for risk stratification regarding the development and severity of cancer cachexia.

## SSC09-09 A Machine Learning Algorithm for the Assessment of Osteoporosis on Chest Radiographs

Monday, Dec. 2 11:50AM - 12:00PM Room: E450B

### Participants

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Paul H. Yi, MD, Baltimore, MD (*Abstract Co-Author*) Nothing to Disclose  
Jinchi Wei, Baltimore, MD (*Abstract Co-Author*) Nothing to Disclose  
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## PURPOSE

Assessment of bone mineral density has typically relied on dual-energy x-ray absorptiometry (DEXA). While osteopenia can be detected on radiographs, assessment is subjective with high interreader variability. The purpose of this study was to assess the ability of deep convolutional neural networks (DCNNs) to detect osteopenia and osteoporosis on chest radiographs (CXRs) based on objective bone mineral density measurements.

## METHOD AND MATERIALS

Our dataset was comprised of 875 post-menopausal females who had undergone a DEXA scan and a PA and lateral CXR within 3 months of the DEXA scan. DEXA-derived T-scores of the lumbar spine were considered ground truth and used as labels for DCNN training on radiographs. Radiographs were split into 70% training and 30% testing, ensuring no patient overlap. Weighted augmentation was performed on the images using random geometric manipulations to increase data size. An attention-based network architecture was built on a variety of standard DCNNs including ResNet50 and VGG-16 and used for (1) classification between normal bone mineral density, osteopenia, and osteoporosis and (2) linear regression prediction of T-score. Classifier performance was measured using area under the curve (AUC) and regression assessed with the mean absolute error. Attention maps were produced to highlight areas of decision-making.

## RESULTS

DCNNs trained on PA radiographs outperformed those trained on lateral radiographs. Classification algorithms detected osteopenia or osteoporosis (defined as T-score < -1.0) with AUC of 0.78 on PA radiographs and 0.73 on laterals (Fig. 1a,b). When limited to classifying between osteoporotic and normal radiographs, AUC reached 0.87. Best performing regression-based algorithms predicted T-scores with a mean absolute error of 1.89 on PA radiographs and 1.96 on laterals. Class activation maps primarily localized to structures such as the medial clavicles, spine, and sternum (Fig. 1c).

## CONCLUSION

DCNNs, which can be trained on bone mineral measurements, can provide an objective method for the prediction of osteopenia and osteoporosis on chest radiographs, which suggests potential use for opportunistic screening of these conditions.

## CLINICAL RELEVANCE/APPLICATION

We illustrate the potential for deep learning to objectively estimate bone mineral density on standard chest radiographs.

Printed on: 10/29/20



SSC10

## Neuroradiology (Diffusion/Perfusion)

Monday, Dec. 2 10:30AM - 12:00PM Room: S502AB



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



Discussions may include off-label uses.

### Participants

Kei Yamada, MD, Kyoto, Japan (*Moderator*) Nothing to Disclose

Joshua S. Shimony, MD, PhD, Saint Louis, MO (*Moderator*) Nothing to Disclose

Jochen B. Fiebach, MD, Heidelberg, Germany (*Moderator*) Consultant, BioClinica, Inc; Speaker, BioClinica, Inc; Advisory Board, BioClinica, Inc; Consultant, Cerevast; Speaker, Cerevast; Advisory Board, Cerevast; Consultant, Artemida; Speaker, Artemida; Advisory Board, Artemida; Consultant, Brainomix; Speaker, Brainomix; Advisory Board, Brainomix; Consultant, Biogen Idec Inc; Speaker, Biogen Idec Inc; Advisory Board, Biogen Idec Inc; Consultant, Bristol-Myers Squibb Company; Speaker, Bristol-Myers Squibb Company; Advisory Board, Bristol-Myers Squibb Company; Consultant, Eisai Co, Ltd; Speaker, Eisai Co, Ltd; Advisory Board, Eisai Co, Ltd

### Sub-Events

#### SSC10-01 Super-Resolution Reconstruction from Orthogonal Slice-Undersampled Diffusion MRI Data

Monday, Dec. 2 10:30AM - 10:40AM Room: S502AB

### Participants

Yoonmi Hong, PhD, Chapel Hill, NC (*Presenter*) Nothing to Disclose

Geng Chen, Chapel Hill, NC (*Abstract Co-Author*) Nothing to Disclose

Pew-Thian Yap, PhD, Chapel Hill, NC (*Abstract Co-Author*) Nothing to Disclose

Dinggang Shen, Chapel Hill, NC (*Abstract Co-Author*) Nothing to Disclose

### PURPOSE

Diffusion MRI (dMRI) is a powerful imaging technique for characterizing the brain white matter tissue microstructure. However, dMRI requires longer acquisition times for sufficient coverage of the  $q$ -space. Each point in  $q$ -space corresponds to a diffusion-weighted image (DWI), and a sufficient number of DWIs are required for accurate characterization of the microstructure. To accelerate acquisition, we introduce a super-resolution (SR) reconstruction that only requires a subsample of slices for each DWI, instead of scanning full DWIs. Each DWI is subsampled with a different slice offset and imaging plane, so that the volume captures complementary information that can be used to improve the reconstruction of other DWIs.

### METHOD AND MATERIALS

We selected 16 subjects from the HCP database and performed 4-fold cross-validation with 12 subjects for training and 4 subjects for testing. For each subject, 90 DWIs with  $b=2000$  s/mm<sup>2</sup> were used for evaluation. DWIs were retrospectively undersampled by factors  $R=3, 4$  and  $5$ . The mapping from the undersampled to the full DWIs is learned using a graph convolutional neural network (GCNN). We fully exploit the relationships of neighboring sampling points in the spatial domain and  $q$ -space in the form of a graph. To learn the target with better perceptual quality, we employ the GCNN as the generator in a generative adversarial network.

### RESULTS

We compared our SR method with two conventional methods: Bicubic interpolation and 3D U-Net. Representative reconstruction results for GFA at  $R=4$ , shown in the figure, indicate that the proposed SR recovers more structural details compared with the two conventional methods which exploit only spatial correlation. We measure the reconstruction accuracy of the reconstructed dMRI by mean absolute error (MAE), peak signal-to-noise ratio (PSNR), and structural similarity index (SSIM). The quantitative results are summarized in the figure.

### CONCLUSION

We have proposed to employ slice-undersampling for acceleration of dMRI. The non-linear mapping from undersampled DWI to the full DWIs is learned using GCNN. The spatio-angular relationship is jointly considered when constructing the graph. The experimental results demonstrate that the proposed SR outperforms the conventional interpolation and a 3D U-Net based SR.

### CLINICAL RELEVANCE/APPLICATION

The proposed method can efficiently accelerate the acquisition of dMRI data and reconstruct DW images with minimal information loss.

#### SSC10-02 Prediction of Multi-Shell Diffusion MRI Data Using Deep Neural Networks with Diffusion Loss

Monday, Dec. 2 10:40AM - 10:50AM Room: S502AB

### Participants

Geng Chen, Chapel Hill, NC (*Presenter*) Nothing to Disclose

Yoonmi Hong, PhD, Chapel Hill, NC (*Abstract Co-Author*) Nothing to Disclose

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## PURPOSE

Acquisition of multi-shell (MS) diffusion MRI (dMRI) data requires longer acquisition time, beyond what is typical in clinical settings. Deep learning can be used to reduce scan time by predicting MS data from data with fewer shells. Existing deep learning methods utilize an l1 loss function as the network optimization target. This is effective in constraining the prediction to match the target MS data but may not ensure the quality of microstructure indices estimated from the predicted data. To overcome this limitation, we propose a novel loss function, called diffusion loss, to explicitly take into account microstructural properties in dMRI prediction. The diffusion loss consists of two parts, including an l1 loss for the predicted dMRI data and another l1 loss for microstructure indices.

## METHOD AND MATERIALS

An overview of our network is shown in Fig. 1. Overall, the network consists of two parts, including a sub-network for MS dMRI data prediction and another sub-network for microstructure estimation. We aim to learn a non-linear function  $f_P$  for predicting the expected MS dMRI data,  $S_{MS}$  from the input dMRI data  $S_{In}$ . The microstructure estimator  $f_E$  predicts microstructure indices from the dMRI data. We demonstrate the effectiveness of diffusion loss using data from the Baby Connectome Project. Our dataset consists of 13 subjects. We utilize 5 of them for training, 5 for testing, and another 3 for validation. All the data were acquired using a Siemens MR scanner with two imaging protocols, including (i) a 2-shell protocol with 74 gradient directions and (ii) a 6-shell protocol with 144 gradient directions.

## RESULTS

In this work, we aim to predict the 6-shell data from their 2-shell counterpart. The data predictor, trained without the microstructure estimator, was utilized as the comparison baseline. The results, shown in Fig. 2, indicate that the diffusion loss reduces the mean square error value of not only the predicted dMRI data but also a variety of microstructure indices. Furthermore, the results, shown in Fig. 3, indicate that the diffusion loss reduces GFA errors significantly.

## CONCLUSION

We have proposed a novel loss function specifically designed for predicting MS dMRI data. The experimental results demonstrate the effectiveness of our method.

## CLINICAL RELEVANCE/APPLICATION

The proposed method predicts high-quality MS data from the dMRI data with fewer shells, allowing analysis with advanced microstructure models.

## SSC10-03 White Matter Changes Near to and Distant from Chronic Black Holes in Multiple Sclerosis

Monday, Dec. 2 10:50AM - 11:00AM Room: S502AB

### Participants

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## PURPOSE

Histopathological evidence show that anterograde and retrograde degeneration follows focal axonal transection in brains of persons with multiple sclerosis (MS). However, quantifying and characterizing this damage in vivo is challenging due to lack of imaging techniques sensitive to axonal and myelin injury. We propose to use quantitative magnetization transfer imaging (qMT), Spherical Mean Technique (SMT) and Neurite Orientation Dispersion and Density Imaging (NODDI) to identify and characterize myelin and axonal injuries following focal lesional transection, in vivo.

## METHOD AND MATERIALS

In this prospective case-control study 18 persons with MS and nine age-and-sex-matched healthy controls (HCs) were included. T2-lesions with and without an associated chronic black hole (cBH) were identified. Region of interests (ROIs) on T2-lesions and cBHs as well as on adjacent normal appearing white matter (NAWM) referred as border zone hereafter and contra-lateral NAWM were drawn. ROIs were then co-registered on SIR-qMT, SMT and NODDI maps. Differences between tissues types were measured using paired t-tests as appropriate.

## RESULTS

Preliminary results indicate differences in PSR ( $p < 0.001$ ) and Vax ( $p < 0.001$ ) between NAWM adjacent to cBHs compared to contralateral anatomically matched NAWM ROIs. (Fig1) No significant associations were seen between PSR and Vax values within each tissue type.

## CONCLUSION

Our preliminary findings suggest that border zones adjacent to cBHs have reduced values of PSR and Vax. Which confirms the ability of MRI metrics to capture anterograde and retrograde degeneration following a focal MS lesion. However, no correlation was observed with PSR and Vax in each tissue subtypes. In border zones and NAWM in general typically myelin loss is secondary to axonal degeneration thus an association between the two measures should be expected. We postulate that different scales of the two metrics may contribute to our finding. It is also conceivable that longitudinal, rather than cross-sectional measurements may

better capture such an association. Last, it may be plausible that the degree of axonal and myelin loss seen in NAWM are not sufficient to result into significant associations between the two.

#### CLINICAL RELEVANCE/APPLICATION

NAWM near cBHs has a different composition as compared to NAWM. Targeting border zones disease may serve as measure of outcome during clinical trials exploring reparative effects of experimental molecules.

#### SSC10-04 Visualization and Microstructural Investigation of the Vestibulocochlear Nerve and Central Hearing Pathways Using MR Diffusion Tensor Imaging

Monday, Dec. 2 11:00AM - 11:10AM Room: S502AB

##### Participants

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Meinrad J. Beer, MD, Ulm, Germany (*Abstract Co-Author*) Nothing to Disclose  
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##### PURPOSE

Diffusion Tensor Imaging (DTI) is an MRI based method for non-invasive visualization and characterization of nerve tracts. It allows to study the microstructure of white matter pathways and to analyze changes related to different pathologies. While it has had great impact in the field of neuroradiology and psychiatry, there are only few studies involving DTI in otorhinolaryngology. This study was performed to investigate whether DTI is feasible in the vestibulocochlear nerve (VN) and auditory pathways.

##### METHOD AND MATERIALS

We investigated fourteen healthy, normal hearing volunteers on a 3 T MRI scanner (Magnetom Skyra, Siemens Healthcare, Erlangen, Germany). Diffusion weighted images at an isotropic resolution of 1.5 mm, 96 slices covering the whole brain, and with 30 diffusion directions were acquired. A special diffusion sequence using readout segmentation of long variable echo-trains (RESOLVE) was used which reduces distortion and signal loss in regions with field inhomogeneity. Acquisition time was 76 min. After manually defining and applying regions of interest, two-tensor tractography was used to identify the VN, arcuate fasciculus and the interhemispheric auditory pathway of the corpus callosum. Subsequently, diffusion parameters, namely fractional anisotropy (FA), trace, axial, and radial diffusivity, were calculated. Parameters were statistically tested for side and gender differences.

##### RESULTS

The desired auditory pathways could be isolated from the datasets in all subjects and were visualized. For the left VN, we found a gender difference: men showed significantly lower FA values than women [mean FA =  $0.32 \pm 0.05$  vs.  $0.38 \pm 0.04$ ;  $F(1,12) = 7.989$ ,  $p < 0.05$ ]. The right VN did not show a significant gender difference: group mean values of FA were  $0.33 \pm 0.05$  in men and  $0.36 \pm 0.05$  in women.

##### CONCLUSION

Despite its small size and challenging location, we were able to visualize and characterize the vestibulocochlear nerve (VN). Moreover, the arcuate fasciculus and the interhemispheric auditory pathway were displayed. Surprisingly, significant gender differences were found for FA in the left VN of normal-hearing subjects.

#### CLINICAL RELEVANCE/APPLICATION

DTI is a promising new tool for microstructural analysis of vestibulocochlear nerve and central hearing pathways and might provide new insights for the investigation of different hearing impairments.

#### SSC10-05 Mapping the Cortical Connections of the Ventral Intermediate Nucleus (VIM) with Tractography in Patients Undergoing MRI-Guided High Intensity Focused Ultrasound (HIFU) Thalamotomy

Monday, Dec. 2 11:10AM - 11:20AM Room: S502AB

##### Participants

Ana Ezponda, MD, Pamplona, Spain (*Presenter*) Nothing to Disclose  
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##### PURPOSE

MRI-guided high-intensity focused ultrasound (HIFU) is an effective therapeutic approach for the ablation of the ventral

intermediate nucleus (VIM) of the thalamus in drug refractory tremor. Cortical connections of VIM might differ from person to person. For treatment planning best seeds points at cortex are not defined. The aim of this study was to assess the cortical connections of VIM nucleus using diffusion tensor Imaging (DTI)-based tractography that overlap with the lesion location.

## METHOD AND MATERIALS

Twenty-two consecutive patients (20 right-handed) with medication-refractory ET (n=17) or PD (n=5) were recruited. All of them underwent VIM ablations contralateral to the patient's hand dominance using HIFU equipment compatible with the 3-T MR scanner. Pre-treatment and immediately after treatment structural and DTI MRI data were acquired. Pre-treatment DTI was co-registered with the post-treatment 3D T2WI sequences. The treatment-induced VIM lesion was used as seed for the DTI-based tractography. Topography of the VIM lesions and cortical connections were registered. Distance to the mid-sagittal plane was quantified at the juxtacortical white matter on axial T2WI.

## RESULTS

Overall, HIFU was effective for immediate tremor control, awaiting for a longer follow-up. Mean size of the focused-sonography lesions was  $6.3 \pm 2.7$  mm on axial 3D-T2WI. Mean distances to the midline and lateral wall of the third ventricle were  $14.7 \pm 1.1$  and  $10.5 \pm 0.6$  mm, respectively. Lesions were  $1.6 \pm 1.4$  mm above the intercommissural plane and  $6.8 \pm 1.2$  anterior to the posterior commissure. According to the cortical connections of the VIM nucleus, patients were allocated in 4 groups: medial aspect of the primary motor cortex (mM, n=7); intermediate region of the primary motor cortex (between m-M and hand-knob, iM, n=10); hand-knob region of the primary motor cortex (hM, n=2) and medial premotor area (preM, n=3). Mean distance from mid-sagittal plane at these sites were  $10.7 \pm 1$  (mM),  $17.9 \pm 3.4$  (iM),  $21.9 \pm 4.5$  (hM) and  $8.6 \pm 3.1$  (preM) mm.

## CONCLUSION

Seeding of the VIM lesions on pre-treatment DTI shows connections predominantly to the primary motor cortex, usually medial to the hand-knob region.

## CLINICAL RELEVANCE/APPLICATION

DTI tractography defines the topography of juxtacortical white matter projections of the VIM. For treatment planning, cortical seeds should more frequently be placed at the primary motor cortex, medial to the hand-knob region.

### SSC10-06 Comparison between Readout-Segmented EPI and Single-Shot Turbo Spin Echo Diffusion-Weighted Imaging for Cholesteatoma Diagnostics

Monday, Dec. 2 11:20AM - 11:30AM Room: S502AB

#### Participants

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## PURPOSE

Comparison of the diagnostic value of readout-segmented diffusion-weighted imaging (rsDWI) and single-shot turbo spin echo diffusion-weighted imaging (tseDWI) for cholesteatoma diagnostics.

## METHOD AND MATERIALS

30 patients with clinically suspected cholesteatoma were examined with a protocol including a rsDWI and a single-shot tseDWI sequence at 1.5 T. Acquisition parameters of both diffusion-weighted sequences were:  $b = 1000$  s/mm<sup>2</sup>, axial and coronal slice orientation, slice thickness 3 mm. Image quality was evaluated by two readers on a 5-point Likert scale with respect to subjective image resolution, lesion conspicuity, and for the presence of artifacts mimicking cholesteatomas. Sensitivity and specificity were calculated using histology results as the gold standard.

## RESULTS

30 patients with clinically suspected cholesteatoma were examined with a protocol including a rsDWI and a single-shot tseDWI sequence at 1.5 T. Acquisition parameters of both diffusion-weighted sequences were:  $b = 1000$  s/mm<sup>2</sup>, axial and coronal slice orientation, slice thickness 3 mm. Image quality was evaluated by two readers on a 5-point Likert scale with respect to lesion conspicuity, for the presence of artifacts mimicking cholesteatomas and overall subjective image quality. Sensitivity and specificity were calculated using histology results as the gold standard.

## CONCLUSION

Our data indicate that the use of tseDWI is advisable for cholesteatoma diagnostics in comparison to rsDWI.

## CLINICAL RELEVANCE/APPLICATION

In cholesteatoma diagnostics, the use of single-shot turbo spin echo DWI is recommended over readout-segmented DWI.

### SSC10-07 Machine Learning for Definition of Optimal Timing and Duration of CT Perfusion Scanning: Recommendations Based on Evaluation of 1400 Patients

Monday, Dec. 2 11:30AM - 11:40AM Room: S502AB

#### Participants

Grzegorz M. Karwacki, Luzern, Switzerland (*Presenter*) Nothing to Disclose

## PURPOSE

CT Perfusion used in imaging of patients suspected for an ischemic stroke is a dose intensive examination as it involves numerous scans in order to enable a complete acquisition of the first pass of iodinated contrast medium through brain tissue, nevertheless, the radiation exposure should be limited to abide by the ALARA principle. We present a proposal for optimal timing and scan duration based on evaluation of more than 1400 examinations.

## METHOD AND MATERIALS

More than 1400 examinations performed with our standard CT Perfusion protocol consisting of 28 scans were included. 54 seconds of scanning was started with a fixed delay of 6 seconds after beginning of injection of iodinated contrast medium (50 ml, flow of 5 ml/s). Syngo.Via (Siemens) was used for depiction of vessel attenuation changes. Retrospective analysis using machine learning was performed.

## RESULTS

Statistical analysis revealed that in the majority of the patients the attenuation values at first time point stayed at the baseline and thus could be omitted without affecting arterial time-attenuation curve. The venous time attenuation-curve on the other hand was truncated in 5% of the patients. Machine learning with a "nearest-neighbour analysis" determined that a 60 second scan duration would allow for full coverage of venous output of this subgroup.

## CONCLUSION

A scan time of 54 seconds allows for acquisition of attenuation changes of arterial input function but based on analysis of our data, the start of CTP scanning could be initiated with a longer delay after contrast injection (7,5 seconds) or the initial scans could be acquired with a lower sampling rate (resulting in lower radiation exposure). Conversely, using this length of scan time results in truncation of venous output function curve in some patients and this in turn might lead to over/underestimation of infarct core and penumbra volume, depending on CT perfusion parameters used for its calculation; therefore, an additional 2 scans at the end, with a temporal resolution of 1 scan every 3 seconds, should be considered.

## CLINICAL RELEVANCE/APPLICATION

Acquisition of complete arterial input and venous output is necessary for proper calculation of CT perfusion maps. Failure to do so might lead to over/underestimation of infarct core and penumbra. At the same time limiting the number of scans leads to lower radiation exposure of patients.

## SSC10-08 Diagnostic Value of Multiple Post-Labeling Delay Arterial Spin Labeling for Cerebrovascular Reactivity in Steal Phenomenon

Monday, Dec. 2 11:40AM - 11:50AM Room: S502AB

### Participants

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## PURPOSE

Cerebrovascular reactivity is a physiological characteristic of the brain that is related to the intrinsic ability of arteries to alter their diameters in response to a vasoactive stimulus, and this parameter is important in cerebrovascular disease. Steal is one of the impairment of CVR which refers a paradoxical flow reduction in response to a vasodilatory stress. In the present study, we evaluated the arterial transit time (ATT) in addition to the time corrected CBF (TCF) from the multiple post-labeling delay ASL as compared with basal/acetazolamide stress Technetium99-hexamethylpropylene amineoxime (99mTc-HMPAO) SPECT in prediction of the cerebrovascular reactivity, especially in steal phenomenon.

## METHOD AND MATERIALS

TCF maps and ATT maps were acquired in 30 consecutive patients with unilateral ICA or MCA steno-occlusive disease (severe stenosis or occlusion). Internal carotid artery territory-based ROIs were applied to both perfusion maps. Additionally, impairments in the CVR were evaluated according to both qualitative and quantitative analyses of the ROIs on basal/acetazolamide stress 99mTc-HMPAO SPECT using a previously described method. The ROIs were divided into four groups; group A included normal basal CBF and normal reactivity on acetazolamide challenge, group B included decreased CBF and impaired reactivity on acetazolamide challenge, group C included normal CBF and impaired reactivity on acetazolamide challenge and group D included decreased CBF in baseline and further decreased CBF in Diamox challenge (Figure 1). ANOVA test was performed to compare the ATT and TCF among four groups. Diagnostic decision tree was developed to differentiate among four groups.

## RESULTS

ATT is significantly prolonged in group C (1848.0 [1644.0; 1980.0] [ms], compared with other groups (Figure.2). In the diagnostic tree, a cut off value of ATT as 1816 [ms] and TCF as 26 [ml/100 g/min], the four groups were differentiated 83.82% of accuracy (Figure 3).

## CONCLUSION

Our results demonstrate that the ATT with TCF based on multiple postlabeling delay ASL perfusion MRI can be useful in prediction of the cerebrovascular reactivity, especially in steal phenomenon.

## CLINICAL RELEVANCE/APPLICATION

ATT and TCF from multiple postlabeling delay ASL is useful in detecting cerebrovascular reactivity (CVR), especially in steal phenomenon, and is recommended in evaluation of CVR, instead of acetazolamide stress test.



## SSC10-09 Predicting PET Cerebrovascular Reserve with Deep Learning from Baseline MRI: Towards a "Drug-Free" Brain Stress Test

Monday, Dec. 2 11:50AM - 12:00PM Room: S502AB

### Participants

David Y. Chen, MD, New Taipei City, Taiwan (*Presenter*) Nothing to Disclose

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Audrey Fan, Stanford, CA (*Abstract Co-Author*) Nothing to Disclose

Greg Zaharchuk, MD, PhD, Stanford, CA (*Abstract Co-Author*) Research Grant, General Electric Company; Research Grant, Bayer AG; Stockholder, Subtle Medical

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### PURPOSE

To predict the cerebrovascular reserve (CVR) in Moyamoya patients using deep learning on PET/MRI images without the need for pharmacological vasodilation.

### METHOD AND MATERIALS

Simultaneous [15O]-water PET/MRI including arterial spin labeling (ASL) MRI was acquired to assess cerebral blood flow (CBF) in 20 Moyamoya patients and 10 healthy controls before and after a vasodilator (acetazolamide, ACZ) injection. A deep convolutional neural network (dCNN) was used to predict the absolute change in perfusion ( $\Delta$ CBF) due to vasodilation from only baseline MRI. The dCNN structure was a U-Net, with multiple baseline MR inputs, including perfusion images (CBF, arterial transit time on ASL), structural scans (T2 FLAIR, T1) and brain template coordinate, to predict the voxelwise synthesized  $\Delta$ CBF (syn- $\Delta$ CBF). The dCNN was trained on the ground truth (PET- $\Delta$ CBF) and tested on the 30 studies with 5-fold cross-validation. Image quality was evaluated with peak signal-to-noise ratio (PSNR) and normalized root mean squared error (NRMSE). Mean  $\Delta$ CBF was calculated in ASPECTS ROIs. Syn- $\Delta$ CBF and ASL- $\Delta$ CBF were compared to the PET reference with correlation and Bland-Altman analyses. The accuracy for identifying vascular territories with impaired PET- $\Delta$ CBF (<75%  $\Delta$ CBF in cerebellum) was evaluated.

### RESULTS

Syn- $\Delta$ CBF had significantly higher PSNR (20.4 $\pm$ 1.2 vs. 14.3 $\pm$ 4.7,  $p$ <0.001) and lower NRMSE (0.36 $\pm$ 0.07 vs. 0.87 $\pm$ 0.67,  $p$ <0.001) than ASL- $\Delta$ CBF. Quantitatively, syn- $\Delta$ CBF yielded similar ROI values compared to PET- $\Delta$ CBF (0.90 $\pm$ 0.20 vs. 0.91 $\pm$ 0.24,  $p$ =0.77), while ASL- $\Delta$ CBF significantly overestimated  $\Delta$ CBF (0.99 $\pm$ 0.52,  $p$ <0.001). Both syn- $\Delta$ CBF and ASL- $\Delta$ CBF showed significant correlation with PET- $\Delta$ CBF ( $\beta$ =0.51,  $r$ =0.68 vs.  $\beta$ =1.28,  $r$ =0.57). However, on Bland-Altman plots, syn- $\Delta$ CBF showed less bias and reduced variance than ASL- $\Delta$ CBF, which showed overestimation errors for larger  $\Delta$ CBF values. The sensitivity/specificity for identifying impaired PET- $\Delta$ CBF was 81%/95% for syn- $\Delta$ CBF and 76%/85% for ASL- $\Delta$ CBF.

### CONCLUSION

The dCNN combines multi-contrast from baseline ASL and structural MRI to predict PET- $\Delta$ CBF, with higher image quality and quantification accuracy than ASL- $\Delta$ CBF. The prediction of PET-based CVR using only MRI and without injecting ACZ enables accurate CVR measurements in routine MRI settings.

### CLINICAL RELEVANCE/APPLICATION

The ability to assess PET-CVR without the need for pharmacological vasodilation and radiotracers is of high value to the clinical evaluation in chronic cerebrovascular patients.

Printed on: 10/29/20



SSC11

## Neuroradiology (Spine)

Monday, Dec. 2 10:30AM - 12:00PM Room: S504CD

NR

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

### Participants

Wende N. Gibbs, MD, Scottsdale, AZ (*Moderator*) Nothing to Disclose  
Amit M. Saindane, MD, Decatur, GA (*Moderator*) Nothing to Disclose  
Asim Z. Mian, MD, Cambridge, MA (*Moderator*) Stockholder, Boston Imaging Core Lab, LLC Consultant, MEDIAN Technologies

### Sub-Events

#### SSC11-01 Validation of the National Institute of Neurologic Disease and Stroke (NINDS) Spinal Cord Injury MRI Common Data Elements (CDE) Instrument: Is it Ready for Prime Time?

Monday, Dec. 2 10:30AM - 10:40AM Room: S504CD

### Participants

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### PURPOSE

The NINDS CDE project was designed to harmonize data collection for NIH funded clinical studies in Neurologic disease. The purpose of this investigation was to perform a multi-site, multi-reader validation study of the SCI MRI CDEs to gauge the reliability of this instrument in clinical and research investigations.

### METHOD AND MATERIALS

This study specifically focused on a subset of 18 of 52 CDE elements directly related to the injured spinal cord. Features included: length/location of cord edema/hemorrhage, absolute measures of canal/cord and lesion length. Four neuroradiologists and one spine neurosurgeon from five institutions were recruited as independent readers. 35 SCI MRI studies from twelve different centers were pre-selected from a collection of over 120 studies. Anonymized exams were loaded into a cloud-based viewer platform. All 35 exams were scored independently by the five experts at their own pace. The exam order was randomized and then re-scored for a second round. Inter- and intra-rater assessment was performed using intraclass correlation coefficient (ICC) at 95% CI.

### RESULTS

Inter-rater agreement for all features in round one evaluations ranged from poor 0.22 (0.06, 0.37) to excellent 0.99 (0.99, 1.00). Highest inter-rater agreement was found for categorical features of edema/hemorrhage length/location relative to anatomic reference (ICC range 0.69 - 0.99) whereas lower inter-rater ICCs were found for absolute measures (ICC range 0.22 - 0.83). Good agreement for measures at the level of injury (ICC range 0.73 - 0.83). Minor differences in agreement were observed overall between the two reading sessions. Intra-rater ICCs overall ranged from good to excellent (ICC range 0.78 to 1.00) with removal of outliers. There was no significant difference in performance between experienced neuroradiologists and spine surgeon.

### CONCLUSION

The devised NINDS SCI MRI CDE instrument provides a uniform method for capturing reliable quantitative and categorical data for SCI investigational work and clinical trials. The system is highly reliable and reproducible by radiologists and spine surgeons.

### CLINICAL RELEVANCE/APPLICATION

Multi-center investigations and pharmaceutical trials for SCI are highly dependant upon MRI as a surrogate representation of the extent of injury and to monitor therapeutic interventions. Validation of the NINDS SCI MRI CDE instrument was a necessary step to justify its use in clinical research.

#### SSC11-02 Assessment of Cervical Spinal Stenosis: Can We Assume that Most Compression of the Cord Occurs Along the Midsagittal AP Direction?

Monday, Dec. 2 10:40AM - 10:50AM Room: S504CD

## Participants

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## PURPOSE

Cervical spinal stenosis (CSS) has been assessed by the midsagittal distance of the spinal canal along the straight anterior-posterior (S-AP) direction. This study aims to investigate the incidence of the maximal compression force (MCF) to the cord that occurs not along the S-AP direction, and to compare the inter-rater consistency of stenotic distance as measured by the CSF space along the S-AP and MCF directions.

## METHOD AND MATERIALS

Cervical MRI of 30 consecutive CSS patients were retrospectively reviewed by 2 raters. Axial T2W images were used to determine the point with MCF to the cord. The vector of the MCF (V-MCF) was defined as a line drawn between the point with MCF and the center of the cord. To quantify the deviation of V-MCF away from the S-AP direction, the angle of MCF (A-MCF) was defined as the angle intersected by the S-AP line and line of V-MCF. To assess the severity of CSS along either S-AP or V-MCF direction, the stenotic distance was measured as the CSF distance anterior and posterior to the cord. Consistency between 2 raters was assessed using descriptive statistical analysis with intra-class correlation coefficients (ICC).

## RESULTS

Overall, the incidence of A-MCF being within <10 degrees of the S-AP direction was low (n=6; 20%), with the majority of MCF occurring further off of the midsagittal plane (n=24; 80%; maximum A-MCF 48.54° and 42.66°; median A-MCF 18.1°, and 19.2°, respectively from 2 raters). The stenotic distances measured along the V-MCF direction were significantly lower (more severe) than those measured along the S-AP direction (2 raters, p=0.024 and 0.001, paired t-test) with a good ICC agreement (ICC=0.717 for V-MCF, 0.714 for S-AP).

## CONCLUSION

Our preliminary data suggest that most CSS occur not in the S-AP direction. The stenotic distance measured along the V-MCF is significantly smaller than that measured along the S-AP direction. The current standard of practice assessing only the S-AP direction may underestimate the severity of CSS. Quantitative evaluation of the CSF distance along the V-MCF can be readily performed in the clinical setting with reliable consistency.

## CLINICAL RELEVANCE/APPLICATION

To quantify the severity of cervical spine stenosis, the canal size should be measured along the direction of the maximal compression force to the cord, not along the AP direction as currently used.

## SSC11-03 Dual Energy CT (DECT) Collagen Material Decomposition Application for Detection of Lumbar Spine Disc Extrusion and Sequestration

Monday, Dec. 2 10:50AM - 11:00AM Room: S504CD

## Participants

Waleed Abdellatif, MD, Vancouver, BC (*Presenter*) Nothing to Disclose  
Faisal Albla, Vancouver, BC (*Abstract Co-Author*) Nothing to Disclose  
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Savvas Nicolaou, MD, Vancouver, BC (*Abstract Co-Author*) Institutional research agreement, Siemens AG; Stockholder, Canada Diagnostic Centres

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## PURPOSE

To assess the value and diagnostic accuracy of DECT Tendon application (collagen material decomposition algorithm) in detection of lumbar spine disc extrusion and sequestration.

## METHOD AND MATERIALS

All CT lumbar spine DECT scans with reported diagnosis of disc extrusion and/or sequestration done in the emergency department between March 1st, 2016 and March 1st 2019 with MRI lumbar spine correlation (gold standard) within 60 days were included. Additional age and sex-matched 42 DECT lumbar spine studies (i.e. control) done on the same scanners during the same duration were added to the pool. The added studies have variable degree of disc prolapse or protrusion confirmed by MRI but no extrusion or sequestration. The DECT scans were grouped into 1) Standard CT Lumbar spine alone and 2) Standard CT plus reformatted series with collagen material decomposition application. Two radiologists independently reviewed both sets of scans in two settings (5-week interval) for diagnosis of the disc extrusion and sequestration.

## RESULTS

The study included 42 CT lumbar spine with MRI-confirmed extrusion (n= 33) or sequestration (n= 9). The reported sensitivity, specificity, negative predictive value (NPP) and accuracy were higher in the second group in comparison to the first (Standard CT

only) group: 97.6%, 100%, 97.7% and 98.8 % in comparison to 90.5%, 85.7%, 90% and 88% respectively. Two-sample t-test showed statistically significant difference in specificity ( $p=0.01$ ) and accuracy ( $p=0.04$ ). No statistical difference was demonstrated for sensitivity and NPP ( $p > 0.05$ ). Interobserver reliability indicates strong agreement on both, the Force ( $K= 0.89$ ,  $P<0.005$ ).

## CONCLUSION

The use of DECT collagen material decomposition application increases specificity and accuracy of lumbar spine disc extrusion and sequestration detection.

## CLINICAL RELEVANCE/APPLICATION

Recommend use of DECT collagen material decomposition application for all CT lumbar spine scans to confidently and accurately report disc extrusion and/or sequestration (particularly in emergency setting), limiting the need for unnecessary MRIs.

### SSC11-04 Utility of Spine MRI in Trauma at a Northern California Level I Trauma Emergency Department

Monday, Dec. 2 11:00AM - 11:10AM Room: S504CD

#### Participants

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## PURPOSE

The purpose of this presentation is to examine the added utility of spine MRI in the setting of trauma in the context of the AOSpine Subaxial Cervical and Thoracolumbar Spine Injury Classification Systems (AOSSC & TLICS). AOSSC & TLICS have been shown useful in characterizing spinal injuries with predictive scoring to suggest instability and need for surgical intervention. However, appropriate indications for MRI to evaluate integrity of the spinal column are poorly defined. Our purpose is to examine the frequency of changed AOSSC & TLICS scoring with additional spine MRI as compared to CT alone and determine the clinical significance of adding MRI for evaluating spinal instability in the trauma setting.

## METHOD AND MATERIALS

A retrospective analysis was performed by querying our imaging database for all spine MRIs ordered by the emergency department by CPT code from the dates of January 1, 2017 to August 31, 2018. 458 such scans were identified and reviewed by the authors. Exclusion criteria included atlanto-axial injuries, non-traumatic injuries, and MRI scans without a CT scan within the prior 3 days leaving 260 total patients. Subsequent review characterized AOSSC & TLICS scores for the initial CT scan and the subsequent MRI and compared differences in score.

## RESULTS

Of the 260 total patients that were reviewed, 99/260 (38.1%) had a change in AOSSC or TLICS score when assessed by MRI as compared to CT alone. Further, of 86 negative CT scans, subsequent imaging with MR revealed pathology relevant to AOSSC or TLICS scoring in 24 (27.9%). The most common pathology revealed with MRI related to CT-occult ligamentous injury of the posterior ligamentous complex.

## CONCLUSION

The AOSSC & TLICS system provide a framework for stratifying patients based on risk of traumatic spinal instability; however, CT has limited ability to evaluate the soft tissues in the spine. In our study, MRI revealed CT-occult findings relevant to AOSSC & TLICS scoring in more than 1/3 of cases where MRI was obtained. CT-occult ligamentous injuries of the PLC were most commonly identified with MRI.

## CLINICAL RELEVANCE/APPLICATION

This retrospective study investigated the added benefit of MRI in the acute trauma setting for defining traumatic spinal instability based on AOSpine Subaxial Cervical and TLICS grading.

### SSC11-05 Rates of Vertebral Augmentation for the Treatment of Osteoporotic Vertebral Compression Fractures Among the Commercially Insured

Monday, Dec. 2 11:10AM - 11:20AM Room: S504CD

#### Participants

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## PURPOSE

750,000 people/yr in the U.S. sustain osteoporotic vertebral compression fractures (OVCF). Vertebroplasty and kyphoplasty,

collectively termed vertebral augmentation (VA), continue to be utilized as minimally invasive treatments for OVCF. Since 2009 strong evidence has emerged refuting the efficacy of vertebroplasty. Kyphoplasty does not currently have a strong evidence base to support or reject its use. Prior publications have examined the role of VA primarily in adults 65 and older. Notably, there is a knowledge gap regarding VA in younger patients. Our aim was to determine the temporal trends in vertebral augmentation over the past decade in a commercially insured, working-age American population.

## METHOD AND MATERIALS

Retrospective cohort analysis of patients with OVCF in the IBM MarketScan® Research Database of Americans with employer-provided health insurance for the 2008-2017 period. 149 million individual patients were screened over this time period with an age range of 18-65. Our cohort included only thoracic and lumbar osteoporotic fractures treated with VA within 6 months of initial fracture identified using ICD-CM 9/10 codes. We excluded patients with confounders such as neoplasm or recent transportation accidents.

## RESULTS

We identified 14,581 patients with OVCF with an average age of 55. 2535 (17%) underwent any VA with 522 (3.6%) treated with vertebroplasty, 1912 (13%) received kyphoplasty and 101 (0.7%) had both. As a percentage of VA performed, vertebroplasty decreased from 25.5% in 2009 to a low of 10.6% in 2015 where kyphoplasty increased from 71.7% to 83.3% across the same time period. The overall percentage of fractures treated with VA remained relatively stable over the time period ranging from 14.9% in 2011 to a high of 19.9% in 2016.

## CONCLUSION

This work shows VA is used in this younger patient cohort. Vertebroplasty continued to be utilized, although at a decreased rate over time. The rates of kyphoplasty, initially a substantial proportion of total procedures performed, increased in the same period. It appears kyphoplasty is being substituted for vertebroplasty in the treatment of some OVCF. This implies the need for rigorous studies assessing the efficacy of kyphoplasty.

## CLINICAL RELEVANCE/APPLICATION

Vertebral augmentation is used in younger patients with osteoporotic fractures and a higher proportion are treated with kyphoplasty. We need rigorous studies evaluating kyphoplasty for efficacy.

## SSC11-06 Qualitative and Quantitative Comparison of Compressed SENSE (C-SENSE) accelerated T2, STIR and White Matter Suppressed (WMS) Imaging of Multiple Sclerosis (MS) Lesions in The Cervical Spinal Cord

Monday, Dec. 2 11:20AM - 11:30AM Room: S504CD

### Participants

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## PURPOSE

To compare subjective conspicuity and contrast ratio in MS lesions on Compressed-SENSE accelerated WMS, T2 and STIR scans.

## METHOD AND MATERIALS

Twenty four patients (5 male, 19 female, average age 45±12) underwent cervical spine MRI for MS on a 3T scanner. 2D TSE based sequences were acquired in sagittal plane using compressed SENSE, including T2 (C-SENSE= 1.4, Time =1:54), STIR (C-SENSE=2, Time = 2:30) and WMS (C-SENSE=3, Time =3:32). WMS uses an inversion time to suppress the signal from white matter. Images were reviewed by a radiologist. Definite and uncertain lesions were counted on each series and compared by paired student t-test. Lesion conspicuity was compared using an ordinal five-point Likert scale on side-by-side comparison. Region of Interest based lesion-to-cord contrast ratio (CR) was then calculated for a subset of definite lesions. Image review and measurement was done in Philips Intellispace Discovery system.

## RESULTS

There was no significant difference between total lesion counts (total: nWMS=53, nT2=46, nSTIR=48, p=0.17). WMS showed 88.5% (p<0.001) and 33.4% (p<0.002) more definite lesions and 80% (p<0.002) and 63.6% (p<0.016) less uncertain lesions compared to T2 and STIR, respectively (definite: nWMS=49, nT2= 26, nSTIR=37; uncertain: nWMS=4, nT2=20, nSTIR=11). The average scores for subjective lesion conspicuity were 4.72/5 for WMS vs. T2 (p<0.01) and 3.89/5 for WMS vs. STIR (p<0.01). Lesion-to-cord contrast ratio was compared in 41 lesions. CR was higher on WMS (M=0.31, SD=0.2) compared to T2 (M=0.51, SD=0.3, p<0.01) and STIR (M=1.57, SD=0.6, p<0.01). Combined time reduction with C-SENSE for T2 and STIR acquisitions was 3:03min.

## CONCLUSION

On WMS more lesions were classified as definite and fewer were classified as uncertain compared to T2 and STIR. The significantly higher lesion CR on WMS reinforces the findings of the subjective assessment. By applying C-SENSE only 29sec additional time was needed to run the WMS scan. The findings suggest that C-SENSE WMS may be a faster and more sensitive alternative for T2 and STIR in MS.

## CLINICAL RELEVANCE/APPLICATION

C-SENSE accelerated WMS may increase diagnostic confidence through better lesion detection and may reduce exam time (when replacing T2 and STIR) and the reading time, thereby improving workflow.

### **SSC11-07 Cervical Cord Cross-Sectional Area and Progressive Multiple Sclerosis: A Meta-Analysis**

Monday, Dec. 2 11:30AM - 11:40AM Room: S504CD

#### **Participants**

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#### **PURPOSE**

To verify whether MRI had the appropriate sensitivity to distinguish patients with multiple sclerosis (MS) from healthy controls. In particular, the study focused on the identification of a significant threshold area that would discriminate healthy controls' cervical cords from MS patients' cervical cords.

#### **METHOD AND MATERIALS**

Two operators separately reviewed the literature published between 2000 and 2018, taking into consideration cervical cord areas measured in patients with MS and in healthy controls, studied by MRI; and built parametric tables based on cervical cord areas. We included 1545 MS patients: [benign MS (BMS): 120; remitting-relapsing MS (RRMS): 669; primary progressive MS (PPMS ): 230; secondary progressive MS (SPMS): 428; clinically isolated syndrome (CIS): 64; radiologically isolated syndrome (RIS): 34] and 505 healthy controls, from 17 studies, which included cervical cord areas measured on MRIs, with standard measurement techniques, in patients with MS and in healthy controls. Exclusion criteria ruled out articles that examined the size or changes in size of MS plaques, non-homogeneous patient categories and patients with MS undergoing experimental therapies. Data were analysed using Discipline Biomedical Statistics software. Finally two ROC curves were created, taking into account PMS (progressive multiple sclerosis = PPMS + SPMS) and RRMS patients, respectively.

#### **RESULTS**

A significant statistical difference between PMS patients' and healthy controls' cervical cord areas ( $p < 0.05$ ) was found. Furthermore, using ROC curves, we hypothesized a threshold area of 71 mm<sup>2</sup> to determine MS patients with severe prognosis as PMS from other MS patients and healthy controls (Odds Ratio value  $p < 0.001$ ).

#### **CONCLUSION**

The detection of a cervical cord area  $\leq 71$  mm<sup>2</sup>, measured on MRI scans, in patients with MS, allows physicians to discriminate PMS (progressive multiple sclerosis) forms from less aggressive forms of MS and healthy subjects. This threshold value could be used in clinical practice to determine MS patients' clinical prognoses.

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

A cervical cord threshold area  $\leq 71$  mm<sup>2</sup> allows physicians to discriminate PMS forms from other forms of MS and healthy controls, and to determine MS patients' clinical prognoses.

### **SSC11-08 Lateral Decubitus Digital Subtraction Myelography to Identify Spinal CSF-Venous Fistulas in Spontaneous Intracranial Hypotension**

Monday, Dec. 2 11:40AM - 11:50AM Room: S504CD

#### **Participants**

Franklin G. Moser, MD, Los Angeles, CA (*Presenter*) Nothing to Disclose  
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Wouter I. Schievink, MD, Los Angeles, CA (*Abstract Co-Author*) Nothing to Disclose  
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Miriam Nuno, PhD, Sacramento,, CA (*Abstract Co-Author*) Nothing to Disclose  
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#### **PURPOSE**

Objective Spontaneous spinal CSF-venous fistulas are a distinct type of spinal CSF leak recently described in patients with spontaneous intracranial hypotension (SIH). Using digital subtraction myelography (DSM) in the prone position we have been able to demonstrate such fistulas in about one-fifth of patients with SIH who had no evidence for a CSF leak on conventional spinal imaging with MRI or CT-myelography. We compared DSM in the lateral decubitus position versus the prone position and now report a significantly increased yield of identifying spinal CSF-venous fistulas with modification of our imaging protocol.

#### **METHOD AND MATERIALS**

The patient population consisted of 23 patients with SIH who underwent DSM in the lateral decubitus position and 26 patients with SIH who underwent DSM in the prone position. None of the patients had evidence for a CSF leak on conventional spinal imaging. A Chi-square test was used to evaluate differences in fistula rates between patients who underwent DSM in the prone versus lateral decubitus position. A p-value  $< 0.05$  was concluded statistically significant. Analysis was performed with SAS software, version 9.4 (SAS Institute, Cary, NC, USA).

#### **RESULTS**

A CSF-venous fistula was demonstrated in 17 (74%) of the 23 patients who underwent DSM in the lateral decubitus position

compared to four (15%) of the 26 patients who underwent DSM in the prone position ( $p < 0.0001$ ). The mean age of these 16 women and five men with a spinal CSF-venous fistula was 52.5 years (range, 36 to 66 years). The duration of symptoms ranged from 8 to 105 months (mean, 34 months). CSF-venous fistulas were found in 13 (76%) of 17 women and in four (67%) of six men who underwent the DSM in the lateral decubitus position. .

## CONCLUSION

Among SIH patients who have no evidence for a CSF leak on conventional spinal imaging, DSM in the lateral decubitus position demonstrates a CSF-venous fistula in about three-fourths of patients compared to only about 15% of patients when the DSM is performed in a prone position, an approximately five-fold increase in the detection rate.

## CLINICAL RELEVANCE/APPLICATION

Among SIH patients who have no evidence for a CSF leak on conventional spinal imaging, DSM in the lateral decubitus position demonstrates a CSF-venous fistula in about three-fourths of patients compared to only about 15% of patients when the DSM is performed in a prone position, an approximately five-fold increase in the detection rate.

## SSC11-09 Usefulness of Dual-Layer Spectral Computed Tomography for Cervical and Thoracic Myelography

Monday, Dec. 2 11:50AM - 12:00PM Room: S504CD

### Participants

Akio Hiwatashi, MD, Fukuoka, Japan (*Presenter*) Nothing to Disclose  
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## PURPOSE

The image quality in cervical and upper thoracic CT myelography is sometimes suboptimal due to insufficient distribution of the intrathecal contrast material. Dual-layer spectral CT has been reported to increase contrast enhancement using low keV virtual monochromatic (MonoE) images. The purpose of this study was to evaluate the usefulness of dual-layer spectral CT for cervical and thoracic myelography.

## METHOD AND MATERIALS

This retrospective study included 18 patients (14 males and 4 females; age range 35-82 year-old; median 64.5 year) from 2018 to 2019 with clinical suspicions for spinal stenosis. All patients underwent dual-layer spectral CT (IQon Spectral CT; Philips Healthcare, Best, Netherlands) 30-60 min after intrathecal injection of contrast material (Iotrolan 240; 15-20 ml). The imaging parameters for CT were as follows: 120 kVp, 445 mA, slice collimation =  $64 \times 0.625$  mm, rotation time = 0.5 sec, and CTDIvol = 38.1 mGy. The images were reconstructed at 1-mm thickness. The regions-of-interest (ROIs) were placed on the spinal cord, cerebrospinal fluid and erector spinae muscles at foramen magnum, C4/5, C7/T1, T6/7 and T12/L1. Attenuation and standard deviation (SD) were recorded on 120 kVp and MonoE images (40-70 keV; 10-keV interval) The contrast was defined as follows:  $(ROI_{CSF} - ROI_{cord})$ . The contrast-to noise ratio (CNR) was calculated as follows:  $(ROI_{CSF} - ROI_{cord})/SD_{muscle}$ . Statistical analysis was performed with Steel-Dwass test.

## RESULTS

The contrast (range; 696.7-2456.3 vs. 219.0-1369.4) and CNR (range; 43.3-112.1 vs. 14.0-59.6) were higher on MonoE images using 40-70 keV than on 120 kVp images at all locations. There were statistically significant differences among these values ( $P < 0.05$ ).

## CONCLUSION

Dual-layer spectral detector CT could retrospectively increase the contrast and CNR in cervical and thoracic myelography which could help precise evaluation in these regions.

## CLINICAL RELEVANCE/APPLICATION

Dual-layer spectral detector CT can retrospectively yield virtual monochromatic images with higher contrast and CNR in cervical and thoracic CT myelography.

Printed on: 10/29/20



SSC12

## Physics (CT Radiation Dose)

Monday, Dec. 2 10:30AM - 12:00PM Room: S504AB

**CT** **PH** **SQ**

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

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

### Participants

Kai Yang, PhD, Boston, MA (*Moderator*) Nothing to Disclose  
Sarah E. McKenney, PhD, Stanford, CA (*Moderator*) Nothing to Disclose  
Baojun Li, PhD, Iowa City, IA (*Moderator*) Research Grant, General Electric Company

### Sub-Events

#### SSC12-01 Coronary Calcium Scoring Using Tin Filtration to Dramatically Reduce Radiation Dose

Monday, Dec. 2 10:30AM - 10:40AM Room: S504AB

### Participants

Shengzhen Tao, Rochester, MN (*Presenter*) Nothing to Disclose  
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Shuai Leng, PHD, Rochester, MN (*Abstract Co-Author*) Nothing to Disclose

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### PURPOSE

The purpose of this work is to evaluate the ability of tin (Sn) filtration to dramatically reduce radiation dose for CT calcium (Ca) scoring to dose levels comparable to a few chest x-rays.

### METHOD AND MATERIALS

Chest phantoms emulating small/medium/large patients were scanned on a dual-source CT (Definition Force, VB10, Siemens). A piece of pork was placed at the center of the phantoms, which contained three cylindrical hydroxyapatite (HA) inserts (diameter/length = 5 mm, HA concentration = 200/400/800 mg/mL) emulating coronary calcifications. Phantoms were scanned at 100 kV and 600 mAs/rot using a Sn filter to remove low-energy photons that increase patient radiation dose but do not substantially contribute to image quality. The same phantoms were then scanned using a standard Ca scoring protocol at 120 kV, with mAs determined by a clinical technique chart designed for different patient sizes. Images were reconstructed using a specially designed reconstruction kernel (Sa36 kernel), which accounts for the different attenuation of Ca materials due to different x-ray spectra of Sn100 and 120 kV, and generates 120 kV-like images. The CT numbers of pork and a 200 mg/mL HA insert were measured, the Ca scores were calculated using commercial software, and the results compared between 120 kV and Sn100 kV scans.

### RESULTS

Radiation dose was reduced from 2.3/6.8/14.3 at 120kV to 1.5/1.5/1.5 mGy at Sn100 kV for the small/medium/large phantoms, yielding a 34%/78%/90% dose reduction. CT numbers of soft tissue and HA measured from Sn100 kV images were consistent with those of the 120 kV images (max differences < 7/15 HU for tissue/Ca, respectively). Ca scores of HA inserts measured from Sn100 kV images were consistent with those of 120 kV images for the small/medium phantoms (max difference < 16). Larger differences (40-140) were observed for the large phantom.

### CONCLUSION

Ca scoring using a Sn filtered x-ray beam was found to achieve 34-78% dose reduction compared to the standard 120 kV technique while yielding consistent Ca scores for small/medium patients. However, it may not be suitable for large patients due to considerable score elevation.

### CLINICAL RELEVANCE/APPLICATION

The evaluated technique can reduce patient dose from coronary calcium screening to levels comparable to a few chest x-rays.

#### SSC12-02 Impact of Imaging Conditions on Localizer-Based Water Equivalent Diameter Estimation and on Dose Modulation

Monday, Dec. 2 10:40AM - 10:50AM Room: S504AB



## Participants

Da Zhang, PhD, Boston, MA (*Abstract Co-Author*) Investigator, Canon Medical Systems Corporation; Consultant, Clementia Pharmaceuticals Inc

Xiujiang J. Rong, PhD, Houston, TX (*Presenter*) Nothing to Disclose

Xinhui Duan, PhD, Dallas, TX (*Abstract Co-Author*) Nothing to Disclose

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Alexander A. Bankier, MD, PhD, Boston, MA (*Abstract Co-Author*) Consultant, DAIICHI SANKYO Group

Matthew R. Palmer, PhD, Boston, MA (*Abstract Co-Author*) Nothing to Disclose

## PURPOSE

Water equivalent diameter (WED) is a sound patient-size descriptor, and CTs use localizers to determine WED and to guide dose modulation. Localizer-based WED estimation requires a calibration to relate localizer pixel values to attenuation. We investigated how imaging conditions affect the WED calibration and dose modulation performance.

## METHOD AND MATERIALS

We acquired localizer and axial images of ACR and body CTDI phantoms on 11 CT models from GE, Siemens, Philips, and Canon. We estimated calibration parameters (slope and intercept) by associating axial images with the corresponding localizer lines using custom built software. Experiments were conducted under combinations of kV, mA, orientation, and imaging kernel of localizer radiographs, and axial kV. In separate experiments, the ACR phantom and body CTDI phantom (iso-centered) were imaged together on table top. We repeatedly acquired 120kV-helical scans with dose modulation, after taking localizers at varied kV and mA levels, to examine their impact on dose modulation.

## RESULTS

Calibration slope and intercept depends on localizer kV on all CTs. E.g., on a Canon A-One CT, slope changed from 1.47 to 1.64 for localizers from 80 to 135 kV. Using calibration of 120kV localizers, we simulated errors in WED estimation caused by using unmatched calibrations: WED from 80kV- ~ 135kV-localizers deviated from the truth by 1-5% for the body CTDI phantom and 1-7% for the ACR phantom. Localizer mA and directions have small impacts on calibrations and WED results. Calibration also depends on localizer kernels for Canon CTs. For the A-One, WED calibration slopes under Sharp- and STD-kernels were identical (diff. < 0.01%) but differed from the Soft-kernel slope by 55%. Using the Sharp-kernel calibration, WED from Soft-kernel localizers deviated from the truth by 35% for the CTDI phantom and 42% for the ACR phantom. Localizer kV affected dose modulation performance. On a GE CT750HD, comparing to the CTDI<sub>v</sub> (11.65 mGy) of a baseline condition (120kV-localizer), CTDI<sub>v</sub> from the same helical scans after 80kV-, 100kV-, 140kV-localizers were 12.43 (+7%), 11.98 (+3%), and 11.41 mGy (-2%). Localizer mA did not affect dose modulation.

## CONCLUSION

Localizer kV and image kernels have stronger impacts on WED calibration and dose modulation than other factors.

## CLINICAL RELEVANCE/APPLICATION

Using the same kV and image kernel for localizers may improve consistency of dose modulation and WED estimation.

## SSC12-03 Protocol Optimization of Whole-Body Low-Dose CT in Patients with Multiple Myeloma: How Low is Too Low?

Monday, Dec. 2 10:50AM - 11:00AM Room: S504AB

## Participants

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## PURPOSE

To investigate the minimum radiation dose needed to perform a whole body low dose CT (WBLDCT) with a latest generation CT scanner while maintaining an optimal diagnostic accuracy for bone lesions detection.

## METHOD AND MATERIALS

A preliminary image quality and patient dose assessment was retrospectively performed in 25 patients using a GE Revolution CT scanner, highlighting high subjective ranks and different reader's agreement in osteolytic lesions detection, with a median effective dose of 1.9 mSv. Base on the reference protocol (120 kV, noise index 25, slice thickness 1.25 mm, iterative ASIR-V 50%, collimation 80 mm, average CTDI<sub>vol</sub> of 2.3 mGy), an anthropomorphic whole body phantom (PIXY phantom) was repeatedly scanned varying the acquisition parameters with a relative CTDI<sub>vol</sub> range of 0.3 - 1.5 mGy. For each slice, a noise analysis was performed with means of an automatic segmentation tool and multiple ROI evaluations. Both noise and tube current profiles were compared along z axis in each acquisition. Some phantom details were identified as potential simulation of pathologic bone and assumed as reference for a subjective evaluation by three radiologists (5-point Likert scale). An optimized protocol was defined and employed primarily on 10 patients.

## RESULTS

Individual reader's scores showed stable high values with average of 4.8 up to a CTDI<sub>vol</sub> of 0.9 mGy. For the lower doses

Individual reader's scores showed stable high values with average of 4.6 up to a CTDIvol of 0.9 mSv. For the lower doses, significant lower average scores were observed (4.2 for CTDIvol of 0.5 mGy and 3.2 for CTDIvol of 0.3 mGy,  $p < 0.01$ ). The minimum CTDIvol without loss of diagnostic information was achieved with different combinations of exposure parameters, and among these, a maximum image quality rank was obtained with a scan performed with 140 kV and a percentage of ASIR-V of 80 %. The overall corresponding medians of automatic noise measurements for the phantom were 49 HU (range 22 - 67) with a sharp convolution kernel and 13 HU (range 7 - 21) with a standard kernel. Using the optimized protocol, the median effective dose for ten patients was estimated 0.7 mSv.

## CONCLUSION

Routinary submillisievert WBLDCT can be performed on latest generation CT scanner with a proper balance between tube current modulation parameters and iterative reconstruction strength.

## CLINICAL RELEVANCE/APPLICATION

Assessing the lowest achievable dose for WBLDCT with phantom studies and image quality metrics can be useful to optimize this imaging modality in accordance with the ALARA principle.

## SSC12-06 The Presence of Contrast Agent Increases Absorbed Organ Radiation Dose in Contrast-Enhanced CT

Monday, Dec. 2 11:20AM - 11:30AM Room: S504AB

### Participants

Mahta Mazloumi, MA, Brussels, Belgium (*Abstract Co-Author*) Nothing to Disclose  
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Nico Buls, DSc, PhD, Jette, Belgium (*Presenter*) Nothing to Disclose

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## PURPOSE

Although intravenous iodinated contrast agents are being used in 50 to 60 % of all computed tomography (CT) scans, their presence is not considered in patient dosimetry calculations. The aim of this study is to investigate the impact of contrast agent on absorbed radiation dose in the venous phase of abdominal CT scans.

## METHOD AND MATERIALS

10 female and 10 male abdominal contrast-enhanced dual energy computed tomography (DECT) scans were retrospectively selected from our patient database. Organ and tissue doses were calculated by an ad-hoc Monte Carlo (MC) simulation model (ImpactMC) that was experimentally validated (accuracy < 5.5%) for the scanner geometry (GE Revolution CT) and acquisition parameters including tube current, tube voltage, beam shape filter, and collimation were modeled. MC simulations were performed in the presence and in the absence of contrast agent using the contrast-enhanced and virtual-unenhanced dataset of DECT as patient models. The simulated dose volumes were segmented (3D slicer) to obtain the dose in the liver, liver parenchyma, left kidney, right kidney, aorta, and spleen. We calculated the relative dose increase due to contrast as  $(DI - D0)/D0$  where DI is the dose in the presence of contrast agent and D0 is the dose in the absence of contrast agent. The iodine concentrations in the simulations were estimated using iodine content calculated by DECT.

## RESULTS

The average iodine concentrations among 20 patients are  $7.16 \pm 1.51$  mg I/ml for left kidney,  $6.98 \pm 1.58$  mg I/ml for right kidney,  $5.62 \pm 1.04$  mg I/ml for aorta,  $3.76 \pm 1.03$  mg I/ml for spleen,  $3.22 \pm 0.97$  mg I/ml for liver, and  $2.95 \pm 0.87$  mg I/ml for liver parenchyma. Compared to a non-contrast scan, the relative doses increase in the liver ( $21 \pm 5$  %), liver parenchyma ( $20 \pm 5$  %), aorta ( $34 \pm 6$  %), right kidney ( $37 \pm 7$  %), left kidney ( $39 \pm 7$  %) and spleen ( $26 \pm 3$  %).

## CONCLUSION

In abdominal CT, organ radiation doses increase due to the presence of contrast agents. On average, doses increase by 29 %. The highest increase is observed in kidneys, then in aorta, spleen, liver, and lowest in liver parenchyma.

## CLINICAL RELEVANCE/APPLICATION

The presence of contrast agents should be considered in patient dosimetry calculations.

## SSC12-07 Paradoxical Increase in Eye Lens Dose When Using Automatic Exposure Control During Non-Contrast Head CT and Mitigation by Organ-Based Tube-Current Modulation

Monday, Dec. 2 11:30AM - 11:40AM Room: S504AB

### Participants

Sean Wo, MD, Seattle, WA (*Presenter*) Nothing to Disclose  
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## PURPOSE

In CT scanning, tube current modulation techniques aim to maintain image quality over a variable anatomy. We examined eye lens

dose and image noise when activating a combination of automatic exposure control (AEC, current modulated based on anatomic attenuation measured on localizer) and organ-based tube-current modulation (OBTCM, current decreased over anterior portion of tube arc).

## METHOD AND MATERIALS

We performed CT scans of an adult anthropomorphic head phantom on 2 scanners (SOMATOM Force and SOMATOM Definition AS+, Siemens Healthcare) using 4 acquisition modes: 1) fixed mAs; 2) AEC (CARE Dose 4D) only; 3) OBTCM (X-CARE) only; 4) and both AEC and OBTCM active. For both scanners, we used 2 protocols: 'trauma' with 310 and 'follow-up' with 250 effective mAs or quality reference mAs, as applicable. We maintained a constant kV of 120. For each of 6 replicates at each acquisition mode, we placed an optically stimulated luminescence (OSL) dosimeter in each orbit to measure absorbed dose. We averaged OSL doses at each mode to obtain generalized lens dose and characterized image noise ( $\sigma$ ) from 4 ROIs placed at the level of the sella on subtraction images derived from consecutive scans with the least interscan motion. We used Student's t-test and distribution to test for significance and to calculate confidence intervals.

## RESULTS

For the Force trauma, Force follow-up, AS+ trauma, and AS+ follow-up protocols, respectively, fixed current technique produced average lens doses of 35.8, 28.0, 32.1 and 25.5 mGy. As compared to the benchmark fixed technique, AEC alone paradoxically increased eye lens dose (+11%, +21%, +22%, +21%), while OBTCM decreased lens dose (-33%, -33%, -29%, -35%), and combining both techniques decreased lens dose (-21%, -21%, -21%, -20%). Every acquisition mode produced a significant change from the benchmark ( $p < 0.05$ ). Noise measurements revealed a roughly inverse linear relationship between  $\sigma$  and vdose ( $R^2 = 0.88$  and 0.72 for Force and AS+, respectively).

## CONCLUSION

Compared to the standard fixed technique, activating AEC on non-contrast head CT paradoxically causes a significant increase in eye lens dose. Conversely, OBTCM with or without AEC significantly decreases lens dose.

## CLINICAL RELEVANCE/APPLICATION

In designing non-contrast CT head protocols, use of AEC requires careful consideration because it may increase eye lens dose despite reducing overall dose. Adding OBTCM to AEC can mitigate this effect.

## SSC12-08 kV Independent Coronary Calcium Scoring: A Phantom Evaluation of Score Accuracy and Potential Radiation Dose Reductions

Monday, Dec. 2 11:40AM - 11:50AM Room: S504AB

### Participants

Shengzhen Tao, Rochester, MN (*Presenter*) Nothing to Disclose  
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## PURPOSE

Because of the use of a fixed CT number threshold in the Agatston calcium (Ca) scoring method, and the dependence of CT numbers on photon energy, coronary Ca CT exams are required to be performed at a fixed tube potential (120kV). Here, we determine the accuracy of a kV-independent Ca scoring technique and its potential to reduce radiation dose by using tube potentials below 120kV.

## METHOD AND MATERIALS

Three hydroxyapatite (HA) cylinders (5 mm diameter and length; 200, 400, 800 mg HA/mL) were inserted into a piece of pork and placed within anthropomorphic chest phantoms representing small, medium, and large adults. Phantoms were first scanned at 8 tube potentials (70-140kV) to compare CT numbers and Ca scores. Next, phantom scans were performed with automatic exposure control (AEC) and automatic kV selection (CareDose4D QRM=180/150/120/90mAs, CarekV setting = 4) to evaluate potential dose reduction. A dedicated reconstruction kernel (Sa36) was used to create 3-mm-thick 120kV-like images every 1.5 mm, from data acquired at other kVs, by appropriately scaling CT numbers above a soft tissue threshold. Phantoms were also scanned at 120kV using our clinical size-dependent mA chart. CT numbers were measured from images at different kVs, and Agatston scores calculated using commercial software.

## RESULTS

Absolute CT number differences at different kVs (relative to 120kV) were small (tissue  $< 4$  HU; HA/Ca  $< 5$  HU for kV  $> 80$  and  $< 18$  HU for kV  $\leq 80$ ). The differences in Ca scores for kV  $\geq 90$  (relative to 120kV) were  $< 13.8$  (8%) for 200/400 mg HA/mL, and  $< 22$  (7%) for 800 mg HA/mL cylinders. The use of AEC and lower tube potentials reduced CT DIvol from 4.1/10.0/20.8 mGy (120kV, small/medium/large phantoms) to 2.1/4.4/5.6 mGy (for QRM=90mAs), yielding 48/56/73% reduction in CT DIvol and Ca score difference (for 400 mg HA/mL insert)  $< 13$  (8%) in relative to 120 kV.

## CONCLUSION

kV independent Ca scoring methods, coupled with AEC and lower tube potentials, provide a 48-73% reduction in CT DIvol and Ca scores that are consistent with those at 120 kV.

## CLINICAL RELEVANCE/APPLICATION

The reported technique benefits patients undergoing coronary Ca scoring CT by considerably reducing radiation dose while maintaining accurate Ca scores.

## **SSC12-09 Exploring the Limits of Size-Specific Dose Estimates (SSDE) as an Estimate of Organ Dose from Routine Chest and Abdomen/Pelvis CT Examinations**

Monday, Dec. 2 11:50AM - 12:00PM Room: S504AB

### **Participants**

Anthony Hardy, MS, Los Angeles, CA (*Presenter*) Nothing to Disclose

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Christopher H. Cagnon, PhD, Los Angeles, CA (*Abstract Co-Author*) Nothing to Disclose

Michael F. McNitt-Gray, PhD, Los Angeles, CA (*Abstract Co-Author*) Institutional research agreement, Siemens AG

### **PURPOSE**

Size-Specific Dose Estimate (SSDE) adjusts scanner-reported CT DIvol to account for patient size and should be widely available on future scanners. While not intended to represent organ doses, the purpose of this work was to explore the ability of SSDE to provide a reasonable estimate of organ doses in routine chest and abdomen/pelvis exams across a wide range of patient sizes.

### **METHOD AND MATERIALS**

Raw projection data and patient protocol pages for 133 routine chest (71 women, 62 men) and 82 routine abdomen/pelvis (40 women, 42 men) CT exams performed with tube current modulation (TCM) were gathered from two Siemens MDCT scanners (Sensation 64 and Definition AS64, Siemens Healthineers, Forchheim, Germany). Image data were reconstructed and were semi-automatically segmented to identify lung and glandular breast tissues in chest exams and liver, spleen, and kidneys in abdomen/pelvis exams. Segmented image data were used to create voxelized models of chest and abdomen/pelvis anatomy. TCM data was extracted from the raw projection data to describe the tube current values as a function of gantry angle and table location. Voxelized patient models and TCM data were incorporated into a validated Monte Carlo (MC) simulation engine to estimate absolute lung, breast, liver, spleen, and kidney dose using MDCT source models. Normalized lung (nDLung), breast (nDBreast), liver (nDLiver), spleen (nDSpleen), and kidney (nDKidney) doses were obtained by dividing respective absolute doses by the CT DIvol values from the patient protocol pages. SSDE values were acquired using AAPM Report 204 and the water equivalent diameter (D<sub>w</sub>) from the image data. Normalized doses were then compared to SSDE f-factors.

### **RESULTS**

The relative bias of nDLung, nDBreast, nDLiver, nDSpleen, and nDKidney to the SSDE f-factors was observed to be 17.4%, 35.4%, 16.2%, 17.9%, and 17.1%, respectively. SSDE overestimates organ dose in small and large patients.

### **CONCLUSION**

SSDE may serve as a reasonable estimate lung, liver, spleen, and kidney dose across patient size within 20%, but may overestimate dose in small and large patients. For breast, SSDE may serve as a reasonable estimate within 36%.

### **CLINICAL RELEVANCE/APPLICATION**

SSDE may provide reasonable estimates of organ dose for routine chest and abdomen/pelvis CT exams for most organs; however, estimates of breast dose may require wider tolerances.

Printed on: 10/29/20



SSC13

## Physics (Breast X-Ray Imaging)

Monday, Dec. 2 10:30AM - 12:00PM Room: S503AB

BR PH

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

FDA Discussions may include off-label uses.

### Participants

Hilde Bosmans, PhD, Leuven, Belgium (*Moderator*) Stockholder, Qaelum NV Research Grant, Siemens AG Research Grant, General Electric Company Research Grant, Agfa-Gevaert Group  
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### Sub-Events

#### SSC13-01 Sensitivity of the New ACR QC Phantom for Detecting Degradations in DBT Systems

Monday, Dec. 2 10:30AM - 10:40AM Room: S503AB

### Participants

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### PURPOSE

Recently the FDA approved the use of the new ACR phantom for QC and to accredit DBT systems. Being new, the extent to which it can capture deficiencies in a 3D system is not well known. In this work we investigate how sensitive the new ACR phantom is to various DBT system degradations.

### METHOD AND MATERIALS

Degradations were added to assess the impact on image quality: 1. Focal spot (FS) positioning error, and 2. Dose levels corresponding to 100%, 50%, and 25% of the AEC dose. For error in the FS positions, prior to reconstruction the x-ray angular position for each projection was perturbed by a Gaussian random value. Four levels of error were modeled:  $\sigma = 0.1^\circ$ ,  $0.3^\circ$ ,  $0.5^\circ$ , and  $1.0^\circ$ . For each  $\sigma$ , five trials with different sets of projection data were created and reconstructed. Acquisitions were taken with both narrow- and wide-angle DBT geometries. The narrow-angle acquisition used 15 projections, a  $15^\circ$  span, and 700 mm SID. The wide-angle used 25 projections, a  $46^\circ$  span, and 655 mm SID. The system used a W/Rh tube at 29 kVp and an Anrad direct conversion detector with 85  $\mu\text{m}$  pixel pitch. To determine the effects, images were evaluated by reader scoring and FWHM of z-axis resolution, according the new ACR QC Manual. Each fiber received 1 point each if the length was  $\geq 8$  mm and  $\frac{1}{2}$  point if 5-8 mm. Speck clusters each get 1 point if 4-6 specks were seen and  $\frac{1}{2}$  point for 2-3 specks. Masses received 1 point each if  $\frac{3}{4}$  of the border was visible and  $\frac{1}{2}$  point if  $\frac{1}{2} - \frac{3}{4}$  was visible. Passing required at least 2 points for fibers, 3 for speck groups, and 2 for masses. Z-resolution failed if the FWHM was greater than 30% of baseline ( $\sigma = 0^\circ$ ).

### RESULTS

For both geometries, reader-averaged results show fiber scores passed until an angular error of  $\sigma = 1.0^\circ$ , speck scores passed until an angular error of  $\sigma = 0.5^\circ$ , and mass scores passed at all error levels. Scores failed at 50% AEC for the  $15^\circ$  geometry, but only show failure at 25% AEC for the  $46^\circ$  geometry. The z-resolution test was more sensitive and failed after  $\sigma = 0.1^\circ$ , for both geometries.

### CONCLUSION

In general the ACR phantom was only mildly sensitive to factors that might degrade clinical performance. In the future, we will investigate the impact of these failures on detectability of signals in an anthropomorphic breast phantom.

### CLINICAL RELEVANCE/APPLICATION

To our knowledge, no work has been done to assess the utility of the ACR phantom in evaluating DBT systems.

#### SSC13-02 Comparison of Digital Mammograms, Breast Tomosynthesis and Synthetic Mammograms for Small Detail Detection: Phantom-Based Observer Performance Studies

Monday, Dec. 2 10:40AM - 10:50AM Room: S503AB

### Participants

Liesbeth Vancoillie, Leuven, Belgium (*Presenter*) Nothing to Disclose  
Lesley Cockmartin, Leuven, Belgium (*Abstract Co-Author*) Nothing to Disclose  
Nicholas Marshall, Leuven, Belgium (*Abstract Co-Author*) Nothing to Disclose  
Hilde Bosmans, PhD, Leuven, Belgium (*Abstract Co-Author*) Stockholder, Qaelum NV Research Grant, Siemens AG Research Grant, General Electric Company Research Grant, Agfa-Gevaert Group

For information about this presentation, contact:

## PURPOSE

Compare small detail detectability in digital mammography (DM), digital breast tomosynthesis (DBT) and synthetic mammograms (SM) of 5 vendors using 2 phantoms: CDMAM (homogeneous background with gold discs) and L1 (structured background with calcification inserts).

## METHOD AND MATERIALS

Phantom images were acquired for DM/DBT on Fujifilm Amulet Innovality ST, GE HC Senographe Pristina, Hologic Selenia Dimensions, IMS Giotto Class and Siemens Mammomat Revelation, with SM calculated from DBT. Automatic exposure control (AEC) dose levels for DM/DBT modes were respectively: 1.37mGy/1.93mGy; 1.33mGy/1.33mGy; 1.55mGy/2.02mGy; 1.20mGy/1.48mGy; 1.08mGy/2.09mGy. Twelve acquisitions were made at AEC/2, AEC and 2xAEC levels. Both phantoms were read manually, with CDMAM also read using CDCOM software, both using a 4-alternative forced choice method. Threshold gold thickness (Ttr) at 0.13 mm diameter for CDMAM and threshold calcification diameter (dtr) for L1 were defined from the 62.5% correct score. One-way analysis of variance was performed to test significant differences among dose levels/modalities.

## RESULTS

For human reading of CDMAM at AEC dose, SM was inferior to DM/DBT. Ttr results for DM/DBT/SM were for Fuji: 0.59µm/0.70µm/1.02µm, GE: 0.61µm/1.10µm/1.27µm, Hologic: 0.71µm/1.09µm/1.19µm, Giotto: 1.17µm/1.30µm/1.65µm, and Siemens: 0.86µm/1.01µm/1.34µm. CDCOM results were within error bars of human results, however CDCOM failed for SM. For L1, dtr results for DM/DBT/SM at AEC dose were for Fuji: 0.118mm/0.117mm/0.118mm, GE: 0.108mm/0.114mm/0.136mm, Hologic: 0.109mm/0.112mm/0.129mm, Giotto: 0.131mm/0.121mm/0.141mm and Siemens: 0.114mm/0.122mm/0.149mm. SM was significantly poorer than DM/DBT for all vendors, all modalities, all doses, except for Fuji, where dtr was not significantly different at AEC dose. For Giotto, differences were only significant between SM and DBT/DM at high dose. dtr of DM and DBT was never significantly different. Dose had a significant impact on object detectability for both phantoms.

## CONCLUSION

For all 5 vendors, better small detail scores were obtained for DM and DBT than for SM. Detectability improved as dose increased.

## CLINICAL RELEVANCE/APPLICATION

SM, in its current stage of development for all 5 vendors, cannot be recommended as a stand-alone modality if the small detail detectability levels achieved in DM or DBT is required.

## SSC13-03 Comparison of Digital Mammograms, Breast Tomosynthesis, and Synthetic Mammograms for Detection of Masses: An Observer Performance Study

Monday, Dec. 2 10:50AM - 11:00AM Room: S503AB

### Participants

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Nicholas Marshall, Leuven, Belgium (*Abstract Co-Author*) Nothing to Disclose

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## PURPOSE

Compare detectability of masses in digital mammography (DM), digital breast tomosynthesis (DBT) and synthetic mammograms (SM) of 5 vendors with a 3D structured (L1) phantom with embedded mass-like lesions.

## METHOD AND MATERIALS

L1 is a hemispherical shaped phantom filled with PMMA spheres and water plus nine 3D-printed lesions: 5 non spiculated (diameter 1.6mm to 6.2mm) and 4 spiculated masses (diameter 3.8mm to 9.7mm). DM, DBT and SM images were acquired on these systems: Fujifilm Amulet Innovality ST, GE HC Senographe Pristina, Hologic Selenia Dimensions, IMS Giotto Class and Siemens Mammomat Revelation. Three dose levels were studied (12 acquisitions at each level): automatic exposure control (AEC) level and manually set at AEC/2 and 2xAEC. A 4-alternative forced choice reading paradigm was used. Threshold diameter to reach a 62.5% correct score was evaluated (dtr). One-way analysis of variance was performed to test for significant differences among dose levels/modalities.

## RESULTS

For GE, Giotto and Siemens, DBT performed significantly better than SM, while SM showed no difference with DM. For Fuji and Hologic, there was no significant difference between DBT and SM, while DM was inferior to DBT and SM. The dtr values for non-spiculated masses for DM/DBT/SM at AEC dose, were respectively: Fuji: 4.21mm/2.12mm/2.89mm; GE: 4.87mm/2.15mm/4.21mm; Hologic: 7.21mm/1.87mm/3.28mm; Giotto: 4.96mm/2.37mm/4.30mm; Siemens: 4.44mm/2.22mm/4.64mm and for spiculated masses: Fuji: 6.65mm/2.58mm/3.66mm; GE: 4.27mm/2.04mm/3.55mm; Hologic: 5.04mm/2.54mm/3.68mm; Giotto: 4.97mm/2.37mm/4.30mm; Siemens: 5.6mm/2.99mm/4.67mm. Dose did not impact detection of both mass types for GE and Hologic. For Fuji, Giotto and Siemens DBT, decreasing the dose lead to a significantly inferior dtr for spiculated masses and in the case of Fuji and Siemens also for non-spiculated masses.

## CONCLUSION

Detectability of mass-like lesions was higher in DBT compared to DM and SM, except for Fuji and Hologic, where SM was not different from DBT. Increasing dose only influenced mass detection in DBT. The L1 phantom demonstrated the superiority of DBT compared to DM for mass detection, for all 5 systems.

## CLINICAL RELEVANCE/APPLICATION

For most vendors. SM. in its current stage of development. cannot be recommended as a stand-alone modality if equal mass

detectability as in DBT is required.

### **SSC13-04 Accurate Local Estimation of Compressed Breast Thickness in Digital Breast Tomosynthesis Using an Iterative Reconstruction Approach**

Monday, Dec. 2 11:00AM - 11:10AM Room: S503AB

#### **Participants**

Lambert Leong, MS, Honolulu, HI (*Presenter*) Nothing to Disclose  
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#### **PURPOSE**

Our purpose is to describe invasive breast cancer in terms of lipid, water, and protein content using dual-energy tomosynthesis. Previous work for full-field digital mammography required an in-image calibration phantom adhered to the compression paddle to describe thickness, tilt, and warp. We show these parameters can be estimated by using an iterative reconstruction approach on the sinograms resulting in a model of the breast characteristics including local breast thickness, compression paddle tilt, and warp.

#### **METHOD AND MATERIALS**

Virtual breast objects (VBO) of known geometries, defined using only five unique parameters (thickness, width, density, warp, and tilt), were constructed in simulation with MATLAB and their corresponding sinograms generated. Breast thicknesses from 1 to 80 mm and chest wall to nipple distances from 1 to 200 mm were generated to sample the space. Single coronal sinograms for training and validation sets of 9600 and 1920 VBO's, respectively, were constructed. Principal component analysis (PCA) was used to generate a model which explains the relationship between the five parameters and the sinograms. Clinical DICOM header thicknesses in 24 tomosynthesis exams were also compared to the local model estimates.

#### **RESULTS**

We found that 25 PCA components explained greater than 99% of model variance. A comparison between iterative reconstructed models and phantom measures is ongoing. A mean thickness difference (DICOM - model) of 24 breasts was found to be 2.80 mm (SD = 2.95 mm, Min/Max=-12/11 mm). The PCA model captured the local thickness decline from the chest wall to the nipple.

#### **CONCLUSION**

We demonstrate a method to capture local breast thickness using an iterative reconstruction method in the sinogram space. The model was able to describe paddle warp and tilt. Phantom calibration of the model is ongoing and accurate local breast thicknesses were seen when compared to DICOM values in clinical images. This method can be implemented on commercial tomosynthesis systems without modification. Future studies will utilize these thickness measures with dual-energy tomosynthesis to create voxels lipid, water, and protein contents instead of greyscale values alone.

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

Accurate and local breast thickness measures enable lesions to be characterized by their lipid, water, and protein content through a dual-energy 3-compartment model while still in situ to better assess malignancy status.

### **SSC13-05 Deep Learning-Driven Sparse-View Reconstruction for Radiation Dose Reduction in Dedicated Breast CT: Quantitative Evaluation**

Monday, Dec. 2 11:10AM - 11:20AM Room: S503AB

#### **Participants**

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#### **PURPOSE**

To objectively quantify and demonstrate the feasibility of deep learning-driven reconstruction for sparse-view dedicated breast CT (BCT) to reduce radiation dose and to identify the best method for reader study.

#### **METHOD AND MATERIALS**

Projection datasets (300 views, full-scan; 12.6 mGy MGD) from 137 BIRADS 4/5 women who underwent BCT prior to biopsy were reconstructed using FDK algorithm (0.273 mm isotropic voxels) and served as reference. Sparse-view (100 views, full-scan; 4.2 mGy median MGD) projection data were reconstructed using FDK algorithm (0.273 mm isotropic voxels) and three variants of multiscale CNN (ResNet) architecture (individual 2D slices, "ResNet2D"; 5 contiguous 2D slices, "ResNet2.5D"; and, residual dense network with 5 contiguous 2D slices, "ResDenseNet2.5D") were used to train the network with sparse-view and reference FDK reconstructions as input and label, respectively. Each network used 2000/900/900 slices from 20/5/5 breasts for training/validation/testing. Once trained, 42868 slices from the remaining 107 breasts were used to quantify normalized mean-squared error (NMSE), bias and absolute bias, all with respect to the reference, and the standard deviation for all reconstructions.

## RESULTS

All 3 deep learning methods suppressed streak artifacts and showed significantly reduced NMSE, bias and absolute bias compared to FDK reconstruction ( $p < 0.001$ ). The NMSE (mean $\pm$ -SD, log scale) was significantly lower for ResDenseNet2.5D (-2.59 $\pm$ -0.27;  $p < 0.001$ ). The bias was lowest for ResNet2.5D (-3.05E-5 $\pm$ -3.05E-4;  $p < 0.001$ ). The absolute bias was lowest for ResDenseNet2.5D (9.05E-4 $\pm$ -3.51E-4;  $p < 0.001$ ). The standard deviation for each deep learning sparse-view reconstruction was lower than the reference 300-view FDK reconstruction as the CNN learns from the ensemble of breasts. The standard deviation in ResNet2.5D was lowest (3.67E-3 $\pm$ -1.38E-3;  $p < 0.001$ ).

## CONCLUSION

Quantitatively, ResNet architectures using multiple contiguous slices performed better than that using individual slices. Deep learning-driven sparse-view reconstruction for radiation dose reduction is feasible and needs to be investigated.

## CLINICAL RELEVANCE/APPLICATION

Deep learning-driven sparse-view reconstruction can potentially enable radiation dose reduction in breast CT to a level that may be suitable for breast cancer screening.

### SSC13-06 Measurements of Resolution in Digital Breast Tomography (DBT) Using a Tomosynthesis Phantom, Special Emphasis on Detecting Calcified Specks

Monday, Dec. 2 11:20AM - 11:30AM Room: S503AB

#### Participants

David J. Goodenough, PhD, Washington, DC (*Abstract Co-Author*) Consultant, The Phantom Laboratory

Joshua Levy, Salem, NY (*Presenter*) Stockholder, The Phantom Laboratory President, The Phantom Laboratory Stockholder, Image Owl, Inc

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## PURPOSE

Investigate measurements of resolution in DBT using a Tomosynthesis Phantom with emphasis on meaning and interpretation of "MTF". The limitations of calcified speck detection in DBT depending on where the speck might occur.

## METHOD AND MATERIALS

Tomosynthesis Phantom is used for testing DBT. Small beads (0.09mm radius) are used as both "point sources" and elements along slice width ramps for slice geometry and scan slice incrementation (z). This study examines the use of this PSF when located at intra and inter slice positions. PSF bead, and the scan slice geometry bead ramps isolate where any given bead is located (intra and inter) within the phantom and the slice. Spatial distribution of the (bead) PSF can be examined at a given position. A summation of data from neighboring beads shows study change in PSF increases the z axis slice width. FWHM of the PSF, and Fourier Transform (FT) of the PSF yielding an "MTF" type function, and corresponding Modulation levels. Nine identical DBT images taken on a DBT Tomosynthesis system and the data analyzed from both individual beads as well as combined beads examining highest resolution and average resolution within the slice. A theoretical model of PSF shows PSF tends to move from a typical function at the isocenter of the slice, annular shapes as one moves off center. Annular shapes simulated by combination of Bessel functions.

## RESULTS

PSF and "MTF" results show changes in positioning of the bead (calcified speck). Results may have important implications to understanding resolution limitations to finding small calcified specks depending on where in the slice the spec occurs. Result within the slice is different than the best-case result within the slice. High contrast object extends along the z axis, then the average result will better reflect spatial resolution.

## CONCLUSION

It is possible to examine the changes in Point Spread Function and "MTF" by using small bead, point sources. It is shown that understanding the resolution differences of location of such specks will depend on inter and intra slice locations. The "MTF" can be used to study this effect.

## CLINICAL RELEVANCE/APPLICATION

DBT phantom using small beads to study resolution in DBT systems results help the clinician understand the process of limited angle tomography degrades the highest resolution of a calcified speck location to the more average resolution a bead/speck at some random position in the slice.

### SSC13-07 Contrast-Enhanced Spectral Mammography with a Compact Synchrotron X-Ray Source

Monday, Dec. 2 11:30AM - 11:40AM Room: S503AB

#### Participants

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## PURPOSE

Contrast-enhanced spectral mammography (CESM) based on K-edge subtraction (KES) helps to identify uncertain findings in standard mammography. As CESM requires two acquisitions, dose reduction is a crucial issue. Here, two dual-energy dose-compatible CESM approaches are evaluated with a compact synchrotron X-ray source.

## METHOD AND MATERIALS

In this study, the commonly used dual-energy KES imaging technique and a two-material decomposition method were used to implement CESM at a quasi-monochromatic compact synchrotron X-ray source. For a better evaluation of the laboratory results, clinical CESM images were also performed. Low-energy attenuation-based images as well as images only showing the contrast agent iodine were acquired with a mammographic accreditation phantom for both the clinical and the laboratory measurements. The phantom has been modified with a tube filled with iodine in a concentration of 6 mg/ml to mimic the contrast agent.

## RESULTS

Confirmed by a higher contrast-to-noise ratio (CNR) and spatial resolution, improved image quality has been accomplished with both aforementioned methods carried out in the laboratory for the iodine images while the spectral approach achieved even better results than the KES imaging technique. Exemplarily, we demonstrate the reduction of the applied dose by up to 66% compared to the clinically applied dose. Additionally, the image quality of the laboratory results of the low-energy images - which are comparable to conventional mammography images - also increases compared to the clinical examinations.

## CONCLUSION

Our findings regarding the CNR and the spatial resolution suggest the great potential of novel quasi-monochromatic X-ray sources in combination with a two-material decomposition method as a means to improve the diagnostic quality and to reduce the applied dose in clinical examinations. Our results show a significant increase in image quality at the same radiation dose or a significantly reduced dose level required to obtain the same image quality as in the clinical system.

## CLINICAL RELEVANCE/APPLICATION

The reduction of radiation dose in mammography, especially for second-level examinations, is a crucial criteria for the improvement of its clinical diagnostic quality.

## SSC13-08 Comparison Between Vendor Reported and Physicist Calculated Doses Within a Quality Control Program for a Tomosynthesis Mammography Screening Trial: Interim Results

Monday, Dec. 2 11:40AM - 11:50AM Room: S503AB

### Participants

Aili K. Maki, BEng, Toronto, ON (*Presenter*) Research collaboration, General Electric Company; Contractor, Mammographic Physics, Inc

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## PURPOSE

We are overseeing the quality control (QC) for a screening trial comparing tomosynthesis (DBT) and 2D mammography. The QC involves weekly, monthly and annual tests. We also collect doses and technique factors used for patient imaging. To understand the reliability of the doses recorded in the DICOM image headers, we are comparing mean glandular dose (MGD\_calc) calculated using physicists' measurements of half value layer (HVL) and tube output with those reported in the headers for scans of phantoms (MGD\_hdr).

## METHOD AND MATERIALS

A set of phantoms is circulated annually among the participating sites and imaged with the DBT mode used for patients. Slabs of PMMA 2, 4, 6 and 8 cm thick, with 0, 0.5, 1.5 and 2.3 cm spacers are used. mR/mAs and HVL values are obtained from the physicist's surveys and used with the imaging technique factors to estimate the MGD\_calc using the Dance et al method. Corrections are made for spectrum, fraction of glandular tissue and DBT geometry, as parameterized by Li et al. The dose percent difference (DPD) is calculated as  $100 \times (\text{MGD\_hdr} - \text{MGD\_calc}) / \text{MGD\_calc}$ . Comparisons of DPDs were made between DBT systems, dosimeter manufacturers and phantom thicknesses.

## RESULTS

To date 45 surveys on 4 models from 2 vendors have been conducted. Dosimeters from 4 different manufacturers were used. The doses match best for the 4.5 cm thickness with a DPD of 2.1% (95% CI -1% to +5%). The mismatch is greatest at 22% for 2 cm (95% CI 12% to 25%). The average DPD is larger for one of the dosimeter manufacturers, suggesting a bias with that technology. Differing trends were noted in the size of the DPD vs phantom thickness when separating out by DBT model. QC testing is ongoing and updated data will be available at RSNA.

## CONCLUSION

Systematic discrepancies between displayed and calculated doses at different thickness suggest that different dose calculation models and assumptions may be used by the various DBT systems. Care must be taken in drawing conclusions about dose estimates to a population when relying on the figures reported in the DICOM headers. In addition, different biases may be present in the different meters used to measure entrance exposure and HVL, further confounding the assessment of dose.

## CLINICAL RELEVANCE/APPLICATION

Differences in assumptions used to calculate dose existing between tomosynthesis mammography systems and in beam quality values mean care must be taken when comparing reported and calculated doses.

### SSC13-09 Automatic Exposure Control Intelligence in Digital Mammography for a Diagnostic and Post-Therapy Patient Population

Monday, Dec. 2 11:50AM - 12:00PM Room: S503AB

#### Participants

Lesley Cockmartin, Leuven, Belgium (*Presenter*) Nothing to Disclose

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## PURPOSE

Automatic exposure control (AEC) systems are designed to find the most attenuating region and adjust the exposure parameters so this region is imaged at some predefined dose/quality level. This study quantifies the success rate of the AEC in selecting the densest breast tissue in diagnostic and post-therapy patient populations.

## METHOD AND MATERIALS

A total of 615 successive mammograms were collected from a GEHC Pristina<sup>TM</sup> system. The AEC-selected region was placed in one of three categories a) AEC region within the densest breast tissue (considered "optimal") b) region located in pectoral muscle and c) clips present inside the region. Second, the images were divided into 1x1 mm<sup>2</sup> areas and mean volumetric breast density (VBD) estimated for each area using Volpara<sup>TM</sup>. Third, images where the difference between maximum VBD within the AEC region and other parts of the breast was >15% were retrieved and visually scored for the presence of disturbing noise.

## RESULTS

In 84% of all mammograms the AEC selected the optimal region. In 5% of all mammograms the AEC selection missed the densest breast part, but only 3.7% resulted in differences in VBD >15%. Visual inspection of these images did not show excessive noise. In 6% of all mammograms, the AEC region was positioned in the pectoral muscle, where the correct selection should have been in the breast tissue. The mean, minimum and maximum difference in pixel values between the pectoral muscle and the densest breast tissue was 5%, -15% and 29%. In 32% of these cases a larger than targeted dose compared to breast tissue selection was given, being on average 6%. Finally, 179 mammograms (29%) contained clips. In 32 images (5% of all mammograms), the AEC selected a region that included the clips, but in 28 of these images the signal due to the clip was excluded when determining the exposure settings.

## CONCLUSION

Automatic exposure control selection within mammograms of breasts with lesions, clips etc. is a challenging task. Region selection by the GEHC Pristina<sup>TM</sup> AEC is intelligent and overcomes the current challenges via segmentation techniques and local density calculations.

## CLINICAL RELEVANCE/APPLICATION

The selection of the automatic exposure control region and subsequent dose level adjustment is a key parameter in the radiation dose/quality balance and should be optimized for all breast types.

Printed on: 10/29/20



SSC14

## Science Session with Keynote: Radiation Oncology (CNS Malignancies)

Monday, Dec. 2 10:30AM - 12:00PM Room: E261

NR RO

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

FDA Discussions may include off-label uses.

### Participants

Sanjay Aneja, MD, New Haven, CT (*Moderator*) Research Consultant, AG Mednet, Inc  
Hyunsuk Shim, PhD, Atlanta, GA (*Moderator*) Nothing to Disclose

### Sub-Events

#### SSC14-01 FET-PET Radiomic Feature Correlates with Outcome in Patients with Recurrent Glioblastoma Multiforme

Monday, Dec. 2 10:30AM - 10:40AM Room: E261

### Participants

Montserrat Carles, PhD, Freiburg, Germany (*Presenter*) Nothing to Disclose  
Micha M. Starke, Freiburg, Germany (*Abstract Co-Author*) Nothing to Disclose  
Michael Mix, Freiburg, Germany (*Abstract Co-Author*) Nothing to Disclose  
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### PURPOSE

Radiotherapy (RT) for primary and recurrent glioblastoma multiforme (GBM) is conventionally planned on anatomical magnetic resonance imaging (MRI), where the target volume is defined as the area of tumor-related gadolinium enhancement on a T1-weighted sequence (Gd-T1-MRI). Recent studies have indicated that O-(2-[18F]fluoroethyl)-L-tyrosine (FET) positron emission tomography (PET) is more specific than MRI and equally sensitive for tumor visualization. However, in recurrent GBM there is yet no clear evidence that the information provided by FET-PET is complementary or superior to MRI in RT target volume delineation and outcome prediction. The aim of this study was to present a comparison of the tumor volumes defined on FET-PET (VFET) and MRI (VMRI) and to analyze the use of FET-PET image features in predicting time to tumor progression (TTP) for patients with recurrent GBM.

### METHOD AND MATERIALS

31 previously irradiated patients with recurrent GBM and treated with re-irradiation were prospectively recruited. Gd-T1-MRI and FET-PET were performed before re-irradiation. PET target volumes were defined with a threshold of 1.8 times the standardized-uptake-value (SUV) of the background (BG, 2 volumes manually defined in cerebrum and cerebellum), while MRI volumes were contoured by experienced radiation oncologists. MRI and PET images were co-registered and 135 FET-PET image features (IF) were derived from VFET and VMRI.

### RESULTS

Results from the Wilcoxon Rank Test demonstrated that VFET and VMRI were comparable in size ( $p > 0.05$ ). However, the low average values for the Dice-Similarity-Coefficient =  $0.3 \pm 0.2$ , Predictive-Positive-Value =  $0.4 \pm 0.3$  and Sensitivity =  $0.4 \pm 0.3$  suggested a poor agreement in localization. 117 IF (87%) showed statistically significant differences between VFET and VMRI. 74% of the IF were significantly different between VFET and BG, including all SUV-related features (min, max, peak and mean). Small-Zone-Low-Gray-Level-Emphasis (SZLGE) showed statistically significant predictive value for TTP ( $p = 0.00027$ , Log-Rank test between TTP curves for patients with  $SZLGE < SZLGE_{median}$  and patients with  $SZLGE > SZLGE_{median}$ ).

### CONCLUSION

Our findings suggest that FET-PET provides complementary information with respect to MRI and could contribute to the outcome assessment of patients with recurrent GBM treated with re-irradiation.

### CLINICAL RELEVANCE/APPLICATION

FET-PET can contribute to the outcome assessment of patients with recurrent glioblastoma treated with re-irradiation.

#### SSC14-02 ASL Perfusion MRI Reveals Reduced Cerebral Blood Flow in the Region of the Hippocampus and Auditory Cortex in Patients with Former Childhood Medulloblastoma

Monday, Dec. 2 10:40AM - 10:50AM Room: E261

### Participants

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**PURPOSE**

Long-term survivors of former childhood Medulloblastoma are increasing. Thus, monitoring of sequelae of the applied radiochemotherapy (RCT) such as vascular damage is gaining importance. In this study Arterial Spin Labeling (ASL) perfusion MRI was used to analyze alterations of cerebral blood flow (CBF) in patients who underwent RCT.

**METHOD AND MATERIALS**

ASL perfusion MRI was performed in 28 patients (mean age: 25.2; range: 10-55 years; mean years after primary RCT 14.9 years, range: 1-45 years) and 24 healthy subjects (mean age: 32; range: 22-63 years). Individual CBF-maps were calculated and brought into MNI-space using SPM12. Mean CBF in grey matter was determined for every group and, based on MNI coordinates, mean CBF was calculated for the hippocampus and auditory cortex and compared on an individual basis by a nonparametric Wilcoxon rank-test.

**RESULTS**

No significant differences of mean grey matter CBF were found in patients and the healthy control group, respectively of 66.57 (65.24-68.90) vs. 65.88 (65.01-66.88)ml/min/100g. Region based comparison, however, revealed a highly significant reduction of CBF of the hippocampus in patients after RCT (69.23 (66.18-74.51)ml/min/100g) compared to the healthy control group (79.84 (78.19-81.75)ml/min/100g), and 63.01 (60.69-65.03)ml/min/100g for the auditory cortex compared to 70.98 (69.01-71.75)ml/min/100g for the healthy control group

**CONCLUSION**

ASL perfusion MRI can be used as a noninvasive tool to analyze CBF after RCT in patients with former childhood medulloblastoma. The significant reduction of hippocampal and auditory cortex CBF is in agreement with hearing impairment and deficient memory and cognition frequently observed in these patients. Hence, ASL perfusion might be considered in routine follow-up MRI protocols.

**CLINICAL RELEVANCE/APPLICATION**

ASL MR perfusion reveals significantly reduced cerebral blood flow in the region of hippocampus and the auditory cortex in patients after RCT with former childhood medulloblastoma.

**SSC14-03 Basic Pretreatment RADIOMICS Features to Predict SRS Outcome of Meningiomas and Vestibular Schwannomas**

Monday, Dec. 2 10:50AM - 11:00AM Room: E261

**Participants**

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**PURPOSE**

The goal of this study was to identify basic RADIOMICS features from conventional Magnetic Resonance imaging (MRI) and from diffusion tensor imaging (DTI) that best predict the volumetric changes in benign meningiomas and vestibular schwannomas (VS) after treatment with Gamma Knife radiosurgery (GKRS).

**METHOD AND MATERIALS**

In 24 patients with VS routine MRI and in 32 patients with meningioma routine MRI and DTI were measured before GKRS. A total of 78 parameters derived from texture analysis of the pretreatment MRI, including calculation of the mean, standard deviation (SD), percentiles, and kurtosis and skewness of data in histograms on a voxel-wise basis, and additionally 10 different DTI parameters were correlated with lesion volume change after a mean follow-up period of 36 month (range 19.5-63.3m) for meningiomas, and 41.8 months (range 21.9-80.3m) for VS.

**RESULTS**

In case of meningiomas, several DTI-derived parameters correlated significantly with volume change. The parameter that best predicted the results of GKRS was the 2.5th percentile value of the smallest eigenvalue (L3) of the diffusion tensor (CC=0.739,  $p \leq 0.001$ ), whereas among the non-DTI parameters, only the SD of T2-weighted images correlated significantly with a tumor volume change (CC=0.505,  $p \leq 0.05$ , after correction for family-wise errors using false-detection-rate FDR correction). In case of VS, 2 histogram parameters from T2-weighted images reached statistical significance ( $p < 0.05$ , FDR corrected). Kurtosis of T2 signal values turned out to predict progression with a sensitivity and specificity of 86% and 78%.

**CONCLUSION**

The prediction of volumetric response after radiosurgery can influence therapeutic strategies, such as modifying radiation dose or

The prediction of volumetric response after radiosurgery can influence therapeutic strategies, such as modifying radiation dose, or strengthen the case for radiosurgery over conventional resection. The results of our texture analysis indicate that DTI-derived parameters have a high correlation to shrinkage of meningioma volume after SRS, while conventional imaging can predict SRS outcome of both meningiomas and VS, though with somewhat less accuracy.

#### CLINICAL RELEVANCE/APPLICATION

Image based prediction of response after radiosurgery can influence therapeutic strategies, such as modifying radiation dose, or strengthen the case for radiosurgery over conventional resection.

#### SSC14-04 Hypofractionated SRS versus Single Session SRS for Perioptic Lesions. A Single-Center Study of 245 Patients

Monday, Dec. 2 11:00AM - 11:10AM Room: E261

##### Participants

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#### PURPOSE

Hypofractionated radiosurgery (HFSRS) of lesions in the sellar region is still controversially discussed as an alternative to single session SRS.

#### METHOD AND MATERIALS

According to our protocol, HFSRS is performed when it is technically impossible to limit the maximum point dose to the anterior visual pathway (AVP) to 12 Gy. Between 2011 and 2018 a total of 72 patients with perioptic lesions (mean distance lesion-to-AVP=0.3mm, 69% in direct contact) were treated with HFSRS and 173 with single fraction (mean margin dose was 15.5 Gy, mean distance lesion-to-AVP=2.0mm, 30% in direct contact). In the HFSRS group, 7 treatments were performed with a 5 day course with a mean margin dose of 5x6.93 Gy, 56 treatments with 4x5.32 Gy, and 9 treatments with 3x6.31 Gy. Exact delineation of the optic pathways was performed on high resolution 3D T1 images and additionally since 2016 by applying FGATIR sequences.

#### RESULTS

After a mean imaging follow-up period (FUP) of 23m [2-72m], local control was achieved in all lesions treated with HFSRS, except for 1 lesion (caused by pituitary apoplexy). An overall mean reduction in volume of 3.05%/m was observed. Mean FUP for ophthalmologic evaluation was 28m [2-79m]. Improved vision was observed in 10 cases; 1 case was confirmed for radiation induced optic neuropathy (RION) after delivery of 4x5.60 Gy as maximum optic point dose. All treatments were well tolerated and concluded satisfactorily. Spatial frame displacement during HFSRS course was measured < 0.3mm using CT images. In the group of single session SRS, after a mean imaging FUP of 27m [4-78m], local control was achieved in all but 7 lesions, with an overall mean reduction of 1.52%/m. Mean FUP for ophthalmologic evaluation was 36m [7-81m]. 1 case was confirmed for RION, after delivery of 10.2 Gy as maximum optic point dose. For all patients dose volume histograms were analyzed for both nerves, both tracts and chiasm.

#### CONCLUSION

According to our preliminary results, HFSRS can be considered as an efficient and relatively safe alternative to treat lesions even contacting the AVP, benefiting from a low alpha/beta ratio of 1.03 Gy (abstract presented at RSNA 2018) of the visual pathway.

#### CLINICAL RELEVANCE/APPLICATION

Hypofractionated radiosurgery can be considered as an efficient and relatively safe alternative to SRS in the treatment of lesions adjacent to the optic pathway

#### SSC14-05 Hyperpolarized Carbon-13 Metabolic MRI for Differentiating between Radiation Necrosis and Brain Tumor

Monday, Dec. 2 11:10AM - 11:20AM Room: E261

##### Participants

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#### PURPOSE

The aim of this study was to explore the feasibility of Hyperpolarized (HP) carbon-13 (<sup>13</sup>C) MRI in differentiating brain tumor from radiation necrosis.

#### METHOD AND MATERIALS

Radiation necrosis was created by an 80Gy single-dose irradiation of a half cerebrum in mice (n=7). 2 brain tumor models were created by intracranial injections of GL261 cell line (n=6) and Lewis Lung carcinoma (LLC) metastasis cells (n=7). The irradiated and tumor-bearing mice developed contrast enhancement (CE) ~2.5 months and ~14 days after treatment, respectively. 13C 3D MRSI data were acquired with the injection of HP 13C1-pyruvate, pre-polarized using a HyperSense. Lactate and pyruvate were normalized by vascular maximum total carbon signal (nLac and nPyr, respectively) and the ratio of lactate to pyruvate (Lac/Pyr) was evaluated

## RESULTS

Conventional MRI exhibited typical radiographic features of radiation necrosis and brain tumor: The irradiated mice developed large CE in post-Gd T1 MRI and were heterogeneous on the T2 MRI. Similarly, the GL261 glioma and LLC metastasis models exhibited CE and T2 hyperintensity. HP 13C data indicated that radiation-induced necrotic tissue and brain tumors had distinct metabolic profiles: Radiation-induced injury exhibited significantly lower Lac/Pyr and nLac than both mouse glioma and LLC metastatic tissue. There was no significant difference in nPyr between the radiation-induced injury and either GL261 glioma or LLC metastasis models, implying that the amount of pyruvate taken up by the three types of tissue were similar. Histological analysis demonstrated distinct characteristics between the radiation-induced necrosis and brain tumors: In contrast to the radiation-induced necrotic tissue, both tumor models showed a high cell density, which is one of the characteristics of cancer. The increased level of cellularity in these tumors was consistent with the high level of lactate observed in HP 13C data.

## CONCLUSION

The results from this study suggest that HP 13C metabolic imaging may provide a unique and noninvasive imaging biomarker for distinguishing recurrent brain tumors from radiation necrosis.

## CLINICAL RELEVANCE/APPLICATION

The differentiation of recurrent tumor from radiation necrosis after radiation therapy remains often challenging in patients with brain tumor despite various advanced MR imaging techniques. We showed the potential of HP 13C MRI to differentiate brain tumor from radiation necrosis.

### SSC14-06 The Value of ADC in the Differential Diagnosis of Benign/Malignant Meningioma and ADC with Ki-67 Proliferation Index in Meningioma

Monday, Dec. 2 11:20AM - 11:30AM Room: E261

#### Participants

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## PURPOSE

To investigate the value of the apparent diffusion coefficient (ADC) value of intracranial meningioma in the differential diagnosis of benign/malignant meningiomas and to distinguish different grades of meningioma, and the correlation between ADC value of meningioma and Ki-67 value-added index.

## METHOD AND MATERIALS

A retrospective analysis of 125 patients with meningioma who were diagnosed by pathology and preoperative Ki-67 positive rate were divided into two groups according to pathological findings: benign and malignant in 94 cases (malignant in 94 cases, malignant in 31 cases), including 52 cases of WHOI level, WHOII There were 59 cases in grade and 14 cases in grade III. The region of interest (ROI) was manually drawn on the ADC image, and the ADC values of the parenchymal region were averaged 6 times in three consecutive sections. The same method was used to obtain the ADC value of the contralateral normal white matter of the tumor entity, and the tumor entity was obtained. The relative ADC values (rADC) of the peritumoral edema area were compared between different grades of meningiomas and benign/malignant meningiomas. The Ki-67 proliferation index was analyzed in the postoperative immunohistochemistry results, and the correlation between ADC value, rADC value and Ki-67 index was analyzed.

## RESULTS

The ADC and rADC values were lower in the benign group than in the benign group ( $P < 0.001$ ). There were differences in ADC and rADC values between different grades of meningiomas, and the high-level group was lower than the low-level group ( $P < 0.001$ ). ADC values (  $r_s = -0.42$ ,  $P$

## CONCLUSION

The data showed that the ADC value can improve the accuracy of benign and malignant identification and preoperative pathological grade of meningioma, and the ADC value is negatively correlated with the Ki-67 index.

## CLINICAL RELEVANCE/APPLICATION

Preoperative MRI is important for the evaluation of patients with meningioma and the treatment of later stage.

### SSC14-08 Radiation Oncology Keynote Speaker: CNS Malignancies

Monday, Dec. 2 11:40AM - 12:00PM Room: E261

#### Participants

Ranjit Bindra, MD, PhD, Madison, CT (*Presenter*) Co-founder, Cybrexa, Inc; Consultant, Cybrexa, Inc; Stockholder, Cybrexa, Inc

Printed on: 10/29/20



SSC15

## Vascular/Interventional (Spine and Pain Intervention)

Monday, Dec. 2 10:30AM - 12:00PM Room: E263

IR VA

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

FDA Discussions may include off-label uses.

### Participants

Rex M. Pillai, MD, Sacramento, CA (*Moderator*) Nothing to Disclose  
Karunakaravel Karuppasamy, MD, FRCR, Westlake, OH (*Moderator*) Nothing to Disclose

### Sub-Events

#### SSC15-01 Risk of Acute Vertebral Fractures Post-Vertebroplasty Depends on the Distance and Location Relative to the Initial Treatment Level

Monday, Dec. 2 10:30AM - 10:40AM Room: E263

### Participants

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### PURPOSE

The risk of developing an acute vertebral fracture following a percutaneous vertebroplasty (PVP) remains unclear in the literature. Some studies suggest an increased risk is placed on adjacent vertebrae while other studies report no additional risk whatsoever.

### METHOD AND MATERIALS

Between 2002 and 2017, 1796 patients (mean age 78.9; 70.1% female) received a PVP secondary to an acute vertebral fracture. Medical records were reviewed for new onset vertebral fractures within one-year post-PVP and for evidence of additional PVP. Fractures were categorized as osteoporotic, traumatic and pathologic. New fractures were evaluated for relative location to the initial PVP level. Risk factors including age, gender, chronic steroid use and body mass index were evaluated. Analysis of post-PVP vertebral fractures stratified fracture risk as a measure of distance from the initial treatment level, evaluated specific fracture risk locations (above or below PVP) and identified risk factors for repeat PVP.

### RESULTS

Distribution of initial fractures was 56.35% osteoporotic, 41.65% traumatic and 2.00% pathologic. Thoracolumbar junction fractures (T12 or L1) accounted for 34.65% of total initial PVP. 403 patients (22.44%) developed a new fracture with a mean time of 76 days post-PVP. The highest frequency of post-PVP vertebral fractures occurred at adjacent vertebrae (34.2%) with 53.3% of total new fractures occurring within two vertebral levels from the initial PVP. Fractures at adjacent vertebrae were 15.1% more likely than fractures two vertebrae removed. Adjacent fractures located above the PVP level were 1.83 times more likely to occur than adjacent fractures below the PVP level ( $p=0.0256$ ). Chronic steroid users were 1.33 times more likely to develop multi-level fractures ( $p=0.034$ ) and 1.65 times more likely to require multiple PVP compared to non-steroid users ( $p<0.01$ ).

### CONCLUSION

Acute vertebral fractures post-PVP occur with greatest frequency at adjacent vertebrae above the PVP level. Chronic steroid use was the most predictive risk factor for multi-level fractures and repeated PVP.

### CLINICAL RELEVANCE/APPLICATION

This is the first report to assess post-vertebroplasty fracture risk as a measure of distance and relative location (above or below) to the previously treated vertebral level.

#### SSC15-02 Clinical Follow-Up of Low-Dose CT Guided Lumbar Foraminal Nerve Blocks: Differential Visual Analogue Scale Score for Pain At 3 Months Can Predict the Need for Spine Surgery

Monday, Dec. 2 10:40AM - 10:50AM Room: E263

### Participants

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**PURPOSE**

To assess the utility of differential VAS in predicting need for surgery at 3months follow up in patients undergoing low dose CT guided lumbar foraminal nerve blocks (LD CTGNB) for radiculopathy. To ascertain cut off differential VAS score to dichotomise patients into groups who will not need surgery.

**METHOD AND MATERIALS**

A total of 34 patients with lumbar radiculopathy were taken for LD CTGNB. All patients had prior MR LS spine for disc level. Procedure was done in low dose presets in 128 slice CT scanner. Pre procedure VAS score was considered baseline. Differential score obtained from subtracting follow up VAS from pre-VAS, these were obtained immediately after procedure, follow up 1-week and at 3-months. Dixon test for performed to identify outliers. ROC curve and one tailed test was used to find cut off differential VAS score, p Value and accuracy predicting for no surgery.

**RESULTS**

In 34 patients, 2 outliers were excluded. Average duration of follow up is 5months. With ROC curve analysis and one tailed test, a differential VAC score of 4 was identified to have highest sensitivity and specificity. This cut off was used for accuracy prediction for surgery free group. Thus, with differential VAC 4 or above, in immediate post procedure, we could predict that patient does not need surgery with 81% accuracy, similarly at 1 week with 92% accuracy and at 3 months with 96% accuracy. These were statistically significant with p value <0.001

**CONCLUSION**

Differential VAC score obtained from follow up showed progressively increasing accuracy in determining surgery free cohort. A differential pain score of 4, at >3 months of follow up (median number of months) would mean that the patient does not have to go into surgery, 97% of the times. This can be said with 95% confidence.

**CLINICAL RELEVANCE/APPLICATION**

In reference to this study, after CT GNB, if pain is alleviated by differential VAC score of 4 immediately post procedure, patient is likely to have same degree of alleviation of pain for next 3 months and 97% of times he may not need spine surgery. This could be used for patient counselling and follow up.

**SSC15-03 The Potential Role of Intervertebral Lumbar Disc FA (Fractional Anisotropy) Map in Diffusion Tensor Imaging (DTI) to Select Patients Suffering from Low Back Pain and Who May Benefit from Intradiscal Oxygen-Ozone Injection**

Monday, Dec. 2 10:50AM - 11:00AM Room: E263

**Participants**

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**PURPOSE**

To assess annular fibers anisotropy through the use of intervertebral disc FA map to select patients suffering from low back pain of lumbar disc origin and who may benefit from intradiscal oxygen-ozone injection.

**METHOD AND MATERIALS**

A total of 75 patients suffering from back pain were selected for prospective non-randomized blinded trial approved by the Medical Ethical Committee of our Institution. Before treatment they underwent MRI 3 Tesla exams performed with conventional sequences (T2-FSE-WI, T2 fat-sat and T1 FSE-WI) and additional DTI sequence, respectively for assessing lumbar disc pathology according to the nomenclature and Fractional Anisotropy (FA) map of the involved intervertebral disc. Discography was obtained before treatments under CT guidance of the involved discs in order to confirm MRI reports. Patients were randomly assigned to two groups; control Group (20 men, 16 women; median age 45 years old) underwent intraforaminal injection of steroid and anesthetic. The remaining 39 patients (Study Group composed by 18 men, 21 women; median age 46 years old) underwent the same treatment with the addition of intradiscal oxygen-ozone (O2-O3) injection. Oswestry Low Back Pain Disability (ODI) Questionnaire was administered before treatment and at intervals, the last at 6-month follow-up. Results were compared with X2, t test and regression analysis.

**RESULTS**



In cases of annular fissures without herniation or extrusion disc, O2-O3 intradiscal injection therapy was successful in 16 (41%) study group patients compared with 10 control group patients (27,5 %) (P < 0.01). ODI questionnaire showed significant improvement of symptoms in both Groups (P < 0.01). Similar results were observed in the remaining cases of both groups when the disc was involved with associated radicular pain (P < 0.01).

## CONCLUSION

An FA disc map congruous with a rupture of annular fibers could be considered as a predictive sign of response to oxygen-ozone lumbar intradiscal injection treatment so it could be added to the routine MR exam.

## CLINICAL RELEVANCE/APPLICATION

Preliminary MRI evaluation before Oxygen-Ozone treatment with FA map of lumbar degenerated discs may be helpful in distinguishing annular tear from herniation and ,therefore, planning which patients may benefit of O2-O3 chemodiscocolysis.

### SSC15-05 Efficacy of MR-Guided Focused Ultrasound Surgery in Facetal arthropathy: A Study of 21 Patients

Monday, Dec. 2 11:10AM - 11:20AM Room: E263

#### Participants

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Chandresh O. Karnavat, Mumbai, India (*Abstract Co-Author*) Nothing to Disclose

Shrinivas B. Desai, MD, Mumbai, India (*Presenter*) Nothing to Disclose

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## PURPOSE

To evaluate efficacy of MR guided Focused Ultrasound Surgery( MRgFUS) in treatment of low backache due to facetal arthropathy by assessing symptomatic improvement in terms of decrease in Numerical rate score (NRS) and Oswestry Disability Index(ODI)

## METHOD AND MATERIALS

126 facet joints (L3-4 to L5-S1)in 21 patients in the age group 40 to 80 yrs were selected for study after approval from ethics committee.The inclusion criteria were LBP due to facetal arthropathy without significant Radiculopathy, Facet joint arthropathy without significant spinal canal or neural foraminal stenosis ,Diagnostic facet jt. injection with local anesthetic & steroid causing significant pain reduction (done in 10 patients ).All included patients had a NRS of >5 and ODI >50% Treatment was performed on GE 1.5 TESLA HDXT with EXBLATE 2000 in supine position under mild conscious sedation Immediate post treatment evaluation was done by identifying Post Contrast enhancement at the posterior margin of the facets joints.1 week, 1 month, 3 and 6 months follow up of all the patients was done by plotting of Numerical rate scale (NRS)scores, Oswestry Disability (ODI)scores .

## RESULTS

Average pre treatment NRS was 9 ,which reduced to 4, 1 month following treatment and to 2 ,6 months following treatment The reduction in NRS score after 1 and 6 months is statistically significant (p=0.00001) Average pre treatment ODS 70% ,with reduction to 35% and 22% following 1 and 6 months respectively .By chi square test ,reduction in ODS was significant with p value of 0.0248 after 1 month and 0.0020 after 6 months .

## CONCLUSION

MRgFUS is a safe and effective procedure in treatment of facetal arthropathy related pain in selected patients with no adverse effects or complications and can be performed on out patient basis .

## CLINICAL RELEVANCE/APPLICATION

MRgFUS is a non invasive modality providing good pain relief in facetal arthropathy ,with results comparable to other more invasive procedures like radiofrequency ablation

### SSC15-06 3T- MRI Analysis of Alcohol Distribution and Side Effects after Sympathetic Blocks and Sympathicolysis: Is 1ml Enough for Harm Avoidance?

Monday, Dec. 2 11:20AM - 11:30AM Room: E263

#### Participants

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## PURPOSE

Sympathicolyses are optional third line treatments in patient with complex regional pain syndrome (CRPS) and peripheral occlusive disease, whose vascular status does not permit reconstructive surgery. To avoid structure damage CT needle guidance is the most often used procedure when performing an alcohol sympathectomy. There are reports that alcohol can cause minor and major complications such as ureter strictures, retroperitoneal bleeding and irritation of peripheral nerves. However, the frequency, mechanism, spread and atypical dilution of injected alcohol is unknown. This is the first 3T-MRI based study for visualization the distribution and diffusion behavior of alcohol at the area of injection and affection of the neighboring tissue.

## RESULTS

In all cases alcohol demonstrated an effective sympathectomy and patients reported pain relief. One Patient reported a peripheral

paresthesia caused by a nerve irritation. One Patient had a retroperitoneal bleeding. No-one had detected erythrocytes in urine as a sign of ureter strictures. Despite small volume injection of 1,5ml alcohol and even when needle placement was performed correctly, MRI showed high signal changes caused by edema in soft tissues and vessel- and ureter walls in all patients. Neurolytic sympathetic ganglia showed an increase of size and proton signal in MRI in 4 patients.

## CONCLUSION

In all cases the interventions lead to an effective sympathicolysis and pain relief. In most cases all detected changes and injuries had no clinical consequences. A prediction of distribution of applicated alcohol and its performance is not possible or seems to be ambiguous and may be accompanied with an intermediate risk for the patient. Therefor after alcohol sympathicolysis patients must be clinical monitored and with present of clinical signs an MRI should be performed. For risk avoidance throughout alcohol injections we suggest radiofrequency ablations of sympathetic ganglia.

## METHODS

14 patients with either CRPS (n=8) or PAOD (n=6) were treated with a diagnostic sympathetic block with an anesthetic at the Level L3 or L4. With positive response a CT guided alcohol sympathicolysis with 1,5ml were performed. Independently all patient received 3 MRI Neurography of the lumbar sympathetic chain prior and after block and following the alcohol injections. MRI-Neurography protocol included T1 sequences in all direction for visualization of the anatomy, an edema and fluid sensitive sequences for detection of tissue changes and structure damage. We calculated fluid volumes and distribution around the injection area anterior to the vertebra, dorsal of Aorta/IVC and around the psoas muscle. Diffuse edema in muscle, fat, nerves and organs were analyzed for each single CT and MRI and were correlated between the different time points.

## SSC15-07 Intraarticular Facet Joint Steroid Injection versus Medial Branch Block: Which One Represents the Best Therapeutic Option in the Management of Lumbar Facet Joint Pain?

Monday, Dec. 2 11:30AM - 11:40AM Room: E263

### Participants

Antonio Izzo, Laquila, Italy (*Presenter*) Nothing to Disclose  
Giampaolo Bianchi, MD, Laquila, Italy (*Abstract Co-Author*) Nothing to Disclose  
Maria Valeria Marcella Micelli, Laquila, Italy (*Abstract Co-Author*) Nothing to Disclose  
Pierpaolo Palumbo, MD, L'Aquila, Italy (*Abstract Co-Author*) Nothing to Disclose  
Luca Panebianco, MD, Rome, Italy (*Abstract Co-Author*) Nothing to Disclose  
Marco Varrassi, L'Aquila, Italy (*Abstract Co-Author*) Nothing to Disclose  
Sergio Carducci, L'Aquila, Italy (*Abstract Co-Author*) Nothing to Disclose  
Aldo Victor Giordano, L'Aquila, Italy (*Abstract Co-Author*) Nothing to Disclose  
Carlo Masciocchi, MD, L'Aquila, Italy (*Abstract Co-Author*) Nothing to Disclose

### For information about this presentation, contact:

izzo1461@gmail.com

## PURPOSE

The aim of our study is to compare the clinical outcome of two different techniques used in the management of lumbar facet joint (LFJ) back pain: intraarticular (IA) steroid injection and medial branch block (MBB).

## METHOD AND MATERIALS

76 patients with LFJ back pain were selected on the basis of clinical evaluation and MR-findings and randomly assigned to one of two groups: 36 patients (Group A) underwent intraarticular LFJ steroid injection while 40 patients (Group B) carried out MBB. Both procedures were performed under CT-guidance. We injected each patient with 1.5mL of Ropivacaine in addition to 2mL of Triamcinolone. We evaluated the clinical-outcome by means of VAS score and Rolland-Morris Questionnaire (RMQ) for respectively evaluating the level of pain and disability, before treatment and after 1, 3 and 6 months of treatment. Clinical effectiveness was determined as a >50% reduction to the pre-treatment VAS value and a value <9 in the RMQ Score.

## RESULTS

Mean values of VAS and RMQ before treatment in Group A were 8.1 and 14.6 respectively. The treatment was effective (VAS reduction >50%, RMQ score <9) in 86.1% of patients after 1month, 72.2% after 3months, 61.1% after 6months. Mean values of VAS and RMQ before treatment in Group B were 7.8 and 14.1. The treatment was effective in 85% of the patients after 1month, 67.5% after 3months and 47.5% after 6months.

## CONCLUSION

In our study both IA steroid injection and MBB showed similar effectiveness in the treatment of LFJ back pain at 1 and 3 months after procedure. However IA steroid injection has proved a greater clinical efficacy at 6 months (61.1% vs. 47.5%). Although there are not important differences in pain reduction between the two groups of patients, it seems that patients in Group A show slightly better results. On the basis of our results, both IA steroid injection and MBB are effective and interchangeable techniques in the treatment of LFJ back pain with good results in the short and medium term and moderate results in the long term. Both the techniques can be repeated indefinitely over time, considering that there are roughly no side effects.

## CLINICAL RELEVANCE/APPLICATION

Intraarticular steroid injection and medial branch block are valid treatment options in the management of lumbar facet joint pain with positive clinical effects for almost six months.

## SSC15-08 Utilization and Outcomes for Vertebral Augmentation in Cancer Patients

Monday, Dec. 2 11:40AM - 11:50AM Room: E263

### Participants

William Borrer, MD, Houston, TX (*Presenter*) Nothing to Disclose  
Joshua D. Kuban, MD, Houston, TX (*Abstract Co-Author*) Nothing to Disclose  
Stephen Lee, Houston, TX (*Abstract Co-Author*) Nothing to Disclose

Steven Yevich, MD, MPH, Houston, TX (*Abstract Co-Author*) Speakers Bureau, Endocare, Inc  
Sunil Sheth, Houston, TX (*Abstract Co-Author*) Nothing to Disclose  
Rahul A. Sheth, MD, Houston, TX (*Abstract Co-Author*) Nothing to Disclose

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

william.j.borror@uth.tmc.edu

**PURPOSE**

The spine is the most common site of bone metastasis, and metastasis often lead to pathological vertebral compression fractures. Vertebral augmentation is commonly used for mitigation of pain associated with these pathological fractures. The purpose of this study was to perform a population health analysis of the time course, demographics, and outcomes following spine augmentation procedures in cancer patients.

**METHOD AND MATERIALS**

Using administrative data from all inpatient and outpatient hospital encounters in California (2005 - 2011) and Florida (2005 - 2014), we identified patients a cancer diagnosis based on the relevant ICD-9 diagnostic codes. Patients who underwent spine augmentation procedure (vertebroplasty or kyphoplasty) were then identified based on the appropriate CPT procedure codes. The influence of spine augmentation on overall survival was determined using Kaplan-Meier statistics

**RESULTS**

We identified 5,757 cancer patients who underwent 7,105 spine augmentation procedures; this population comprised our study cohort. The median age was 76 years, and 58.7% of the cohort was female. Comorbidities included renal insufficiency (19.2%), heart failure (1.6%), chronic obstructive pulmonary disease (27%), diabetes (11.6%), hypertension (36.5%), and osteoporosis (21.3%). Lung, breast, and prostate cancer were the most common histologies. There was a 2.9-fold increase in the utilization of spine augmentation procedures for cancer patients between 2005 - 2014. The mean annual hospital volume for spine augmentation in cancer patients was 1.9, with a range from 1 to 26.9. When compared to a cohort of patients with bone metastases who did not undergo spine augmentation, patients who underwent spine augmentation were noted to have a significant improvement in overall survival ( $P = 0.02$ ).

**CONCLUSION**

The utilization of spine augmentation in cancer patients is increasing. In addition to its palliative role, spine augmentation may play an important role in patient survival outcomes.

**CLINICAL RELEVANCE/APPLICATION**

Understanding the outcomes following spine augmentation can better help with treatment and management of patients with spinal metastasis.

**SSC15-09 Lobster Project®: A New Method for the Percutaneous Treatment of Lumbar Central Canal and Foraminal Stenosis. Preliminary Experience in 40 Patients**

Monday, Dec. 2 11:50AM - 12:00PM Room: E263

**Participants**

Matteo Bellini, MD, Siena, Italy (*Presenter*) Consultant, Stryker Corporation  
Giulia Sadotti, MD, Siena, Italy (*Abstract Co-Author*) Nothing to Disclose  
Dario Notaro, MD, Siena, Italy (*Abstract Co-Author*) Nothing to Disclose  
Chiara Zini, MD, Rome, Italy (*Abstract Co-Author*) Nothing to Disclose  
Lucia Montì, MD, Siena, Italy (*Abstract Co-Author*) Nothing to Disclose

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

matteo.bellini@ao-siena.toscana.it

**PURPOSE**

To evaluate the effectiveness and to describe the technique of Lobster® device in a cohort of 40 patients with lumbar central canal and foraminal stenosis (LSS).

**METHOD AND MATERIALS**

From May 2018 to March 2019, 40 patients (male = age range: 45-92 years, mean: 72,7) with electromyographically confirmed for neurogenic intermittent claudication (NIC), related to mono (N=37) or bi-segmental (N=3) LSS, were enrolled in the present study. We treated 43 levels (n.32 L4-L5, n.8 L3-L4, n.3 L5-S1).Magnetic Resonance (MR), physical exam and VAS scale were performed before the procedure and 3 months later. Technical success was defined as correct placement of Lobster® device demonstrated with computer tomography (CT), performed immediately after treatment. All treatments were performed under fluoroscopic guidance (Innova 3131iq, General Electric Healthcare, CT, USA), using mild sedation plus local anesthesia with standard anti-infectious therapy.

**RESULTS**

All Lobster® device have been placed with 100% of technical success and in 3 cases the device has been placed at L5-S1 level; in 3 patients the treatment was performed in 2 levels at the same time. No major complications occurred; in our population we did not experience any cases of infection, nerve damage, nor bleeding. Most patients (N=36) showed great improvement in symptoms with relevant post-operative VAS scale reduction ( $p < 0,001$ ) and remain stable at 3-month follow-up.

**CONCLUSION**

Lobster® is feasible and safe minimally-invasive decompression method for LSS in selected patients with NIC, despite the age.Further studies on same topic would be highly desirable to investigate the long term effectiveness.

**CLINICAL RELEVANCE/APPLICATION**

Lobster® is implanted under local anesthesia using a small skin incision limiting blood loss and muscle trauma preserving anatomical structures; the device could be removed percutaneously, if necessary.

Printed on: 10/29/20



## 105<sup>TH</sup> Scientific Assembly and Annual Meeting

December 1-6 | McCormick Place, Chicago

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RCA23

### Making the Most of Google Docs: Forms, Sheets, and Documents (Hands-on)

Monday, Dec. 2 12:30PM - 2:00PM Room: S401AB

**IN**

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

#### Participants

James J. Kazam, MD, New York, NY (*Moderator*) Nothing to Disclose  
James J. Kazam, MD, New York, NY (*Presenter*) Nothing to Disclose  
Mark Lum, MD, New York, NY (*Presenter*) Nothing to Disclose  
Hersh R. Patel, MD, New York, NY (*Presenter*) Nothing to Disclose  
Brendan Logiurato, MD, New York, NY (*Presenter*) Nothing to Disclose

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

jjk9004@med.cornell.edu

#### LEARNING OBJECTIVES

1) Understand the benefits and drawbacks of using Google tools for collaborative editing. 2) Become familiar with the potential uses of Google drive applications and native tools. 3) Describe how to maximize Google drive utilizing plug-ins and 3rd party tools.

#### ABSTRACT

Attendees should have an active google account prior to coming to this session. Google's suite of applications provides an accessible, convenient, and powerful platform for collaboration with the potential to improve productivity in education, research, and operations. Participants will become familiar with the various built in and 3rd party tools by working through examples in this hands-on session.

Printed on: 10/29/20



RCC23

## Want to Learn More About Imaging Informatics? Education, Resources, and Certifications

Monday, Dec. 2 12:30PM - 2:00PM Room: N226



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

### Participants

Christopher J. Roth, MD, Raleigh, NC (*Moderator*) Nothing to Disclose

### LEARNING OBJECTIVES

1) Summarize the forces driving physician adoption and leadership in local and national informatics initiatives. 2) Outline freely available educational resources to expand imaging informatics understanding. 3) Describe available imaging informatics courses and fellowships. 4) Detail common certifications available to imaging and non-imaging informatics leaders to demonstrate their knowledge. 5) Know the current imaging informatics 'hot topics.'

### Sub-Events

#### RCC23A Landscape of Online Resources for Informatics Self-Study

Participants

Marc D. Kohli, MD, San Francisco, CA (*Presenter*) Nothing to Disclose

### LEARNING OBJECTIVES

1) Identify online sources of content for didactic informatics self-study. 2) Identify online resources for hands-on study of database and programming concepts.

#### RCC23B Formal Opportunities and Resources for Imaging Informatics Training

Participants

Nabile M. Safdar, MD, Milton, GA (*Presenter*) Nothing to Disclose

### For information about this presentation, contact:

nmsafda@emory.edu

### LEARNING OBJECTIVES

1) Discuss currently available options for basic and advanced training in imaging informatics available to radiologists at all levels of training and career stage.

#### RCC23C Imaging and Nonimaging Informatics Society Certifications: What is Out There and is it Valuable?

Participants

Christopher J. Roth, MD, Raleigh, NC (*Presenter*) Nothing to Disclose

### LEARNING OBJECTIVES

1) Describe the value of obtaining certifications as an informatics leader. 2) Compare available opportunities for pursuing three common informatics certifications relevant to RSNA members and attendees: American Board of Imaging Informatics Certified Imaging Informatics Professional (ABII CIIP) certification, the American Board of Preventative Medicine Clinical Informatics (ABPM CI) ABMS board certification, and Healthcare Information and Management Systems Society Certified Professional in Health Information & Management System (HIMSS CPHIMS).

#### RCC23D Revisioning Informatics Educational Resources

Participants

Douglas Fridsma, MD, PhD, Bethesda, MD (*Presenter*) Nothing to Disclose

### For information about this presentation, contact:

fridsma@amia.org

Printed on: 10/29/20



SPAI22

## RSNA AI Deep Learning Lab: Data Science: Data Wrangling

Monday, Dec. 2 1:00PM - 2:30PM Room: AI Showcase, North Building, Level 2, Booth 10342

AI IN

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

### Participants

Katherine P. Andriole, PhD, Chestnut Hill, MA (*Presenter*) Research funded, NVIDIA Corporation; Research funded, General Electric Company; Research funded, Nuance Communications, Inc; ; ;

### Special Information

In order to get the best experience for this session, it is highly recommended that attendees bring a laptop with a keyboard, a decent-sized screen, and the latest version of Google Chrome. Additionally, it is recommended that attendees have a basic knowledge of deep learning programming and some experience running a Google CoLab notebook. Having a Gmail account is also helpful. Here are instructions for [creating](#) and [deleting](#) a Gmail account.

### ABSTRACT

This session will include a deeper dive into data preparation and analysis tasks required to obtain the best results from your deep learning system. It will include a discussion of data cohort makeup, different options for representing the data, how to normalize the data, particularly image data, the various options for data labeling / image annotation and the benefits of each option. Model performance metrics will also be examined. We will discuss the 'after training' aspects of deep learning including validation and testing to ensure that the results are robust and reliable.

Printed on: 10/29/20



VSI021

## Interventional Oncology Series: Interventional Oncology Basic Science-Progress, Challenges, and Opportunities

Monday, Dec. 2 1:00PM - 3:00PM Room: E450B

IR OI RO

AMA PRA Category 1 Credits™: 2.00  
ARRT Category A+ Credits: 2.25

FDA Discussions may include off-label uses.

### Participants

S. Nahum Goldberg, MD, Efrat, Israel (*Moderator*) Consultant, AngioDynamics, Inc; Consultant, Cosman Medical, Inc; Consultant, XACT Robotics;

### LEARNING OBJECTIVES

1) Characterize the most important cutting-edge advances of interventional oncologic techniques. 2) Gain a better understanding of new intraprocedural and follow-up imaging techniques that facilitate successful state of the art interventional oncologic practice.

### ABSTRACT

This session has been organized into a thematic unit that will provide a series of six lectures by leaders in the field each dedicated to discussing advances in the key aspects that comprise robust interventional oncologic practice. These include lectures on four aspects of tumor eradication thermal and non-thermal ablation devices, and transcatheter and injection therapies, supplemented by presentations highlighting two cutting edge areas that are rapidly being incorporated into treatment algorithms: Robotics and Virtual Navigation and Artificial Intelligence algorithms. The session will further include selected complementary abstract presentations that highlight innovative research in these thematic areas.

### Sub-Events

#### VSI021-01 Thermal Ablation Devices and Physics

Monday, Dec. 2 1:00PM - 1:15PM Room: E450B

#### Participants

Alison R. Gillams, MBChB, London, United Kingdom (*Presenter*) Nothing to Disclose

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

alliesorting@gmail.com

### LEARNING OBJECTIVES

1) To understand the most commonly used ablation devices and the physics underlying their usage. 2) To understand the positives and downsides of each technology. 3) To understand which are the optimal devices to use in various common clinical scenarios.

#### VSI021-02 Combining Shear Wave Ultrasound Elastography and Single Cell Biophysical Analysis to Highlight Differences in Tumor Phenotype and Heterogeneity

Monday, Dec. 2 1:15PM - 1:25PM Room: E450B

#### Participants

Michael D. Beland, MD, Providence, RI (*Presenter*) Nothing to Disclose  
Deepraj Ghosh, Providence, RI (*Abstract Co-Author*) Nothing to Disclose  
Michelle Dawson, PhD, Providence, RI (*Abstract Co-Author*) Nothing to Disclose

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

mbeland@lifespan.org

### PURPOSE

The purpose of this study was to determine if tissue stiffness is related to tumor invasiveness. We describe a novel 3D organoid culture model using 18 gauge core biopsy samples of soft tissue tumors with ultrasound shear wave elastography (SWE) prior to biopsy to characterize tissue stiffness.

### METHOD AND MATERIALS

This prospective study was performed with IRB approval. Ten consenting adult patients underwent biopsy of a superficial soft tissue mass with US guidance. Prior to obtaining 18g core biopsy, multiple SWE images of the mass were obtained. The samples were then monitored using time-lapsed microscopy to study cell interactions with the extracellular matrix, along with single cell morphology and motility parameters. We used this approach to characterize single cell biophysical properties for dissociated cells cultured on 2D polyacrylamide substrates, as well as cells migrating from tumor organoids in our 3D model. The gels were then dissociated and cells isolated from the gels for further biophysical or phenotypical analysis to study intratumor heterogeneity in a controlled way.



## RESULTS

We observed increased variation in tissue stiffness (SWE measurements) correlated with increased heterogeneity in nuclear morphology and cell motility, which appeared to be related to increased incidence of cells with larger nuclei. Based on flow cytometry analysis of multiple markers we suspect these larger nucleated cells are fibroblasts, which may contribute to the increased tissue stiffness through matrix remodeling. Stiffer tumors required more time for cells to invade the surrounding collagen gel than softer lymphomas or benign lymphoid tissue. Lymphomas also contained small round lymphocyte-like cells that rapidly invade the surrounding gel moving randomly; these tumors also contain larger spindle-shaped cells that invade at a later time point, which were more likely fibroblasts.

## CONCLUSION

Early data suggests that combining high content single cell biophysical analysis with in vivo ultrasound SWE shows cells isolated from stiffest regions of malignant tumors have abnormal mechanical signatures, which may be directly related to their invasive behavior.

## CLINICAL RELEVANCE/APPLICATION

Stiffer portions of tumors may behave in a more invasive pattern. SWE may be useful in selecting sites for tumor biopsy or treatment monitoring. There may be future role for therapeutic modification of tumor extracellular environments to alter invasiveness.

## VSIO21-03 Non-thermal Ablation (IRE)

Monday, Dec. 2 1:25PM - 1:40PM Room: E450B

### Participants

Martijn R. Meijerink, MD, Amsterdam, Netherlands (*Presenter*) Research Grant, AngioDynamics, Inc

### For information about this presentation, contact:

mr.meijerink@amsterdamumc.nl

## LEARNING OBJECTIVES

1) To understand the basic physical concept of electroporation. 2) To understand the current and potential future indications of irreversible electroporation. 3) To better understand the immunomodulatory effect of irreversible electroporation and electro-immunotherapy

## ABSTRACT

Irreversible electroporation (IRE) is a predominantly non-thermal ablation technique for the treatment of malignancies considered unsuitable for surgery and thermal ablation. By creating nanopores the cells will lose their homeostasis and go into apoptosis, pyknosis and delayed necrosis, contrary to coagulative necrosis with thermal ablation. The potential to eradicate tumors in the vicinity of critical structures such as bile ducts, intestines, urinary tracts and important blood vessels has slowly led to the adoption of IRE in the treatment of locally advanced pancreatic cancer, perihilar cholangiocarcinoma and central liver tumors, central renal cancers and prostate cancer. In pancreatic cancer a systemic immune-response targeted against tumor-specific antigens, together with a reduction in immune-suppression and increase in cytotoxic and helper T-cell populations have now focused research on combining IRE with local and/or systemic immune-modulatory drugs such as checkpoint inhibitors.

## VSIO21-04 Transcatheter Therapies

Monday, Dec. 2 1:40PM - 1:55PM Room: E450B

### Participants

Stephen J. Hunt, MD, PhD, Philadelphia, PA (*Presenter*) Consultant, Amgen Inc; Research Consultant, BTG International Ltd; Speakers Bureau, Galil Medical Ltd; Research Grant, BTG International Ltd; Research Grant, Geurbet SA

### For information about this presentation, contact:

stephen.hunt@uphs.upenn.edu

## LEARNING OBJECTIVES

1) Be able to provide an overview of the different types of transcatheter therapies, their mechanisms of action, their indications for use, their side effects, and their role in clinical management of solid malignancies.

## ABSTRACT

This lecture provides an overview of transcatheter therapies, with updates on the latest therapies in both research and clinical development. The objective of this course is to review the current state of transcatheter therapies in interventional oncology, and provide an introduction to emerging technologies in the field. At the conclusion, participants in this course will be able to provide a broad overview of transcatheter therapies in interventional oncology as well as the advantages and limitations of individual modalities.

## VSIO21-05 Molecular Imaging of Tumor pH to Monitor Loco-Regional Therapy Effects on Liver Cancer

Monday, Dec. 2 1:55PM - 2:05PM Room: E450B

### Participants

Lynn J. Savic, MD, New Haven, CT (*Presenter*) Nothing to Disclose  
Isabel T. Schobert, BS, New Haven, CT (*Abstract Co-Author*) Nothing to Disclose  
Dana C. Peters, PhD, Bethesda, MD (*Abstract Co-Author*) Nothing to Disclose  
John J. Walsh, MD, New Haven, CT (*Abstract Co-Author*) Nothing to Disclose  
Fabian Laage-Gaupp, MD, New Haven, CT (*Abstract Co-Author*) Nothing to Disclose  
Charlie Hamm, Berlin, Germany (*Abstract Co-Author*) Nothing to Disclose

Nina M. Tritz, New Haven, CT (*Abstract Co-Author*) Nothing to Disclose  
Luzie A. Doemel, New Haven, CT (*Abstract Co-Author*) Nothing to Disclose  
Ming de Lin, PhD, North Haven, CT (*Abstract Co-Author*) Employee, Visage Imaging, Inc; Former Employee, Koninklijke Philips NV  
Albert Sinusas, MD, New Haven, CT (*Abstract Co-Author*) Research Grant, General Electric Company; Research Grant, Lantheus Medical Imaging, Inc; Research Consultant, Astellas Group; Research Consultant, Bayer AG  
Todd Schlachter, MD, New Haven, CT (*Abstract Co-Author*) Research Grant, Guerbet SA  
James S. Duncan, PhD, New Haven, CT (*Abstract Co-Author*) Nothing to Disclose  
Fahmeed Hyder, New Haven, CT (*Abstract Co-Author*) Nothing to Disclose  
Daniel Coman, New Haven, CT (*Abstract Co-Author*) Nothing to Disclose  
Julius Chapiro, MD, New Haven, CT (*Abstract Co-Author*) Research Grant, Guerbet SA; Consultant, Guerbet SA; Research Grant, Koninklijke Philips NV; Consultant, Koninklijke Philips NV; Research Grant, Boston Scientific Corporation;

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

lynn.savic@yale.edu

**PURPOSE**

To establish extracellular pH (pHe) mapping for the non-invasive molecular monitoring of the liver tumor microenvironment and changes induced by loco-regional therapy.

**METHOD AND MATERIALS**

Thirty-two VX2 tumor-bearing rabbits were assigned to non-invasive pHe mapping on human-size 3T MRI-scanners before and up to 2 weeks after complete conventional transarterial chemoembolization (cTACE) using ethiodized oil (Lipiodol, Guerbet) and doxorubicin. Additionally, intentional incomplete cTACE was performed to mimic unsuccessful treatment and employ pHe imaging to detect viable tumor residuals. pHe mapping utilized chemical shift imaging. Additionally, multiparametric MRI and CT were performed before and at several timepoints after cTACE for the quantification of tumor enhancement, diffusion, and Lipiodol coverage. Imaging findings were correlated with histopathology using a panel of metabolic (HIF-1a, GLUT-1, LAMP-2) and viability markers (PCNA, TUNEL).

**RESULTS**

Untreated VX2 tumors demonstrated a significantly lower pHe ( $6.80 \pm 0.09$ ) than liver parenchyma ( $7.19 \pm 0.03$ ,  $p < 0.001$ ). Upregulation of HIF-1a, GLUT-1, and LAMP-2 histologically confirmed a hyperglycolytic phenotype and tumor acidosis. A gradual increase over time toward pHe normalization was revealed after complete cTACE supported by decreasing detectability of the metabolic histological markers. Additionally, pHe 2 weeks after incomplete cTACE indicated both acidosis of viable residuals and increased pHe of treated regions in the same tumor. Multimodal imaging revealed durable devascularization immediately after complete cTACE and gradually increasing necrosis whilst sustained Lipiodol coverage of the tumor.

**CONCLUSION**

In this study, spectroscopic pHe mapping was established as a new non-invasive monitoring tool for therapeutic efficacy in a translational liver tumor model. As most liver tumors are hyperglycolytic and create an acidified microenvironment, normalization of tumor pHe may serve as a functional biomarker for positive therapeutic outcome.

**CLINICAL RELEVANCE/APPLICATION**

In addition to tumor detection, pHe can be used as a functional biomarker for liver cancer to inform personalized treatment decisions and to monitor therapeutic efficacy of loco-regional therapies.

**VSIO21-06 Direct Intra-tumoral Delivery: Drugs and Beyond**

Monday, Dec. 2 2:05PM - 2:20PM Room: E450B

**Participants**

Rahul A. Sheth, MD, Houston, TX (*Presenter*) Nothing to Disclose

**VSIO21-07 Robotics and Virtual Navigation**

Monday, Dec. 2 2:20PM - 2:35PM Room: E450B

**Participants**

Luigi Solbiati, MD, Pieve Emanuele (milano), Italy (*Presenter*) Nothing to Disclose

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

lusolbia@tin.it

**VSIO21-08 Artificial Intelligence: Nuts, Bolts and Clinical Applications**

Monday, Dec. 2 2:35PM - 2:50PM Room: E450B

**Participants**

Julius Chapiro, MD, New Haven, CT (*Presenter*) Research Grant, Guerbet SA; Consultant, Guerbet SA; Research Grant, Koninklijke Philips NV; Consultant, Koninklijke Philips NV; Research Grant, Boston Scientific Corporation;

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

julius.chapiro@yale.edu

**ABSTRACT**

This talk will introduce the 'hot topic' of machine learning to interventional oncology and discuss how machine learning applications for image guidance, big data analysis and clinical decision support may change IO practice and research.

**VSIO21-09 Panel Discussion**

Monday, Dec. 2 2:50PM - 3:00PM Room: E450B

Printed on: 10/29/20



MSAS23

**Providing Radiology Services for Global Health (Sponsored by the Associated Sciences Consortium)  
(Interactive Session)**

Monday, Dec. 2 1:30PM - 3:00PM Room: S105AB

OT

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

**Participants**

Craig St George, ARRT, RT, Albuquerque, NM (*Moderator*) Nothing to Disclose

**Sub-Events**

**MSAS23A Army Radiology: 20+ Years of Peacekeeping and Wartime Radiology**

**Participants**

John J. Beall III, Joint Base Lewis McChord, WA (*Presenter*) Nothing to Disclose

**LEARNING OBJECTIVES**

1) Describe how the military trains their Radiologic Technologists. 2) Identify radiology and CT equipment used over the past 20 years to provide optimal imaging while deployed in a field environment. 3) Discuss the utilization of the deployable picture archiving and communications system and the Theater Medical Data Store.

**Active Handout: John J. Beall**

[http://abstract.rsna.org/uploads/2019/19000358/Active\\_MSAS23A.pdf](http://abstract.rsna.org/uploads/2019/19000358/Active_MSAS23A.pdf)

**MSAS23B Bringing Radiology to the Underserved: Medical Imaging in Global Health**

**Participants**

Melissa Culp, MEd, Chevy Chase, MD (*Presenter*) Nothing to Disclose

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

[mculp@rad-aid.org](mailto:mculp@rad-aid.org)

**LEARNING OBJECTIVES**

1) Be able to define global health, to discuss the need for radiology in global health, and to understand sustainable methodologies for radiology integration within global health. 2) Be able to articulate the impact of radiology's role in the World Health Organization Global Target of reducing non-communicable diseases, such as cancer and cardiovascular disease, and in support of the United Nations Sustainable Development Goals to increase Good Health and Well-Being, to Reduce Inequalities, to promote Gender Equality, to sustain Decent Work and Economic Growth, and to support Industry, Innovation, and Infrastructure - through Partnerships for the Goals. 3) Be able to implement concepts related to the World Health Organization's framework for action on interprofessional education and collaborative practice within global health radiology.

Printed on: 10/29/20



MSCA21

### Case-based Review of the Abdomen (Interactive Session)

Monday, Dec. 2 1:30PM - 3:00PM Room: S100AB



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

#### Participants

Julie H. Song, MD, Sharon, MA (*Director*) Nothing to Disclose

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

Edward.Lee@childrens.harvard.edu

#### Sub-Events

#### MSCA21A Pediatric Abdomen

##### Participants

Pedro Daltro, MD, Rio de Janeiro, Brazil (*Presenter*) Nothing to Disclose

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

daltro.pedro@gmail.com

#### MSCA21B Hepatobiliary Imaging

##### Participants

Khaled M. Elsayes, MD, Pearland, TX (*Presenter*) Nothing to Disclose

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

kmelsayes@mdanderson.org

#### LEARNING OBJECTIVES

1) Describe a spectrum of interesting hepatobiliary cases. 2) Discuss relevant technical background, pathophysiology and hemodynamics of these cases. 3) Correlate imaging features of these masses with clinical and pathologic findings. 4) Provide useful clues to reach a specific diagnosis.

#### Active Handout: Khaled M. Elsayes

[http://abstract.rsna.org/uploads/2019/19000699/Active\\_MSCA21B.pdf](http://abstract.rsna.org/uploads/2019/19000699/Active_MSCA21B.pdf)

#### MSCA21C Gastrointestinal Imaging

##### Participants

Elizabeth G. McFarland, MD, Lake Saint Louis, MO (*Presenter*) Nothing to Disclose

#### LEARNING OBJECTIVES

1) Evaluate GI clinical case review to classify cases into appropriate inflammatory to neoplastic etiologies. 2) Explain pertinent clinical information to increase awareness for appropriate patient management. 3) Define new updated colorectal cancer screening recommendations and how they apply to CT colonography.

#### MSCA21D Genitourinary Imaging

##### Participants

Frank H. Miller, MD, Chicago, IL (*Presenter*) Nothing to Disclose

#### LEARNING OBJECTIVES

1) To interpret interesting genitourinary CT and MR cases to form a differential diagnosis to reach a definitive diagnosis. 2) To apply the teaching points from the individual challenging cases to future clinical cases seen in practice.

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MSMC23

**Cardiac CT Mentored Case Review: Part III (In Conjunction with the North American Society for Cardiovascular Imaging) (Interactive Session)**

Monday, Dec. 2 1:30PM - 3:00PM Room: S406A



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

**Participants**

Karen G. Ordovas, MD, Seattle, WA (*Moderator*) Advisor, Arterys Inc;

**LEARNING OBJECTIVES**

1) Identify cardiac and coronary artery anatomy. 2) Recognize cardiac disease processes, including coronary atherosclerosis, as diagnosed on CT. 3) Understand methods of cardiac CT and coronary CT angiography post-processing. 4) Understand the role of coronary artery calcium scoring. 5) Understand the role of Cardiac CTA in coronary artery pathologies including aneurysms, fistulae and other anomalies.

**Sub-Events**

**MSMC23A Pulmonary Veins and Pericardial Disease**

Participants

Carole J. Dennie, MD, Ottawa, ON (*Presenter*) Nothing to Disclose

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

cdennie@toh.ca

**MSMC23B Coronary Atherosclerosis III**

Participants

U. Joseph Schoepf, MD, Charleston, SC (*Presenter*) Research Grant, Astellas Group; Research Grant, Bayer AG; Research Grant, Bracco Group; Research Grant, Siemens AG; Research Grant, Heartflow, Inc; Research support, Bayer AG; Consultant, Elucid BioImaging Inc; Research Grant, Guerbet SA; Consultant, HeartFlow, Inc; Consultant, Bayer AG; Consultant, Siemens AG; ; ;

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

Schoepf@musc.edu

Printed on: 10/29/20



MSMI23

## Molecular Imaging Symposium: Neurologic MI Applications

Monday, Dec. 2 1:30PM - 3:00PM Room: S405AB

AI MI NR

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

FDA Discussions may include off-label uses.

### Participants

Alexander Drzezga, MD, Cologne, Germany (*Moderator*) Research support, Siemens AG; Speakers Bureau, Siemens AG; Stockholder, Siemens AG; Research support, General Electric Company; Consultant, General Electric Company; Research support, Life Molecular Imaging; Speakers Bureau, sanofi-aventis Group; Speakers Bureau, General Electric Company; Research support, Eli Lilly and Company;

Satoshi Minoshima, MD, PhD, Salt Lake City, UT (*Moderator*) Consultant, Hamamatsu Photonics KK; Research Grant, Hitachi, Ltd; Research Grant, Nihon Medi-Physics Co, Ltd;

### For information about this presentation, contact:

sminoshima@hsc.utah.edu

### Sub-Events

#### MSMI23A New Radiotracers for Molecular Imaging of the Brain

##### Participants

Peter Herscovitch, MD, Bethesda, MD (*Presenter*) Nothing to Disclose

### For information about this presentation, contact:

herscovitch@nih.gov

### LEARNING OBJECTIVES

1) Describe new radiotracers and their targets for molecular imaging (MI) of the brain. 2) Understand how new molecular imaging radiotracers are used to study the pathophysiology of neuropsychiatric diseases. 3) Understand the U.S. FDA and Medicare approval process for new radiotracers for molecular brain imaging.

#### MSMI23B Brain MI in Dementia

##### Participants

Alexander Drzezga, MD, Cologne, Germany (*Presenter*) Research support, Siemens AG; Speakers Bureau, Siemens AG; Stockholder, Siemens AG; Research support, General Electric Company; Consultant, General Electric Company; Research support, Life Molecular Imaging; Speakers Bureau, sanofi-aventis Group; Speakers Bureau, General Electric Company; Research support, Eli Lilly and Company;

### LEARNING OBJECTIVES

1) Understand the molecular targets available for imaging of presynaptic dopaminergic synapses. 2) Appreciate the diagnostic characteristics of dopamine transporter imaging in movement disorder syndromes. 3) Master the appropriate use settings for clinical application of dopamine transporter imaging. 4) Appreciate alternative molecular imaging approaches that may offer value in distinction between movement disorders in the future.

#### MSMI23C Molecular Imaging of Parkinsonism

##### Participants

Kirk A. Frey, MD, PhD, Ann Arbor, MI (*Presenter*) Consultant, MIM Software Inc; Stockholder, General Electric Company; Stockholder, Johnson & Johnson; Stockholder, Novo Nordisk AS; Stockholder, Bristol-Myers Squibb Company; Stockholder, Merck & Co, Inc;

### LEARNING OBJECTIVES

1) Gain insights on available methods of molecular imaging in dementia and their significance. 2) Gain insights in principles and value of dopaminergic imaging in Parkinsonian syndromes. 3) Gain understanding in approval processes for new brain molecular imaging tracers and ongoing clinical trials.

#### MSMI23D Machine Learning in Brain MI

##### Participants

Satoshi Minoshima, MD, PhD, Salt Lake City, UT (*Presenter*) Consultant, Hamamatsu Photonics KK; Research Grant, Hitachi, Ltd; Research Grant, Nihon Medi-Physics Co, Ltd;

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# 105<sup>TH</sup> Scientific Assembly and Annual Meeting

December 1-6 | McCormick Place, Chicago

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MSRO23

## **BOOST: H&N/CNS**

Monday, Dec. 2 1:30PM - 2:30PM Room: S103AB

**HN** **NR** **RO**

AMA PRA Category 1 Credit™: 1.00  
ARRT Category A+ Credit: 0

### **Participants**

Stuart E. Samuels, MD, Miami, FL (*Presenter*) Nothing to Disclose  
Natalya Nagomaya, MD, Miami, FL (*Presenter*) Nothing to Disclose

### **LEARNING OBJECTIVES**

1) Understand common treatment algorithms for H&N cancer and indications for adjuvant therapy. 2) Understand common imaging modalities used to assess and stage H&N cancer, their utility and limitations. 3) Understand and identify subtle imaging findings that inform clinical decisions for H&N cancer patients.

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MSR027

## **BOOST: GYN/Breast**

Monday, Dec. 2 1:30PM - 2:30PM Room: S103CD



AMA PRA Category 1 Credit <sup>™</sup>: 1.00  
ARRT Category A+ Credit: 0

### **Participants**

Janice N. Kim, Seattle, WA (*Presenter*) Nothing to Disclose

Janie M. Lee, MD, Bellevue, WA (*Presenter*) Research Grant, General Electric Company;

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

janicenk@uw.edu

Printed on: 10/29/20



PS20

## Monday Plenary Session

Monday, Dec. 2 1:30PM - 2:45PM Room: Arie Crown Theater

**BQ** **NR**

AMA PRA Category 1 Credits<sup>™</sup>: 1.25  
ARRT Category A+ Credit: .75

### Participants

Valerie P. Jackson, MD, Tucson, AZ (*Presenter*) Nothing to Disclose

### Sub-Events

**PS20A Presentation of the Alexander R. Margulis Award for Scientific Excellence**

**PS20B Presentation of Honorary Membership**

### Participants

Tarek A. El-Diasty, MD, El Mansoura, Egypt (*Recipient*) Nothing to Disclose

Fiona J. Gilbert, MD, Cambridge, United Kingdom (*Recipient*) Research Grant, Hologic, Inc; Research Grant, General Electric Company; Research Consultant, Alphabet Inc; Research support, Bayer AG; Research collaboration, Volpara Health Technologies Limited  
Bernd K. Hamm III, MD, Berlin, Germany (*Recipient*) Research Consultant, Canon Medical Systems Corporation; Stockholder, Siemens AG; Stockholder, General Electric Company; Research Grant, Canon Medical Systems Corporation; Research Grant, Koninklijke Philips NV; Research Grant, Siemens AG; Research Grant, General Electric Company; Research Grant, Elbit Imaging Ltd; Research Grant, Bayer AG; Research Grant, Guerbet SA; Research Grant, Bracco Group; Research Grant, B. Braun Melsungen AG; Research Grant, KRAUTH Medical KG; Research Grant, Boston Scientific Corporation; Equipment support, Elbit Imaging Ltd; Investigator, CMC Contrast AB

**PS20C New Horizons Lecture: The War on Alzheimer's Disease: Neuroimaging, Biomarkers and Genetics on the Front Lines**

### Participants

Andrew J. Saykin, Indianapolis, IN (*Presenter*) Research Grant, Eli Lilly and Company; Research collaboration, Eli Lilly and Company; Investigator, Arkey BioTek; Support, Eli Lilly and Company;  
Valerie P. Jackson, MD, Tucson, AZ (*Presenter*) Nothing to Disclose

### Abstract

Alzheimer's disease, the most common form of dementia, affects an estimated 5.8 million Americans and many more individuals worldwide. Despite more than a century of increasing knowledge about AD, first observed as plaques and tangles in postmortem brain tissue, we do not yet have a disease-modifying medication. Although rare forms of AD are caused by mutations in one of three genes, most Alzheimer's is "complex" reflecting the involvement of multiple risk genes, biological pathways and interactions with the environment, including lifestyle factors. Many patients have mixed pathologies. Neuroimaging has proven important in the diagnosis and management of AD and related dementias with recent studies demonstrating value for clinical decision making. For research, the impact of neuroimaging has been transformative, beginning with quantitative MRI analysis of atrophy and PET measures of glucose hypometabolism and followed by targeted molecular imaging with PET tracers specific for amyloid beta plaque and tau deposition. Coupled with CSF analysis, imaging has shown that pathophysiological changes begin about twenty years prior to dementia. This provides a long window of therapeutic opportunity. Early detection and robust biomarkers of disease progression are critical for therapeutic development efforts as effective treatment will need to be instituted prior to extensive neurodegeneration. Challenges include heterogeneity of phenotypic presentation and underlying disease. There are other misfolded proteins beyond amyloid beta and tau. PET tracers and other biomarkers are needed for alpha-synuclein, TDP-43 and other biological processes including immune dysregulation. A key issue remains as to what sets the pathophysiological cascade in motion and how the different elements interact. Genetics can provide some clues and large-scale studies have identified about 30 promising candidate genes related to multiple biological pathways. Multi-layer "omics" studies are also bringing the transcriptome, proteome and metabolome into focus. Advances in systems biology and bioinformatics are helping to identify dysregulated networks in AD. Progress is also being made in network analysis of MRI-based connectome changes based on functional and structural brain connectivity as early indicators of prodromal disease. An important goal is to translate new knowledge of disease heterogeneity into a precision medicine framework. Polygenetic risk scores that aggregate risk across many genes are showing promise and recent efforts are aimed at developing precision risk profiles for amyloid, tau, microvascular disease and immune dysregulation, among other pathways. New developments in blood-based biomarkers also appear promising and may prove useful for pointing to specific pathways and identifying those who require more invasive and expensive tests. Personalized pathway-specific risk estimates will hopefully lead to individually tailored treatments. At the same time, research on lifestyle modifications including exercise, diet, cognitive engagement and sleep is very promising. Single or combinatorial pharmacological approaches are likely to be most effective coupled with attention to lifestyle factors. Despite recent setbacks in clinical trials, battles are being won through global collaborative research efforts, and victory lies ahead.

**PS20D New Horizons Lecture: Charcot, The Iron Horse, and Creeping Paralysis: Good Science in the Treatment of ALS**

### Participants

Robert M. Pascuzzi, MD, Indianapolis, IN (*Presenter*) Nothing to Disclose  
Valerie P. Jackson, MD, Tucson, AZ (*Presenter*) Nothing to Disclose

### Abstract

Amyotrophic lateral sclerosis (ALS) is "the neurologist's disease". Originally studied by the Father of Neurology Jean-Martin Charcot in the 1860s and formally reported by him in 1874, the subsequent 145 years have been characterized by neurologists obtaining a thorough history and conducting a classic bedside examination to reveal the localization of asymmetrical upper and lower motor neuron deficits with an indolent progressive clinical course best described as a "creeping paralysis". At least 5-10% of cases are known to be genetic and the rest are of unknown cause. Theories of inflammatory, infectious, autoimmune, toxic, and traumatic contributions to the disease remain. Perhaps no other disease over such an expanse of time has generated similarly strong reactions, fears, and existential questions as ALS. Even physicians who experience occasional fasciculations lie awake at night contemplating this diagnosis. The backbone of clinical management of ALS is symptomatic therapy. Today there are two FDA approved drugs that slow down the disease. Riluzole reduces glutamate excitotoxicity and edaravone is an antioxidant. Both treatments have only a mild impact on the disease. Observations from a broad collage of basic and clinical investigations have given us a diverse and imaginative array of new treatment strategies for ALS. Neuroprotection, anti-inflammation, genetic and protein modulation, inhibition of excitotoxicity, anti-viral, pro-mitochondrial, and therapeutic stem cell applications are all receiving attention in clinical trials in patients with ALS. Lou Gehrig (The Iron Horse) himself entered a clinical trial for ALS in 1939 with surprising results. Good science is the hope for patients and their caregivers- and the future of meaningful treatment.

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SPPH21

### Basic Physics Lecture for the RT: Radiation Safety Refresher Course

Monday, Dec. 2 1:30PM - 2:45PM Room: S402AB



AMA PRA Category 1 Credits™: 1.25  
ARRT Category A+ Credits: 1.50

#### Participants

Scott J. Emerson, MS, Royal Oak, MI (*Moderator*) Nothing to Disclose  
Rebecca M. Marsh, PHD, Aurora, CO (*Presenter*) Nothing to Disclose

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

Rebecca.Marsh@ucdenver.edu

#### LEARNING OBJECTIVES

1) Understand and describe the risks and benefits associated with patient shielding. 2) Critically evaluate common radiation safety practices. 3) Apply current data about radiation risk from diagnostic imaging exams to clinical practice.

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SPPH22

## Physics Symposium: Highlights of AAPM Clinical Brachytherapy Physics Summer School

Monday, Dec. 2 1:30PM - 5:45PM Room: S503AB

CT GU MR PH

AMA PRA Category 1 Credits™: 4.25  
ARRT Category A+ Credits: 5.00

FDA Discussions may include off-label uses.

### LEARNING OBJECTIVES

1) Explain the role of model-based dose calculation algorithms and their affects for several anatomic site. 2) provide an in-depth understanding on the application of brachytherapy for prostate, gynecological, breast, and skin diseases. 3) Clarify emerging technologies such as electronic brachytherapy, clinical modalities, and intensity-modulated brachytherapy.

### ABSTRACT

The Symposium will cover the highlights from the 2017 AAPM Summer School on Clinical Brachytherapy Physics. Presentations by the School Program Directors will include the experiences from experts on eight key aspects of clinical brachytherapy physics: model-based dose calculations, prostate brachytherapy, gynecological brachytherapy, skin brachytherapy, breast brachytherapy, electronic brachytherapy, intensity modulated and anisotropic brachytherapy sources, and early clinical advancements in 3D printing, tracking technologies, and robotic brachytherapy.

### Sub-Events

#### SPPH22A Overview of Commercial Algorithms: Needs and Availability

##### Participants

Luc Beaulieu, PhD, Quebec, QC (*Presenter*) License agreement, Standard Imaging, Inc; Researcher, Elekta AB; Researcher, Koninklijke Philips NV;

### LEARNING OBJECTIVES

1) Understand the need for advanced dose calculation algorithms in brachytherapy. 2) Provide an overview of the basis of the underlying algorithms used in brachytherapy commercial treatment planning systems. 3) Know the key strength and limitations of each algorithm.

### ABSTRACT

Brachytherapy is a very efficient cancer treatment modality, essentially due to a best in class dose deposition kernel dominated by  $1/r^2$  sparring tissue at a distance from the source. Furthermore, the energy deposition from the ionizing photons emitted by brachytherapy sources can be calculated, in theory, with very high accuracy. Until recently, the field of brachytherapy relied on a factor-based approach, TG-43, to deal for dose calculation. While TG43 is extremely fast for dose computation and optimization, its accuracy is limited to specific conditions, often not met in clinical situations. This presentation will provide an overview of these different situations and provide ballpark estimates of the expected differences. We will further look at alternatives to solve this issue and briefly described the approaches chosen by the major vendors in providing the next generation of dose calculation engines in their treatment planning system offering. We will finally describe how these new algorithms performed under various scenarios, highlighting both their strength and weakness.

#### SPPH22B Emphasis on MBDC Commissioning Infrastructure and Process

##### Participants

Luc Beaulieu, PhD, Quebec, QC (*Presenter*) License agreement, Standard Imaging, Inc; Researcher, Elekta AB; Researcher, Koninklijke Philips NV;

### LEARNING OBJECTIVES

1) Review the commissioning requirements set forth in TG186. 2) Provide an overview of the existing infrastructure and resources available to the clinical medical physicists. 3) Understand the various steps necessary in the commissioning of model-based dose calculation algorithms.

### ABSTRACT

With the publication in 2012 of the AAPM/ESTRO/ABG TG-186 report, early adopters were provided with a set of guidelines to help in the integration of advanced dose calculation algorithms in brachytherapy, beyond TG43, and ensuring safe and efficient use of the new features that are enabled by these new algorithms. However, the commissioning aspects were minimal in that report. In the following, the work from a subsequent working group, established to tackle this issue, will be presented. It is intended to provide the clinical users (the clinical medical physicists) with a set of comprehensive commissioning guidelines as well as to provide the necessary information for resources that are available to the community in making the transition from TG43 to TG186.

#### SPPH22C Prostate Brachytherapy: Real-time Intra-operative

##### Participants

Luc Beaulieu, PhD, Quebec, QC (*Presenter*) License agreement, Standard Imaging, Inc; Researcher, Elekta AB; Researcher, Koninklijke Philips NV;

## LEARNING OBJECTIVES

1) Underline the system components of a real-time prostate brachytherapy program. 2) Understand the possible workflows of real-time ultrasounds based prostate brachytherapy. 3) Understand the difference between real-time LDR and HDR prostate brachytherapy workflows.

## ABSTRACT

Prostate brachytherapy is a highly effective treatment option for localized prostate cancer. For low-risk prostate cancer patients, LDR seed implants has proven its long-term efficacy. For intermediate risk and high risk localized prostate cancer, both LDR and HDR brachytherapy boost combined to EBRT (either 3D-CRT or IMRT/VMAT) are providing compelling clinical outcomes. Both approaches deliver very high local dose to the cancerous regions while providing enhanced dose sparing to the organs at risk. The move to real-time intra-operative prostate brachytherapy further enables simplified treatment options to patients, in many cases performed as a single day outpatient procedure while improving the overall treatment accuracy by limiting the uncertainties due to moving the patients from the OR to imaging to finally the treatment room. This presentation will look at the key components of an efficient real-time intra-operative as well as the associated workflows.

## SPPH22D Prostate Brachytherapy: Post-implant Evaluation Using CT or MR

Participants

Mark J. Rivard, PhD, Providence, RI (*Presenter*) Nothing to Disclose

## LEARNING OBJECTIVES

1) Learn the importance of post-implant dosimetric analysis. 2) To convey how to evaluate prostate brachytherapy implants using CT or MRI. 3) Be able to utilize modern techniques for post-implant evaluation of prostate brachytherapy implants.

## SPPH22E Gynecological Brachytherapy: MRI Guidance and Targeting

Participants

Bruce R. Thomadsen, PhD, Madison, WI (*Presenter*) Nothing to Disclose

## LEARNING OBJECTIVES

1) To understand the rationale for MR targeting in gynecological brachytherapy. 2) To become familiar with techniques and difficulties in MR targeting.

## ABSTRACT

Cervical brachytherapy has changed greatly over the last few years. The conventional techniques that served well for the last six decades provided many cures; however, failures still plagued the higher staged disease. The challenges to improving outcomes rested with two issues: 1. Visualizing, localizing and assessing the disease, and 2. Adequately treating the disease once it is demarcated. This presentation will address the first of the challenges, imaging and targeting the disease.

**Active Handout:**Bruce Robert Thomadsen

[http://abstract.rsna.org/uploads/2019/19001779/Active\\_SPPH22E.pdf](http://abstract.rsna.org/uploads/2019/19001779/Active_SPPH22E.pdf)

## SPPH22F Gynecological Brachytherapy: Applicators

Participants

Bruce R. Thomadsen, PhD, Madison, WI (*Presenter*) Nothing to Disclose

## LEARNING OBJECTIVES

1) To understand the evolution of brachytherapy applicators for treatment of cervical cancer. 2) To become familiar with the latest generations of cervical brachytherapy applicators.

## ABSTRACT

This presentation continues addressing the challenges for cervical brachytherapy, looking at recent developments in applicator design to facilitate treating the target tissues.

## SPPH22G Gynecological Brachytherapy: Comparisons with Conventional

Participants

Bruce R. Thomadsen, PhD, Madison, WI (*Presenter*) Nothing to Disclose

## LEARNING OBJECTIVES

1) To understand the differences in dosimetry between the conventional approach and the MR-guided approach to cervical brachytherapy. 2) To appreciate the benefits to patients of the newer approach.

## ABSTRACT

This presentation completes the discussion of cervical brachytherapy by comparison of the newer approaches with the conventional treatments, reviewing the dosimetry and outcomes.

## SPPH22H Skin Brachytherapy

Participants

Mark J. Rivard, PhD, Providence, RI (*Presenter*) Nothing to Disclose

## LEARNING OBJECTIVES

1) Develop a sense for the physics concerns surrounding skin brachytherapy. 2) Convey how to dosimetrically evaluate skin brachytherapy treatment plans. 3) Learn several methods for delivering skin brachytherapy.

## **SPPH22I Breast Brachytherapy: Applications and Applicators**

Participants

Bruce R. Thomadsen, PhD, Madison, WI (*Presenter*) Nothing to Disclose

### **LEARNING OBJECTIVES**

1) To understand the geometry, dosimetry and nature of applicators used in breast brachytherapy.

### **ABSTRACT**

Breast brachytherapy has been shown to be a highly effective treatment with very low toxicity. Many types of applicators have been developed to perform the procedure, each with strengths and limitations. This presentation will discuss the various applicators and how they apply to applications.

**Active Handout:** Bruce Robert Thomadsen

[http://abstract.rsna.org/uploads/2019/19001784/09-10 Breast Brachytherapy2019 RSNA.pptx](http://abstract.rsna.org/uploads/2019/19001784/09-10%20Breast%20Brachytherapy2019%20RSNA.pptx)

## **SPPH22J Breast Brachytherapy: Plan Evaluation**

Participants

Bruce R. Thomadsen, PhD, Madison, WI (*Presenter*) Nothing to Disclose

### **LEARNING OBJECTIVES**

1) To understand what should be checked during a treatment plan review for breast brachytherapy. 2) To understand the quantities used in performing the reviews.

### **ABSTRACT**

Review of a treatment plan serves to help improve quality and prevent errors in treatment. Plan evaluations are crucial for breast brachytherapy. This presentation will discuss the techniques used, and quantities evaluated during a treatment plan review.

## **SPPH22K Electronic Brachytherapy**

Participants

Mark J. Rivard, PhD, Providence, RI (*Presenter*) Nothing to Disclose

### **LEARNING OBJECTIVES**

1) Understand the radiological physics differences between electronic brachytherapy and radionuclide-based brachytherapy. 2) Describe several different systems, contrasting and comparing them. 3) Learn how electronic brachytherapy is used clinically.

## **SPPH22L Intensity Modulated and Anisotropic BT Sources**

Participants

Mark J. Rivard, PhD, Providence, RI (*Presenter*) Nothing to Disclose

### **LEARNING OBJECTIVES**

1) Comprehend the designs and goals for intensity modulated and anisotropic brachytherapy sources. 2) Explain how intensity modulated and anisotropic brachytherapy sources can provide improved dose distributions over conventional brachytherapy sources. 3) Learn how to evaluate and commission intensity modulated and anisotropic brachytherapy sources.

## **SPPH22M 3D Printing and Tracking Technologies**

Participants

Luc Beaulieu, PhD, Quebec, QC (*Presenter*) License agreement, Standard Imaging, Inc; Researcher, Elekta AB; Researcher, Koninklijke Philips NV;

### **LEARNING OBJECTIVES**

1) Understand the potential role of 3D printing in brachytherapy. 2) Have an overview of various tracking technologies that can be integrated into catheters, needles and applicators. 3) Discuss envisioned usage in the brachytherapy clinical workflow.

### **ABSTRACT**

This portion of the AAPM summer school was dedicated to an outlook of the use of novel technologies to their field of brachytherapy. First, brachytherapy relies heavily on applicators in which one or more sources can travel. As such, custom-made applicators derived from patient-specific 3D imaging or any other relevant information constitute a potential use of 3D printing technology. Second, to proceed with an optimal treatment the location in space of one or more applicators as well as the full 3D path (called channels in brachytherapy) the source will be traveling needs to be known with precision. Tracking technology can simplify the acquisition and validation of this information, thus simplifying the overall clinical workflow. This presentation will look at the various technologies involved with both the steps described above and how they could impact the current clinical workflows. Prerequisites for clinical use will also be discussed.

## **SPPH22N Robotics and Brachytherapy**

Participants

Bruce R. Thomadsen, PhD, Madison, WI (*Presenter*) Nothing to Disclose

### **LEARNING OBJECTIVES**

1) To understand some of the principles of robotics in brachytherapy. 2) To learn about some of the robots, their designs and limitations.

**ABSTRACT**

As with much of medicine, and life in general, automation is improving consistency and ability. Robots have become part of the surgical landscape and are found in most large pharmacies. Robots are just coming into brachytherapy but promise to improve dose distributions and access to procedures. This presentation will review the current, dynamic state of robotic brachytherapy.

**Active Handout:**[Bruce Robert Thomadsen](#)

[http://abstract.rsna.org/uploads/2019/19001789/Active\\_SPPH22N.pdf](http://abstract.rsna.org/uploads/2019/19001789/Active_SPPH22N.pdf)

**Active Handout:**[Bruce Robert Thomadsen](#)

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SPSP21

**Contrastes y Trazadores: Estado del Art-Sesion del Colegio Interamericano de Radiologia (CIR) en Espanol/Contrast Agents and Radiopharmaceuticals: State of the Art-Session of Interamerican College of Radiology (CIR) in Spanish**

Monday, Dec. 2 1:30PM - 3:30PM Room: E353C

**CT** **GI** **MR** **NM** **SQ** **US**

AMA PRA Category 1 Credits™: 2.00  
ARRT Category A+ Credits: 2.25

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

**Participants**

Jose L. Criales, MD, Huixquilucan, Mexico (*Moderator*) Nothing to Disclose  
Jorge A. Soto, MD, Boston, MA (*Moderator*) Royalties, Reed Elsevier

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

jorge.soto@bmc.org

jcriales@att.net.mx

**LEARNING OBJECTIVES**

1) Conocer el uso actual, ventajas y desventajas de los medios de contraste en diferentes modalidades y en diversas situaciones clinicas. 2) Conocer los diversos trazadores, ademas de FDG, analizando su metabolismo normal y las indicaciones mas frecuentes. 1) Understand the current indications, benefits and limitations of the use of contrast agents for various imaging modalities. 2) Review the various types of radiotracers available today for PET Imaging, along with their normal metabolism and common indications for their use.

**Sub-Events**

**SPSP21A Bienvenida/Welcome**

**Participants**

Jose L. Criales, MD, Huixquilucan, Mexico (*Presenter*) Nothing to Disclose  
Jorge A. Soto, MD, Boston, MA (*Presenter*) Royalties, Reed Elsevier

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

jorge.soto@bmc.org

**SPSP21B Aplicaciones de Contraste en Ultrasonido/Use of Contrast Agents in Ultrasonography**

**Participants**

Alison C. Harris, MBChB, Vancouver, BC (*Presenter*) Nothing to Disclose

**LEARNING OBJECTIVES**

1) Review the general principles and technique of using CEUS in the abdomen. 2) Discuss the role of CEUS in the diagnosis and characterization of masses in the liver and kidney. 3) Briefly discuss other applications of CEUS including guiding interventional procedures and monitoring of therapy.

**ABSTRACT**

Contrast-enhanced ultrasound (CEUS) continues to gain traction as a technique that complements traditional B-mode and Doppler ultrasound in the evaluation of the liver and other organs. Because the micro-vasculature can be visualized with CEUS and real-time imaging of tissue perfusion can be performed, imaging with this technique yields supplementary information, including flow and perfusion kinetics. The contrast agent used in CEUS is comprised of microbubbles, which are injected into a peripheral vein. The microbubble composition varies depending on the agent used, but the agent typically consists of an inert gas encased by a stabilizing shell composed of phospholipid, galactose, or albumin. The microbubbles circulate in the bloodstream and oscillate irregularly at low mechanical index settings within the acoustic field, creating nonlinear reflections that resonate at diagnostic ultrasound frequencies (3-5 MHz) and increase the signal produced. Proper technique and optimization of contrast-enhanced ultrasound require a balance between maintaining the integrity of the microbubble contrast agent and preserving the ultrasound signal. Established and emerging applications in the liver include diagnosis and characterization of focal lesions, aiding ultrasound-guided intervention, monitoring of therapy, and aiding surgical management. Read More:

<https://www.ajronline.org/doi/10.2214/AJR.17.17843> Read More: <https://www.ajronline.org/doi/10.2214/AJR.17.17843> Read More: <https://www.ajronline.org/doi/10.2214/AJR.17.17843>

**SPSP21C Uso de Agentes Organoespecificos en RM de Hgado/Use of Organ-specific Agents in MR of the Liver**

**Participants**

Claudio Bonini, MD, Rosario, Argentina (*Presenter*) Speaker, Bayer AG

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

cbonini@hotmail.com

#### LEARNING OBJECTIVES

1) Medios de contraste hepatoespecíficos por MR. 2) Estructura molecular y su interacción a nivel celular. 3) Indicaciones actuales. 4) Ventajas y desventajas en comparación con los contrastes convencionales. 5) Contraindicaciones / 1) Hepatospecific contrast by MR. 2) Molecular structure and interaction at the cellular level. 3) Current indications. 4) Advantages and disadvantages compared to conventional contrasts. 5) Contraindications.

#### SPSP21D **PET-CT: Radiotrazadores Mas Alla de FDG/PET-CT: Beyond FDG**

Participants

Belen Rivera Bravo, MD, Mexico City, Mexico (*Presenter*) Nothing to Disclose

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

brivera@unam.mx

#### LEARNING OBJECTIVES

1) Identify PET/CT radiopharmaceuticals other than FDG, used in clinical practice. 2) Describe the uptake mechanism of each radiopharmaceutical. 3) Differentiate the normal biodistribution of each radiopharmaceutical by reading the images of the study. 4) Recognize the clinical indication of each radiopharmaceutical based in the uptake mechanism. / 1) Al final de esta actividad, los participantes deberán ser capaces de. 2) Identificar radiofármacos de PET/CT diferentes al FDG utilizados en la práctica clínica. 3) Describir el mecanismo de concentración de cada radiofármaco. 4) Diferenciar la biodistribución habitual de cada radiofármaco al observar las imágenes del estudio. 5) Reconocer la indicación clínica de cada radiofármaco basado en su mecanismo concentración.

#### SPSP21E **Preguntas/Q&A**

#### SPSP21F **Presentacion del CIR/CIR Update**

Participants

Henrique Carrete Jr, MD, Sao Paulo, Brazil (*Presenter*) Nothing to Disclose

#### LEARNING OBJECTIVES

1) Present the Inter-American College of Radiology and its main educational activities. 2) Address the activities of the CIR throughout the year 2019. 3) Outline future directions of CIR.

#### SPSP21G **Contraste Oral en TC: Nunca, Siempre O Algunas Veces?/Oral Contrast for Abdominal CT: Never, Always or Sometimes?**

Participants

Antonio Jose B. Madureira, MD, Porto, Portugal (*Presenter*) Nothing to Disclose

#### LEARNING OBJECTIVES

1) To understand the rationale for the use of oral contrast agents in CT examinations. 2) To become familiar with the major indications of oral contrast use. 3) To discuss the benefits and drawbacks of their use.

#### ABSTRACT

There has been a gradual decline in the last years in the use of oral contrast agents in CT examinations. In spite of these there are some clinical scenarios in which their use is of great benefit as it can clearly establish a diagnosis. In the emergency setting and in patients suspected of high-grade bowel obstruction their use is not warranted and may even be contraindicated. Oral contrast agents administration still has a role in CT imaging and every radiologist should be familiar with their indications and benefits in specific clinical situations.

#### SPSP21H **Daño Renal Agudo por Contraste Iodado: Conceptos Actuales/Iodine Contrast Induced Acute Kidney Injury: Current Concepts**

Participants

Cristian Varela, MD, Santiago, Chile (*Presenter*) Nothing to Disclose

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cvarelaubilla@gmail.com

#### LEARNING OBJECTIVES

1) Revisar la definición actual de daño renal agudo inducido por medio de contraste iodado/Review the current definition of contrast induced acute renal injury. 2) Conocer las características de los pacientes en riesgo/To know the characteristics of the high risk patients. 3) Definir las medidas de prevención basadas en la evidencia que el radiólogo debe conocer y practicar/Define the evidence based prevention that the radiology need to know and apply.

#### SPSP21I **Retencion de Gadolinio/Gadolinium Retention**

Participants

Juan E. Gutierrez, MD, Medellin, Colombia (*Presenter*) Speakers Bureau, Bayer AG

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

juanes65@gmail.com

#### LEARNING OBJECTIVES

1) Define the classification of GBCAs based on molecular structure and other physicochemical properties. 2) Discuss current

literature regarding deposition of gadolinium in the brain (Clinical - Pre Clinical). 3) Describe the relationship between the type of contrast agents and gadolinium deposition in brain Describe FDA, ACR, and European Medicines Agency (EMA) guidelines for GBCA usage.

#### **ABSTRACT**

Gadolinium Based Contrast Agents (GCBA) had been part of MRI environment for three decades with great benefits on the development of imaging as well as helping radiologists to achieve a better knowledge of the human body and its diseases. So far more than 500 million injections of GCBA's have been applied Worldwide, initially and for many years GBBA's were believed to be a harmless solution, to the point of being used as contrast for DSA and also in double or triple dose for MRI, however, in 2006 evidence of Gadolinium retention in tissues was published proving its link with Nefrogenic Systemic Fibrosis (NSF) in renal impaired patients. This situation triggered multiple academic and regulatory evaluations, involving the pharma industry to define the risk benefit of using GBCA's depending on its safety profile, plus new warning regulations and classification for this agents issued by the FDA, EMA and ACR. New evidence of Gadolinium deposition in the brain, specifically locate at Dentate Nucleus and Globus Pallidus, after multiple GCBA's injections in patients with normal kidney function was recently published (2014), and gives again new evidence of the potential harmful effect of Gadolinium in tissues. This situation brought a new regulatory environment with different approach by the FDA and EMA, as well as a new challenge for the MRI practice worldwide.

#### **SPSP21J Preguntas/Q&A**

#### **SPSP21K Clausura/Closing**

##### Participants

Jose L. Criales, MD, Huixquilucan, Mexico (*Presenter*) Nothing to Disclose

Jorge A. Soto, MD, Boston, MA (*Presenter*) Royalties, Reed Elsevier

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Printed on: 10/29/20



## 105<sup>TH</sup> Scientific Assembly and Annual Meeting

December 1-6 | McCormick Place, Chicago



RCA24

### RSNA Diagnosis Live Interactive and Mobile Device Integrated Audience Response: Tips, Tricks, and How to Get Started (Hands-on)

Monday, Dec. 2 2:30PM - 4:00PM Room: S401AB

**ED** **IN**

AMA PRA Category 1 Credits <sup>TM</sup>: 1.50  
ARRT Category A+ Credit: 0

#### Participants

Christopher G. Roth, MD,MS, Philadelphia, PA (*Moderator*) Nothing to Disclose  
Christopher G. Roth, MD,MS, Philadelphia, PA (*Presenter*) Nothing to Disclose  
Sandeep P. Deshmukh, MD, Philadelphia, PA (*Presenter*) Nothing to Disclose

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

sandeep.deshmukh@jefferson.edu

#### LEARNING OBJECTIVES

1) Appreciate the higher receptiveness of interactive content by adult learners compared with traditional didactic techniques. 2) Understand the basic operational features of the Diagnosis Live audience participation authoring tool, including the types of questions offered and how to embed them into PowerPoint presentations. 3) Learn how to manage the Diagnosis Live administrator portal and launch and run interactive games and review analytics regarding student performance.

Printed on: 10/29/20



RCC24

## Interoperability: Imaging and Beyond-Integrating the Healthcare Enterprise, Standards, and the RSNA Image Share

Monday, Dec. 2 2:30PM - 4:00PM Room: N226

IN

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

### Participants

David S. Mendelson, MD, Larchmont, NY (*Moderator*) Spouse, Employee, Novartis AG; Advisory Board, General Electric Company; Advisory Board, Bayer AG; Advisory Board, Nines; Advisory Board, Maverick AI  
David S. Mendelson, MD, Larchmont, NY (*Presenter*) Spouse, Employee, Novartis AG; Advisory Board, General Electric Company; Advisory Board, Bayer AG; Advisory Board, Nines; Advisory Board, Maverick AI  
Didi Davis, Knoxville, TN (*Presenter*) Nothing to Disclose

### For information about this presentation, contact:

ddavis@sequoiaproject.org

### LEARNING OBJECTIVES

1) Understand the importance of interoperability throughout healthcare; imaging and beyond. 2) Understand the importance of standards to ensure interoperability. 3) Understand the role of IHE profiles in defining workflows and the applicable standards including IHE XDS-I and XCA-I. 4) Learn about real world implementations including Health Information Exchanges and Networks (The Sequoia Project, eHealth Exchange, Carequality and other national and international projects) and image enabled Personal Health Records (The RSNA Image Share). 5) Learn the status of the RSNA Image Share and the RSNA Image Share Validation Program.

### ABSTRACT

This course will focus on HIT interoperability and its importance in providing for the optimal care of patients. Interoperability has become a major focus of ONC in the United States as well as part of many international regulatory bodies. The evolution and current state of imaging interoperability will be discussed. The session will review the standards employed in delivering healthcare interoperability and the role of IHE nationally and internationally. The discussion will initially focus on imaging interoperability and progress to a broader discussion of healthcare interoperability. In addition to describing the RSNA Image Share Validation program and its recent enhancements, interoperability solutions such as PHRs and other efforts of The Sequoia Project will be presented including a review of nationwide health information networks, such as the eHealth Exchange, and interoperability frameworks, such as Carequality.

Printed on: 10/29/20



MSRO24

## BOOST: Head and Neck-Case-based Multidisciplinary Review (Interactive Session)

Monday, Dec. 2 3:00PM - 4:15PM Room: S103AB



AMA PRA Category 1 Credits™: 1.25  
ARRT Category A+ Credits: 1.50

### Participants

Sung Kim, MD, New Brunswick, NJ (*Presenter*) Consultant, Nanobiotix

Suresh K. Mukherji, MD, Carmel, IN (*Presenter*) Nothing to Disclose

Francis P. Worden, MD, Ann Arbor, MI (*Presenter*) Grant, Bayer AG Grant, Eisai Co, Ltd Grant, AstraZeneca PLC Grant, IRX Therapeutics Grant, Galera Therapeutics Grant, Bristol-Myers Squibb Company Grant, Merck & Co, Inc Consultant, Merck & Co, Inc  
Chad Zender, MD, Cincinnati, OH (*Presenter*) Nothing to Disclose

### LEARNING OBJECTIVES

1) Expose to audience to the experience of a multidisciplinary tumor board. 2) Discuss specific imaging findings that directly affect staging, treatment and management. 3) Review the optimum modalities to detect cartilage invasion and perineural spread.

### ABSTRACT

The intent of this session is to expose to audience to the experience of a multidisciplinary tumor board. Specific cases will be presented that will discuss specific imaging findings that directly affect staging, treatment and management. The session will also review the optimum modalities to detect important imaging findings such as cartilage invasion and perineural spread.

Printed on: 10/29/20



## 105<sup>TH</sup> Scientific Assembly and Annual Meeting

December 1-6 | McCormick Place, Chicago

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MSRO28

### **BOOST: Gynecologic-Case-based Multidisciplinary Review (Interactive Session)**

Monday, Dec. 2 3:00PM - 4:15PM Room: S103CD



AMA PRA Category 1 Credits™: 1.25  
ARRT Category A+ Credits: 1.50

#### **Participants**

Aoife Kilcoyne, MBBCh, Boston, MA (*Moderator*) Author, Wolters Kluwer nv  
Susanna I. Lee, MD, PhD, Boston, MA (*Presenter*) Royalties, Wolters Kluwer nv; Royalties, Springer Nature  
Lilie Lin, MD, Houston, TX (*Presenter*) Investigator, AstraZeneca PLC

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#### **LEARNING OBJECTIVES**

- 1) Describe the surgical treatment and systemic therapies for gynecologic cancers based on standard of care current treatment strategies.
- 2) Describe the use of radiotherapy techniques used for the adjuvant and definitive treatment of gynecologic cancers.
- 3) Identify key imaging findings and avoid pitfalls when reading MRI and PET CT for gynecologic cancers.

#### **ABSTRACT**

This is a case based, multidisciplinary review of gynecologic malignancies including uterine cervical and endometrial cancer, vulvar cancer, and ovarian cancer.

Printed on: 10/29/20



SPAI23

## RSNA AI Deep Learning Lab: Generative Adversarial Networks (GANs)

Monday, Dec. 2 3:00PM - 4:30PM Room: AI Showcase, North Building, Level 2, Booth 10342

**AI** **CT** **MR** **NM**

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

### Participants

Bradley J. Erickson, MD, PhD, Rochester, MN (*Presenter*) Board of Directors, VoiceIt Technologies, LLC; Stockholder, VoiceIt Technologies, LLC; Board of Directors, FlowSigma, LLC; Officer, FlowSigma, LLC ; Stockholder, FlowSigma, LLC

### Special Information

In order to get the best experience for this session, it is highly recommended that attendees bring a laptop with a keyboard, a decent-sized screen, and the latest version of Google Chrome. Additionally, it is recommended that attendees have a basic knowledge of deep learning programming and some experience running a Google CoLab notebook. Having a Gmail account is also helpful. Here are instructions for [creating](#) and [deleting](#) a Gmail account.

### ABSTRACT

This course describes a more recent advance in deep learning known as Generative Adversarial Networks (GANs). GANs are a deep learning technology in which a computer is trained to create images that look very 'real' even though they are completely synthetic. Getting 'large enough' data sets is a problem for most deep learning applications, and this is particularly true in medical imaging. This may be one way to address the 'data shortage' problem in medicine. GANs have also been created that can convert MRIs to CTs (e.g. for attenuation correction with MR/PET).

Printed on: 10/29/20





SSE01

## Breast Imaging (Risk and Density)

Monday, Dec. 2 3:00PM - 4:00PM Room: E450A

BR SQ

AMA PRA Category 1 Credit™: 1.00  
ARRT Category A+ Credit: 1.00

FDA Discussions may include off-label uses.

### Participants

Ritse M. Mann, MD, PhD, Nijmegen, Netherlands (*Moderator*) Researcher, Siemens AG Researcher, Seno Medical Instruments, Inc Researcher, Identification Solutions, Inc Researcher, Micrima Limited Researcher, Medtronic plc Scientific Advisor, ScreenPoint Medical BV Scientific Advisor, Transonic Imaging, Inc Stockholder, Transonic Imaging, Inc  
Despina Kontos, PhD, Philadelphia, PA (*Moderator*) Research Grant, Hologic, Inc

### Sub-Events

#### SSE01-01 Use of Comprehensive Health Records to Improve Breast Cancer Risk Prediction

Monday, Dec. 2 3:00PM - 3:10PM Room: E450A

### Participants

Michal Chorev, PhD, Haifa, Israel (*Presenter*) Researcher, IBM Corporation  
Adam Spiro, Haifa, Israel (*Abstract Co-Author*) Nothing to Disclose  
Michal Guindy, MD, Tel Aviv, Israel (*Abstract Co-Author*) Nothing to Disclose

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### PURPOSE

To evaluate the efficacy of a machine learning model to predict 1-year risk of breast cancer on the basis of complete electronic health records (EHR).

### METHOD AND MATERIALS

We collected EHR data of 68,342 women who underwent a screening mammogram between April 2013 and February 2017, to predict the risk of cancer developing within 1 year of the screening. We developed a gradient boosting machines model based on 17,651 clinical factors. We compared our model against Gail model. Based on sequential factor selection, we have identified the factors most contributing to the prediction. All models were evaluated using area under the ROC curve (AUC) values and DeLong's 95% confidence interval.

### RESULTS

The cohort comprised the clinical records of 68,342 women, of which 1,478 (2%) women were diagnosed with breast cancer within 12 months, 5,495 (8%) women had a negative biopsy within 12 months, 1,260 (2%) women had a BI-RADS 3 exam without a follow-up biopsy, and 60,109 (88%) women had at least two years of normal (BI-RADS 1 or 2) exams. We split the women's records to 51,256 (75%) in the train set and 17,086 (25%) in the test set. The model obtained AUC of 0.74 (95% CI, 0.72-0.77) and 0.73 (95% CI, 0.70-0.76) on the test set, based on the 17,651 factors and the top 40 factors, respectively. Gail model obtained AUC of 0.55 (95% CI, 0.51-0.58) on the test set, while a model based on factors from Gail's and other common risk models obtained an AUC of 0.66 (95% CI, 0.63-0.69). In addition to the traditional factors, the model identified factors concerning thyroid function, the immune system, indications of metabolic syndrome, iron deficiency, as well as others.

### CONCLUSION

Based on complete EHR data, our model showed an improved 1-year cancer risk assessment in comparison to Gail model. Limiting the model to only the 40 most contributing factors did not significantly affect its performance. We identified additional factors that improve breast cancer prediction.

### CLINICAL RELEVANCE/APPLICATION

A machine learning model based on health records for 1-year breast cancer risk outperformed state-of-the-art risk assessment models, and shed light on additional risk factors linked to breast cancer.

#### SSE01-02 The Correlation between the Breast Density, Body Mass Index, and the Risk of Breast Cancer Development in Relation to the Menopausal Status

Monday, Dec. 2 3:10PM - 3:20PM Room: E450A

### Participants

Rasha M. Kamal, MD, Cairo, Egypt (*Presenter*) Nothing to Disclose  
Salma Mostafa III, Cairo, Egypt (*Abstract Co-Author*) Nothing to Disclose  
Rasha W. Abdelhamid, MD, PhD, Cairo, Egypt (*Abstract Co-Author*) Nothing to Disclose  
Sherif Mokhtar, Cairo, Egypt (*Abstract Co-Author*) Nothing to Disclose

Norran H. Said, MD, FRCR, Cairo, Egypt (*Abstract Co-Author*) Nothing to Disclose  
Rihab Elsheikh, MA, Cairo, Egypt (*Abstract Co-Author*) Nothing to Disclose  
Iman Adel, MA, Cairo, Egypt (*Abstract Co-Author*) Nothing to Disclose  
Hebatallah M. Azzam, Cairo, Egypt (*Abstract Co-Author*) Nothing to Disclose  
Lamia Bassam, Cairo, Egypt (*Abstract Co-Author*) Nothing to Disclose  
Ahmed M. Hatw, Cairo, Egypt (*Abstract Co-Author*) Nothing to Disclose

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**PURPOSE**

To evaluate the correlation between the breast density, body mass index and the risk of breast cancer development in relation to the menopausal status.

**METHOD AND MATERIALS**

The study included 30,443 screened females who were classified into cancer and non-cancer groups and each group was sub-classified into pre- and post-menopausal groups. All patients performed mammography examination. The breast density was classified according to the 2013 ACR BI-RADS breast density classification. The weight and height were measured and the BMI was calculated. Independent t test was carried to compare the means of BMI among cancer and non-cancer groups as well as among pre- and post-menopausal groups. The correlation between breast density and breast cancer in the pre and post-menopausal groups was carried using Chi square test and Pearson's correlation. Measures of association were verified by calculating the Odds Ratio (OR) and the independence of each risk factor was verified by performing logistic regression analysis.

**RESULTS**

According to the BMI, 93.3% of the studied population were classified as over-weight and obese. A statistically significant difference was calculated between the mean BMI in the cancer and non-cancer groups ( $p = 0.027$ ) as well as between the pre- and post-menopausal groups ( $p < 0.001$ ). A positive statistically insignificant correlation was calculated between the breast density and the risk of breast cancer in the pre-menopausal group (OR: 1.062,  $p = 0.919$ ) and a negative highly significant correlation was calculated in the post-menopausal group (OR: 0.234,  $p < 0.001$ ). A highly statistical negative correlation was found between breast density and BMI ( $p < 0.001$ ) among both pre- and post-menopausal groups.

**CONCLUSION**

BMI and breast density are inversely associated with each other. This inverse relationship had an impact on the results of this study as the majority of the studied population were obese and overweight. In spite of this, both risk factors still play an independent significant role in increasing the risk of breast cancer development with variations according to the menopausal status.

**CLINICAL RELEVANCE/APPLICATION**

Identifying the modifiable breast cancer risk factors is essential in breast cancer preventive measures. In view of the results of the current study, strict weight control strategies should be implemented for post-menopausal women to decrease their risk for breast cancer development.

**SSE01-03 Changes in Breast Density Awareness, Knowledge, and Attitudes: A National Survey**

Monday, Dec. 2 3:20PM - 3:30PM Room: E450A

**Participants**

Deborah J. Rhodes, MD, Rochester, MN (*Presenter*) Nothing to Disclose  
Sarah Jenkins, Rochester, ME (*Abstract Co-Author*) Nothing to Disclose  
Celine M. Vachon, Rochester, MN (*Abstract Co-Author*) Nothing to Disclose  
Carrie B. Hruska, PhD, Rochester, MN (*Abstract Co-Author*) Institutional license agreement, CMR Naviscan Corporation  
Carmen Radecki Breitkopf, PhD, Rochester, MN (*Abstract Co-Author*) Nothing to Disclose

**PURPOSE**

Recent federal breast density (BD) notification legislation requires standardization of BD communication to women after a mammogram and will supersede BD legislation now active in 37 U.S. states, but little is known about the impact of state BD legislation on women's understanding of BD. We assessed changes in BD awareness, knowledge, and attitudes over a 5-year interval.

**METHOD AND MATERIALS**

Using a probability-based web panel representative of the U.S. population, we administered an identical survey in 2012 and 2017 to women aged 40 -74 years.

**RESULTS**

Survey cooperation rate was 55% (1502/2730). Relative to 2012, more U.S. women in 2017 had heard of BD (65.8% vs 57.5%;  $P = .0002$ ) and had knowledge of BD's relationship to masking (57.9% vs. 48.6%;  $P < .0001$ ) and breast cancer risk (58.8% vs. 53.2%;  $P = .01$ ). Of those aware of BD in 2017, 47.3% had discussed BD with their provider (4.2% increase from 2012;  $P = .13$ ). After multivariable adjustment, factors significantly ( $p < .01$ ) associated with BD awareness in 2017 included white non-Hispanic race, income, education, and having >5 mammograms. As compared to women residing in state(s) without at least 1 year of legislation, those with legislation in effect were more likely to know the masking effect of BD in 2012 (89.9% vs 71.2%,  $p < .001$ ) and to know the associated breast cancer risk in 2017 (68.3% vs 58.3%,  $p < .001$ ); however, BD awareness was not associated with legislation status in 2012 or 2017. Similar to 2012, 62.5% would want to know their BD even in the absence of supplemental screening consensus. Fewer women reported that knowing their BD would make them feel confused in 2017 as compared to 2012 (35.9% vs 43.0%,  $p = 0.002$ ); however there was no change from 2012 in the proportion that would feel anxious or informed to make breast health decisions (44.8% and 89.7%, respectively). The majority (78.8%) felt that the federally mandated letter sent to women after a mammogram should include BD information.

**CONCLUSION**

Although BD awareness, knowledge, and discussions with providers have increased since 2012, there are few differences by state legislation status. Fewer than half of women acknowledged that knowing their BD would cause anxiety or confusion, while more than three-quarters want to know their BD, would feel empowered to make decisions, and would support federal BD notification legislation.

#### CLINICAL RELEVANCE/APPLICATION

BD awareness and knowledge is increasing, although the proportion of women who have discussed their BD with a healthcare provider is not. Important disparities in BD awareness remain by race, income, and education. The federal BD notification legislation presents an opportunity to clarify BD information to improve awareness and knowledge and to encourage BD conversations with providers.

#### SSE01-04 Background Parenchymal Uptake on MBI and Risk of Future Breast Cancer Diagnosis: A Cohort Analysis

Monday, Dec. 2 3:30PM - 3:40PM Room: E450A

##### Participants

Carrie B. Hruska, PhD, Rochester, MN (*Presenter*) Institutional license agreement, CMR Naviscan Corporation  
Jennifer R. Geske, Rochester, MN (*Abstract Co-Author*) Nothing to Disclose  
Amy Lynn Connors, MD, Rochester, MN (*Abstract Co-Author*) Nothing to Disclose  
Dana H. Whaley, MD, Rochester, MN (*Abstract Co-Author*) Nothing to Disclose  
Deborah J. Rhodes, MD, Rochester, MN (*Abstract Co-Author*) Nothing to Disclose  
Michael K. O'Connor, PhD, Rochester, MN (*Abstract Co-Author*) Royalties, Gamma Medica, Inc  
Rickey E. Carter, PhD, Jacksonville, FL (*Abstract Co-Author*) Nothing to Disclose  
Celine M. Vachon, Rochester, MN (*Abstract Co-Author*) Nothing to Disclose

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#### PURPOSE

Background parenchymal uptake (BPU), which describes the intensity of radiotracer uptake in fibroglandular tissue relative to fat on molecular breast imaging (MBI), was associated with breast cancer (BC) in case-control studies. Here, we performed the first cohort analysis to examine association of BPU and risk of future BC.

#### METHOD AND MATERIALS

Women undergoing MBI with Tc-99m sestamibi and a dedicated gamma camera from 2004-2015 without BC diagnosis before MBI or <180 days after MBI were analyzed. BPU on baseline MBI exam was assessed as photopenic, minimal, mild, moderate, or marked; mammographic density was assessed according to BIRADS 5th edition categories. Follow up was performed via tumor registry linkage, record review, and patient survey. Multivariable proportional hazards models of time from baseline MBI until BC diagnosis or most recent negative breast imaging exam were employed.

#### RESULTS

Of 2987 women, 122 (4.1%) had future BC (86 invasive, 34 DCIS, 2 unknown). Mean time from baseline MBI to BC diagnosis was 48 months (range 6-115 months); mean follow-up in women without BC was 75 months (range 6-151 months). There were 66 BC cases in 2143 (3.1%) women with photopenic/minimal BPU, 27 cases in 434 (6.2%) with mild BPU, and 29 cases in 410 (7.1%) with moderate/marked BPU. 102 of 122 (84%) cases and 2300 of 2865 (80%) women without BC had dense breasts (BIRADS c or d). Relative to photopenic/minimal BPU, age and BMI-adjusted hazard ratios (HR) with 95%CI were 2.4 (1.5,3.7) for mild and 3.1 (1.9,4.9) for moderate/marked BPU ( $p < 0.0001$ ). Additional adjustment for BI-RADS density and hormone use minimally impacted HRs: 2.6 (1.6,4.2) for mild, 3.2 (2.0,5.2) for moderate/marked ( $p < 0.0001$ ). In 1827 postmenopausal women with 84 cases, HR was 3.5 (2.1,6.0) for mild and 5.0 (2.6,9.4) for moderate/marked ( $p < 0.0001$ ). In 1160 premenopausal women with 38 cases, HR was 1.3 (0.5,3.3) for mild and 2.0 (1.0,4.2) for moderate/marked ( $p = 0.18$ ).

#### CONCLUSION

BPU on MBI is associated with future BC and this risk remains after adjustment for mammographic density. Postmenopausal women with moderate/marked BPU have 5-fold risk of those with photopenic/minimal BPU and similar age, BMI, breast density, and hormone use.

#### CLINICAL RELEVANCE/APPLICATION

Postmenopausal women with high BPU on MBI should be informed of this risk association. Future studies are needed to examine the role of supplemental screening and prevention strategies in this group.

#### SSE01-05 Application of Machine Learning in the Calculation of Breast Density Using Transmission Ultrasound: A Comparison with Automated Mammographic Assessment

Monday, Dec. 2 3:40PM - 3:50PM Room: E450A

##### Participants

Bilal Malik, PhD, Novato, CA (*Presenter*) Employee, QT Ultrasound Labs  
Sanghyeb Lee, PhD, Novato, CA (*Abstract Co-Author*) Employee, QT Ultrasound  
James Wiskin, PhD, Salt Lake City, UT (*Abstract Co-Author*) Employee, QT Ultrasound Labs  
Rajni Natesan, MD, MBA, Houston, TX (*Abstract Co-Author*) Officer, QT Ultrasound Labs

#### PURPOSE

Increased mammographic density has been found to be an important input into breast cancer risk models. Current breast density assessments rely upon 2D projections or a 3D model consisting of 2D reconstructed images, which may not fully capture the topologically complex nature of the breast. In this study, we (1) describe and compare threshold- and clustering-based algorithms that use transmission ultrasound (TU) for the calculation of breast density, and (2) compare Quantitative Breast Density (QBD) with

automated mammographic density calculations.

## **METHOD AND MATERIALS**

Retrospective data was used from all women screened at a single breast center between April 2017 and November 2018 for a total of 309 breast scans. Within a 3-month interval, each subject received both a digital screening mammogram with tomosynthesis and TU of the breast. Mammographic breast density values were provided by VolparaDensity 3.1 (Volpara Health Technologies). QBD algorithms (1) segment breast tissue from water using attenuation, and (2) segment fibroglandular tissue by both thresholding based on the speed of sound, and clustering into fibroglandular tissue and fat. The ratio of fibroglandular tissue to total breast volume is calculated as QBD. QBD values were correlated with mammographic breast density scores and BI-RADS breast composition categories using Spearman's correlation coefficient ( $r$ ), where  $p < 0.05$  was considered significant. We discuss the variability of QBD as affected by iterative image reconstruction schemes.

## **RESULTS**

We found strong correlations between automated breast density values from TU and mammography (Spearman  $r=0.93$ , 95% CI: 0.91-0.94,  $p < 0.01$ ), and between QBD and BI-RADS breast composition categories (Spearman  $r=0.88$ , 95% CI: 0.86-0.91,  $p < 0.01$ ). The machine learning-based QBD was less sensitive to variability (by 65%) than the threshold-based QBD.

## **CONCLUSION**

We provide evidence that QBD calculations derived from TU are strongly correlated with automated mammographic breast density assessments. Further, machine learning-based QBD calculation is more robust and repeatable than threshold-based methods.

## **CLINICAL RELEVANCE/APPLICATION**

The presence of dense breast tissue is an independent risk factor for breast cancer. An accurate calculation of breast density is critical for risk stratification in screening for breast cancer.

## **SSE01-06 Breast Cancer Development During Postoperative Surveillance for Women Treated for Atypical Ductal Hyperplasia (ADH): Analysis Evaluating Predictive Factors Including Clinical and Radiologic Features**

Monday, Dec. 2 3:50PM - 4:00PM Room: E450A

### **Participants**

Hee Jung Moon, MD, Seoul, Korea, Republic Of (*Presenter*) Nothing to Disclose  
Jung Hyun Yoon, MD, Seoul, Korea, Republic Of (*Abstract Co-Author*) Nothing to Disclose  
Hye Sun Lee, Seoul, Korea, Republic Of (*Abstract Co-Author*) Nothing to Disclose  
Eun-Kyung Kim, MD, Seoul, Korea, Republic Of (*Abstract Co-Author*) Nothing to Disclose  
Min Jung Kim, MD, Seoul, Korea, Republic Of (*Abstract Co-Author*) Nothing to Disclose  
Vivian Y. Park, MD, Seoul, Korea, Republic Of (*Abstract Co-Author*) Nothing to Disclose

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## **PURPOSE**

To evaluate cancer development rates and the clinicopathological factors associated to them during surveillance after surgery for atypical ductal hyperplasia (ADH) in the current era.

## **METHOD AND MATERIALS**

From November 2003 to December 2014, 205 women (mean age:  $47.1 \pm 11.2$  years) diagnosed as ADH via excisional biopsy were included. Preoperative breast images of the proven ADH were analyzed and grouped as follows: 1) negative, lesions not detectable on either mammography or ultrasonography (US), 2) lesions with calcifications detected on either mammography and/or US, 3) lesions without suspicious calcifications. Cox regression analysis was performed to evaluate clinical and radiological factors associated to breast cancer development after excision for ADH.

## **RESULTS**

Of the 205 women, 15 (7.3%) had developed either ductal carcinoma in situ (DCIS) or invasive breast cancer during surveillance (mean follow-up interval:  $63.9 \pm 40.8$  months). Symptomatic ADH was significantly associated to breast cancer during postoperative surveillance, 2.091 (95% confidence interval 0.008, 4.289,  $P=0.039$ ). None of the other clinicopathologic features were associated to breast cancer development after excision for ADH (all  $P > 0.05$ , respectively). Among the imaging features, the presence of calcifications detected on preoperative mammography/US did not show significant association to breast cancer development ( $P=0.268$ ).

## **CONCLUSION**

Breast cancer development rate during surveillance after excision for ADH was 7.3%. Presence of symptoms may have association to breast cancer development after excision for ADH.

## **CLINICAL RELEVANCE/APPLICATION**

Breast cancer development rate during surveillance after excision for ADH was 7.3%, in which symptomatic patients diagnosed with ADH may have higher association with breast cancer development after excision for ADH.

Printed on: 10/29/20



SSE02

## Breast Imaging (Ultrasound Screening)

Monday, Dec. 2 3:00PM - 4:00PM Room: E451B



AMA PRA Category 1 Credit™: 1.00  
ARRT Category A+ Credit: 1.00

### Participants

Jung Min Chang, MD, Seoul, Korea, Republic Of (*Moderator*) Nothing to Disclose  
H. Carisa Le-Petross, MD, FRCPC, Houston, TX (*Moderator*) Nothing to Disclose

### Sub-Events

#### SSE02-01 Assessing Real-World Contribution of Ultrasound and Clinical Data to Breast Cancer Screening Accuracy

Monday, Dec. 2 3:00PM - 3:10PM Room: E451B

### Participants

Michal Chorev, PhD, Haifa, Israel (*Abstract Co-Author*) Researcher, IBM Corporation  
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### PURPOSE

To evaluate the contribution of supplemental breast ultrasound performed regularly in addition to mammography as part of breast screening regime, as well as to assess machine learning model based on clinical information from electronic health records (EHR) in further optimizing personalized screening.

### METHOD AND MATERIALS

We extracted data of 32,058 women who underwent ultrasound examination as part of their regular breast cancer screening procedure between April 2013 and February 2017 (median age of 58 years). We utilized 17,651 clinical factors from the women's EHR and developed a gradient boosting machines model to predict breast cancer within one year based on mammogram BI-RADS, ultrasound BI-RADS, and their combination.

### RESULTS

The cohort comprised the clinical records of 32,058 women, of which 1,087 (3%) were diagnosed with breast cancer within 12 months, 12,362 (39%) had high breast density and 19,696 (61%) had low breast density. Adding ultrasound to screening increased sensitivity from 77% to 93% while decreasing biopsy positive predictive value (PPV) from 40% to 24%. For women with dense breasts, ultrasound increased sensitivity from 67% to 92% and decreased biopsy PPV from 34% to 16%. In order to examine whether EHR data can further improve our results by lowering the false positive rate, we developed a machine learning model, trained on 75% of the data and tested on 25%. Using an operation point of 87% sensitivity, the model's true negative rate (TNR) increased from 66% when using only mammogram BI-RADS to 82% when using mammogram BI-RADS combined with EHR data. Using an operation point of 95% sensitivity, the TNR increased from 68% when using mammograms and ultrasound BI-RADS to 78% when adding EHR data. This effect was more prominent in the high-density sub-population, where TNR improved from 43% to 70%.

### CONCLUSION

Supplementing ultrasound examination increased sensitivity, while increasing false positives by increasing biopsy rates. Use of clinical data improved specificity and therefore may reduce unnecessary biopsies. Further analysis may elucidate when ultrasound would be beneficial.

### CLINICAL RELEVANCE/APPLICATION

In a population that undergo ultrasound examination as part of their breast cancer screening regime, ultrasound increased sensitivity but reduced specificity. Using comprehensive EHR data can compensate for this reduction, and reduce unnecessary biopsies.

#### SSE02-02 Is There Value to Screening Breast Ultrasound as a Supplement to Mammography in Women at Average Risk in Comparison to Those with Known Risk Factors?

Monday, Dec. 2 3:10PM - 3:20PM Room: E451B

### Participants

Stamatia V. Destounis, MD, Scottsville, NY (*Presenter*) Advisory Committee, Hologic, Inc; Medical Advisory Board, iCad, Inc  
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**PURPOSE**

To review the outcomes of screening breast ultrasound performed in women dense breast tissue and no other known risk factors and compare with women with dense breasts and at least one known risk factor.

**METHOD AND MATERIALS**

Retrospective review of 24778 screening ultrasound (US) exams performed during period of 2013-2017 revealed 8415 (34%) exams in patients with no known risk factors (average risk), and 16364 (66%) with one or more known risk factors. All patients undergoing screening US also had screening mammography either on the same day, or within 1 year of the screening US exam. Cases given a BI-RADS 4 or 5 are the focus of further analysis.

**RESULTS**

There were 550 findings in patients with known risk factor(s) of which 395 were BIRADS 4 or 5 (2.4%). 103 findings were seen on both mammography and US (with 41 invasive cancers diagnosed), and 27 were on mammography only (3 invasive cancers diagnosed). Lesions were detected on US only in 265 (67%); 56 positive biopsies resulted from US only findings of which 50 were invasive breast carcinoma; 70% grade 1 or 2, 6 lymph node positive, and average size at excision of 1.4cm. There were 243 findings from exams performed in patients with no known risk factors; 168 were BIRADS 4 or 5 (2.0%). 13 were on mammography only (1 invasive cancer diagnosed) and 45 on both mammography and US (with 19 invasive cancers diagnosed). 109 US only findings resulted in diagnosis of 14 malignancies; 12 were invasive breast carcinoma, 100% grade 1 or 2, all node negative, and an average size at excision of 1.2cm. US only cancer detection was 3.2/1000 in those with known risk factors, and 1.4/1000 for those with no known risk factors.

**CONCLUSION**

Screening breast US in patients at average risk can identify invasive malignancy missed on screening mammography, though at a lower rate compared with those with one or more known risk factors (1.4/1000 v. 3.2/1000, respectively). Similar biopsy rates were observed in those with no risk factors compared with those with risk factors (2.0% v. 2.4%). The cancers visualized on US only in the average risk patients were all lower grade, node negative, and averaged 1.2cm, demonstrating there may be value of US in this population.

**CLINICAL RELEVANCE/APPLICATION**

Determining the optimal screening regimen for women at average risk is an area of continued investigation. Screening US may provide value when used as a supplemental tool with mammography.

**SSE02-03 Update on Population Level Supplemental Whole Breast Screening Ultrasound in Women with Dense Breasts**

Monday, Dec. 2 3:20PM - 3:30PM Room: E451B

**Participants**

Liane E. Philpotts, MD, Madison, CT (*Presenter*) Consultant, Hologic, Inc  
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**PURPOSE**

Since 2009, we have offered technologist-performed hand-held whole breast screening (WBUS) as supplemental screening for women with dense breasts. With new federal breast density notification legislation recently passed, more women with dense breasts may seek supplemental screening. Understanding the performance outcomes of this adjuvant screening exam is of importance.

**METHOD AND MATERIALS**

An IRB-approved retrospective search of the breast imaging electronic database (PenRad, MN) was performed for a one-year period (10/1/17 - 9/30/18) for all supplemental WBUS after a normal tomosynthesis screening mammogram. All cases were performed at 3 out-patient satellite offices of a large academic practice by mammography technologists cross-trained in breast sonography using hand-held ultrasound. The final BI-RADS (BR) assessment of WBUS exams was recorded. The lesion size, type and outcome of BR 3 and 4 cases were recorded. Pathology outcomes of all biopsies were reviewed. For malignant cases, cancer size, type and stage was assessed.

**RESULTS**

A total of 5742 WBUS exams were performed. Final BR assessment was BR1/2 5585 (97.2%), BR3 136 (2.4%), BR4 21 (0.4%). Of 20 biopsies performed (1 cancelled), 2 cases were initially found malignant, PPV 10%. Two BR3 cases showed change on 6 month follow up and were found to be malignant for a total cancer detection 4 (0.7 per 1000). All cancers were 1cm or less, 2 were moderately and 2 were well-differentiated invasive ductal carcinoma. Three were irregular masses and 1 was a 5mm round mass.

Three had negative axillary lymph nodes, but the 5mm round mass had lymphovascular invasion and 2 positive nodes. Reasons for BR3 included: oval mass (58), clustered or complicated cysts (24), likely fibroadenoma (22), multiple masses (9), prominent axillary nodes (6), round mass (5), lobulated mass (4), dilated ducts (4), other (4). All BR3 and BR4 oval masses were all found to be benign on follow up or biopsy.

## CONCLUSION

After normal tomosynthesis mammograms, the majority of WBUS cases were found to be normal, with only a small proportion of cases requiring follow up or biopsy. All BR3 and 4 oval masses were found to be benign, suggesting these may be considered BR2. The supplemental cancer detection rate is found to be low.

## CLINICAL RELEVANCE/APPLICATION

With experience, the false positive rate of supplemental screening with WBUS over time is low but the supplemental cancer detection is also low.

### SSE02-04 BI-RADS 3 on Dense Breast Screening Ultrasound after Digital Mammography versus Digital Breast Tomosynthesis

Monday, Dec. 2 3:30PM - 3:40PM Room: E451B

#### Participants

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Grayson L. Baird, PhD, Providence, RI (*Abstract Co-Author*) Nothing to Disclose  
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#### PURPOSE

Compare BI-RADS 3 rate and follow-up of dense breast ultrasound (US) screening following digital mammography (DM) vs digital breast tomosynthesis (DBT)

#### METHOD AND MATERIALS

For this IRB-approved, HIPAA compliant study, we retrospectively searched databases at two tertiary breast imaging centers and an office practice staffed by the same fellowship-trained breast radiologists for BI-RADS 3 screening US examinations performed 10/1/14-9/30/16. All patients had at least two years of follow-up. Prior DM versus DBT, number and timing of patients lost to follow-up, downgrade rate and timing, upgrade rate and timing, and any pathology results were recorded. Differences between DM and DBT were compared using Chi Square and Fisher's Exact Tests.

#### RESULTS

3189 screening US examinations were performed, 1434/3189 (45%) after DM and 1674/3189 (52%) after DBT. 81/3189 (2.5%) had no prior mammogram available. 201/1434 (14%) had BI-RADS 3 results after DM and 179/1674 (11%) after DBT ( $p=0.006$ ). 95% of US screening exams were initial US screening exams. BIRADS 3 rate was 75/624 (12.0%) (42/317 (13%) for DM and 33/307 (11%) for DBT) during the first year of US screening and 75/624 (12.0%) (159/1117 (14%) for DM and 146/1367 (11%) for DBT) during the second year, a small but significant increase ( $p=0.0162$ ). Median follow-up time after DBT was 13 months (IQR 9, 24) versus 12 after DM (IQR 6, 23),  $p=0.0027$  (Figure 1). 73/375 (19.5%) of patients were lost to follow-up (38/198 (19%) after DM (26/38 (68.4%) no follow-up after initial exam) and 35/177 (20%) after DBT (19/35 (54.3%) no follow-up after initial exam) 5/375 (1.3%) elected biopsy (3/198 (1.5%) after DM and 2/177 (1.1%) after DBT). 282/375 (75.2%) patients were downgraded (149/198 (74%) after DM and 133/177 (75%) after DBT). 5/198 (2.5%) were upgraded after DM and 1/177 (0.6%) after DBT,  $p=.6866$  Median time to upgrade was 6 months after both DM and DBT. 1/375 (0.3%) patients with BI-RADS 3 results had cancer on follow-up.

#### CONCLUSION

The BI-RADS 3 rate of screening US was lower after DBT compared to DM. Many patients were lost to follow-up. Median follow-up time was longer after DBT vs DM. The cancer rate of BI-RADS 3 findings was 0.3%.

#### CLINICAL RELEVANCE/APPLICATION

Patients with prior DBT have the benefit of a lower risk of encountering probably benign findings on screening US that require follow-up imaging, and probably benign findings on screening US have a very low rate of being cancer.

### SSE02-05 Added Value of Supplemental Screening Breast Ultrasound Following Digital Breast Tomosynthesis Screening

Monday, Dec. 2 3:40PM - 3:50PM Room: E451B

#### Participants

Jung Min Chang, MD, Seoul, Korea, Republic Of (*Presenter*) Nothing to Disclose  
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#### PURPOSE

To evaluate the added value of screening breast ultrasound (US) following digital mammography (DM) combined with digital breast tomosynthesis (DBT) (DM/DBT).

#### METHOD AND MATERIALS

This institutional review board approved retrospective review included 958 asymptomatic women (mean age, 54 years; range, 33-

81 years) who underwent screening DM/DBT and whole-breast screening US simultaneously at our health care center between March 2016 and October 2017. On the basis of the findings from DM and DBT, supplemental screening US was performed by one of 5 experienced radiologists using a handheld device, and they reported the DM/DBT and US findings separately. The cancer detection rate (CDR), sensitivity, specificity, and positive predictive value (PPV) of DM/DBT and DM/DBT combined with US were compared to those from histological examinations and to 12-month follow-up data, as a reference standard.

## RESULTS

Among 958 women, the breast density was almost entirely fatty in 6.5%, scattered areas of fibroglandular density in 23.9%, heterogeneously dense in 46.6%, and extremely dense in 23.1%. Seven cancers (6 invasive ductal cancer [IDC] and 1 ductal carcinoma in situ [DCIS]) were diagnosed, and the mean size of the invasive cancer was 1.6 cm (range, 0.3-3.3 cm). Four cases of cancer were detected on both DM/DBT and DM/DBT combined with US (4 IDCs), and the other three cases of cancer (2 IDCs and 1 DCIS) were detected when US was added to DM/DBT. All three US-detected cancers were node-negative, and the T stages of the 2 IDCs were T1 and T2, respectively. The sensitivities were 57.1% (95% confidence interval [CI]: 0.25-0.84) for DM/DBT and 100% (95% CI: 0.60-1.00) for DM/DBT combined with US ( $p=0.25$ ). Supplemental screening US detected additional 3.1 cancers per 1000 screens (95% CI: 0.6-9.6). Regarding specificity, DM/DBT had a 99.4% (95% CI: 0.99-1.00) specificity, whereas the specificity on addition of US was 96.4% (95% CI: 0.95-0.97) ( $P<0.0001$ ). The PPV was 40.0% (95% CI: 0.17-0.69) for DM/DBT, and the addition of US decreased the PPV to 17.5% (95% CI: 0.08-0.32).

## CONCLUSION

The addition of screening US resulted in minor increased CDR, however, increased the number of false-positive results.

## CLINICAL RELEVANCE/APPLICATION

Supplemental screening US can detect cancers that may not have been detected on DM/DBT screening; however, it increases the number of false-positive results, leading to recall examinations and biopsies.

## SSE02-06 Second Reading DBT versus Supplemental Screening US in Dense Breasts: Interim Analysis from the DBTUST

Monday, Dec. 2 3:50PM - 4:00PM Room: E451B

### Participants

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## PURPOSE

To determine the supplemental cancer detection rate from double reading tomosynthesis (DBT) compared to addition of technologist-performed whole breast handheld screening ultrasound (US).

## METHOD AND MATERIALS

In an IRB-approved, HIPAA-compliant protocol, 6258 women age 40-75 with heterogeneously dense or extremely dense breasts consented to annual technologist-performed US after DBT for three years at one of three sites in western Pennsylvania. Each modality was independently interpreted in opposing order by two radiologists who were MQSA qualified and met ACRIN 6666 US experience criteria. An interim analysis was performed of 6258 prevalence and 7616 incidence screens through 12/31/18.

## RESULTS

Median patient age was 53 years. Among 13,874 analyzable screens, 91 women were diagnosed with cancer (CDR 6.6 per 1000, median invasive size 1.5 cm): 68 (74.7%) detected by reader 1 on DBT; 9 (9.9%) only by reader 2 on DBT (one of which was also visible on US by the primary radiologist, and one of which was dismissed, detected due to symptoms); 12 (12.2%) only on US; 1 (1.1%) by MRI performed for other reasons, and 1 (1.1%) only because of symptoms (interval cancer). Nineteen cancers were DCIS, 18 seen only on DBT (2 only on double reading); 72 were invasive (median size 13 mm), 7 only on DBT double reading (median size 10 mm, 6/7 node negative) and 12 seen only on US (median size 10 mm, 10/12 node negative). Supplemental cancer detection rate of second reading DBT was 0.65/1000 vs. 0.9/1000 for US ( $p=0.37$ ). Supplemental recall rates were 36.9/1000 for double reading DBT vs. 50.4/1000 for US ( $p<0.001$ ); PPV 5.27% vs. 5.33%; NPV 99.89 vs. 99.92%. Of note, 6 cancers detected by reader 1 on DBT in year 1 had been missed on clinical reading of DBT in a subset of 3876 women prior to study entry: if attributed to double reading DBT, yield would be 15/13,874 or 1.1/1000 for double reading.

## CONCLUSION



In women with dense breasts, there is a significant yield from supplemental screening with technologist-performed US even after DBT, albeit with sizable increase in recall rate. Double reading DBT increases recall rate less than US. Additional cancers detected by double reading DBT vs. adding US were mostly nonoverlapping and invasive.

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

The adequacy of screening DBT for women with dense breasts is uncertain. Noninvasive methods to improve cancer detection, including double reading and screening US, merit consideration.

Printed on: 10/29/20



SSE03

## Science Session with Keynote: Cardiac (Congenital and Pediatric Imaging)

Monday, Dec. 2 3:00PM - 4:00PM Room: E350

CA MR PD

AMA PRA Category 1 Credit™: 1.00  
ARRT Category A+ Credit: 1.00

FDA Discussions may include off-label uses.

### Participants

Gautham P. Reddy, MD, Seattle, WA (*Moderator*) Researcher, Koninklijke Philips NV  
Jean Jeudy JR, MD, Baltimore, MD (*Moderator*) Nothing to Disclose  
Cylen Javidan, MD, Saint Louis, MO (*Moderator*) Nothing to Disclose

### Sub-Events

#### SSE03-01 Cardiac Keynote Speaker: MRI Evaluation of Function and Physiology in Congenital Heart Disease

Monday, Dec. 2 3:00PM - 3:20PM Room: E350

#### Participants

Gautham P. Reddy, MD, Seattle, WA (*Presenter*) Researcher, Koninklijke Philips NV

#### SSE03-03 Dual-Venc 4D-Flow MRI For the Follow-Up of Patients with Complex Congenital Heart Disease

Monday, Dec. 2 3:20PM - 3:30PM Room: E350

#### Participants

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### PURPOSE

To test the feasibility of dual-velocity encoding (dual-venc) 4D-flow MRI accelerated by katARC for the follow-up of patients with complex congenital heart disease (CHD), to improve dynamic velocity range of 4D-flow MRI and reduce velocity to noise ratio for low velocities measurements.

### METHOD AND MATERIALS

A dual-venc 4D flow MRI sequence accelerated by k- & adaptive-t-ARC, assessed vena cava, pulmonary and aortic flows in 10 young adults followed-up after surgery for various complex CHD. Routine cardiac MRI was performed on a 3T magnet followed by a dual-venc 4D-flow MRI sequence (High-Venc/low-venc were set at 300/100cm/s, temporal/spatial resolution=40-45msec/2x2x2.2mm<sup>3</sup>) after the injection of gadolinium contrast agent (0.15 mmol/kg). The dataset was anonymized and sent on a cloud-based software. After deep learning based phase offsets correction, both high- and low-venc data were analysed separately and simultaneously for the feasibility and for assessing arterial and venous hemodynamics (flows) at the great vessels. All patients were informed and signed a consent to test dual-venc 4D flow sequence.

### RESULTS

All dual-venc 4D flow MRI scans were acquired successfully with an acquisition time of 12±3 minutes. Dual-venc sequence acquisition time was 1.5 times longer than a single venc sequence, the total acquisition time was reduced by 25% compared to two separate scans. Cloud based data analysis enabled 'real-time' simultaneous analysis of both low-venc and high-venc volumes. Concerning vena cavas velocity measurements, Bland-Altman plot showed good agreement within the 95% limits between high- and low- Venc datasets, noise was noted 25% lower on low-venc vs high-venc dataset. Aliasing occurred on most arterial measurements using low-venc volume.

### CONCLUSION

Dual-venc 4D flow MRI used for the follow up of patients with complex CHD reliably incorporates low- and high-velocity fields simultaneously, within a reasonable scan time.

### CLINICAL RELEVANCE/APPLICATION

Recently, 4-D flow MRI has shown to bring relevant findings in the follow-up of patients with complex CHD. In these patients,

arterial high velocities and venous lower velocities have to be reliably explored but with always a compromise for the choice of the velocity range to explore. Dual-venc sequences enable a new approach enabling reliable measurement of these low and high velocity flows within a reasonable scan time, faster than 2 consecutive single Venc 4D flow sequence.

### **SSE03-04 Rapid Reconstruction of Highly-Accelerated Real-Time Phase Contrast MRI Using Deep Convolutional Network: A Feasibility Study in Patients with Congenital Heart Disease**

Monday, Dec. 2 3:30PM - 3:40PM Room: E350

#### **Participants**

Hassan Haji-Valizadeh, Evanston, IL (*Presenter*) Nothing to Disclose  
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#### **PURPOSE**

Standard real-time phase-contrast (rt-PC) MRI produces inadequate spatial and temporal resolution, limiting pediatric applications. Compressed sensing (CS) can be used to highly accelerate real-time phase contrast (rt-PC) MRI for achieving high spatial (1.5x1.5x6mm<sup>3</sup>) and temporal (40ms) resolution. However, it is challenging to clinically translate CS approaches due to the lengthy image reconstruction time (~10 min). We sought to apply a deep learning (DL) framework to rapidly reconstruct rt-PC images and evaluate its performance in patients with CHD.

#### **METHOD AND MATERIALS**

We scanned 14 CHD patients (mean age=14.2 ± 7.1yr; 10 males) on a 1.5T scanner (Aera, Siemens) using our 38.4-fold accelerated, rt-PC sequence employing radial k-space sampling with golden angles. Image reconstruction was performed on a GPU workstation equipped with Pytorch. A convolutional neural network was trained with 9860 (29 valve planes x 85 timeframes per plane x 2 complex components x 2 velocity encodings) zero-filled and the corresponding CS reconstructed images obtained from 9 randomly selected patients as input/output pairs. For validation, we reconstructed 6460 zero-filled images from the remaining 5 patients using our trained network, and the resulting images representing a single heartbeat were compared with the corresponding CS reconstructed images. Our proposed DL network was composed of 10 hidden layers with 16 features each, two concatenation connections, and convolution kernel size of 1x1x3 (Figure 1A).

#### **RESULTS**

The reconstruction time for DL (5.9±0.5s) was significantly lower (p<0.05) than CS (551.4±27.6s). Figure 1B shows representative images reconstructed with CS and DL as well as their corresponding forward flow and peak velocity curves. Compared to CS, DL produced negligible error in valvular velocities (NRMSE = 4.8±1.9%). Flow and velocity curves produced by CS and DL reconstruction were strongly correlated (R<sup>2</sup>>0.94) with small mean differences (<5.9% of means, Figure 1C).

#### **CONCLUSION**

This study demonstrates a DL framework to significantly decrease the reconstruction time (93 times) compared with CS for 38.4-fold accelerated rt-PC MRI.

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

Patients with CHD may benefit from a rapid rt-PC MRI pulse sequence which enables free-breathing imaging.

### **SSE03-05 Evaluation of Pulmonary Pressure After Glenn Shunts by CT-Based Machine Learning Model**

Monday, Dec. 2 3:40PM - 3:50PM Room: E350

#### **Participants**

Yuhao Dong, Guangzhou, China (*Presenter*) Nothing to Disclose

#### **PURPOSE**

To develop and validate non-invasive machine-learning classifiers for the separation of post-Glenn shunt patients with mean pulmonary arterial pressure (mPAP) >15 mmHg from those ≤15 mmHg based on preoperative cardiac computed tomography (CT).

#### **METHOD AND MATERIALS**

This retrospective study included 96 patients with functional single ventricle who had undergone a bidirectional Glenn procedure (BDG) between November 1, 2019 and July, 31, 2017. All underwent post-procedure CT examination, followed by cardiac catheterization within six months. In all, 23 morphologic parameters were manually extracted from cardiac CT images for each patient. The Mann-Whitney U test or Chi-square test was applied to select the predictors associated with the outcome of interest. Six machine-learning algorithms including logistic regression (LR), Naive Bayes (NB), Random Forest (RF), Linear Discriminant Analysis (LDA), Support Vector Machine (SVM), and K-Nearest Neighbor (KNN) were used for modeling. The algorithms were independently trained on the 100 train-validation random splits with a 3:1 ratio. The average performance of algorithms were evaluated by area under ROC curve (AUC), accuracy, sensitivity, and specificity.

#### **RESULTS**

Seven CT morphologic parameters were selected for modeling. RF method obtained the best predictive performance compared with other methods, with mean AUC of 0.840 (confidence interval [CI]: 0.832-0.850), 0.787 (95%CI: 0.780-0.794); sensitivity of 0.815 (95%CI: 0.797-0.833), 0.778 (95%CI: 0.767-0.788), specificity of 0.766 (95%CI: 0.748-0.785), 0.746 (95%CI: 0.735-0.757), accuracy of 0.782 (95%CI: 0.771-0.793), 0.756 (95%CI: 0.748-0.764) in the training and validation cohorts, respectively.

#### **CONCLUSION**

The CT-based ML model can accurately predict mPAP >15 mmHg in post-Glenn shunt patients.

The CI-based RF model demonstrates good performance in the classification of mPAP.

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

The CT-based RF model may reduce the need for right heart catheterization in post-Glenn shunts patients with suspected mPAP >15 mmHg.

#### **SSE03-06 Dynamic Fetal Cardiac Magnetic Resonance Imaging Using Doppler Ultrasound Gating in the Assessment of the Fetal Aortic Arch: A Feasibility Study and Comparison to Fetal Echocardiography**

Monday, Dec. 2 3:50PM - 4:00PM Room: E350

#### **Participants**

Bjoern Schoennagel, MD, Hamburg, Germany (*Presenter*) Co-founder and Stakeholder, Northh-Medical GmbH  
Jin Yamamura, MD, Hamburg, Germany (*Abstract Co-Author*) Nothing to Disclose  
Fabian Kording, Hamburg, Germany (*Abstract Co-Author*) Co-founder and Stakeholder, Northh Medical GmbH  
Christian Ruprecht, Hamburg, Germany (*Abstract Co-Author*) Co-founder and Stakeholder, Northh Medical GmbH  
Kai Fehrs, Hamburg, Germany (*Abstract Co-Author*) Co-founder and Stakeholder, Northh Medical  
Gerhard B. Adam, MD, Hamburg, Germany (*Abstract Co-Author*) Nothing to Disclose  
Manuela Tavares de Sousa, Hamburg, Germany (*Abstract Co-Author*) Co-founder and Stakeholder, Northh Medical GmbH

#### **PURPOSE**

To investigate the feasibility of dynamic fetal cardiac MRI using a newly developed MR compatible Doppler Ultrasound (DUS) device for fetal cardiac gating for evaluation of the fetal aortic arch in comparison to fetal echocardiography.

#### **METHOD AND MATERIALS**

This was a prospective study including 19 fetuses, with 17 of them having a normal aortic arch and two a suspicion of coarctation of the aorta (CoA) at initial fetal echocardiography. Median fetal age was 33 weeks (range 26-38). Dynamic fetal cardiac MRI was performed using a newly developed DUS device for direct fetal cardiac gating at a 1.5 T scanner. The aortic arch was evaluated in para-sagittal planes using a cine steady state free precession (SSFP) sequence. The visualization of the aortic arch and left subclavian artery was studied. MR image quality was assessed by two observers using a 4-point grading scale (increasing image quality from 1-4). Postnatal fetal echocardiography was considered as the standard of reference.

#### **RESULTS**

Direct fetal cardiac gating using the DUS device allowed continuous gating of the fetal heart beat. In four cases the DUS device had to be repositioned during examination due to fetal movement. Examination of one fetus was not possible due to severe fetal movement and loss of the cardiac gating signal. Both, fetal cardiac MRI and echocardiography detected the CoA and enabled visualization of the aortic arch in 16/18 cases (89%). Overall MR image quality according to the 4-point scale grading was high with no or only few artifacts and a resulting mean value of 3.1 ( $\pm 1.1$ ). Agreement in overall image quality between the two observers was good ( $\kappa = 0.75 \pm 0.13$ ).

#### **CONCLUSION**

This study shows that dynamic fetal cardiac MRI using the newly developed DUS device for direct cardiac gating allows reliable evaluation of the fetal aortic arch and in agreement to fetal echocardiography.

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

Dynamic fetal cardiac MRI may be useful in addition to fetal echocardiography for the evaluation of CoA, especially in cases where echocardiography is inconclusive.

Printed on: 10/29/20



SSE04

## Science Session with Keynote: Cardiac (Arrhythmia and Electrophysiology)

Monday, Dec. 2 3:00PM - 4:00PM Room: E353B

CA

AMA PRA Category 1 Credit™: 1.00  
ARRT Category A+ Credit: 1.00

FDA

Discussions may include off-label uses.

### Participants

Jacobo Kirsch, MD, Miami, FL (*Moderator*) Nothing to Disclose  
Dharshan R. Vummidi, MD, FRCR, Sale, United Kingdom (*Moderator*) Nothing to Disclose  
Benoit Desjardins, MD, PhD, Philadelphia, PA (*Moderator*) Nothing to Disclose

### Sub-Events

#### SSE04-01 Cardiac Keynote Speaker: The Role of Imaging in Electrophysiology

Monday, Dec. 2 3:00PM - 3:20PM Room: E353B

#### Participants

Benoit Desjardins, MD, PhD, Philadelphia, PA (*Presenter*) Nothing to Disclose

#### SSE04-03 Self-Navigated, Free-Breathing 3D Left Atrial Late Gadolinium Enhancement MRI: A Preliminary Study for Evaluation of Image Quality and Quantification of Atrial Fibrosis in Patients with Atrial Fibrillation at 1.5T MRI Scanners

Monday, Dec. 2 3:20PM - 3:30PM Room: E353B

#### Participants

Suvai Gunasekaran, PhD, Chicago, IL (*Presenter*) Nothing to Disclose  
Daniel Lee, Chicago, IL (*Abstract Co-Author*) Nothing to Disclose  
Bradley Knight, MD, Chicago, IL (*Abstract Co-Author*) Nothing to Disclose  
Ryan J. Avery, MD, Chicago, IL (*Abstract Co-Author*) Nothing to Disclose  
Hassan Haji-Valizadeh, Evanston, IL (*Abstract Co-Author*) Nothing to Disclose  
Rishi Arora, Chicago, IL (*Abstract Co-Author*) Nothing to Disclose  
Philip Greenland, Chicago, IL (*Abstract Co-Author*) Nothing to Disclose  
Rod Passman, Chicago, IL (*Abstract Co-Author*) Nothing to Disclose  
Michael Markl, PhD, Chicago, IL (*Abstract Co-Author*) Institutional research support, Siemens AG; Consultant, Circle Cardiovascular Imaging Inc;  
Daniel Kim, PhD, Chicago, IL (*Abstract Co-Author*) Nothing to Disclose

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

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### PURPOSE

Given the thin nature of the left atrial (LA) wall and the need to perform respiratory gating, the clinical translation of LA late gadolinium-enhanced (LGE) MRI has proven difficult, particularly at 1.5T MR scanners. This study describes a self-navigated, free-breathing 3D LA LGE pulse sequence with stack-of-stars k-space sampling and GRASP reconstruction for quantifying atrial fibrosis in patients with atrial fibrillation (AF) at 1.5T.

### METHOD AND MATERIALS

8 patients (5 males, 63 ± 6 years) with AF (6 paroxysmal, 2 persistent) were scanned on 1.5 T scanners (Siemens, AERA or AVANTO) using the proposed pulse sequence (1.5 x 1.5 x 2 mm<sup>3</sup> spatial resolution, 500 heartbeats). GRASP reconstruction with self-navigation of respiratory motion and temporal total variation as the sparsifying transform was performed with and without adaptive optimized nonlocal means (AONLM) filtering during post-processing. Reconstructed images were analyzed using commercial software (ADAS 3D, Galgo Medical) to quantify LA fibrosis, which was subsequently tested against relevant clinical characteristics. Images were evaluated by two attending readers on a 5-point scale (1=worst, 3=acceptable, 5=best) for each of three categories (conspicuity, noise, artifact), and the overall image quality index was defined as the sum of three scores, where 9 is defined as clinically acceptable. Additionally, LA SNR and edge sharpness were computed.

### RESULTS

Use of AONLM significantly ( $p < 0.05$ ) increased SNR (from 21.1 to 28.0), whereas sharpness was not significantly different (from 1.15mm to 1.16mm), representative example shown in Figure 1A-B. The median image quality index was significantly ( $p < 0.05$ ) higher with filtering (12.5) than without (9). Figure 1C shows fibrosis quantification of a persistent AF patient with mean atrial fibrosis of 20.41%. The mean LA fibrosis of our patients was 6.5 ± 6.1%. As shown in Figure 1D, unpaired t-tests demonstrated non-significant differences for all variables, except for AF type ( $p=0.0058$ ).

### CONCLUSION

This study demonstrates that the proposed 3D LA LGE sequence with post-processing is capable of producing clinically acceptable

This study demonstrated that the proposed 3D LGE sequence with post-processing is superior to processing clinically acceptable image quality (12.5) for quantifying LA fibrosis in patients with AF at 1.5 MRI scanners.

#### CLINICAL RELEVANCE/APPLICATION

A robust 3D LGE MRI pulse sequence at 1.5T for quantification of LA fibrosis is potentially a useful test for predicting AF recurrence following AF ablation.

#### SSE04-04 Improvement in Left Ventricular Myocardial Extracellular Volume Fraction Determined with Cardiac MRI after Successful Catheter Ablation for Atrial Fibrillation

Monday, Dec. 2 3:30PM - 3:40PM Room: E353B

##### Participants

Sang Eun Park, Seoul, Korea, Republic Of (*Presenter*) Nothing to Disclose

Sung Ho Hwang, MD, Seoul, Korea, Republic Of (*Abstract Co-Author*) Nothing to Disclose

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#### PURPOSE

The effect of catheter ablation of atrial fibrillation (AF) on left ventricular myocardial extracellular volume fraction (LV-ECV) is unknown. We aimed to assess the long-term effects of catheter ablation of AF on the LV-ECV using cardiac magnetic resonance imaging (MRI).

#### METHOD AND MATERIALS

This retrospective study included 60 patients (mean age, 58 ± 12 years; age range, 32-77 years; 44 men and 16 women) who underwent catheter ablation of AF and cardiac MRI to assess mid LV-ECV at baseline and after 12-months follow-up between March 2016 and March 2018. The study population was divided into 2 groups: 1) sinus rhythm (SR) group and AF group, according to the maintenance of rhythm status during follow-up after catheter ablation. Changes of LV-ECV from baseline to follow-up were evaluated using paired Student t test.

#### RESULTS

Of all 60 patients, 38 (63%) and 22 (37%) were in SR group and AF group, respectively. No significant difference of baseline LV-ECV was noted between the SR and AF groups (26.2 ± 1.7% vs. 27.0 ± 2.4%, P = 0.09). In the SR group, a significant decrease of LV-ECV from baseline to follow-up was noted (26.2 ± 1.7% vs. 24.4 ± 1.6%, P <0.001). Whereas in the AF group, a significant increase of LV-ECV from baseline to follow-up was noted (27.0 ± 2.4% vs. 28.8 ± 2.0%, P <0.001).

#### CONCLUSION

After catheter ablation of AF, LV-ECV improves significantly in patients who maintain sinus rhythm. In contrast, an increase of LV-ECV is observed in patients with recurrence of AF.

#### CLINICAL RELEVANCE/APPLICATION

Catheter ablation may affect the left ventricular myocardium with management of atrial fibrillation. The change of left ventricular myocardium after catheter ablation may be described by extracellular volume fraction determined with cardiac MRI.

#### SSE04-05 Atrial Remodeling Features in CT to Predict the Recurrence of Atrial Fibrillation After Ablation Therapy

Monday, Dec. 2 3:40PM - 3:50PM Room: E353B

##### Participants

Christoph Beyer, Innsbruck, Austria (*Abstract Co-Author*) Nothing to Disclose

Lyudmila Tokarska, Wiener Neustadt, Austria (*Abstract Co-Author*) Nothing to Disclose

Gudrun Feuchtnner, MD, Innsbruck, Austria (*Abstract Co-Author*) Nothing to Disclose

Markus Stuhlinger, Innsbruck, Austria (*Abstract Co-Author*) Nothing to Disclose

Florian Hintringer, MD, Innsbruck, Austria (*Abstract Co-Author*) Nothing to Disclose

Lukas Fiedler, Wiener Neustadt, Austria (*Abstract Co-Author*) Nothing to Disclose

Robert Schonbauer, Wiener Neustadt, Austria (*Abstract Co-Author*) Nothing to Disclose

Fabian Plank, MD, Innsbruck, Austria (*Presenter*) Nothing to Disclose

#### PURPOSE

Atrial fibrillation (AF) is the most common arrhythmia and is associated with significant morbidity and mortality. Structural atrial remodeling triggers increased automaticity and is important for AF recurrence and persistence. We evaluated qualitative atrial and epicardial features to predict AF recurrence after ablation therapy.

#### METHOD AND MATERIALS

812 consecutive patients at two high-volume centers with non-valvular, drug-resistant AF and without significant comorbidities underwent cardiac CT angiography before AF ablation. CT images were evaluated for left and right atrial (RA) diameters and volume, left atrial (LA) wall thickness (LAWT, anterior and posterior), epicardial adipose tissue volume (EAT) and density. Close clinical follow-up for min. 12 months was performed. Interrater variability was assessed.

#### RESULTS

The final analysis included 732 patients (mean age 56y, 24% female), 321 (43.9%) had a recurrence of AF after a mean of 7 months (mean follow-up period 31 months). CT analysis showed significantly larger LA (47.1 ± 15.5 ml/m<sup>2</sup> vs. 43.4 ± 15.1 ml/m<sup>2</sup>, p=0.0001) and RA indexed volumes (38.6 ± 12.6 ml/m<sup>2</sup> vs. 34.2 ± 12.3 ml/m<sup>2</sup>, p=0.0001). Mean anterior LAWТ measurements were higher (1.88 ± 0.5 mm vs. 1.64 ± 0.5 mm, p<0.0001), posterior (1.60 ± 0.4 mm vs. 1.36 ± 0.4 mm, p=0.001). Epicardial adipose tissue volume was higher amount in the patients with AF recurrence (141.5 ± 55.1 mm<sup>3</sup> vs 129.9 ± 51.3 mm<sup>3</sup>, p<0.0001) with increased distribution around the left atrium (19.0 ± 8.3 vs. 17.1 ± 7.1, p<0.0001) but not the right atrium (15.6 ± 7.0 vs. 14.7 ± 6.5, p=0.072).

## CONCLUSION

Atrial wall thickness as well as epicardial fat volume and attenuation assessed in computed tomography predicts AF recurrence in patients undergoing ablation therapy.

## CLINICAL RELEVANCE/APPLICATION

Atrial wall thickness and epicardial adipose tissue are cardiac remodelling factors that help understand the recurrence of atrial fibrillation.

## SSE04-06 Early Detection of Left Atrial Dysfunction Assessed by CMR-Feature Tracking in Hypertensive Patients

Monday, Dec. 2 3:50PM - 4:00PM Room: E353B

### Participants

Yanyan Song, Beijing, China (*Presenter*) Nothing to Disclose  
Xiuyu Chen, Beijing, China (*Abstract Co-Author*) Nothing to Disclose  
Lu Li, BA, Beijing, China (*Abstract Co-Author*) Nothing to Disclose  
Shihua Zhao, Beijing, China (*Abstract Co-Author*) Nothing to Disclose

### For information about this presentation, contact:

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## PURPOSE

To evaluate whether cardiovascular magnetic resonance feature tracking (CMR-FT) can detect early left atrial (LA) dysfunction in hypertensive patients with or without left ventricular hypertrophy (LVH).

## METHOD AND MATERIALS

Seventy-three patients with hypertension (HTN) and 29 healthy controls were retrospectively recruited. HTN patients were divided into the LVH (n=29) and non-LVH group (n=44). LA performance was analysed by using CMR-FT in 2- and 4-chamber cine images, including LA reservoir function (LA total ejection fraction [EF], total strain [ $\epsilon_s$ ], peak positive strain rate [SRs]), conduit function (LA passive EF, passive strain [ $\epsilon_e$ ], peak early negative strain rate [SRe]) and booster pump function (LA booster EF, active strain [ $\epsilon_a$ ], late peak negative strain rate [SRa]). The intra- and inter-observer reproducibility was evaluated by the intra-class correlation coefficient (ICC) analysis.

## RESULTS

Compared with controls, LA reservoir (LA total EF,  $\epsilon_s$ , SRs) and conduit function (LA passive EF,  $\epsilon_e$ , SRe) were significantly impaired in HTN patients with or without LVH (all  $p < 0.05$ ), and these parameters significantly correlated with mitral E/A < 1 (all  $p < 0.01$ ). In contrast, the LA booster pump function was relatively preserved in non-LVH group, representing an intermediate stage between the LVH group and healthy controls. Among LA deformation parameters,  $\epsilon_e$  showed the highest diagnostic value for differentiation of HTN patients with controls (AUC:0.82; sensitivity:80.82%; specificity:72.41%). Observer reproducibility was good-excellent (ICC:0.83-0.97) for all CMR-FT derived parameters.

## CONCLUSION

CMR-FT was a promising tool for quantification of LA function. LA reservoir and conduit dysfunction might be detected early by CMR-FT in HTN patients before the presence of LVH.

## CLINICAL RELEVANCE/APPLICATION

CMR-FT was a promising tool for early detection of impaired LA reservoir and conduit function in hypertensive patients before the presence of left ventricular hypertrophy.

Printed on: 10/29/20



SSE05

## Chest (Radiomics and Machine Learning)

Monday, Dec. 2 3:00PM - 4:00PM Room: S102CD

AI CH CT

AMA PRA Category 1 Credit™: 1.00  
ARRT Category A+ Credit: 1.00

FDA Discussions may include off-label uses.

### Participants

Brett W. Carter, MD, Houston, TX (*Moderator*) Nothing to Disclose  
Archana T. Laroia, MD, Fargo, ND (*Moderator*) Nothing to Disclose

### Sub-Events

#### SSE05-01 Radiomics-Based Prediction of Acute Respiratory Distress Syndrome in Chest Computed Tomography of Polytraumatized Patients at Admission

Monday, Dec. 2 3:00PM - 3:10PM Room: S102CD

### Awards

#### Trainee Research Prize - Resident

#### Participants

Sebastian Roehrich, MD, Vienna, Austria (*Presenter*) Consultant, contextflow GmbH  
Johannes Hofmanninger, Vienna, Austria (*Abstract Co-Author*) Siemens AG Boehringer Ingelheim GmbH  
Lukas Negrin, Vienna, Austria (*Abstract Co-Author*) Nothing to Disclose  
Georg Langs, Vienna, Austria (*Abstract Co-Author*) Co-founder, contextflow GmbH; Shareholder, contextflow GmbH  
Helmut Prosch, MD, Vienna, Austria (*Abstract Co-Author*) Nothing to Disclose

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

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### PURPOSE

The aim of this prospective, internal review board approved study was to investigate the possibility of fully automatic, machine-learning-based prediction of the development of acute respiratory distress syndrome (ARDS) in polytraumatized patients based on the initial computed tomography (CT) scan of the chest.

### METHOD AND MATERIALS

Over a timeframe of four years, polytraumatized patients, 18 years or older, with an Injury Severity Score (ISS) greater than 15, were included in the study. Exclusion criteria were: death within 48 hours, burning injury and known oncologic or chronic inflammatory lung disease. All scans were conducted on the same scanner and all scans were conducted within one hour of the accident. ARDS was defined by the Berlin definition. We performed deep-learning-based segmentation of the lungs including pleural effusions. Within the masks we densely sampled 83 radiomics features on locations throughout the lung and learned a spatio-visual vocabulary of radiomics feature expressions. Subsequently, we used the histogram of spatio-visual words of each lung to train a Support Vector Machine (SVM) classifier for prediction of ARDS and compared the algorithm to commonly used scores for prognosis estimation (ISS and abbreviated injury score of the thorax (AIS)). We performed 40-fold stratified cross validation to split training and test sets.

### RESULTS

123 patients met the inclusion criteria. 101 of the polytraumatized patients had a thoracic AIS of 3 or greater (indicating severe thoracic injury). 40 out of 123 patients (32,5%) developed ARDS. The machine learning-based ARDS risk-score yielded an AUC of 0.78 (ISS: 0.66; AIS: 0.68). At a cutoff at 0.3, the radiomics risk-score yields a precision of 0.59, recall of 0.73 and an f1-score of 0.65 for ARDS prediction.

### CONCLUSION

Machine-learning-based radiomic features of the lung in polytraumatized patients are able to predict ARDS at a higher level than common clinical scores in the same collective.

### CLINICAL RELEVANCE/APPLICATION

Clinical decision support regarding the development of ARDS may be supported by extracting and analysing imaging data that is routinely available in polytraumatized patients at their admission to the hospital.

#### SSE05-02 The Incidental Thyroid Nodule on Chest CT: Application of CT Texture Analysis in the Prediction of Ultrasound Classification

Monday, Dec. 2 3:10PM - 3:20PM Room: S102CD

Participants



Jung In Jo, Seoul, Korea, Republic Of (*Abstract Co-Author*) Nothing to Disclose  
Jung Im Kim, MD, Seoul, Korea, Republic Of (*Presenter*) Nothing to Disclose  
Han Na Lee, MD, Seoul, Korea, Republic Of (*Abstract Co-Author*) Nothing to Disclose  
Jung Kyu Ryu, MD, PhD, Seoul, Korea, Republic Of (*Abstract Co-Author*) Nothing to Disclose

## PURPOSE

To explore the value of CT texture analysis (CTTA) in predicting subsequent ultrasound (US) classification of incidentally detected thyroid nodule on chest CT.

## METHOD AND MATERIALS

A total of 117 incidental thyroid nodules ( $\geq 1$ cm in the longest diameter) on the chest CT scan of 107 patients were enrolled. CCTA parameters (mean value of positive pixels (MPP), kurtosis, entropy, skewness) were extracted using commercial software (TexRAD) with soft, medium and coarse spatial filters. CT texture features were correlated with the Korean Thyroid Imaging Reporting and Data System (K-TIRADS) classification on recent thyroid US within 1 month. All of the single texture features were compared between benign (K-TIRADS 2; n=21) and suspicion (K-TIRADS 3, 4, 5; n=96) nodules by Mann-Whitney U test. Combinations of significant texture features were entered as predictors in logistic regression models for predicting suspicion nodule and the performance of logistic regression model was analyzed by area under receiver operating characteristic curve (AUROC).

## RESULTS

The mean values of MPP of benign nodule were significantly lower than suspicion nodule at all filter levels (all,  $p < 0.05$ ). Entropy of benign nodule was significantly lower than suspicion nodule at fine and coarse filters ( $p = 0.018, 0.040$ , respectively), besides kurtosis of benign nodule was significantly lower than suspicion nodule at medium filter ( $p = 0.002$ ). Skewness of benign nodule were slightly higher than suspicion nodule at medium and coarse filters (both,  $p = 0.074$ ). A logistic regression analysis with combination of kurtosis, mpp and skewness at medium filter showed the best performance for the prediction of suspicion nodule with AUROC of 0.841 ( $p < 0.001$ , sensitivity 84.4% and specificity 81.0%). The logistic regression model correctly classified 85.7% benign and 84.3% suspicion nodules.

## CONCLUSION

CTTA features of ITN were significantly associated with systematic US classification and can accurately discriminate between benign (K-TIRADS 2) and suspicion (K-TIRADS 3, 4, 5) nodule.

## CLINICAL RELEVANCE/APPLICATION

Quantitative CT texture analysis of ITN has the potential to predict benign or suspicion nodule on subsequent ultrasound and can be used to direct further workup of ITN on CT images.

## SSE05-04 Deep Learning (DL) Based Interpretation of Frontal Chest Radiographs: Assessing Accuracy of the DL Algorithm

Monday, Dec. 2 3:30PM - 3:40PM Room: S102CD

### Participants

Ramandeep Singh, MBBS, Boston, MA (*Presenter*) Nothing to Disclose  
Fatemeh Homayounieh, MD, Boston, MA (*Abstract Co-Author*) Nothing to Disclose  
Sasa Grbic, Princeton, NJ (*Abstract Co-Author*) Nothing to Disclose  
Subba R. Digumarthy, MD, Boston, MA (*Abstract Co-Author*) Speaker, Siemens AG; Research Grant, Lunit Inc; Researcher, Merck & Co, Inc; Researcher, Pfizer Inc; Researcher, Bristol-Myers Squibb Company; Researcher, Novartis AG; Researcher, F. Hoffmann-La Roche Ltd; Researcher, Polaris Pharmaceuticals, Inc; Researcher, Cascadia Healthcare, LLC; Researcher, AbbVie Inc; Researcher, Gradalis, Inc; Researcher, Clinical Bay; Researcher, Zai Lab  
Mannudeep K. Kalra, MD, Lexington, MA (*Abstract Co-Author*) Research Grant, Siemens AG; Research Grant, Riverain Technologies, LLC;  
Jo-Anne O. Shepard, MD, Boston, MA (*Abstract Co-Author*) Editor with royalties, Reed Elsevier  
Sebastian Vogt, PhD, Malvern, PA (*Abstract Co-Author*) R&D Director, Siemens AG; Stockholder, Siemens AG;  
Eli Gibson, MSc, Princeton, NJ (*Abstract Co-Author*) Employee, Siemens AG

## PURPOSE

Deep learning-based algorithm can improve the workflow and turnaround of interpretation of chest radiographs which are one of the most commonly performed imaging exams in hospital settings. The purpose of our study was to assess accuracy of deep learning based algorithm for detection of radiographic findings on frontal chest radiographs (CXR).

## METHOD AND MATERIALS

A DL prototype (DNetLoc, Siemens) was trained for detecting and classifying radiographic abnormalities on 112,120 CXRs from the CXR14 data (NIH) and 185,421 CXRs belonging to the PLCO data (Prostate, Lung, Ovarian, and Colon Cancer). Five hundred deidentified CXR (47 PA and 453 AP projection radiographs; 280 males, 220 female; mean age  $64 \pm 18$  years) belonging to the CheXpert data (from Stanford) were processed with the DL prototype. The prototype processed the CXRs and provided prediction statistics and scores for consolidation, pneumonia, atelectasis, pulmonary edema, pleural effusion, and enlarged cardiac silhouette. Statistical analysis was performed with receiver operating characteristics (ROC) to determine the area under the curve (AUC).

## RESULTS

Distribution of findings on CXR included 320 pleural effusions, 242 pulmonary edema, 183 consolidation, 126 atelectasis, 66 enlarged cardiac silhouette, and 54 pneumonia. Of the included CXR, 183/500 (37%) had multiple radiographic findings, 169/500 (34%) had single radiographic finding per CXR, and 148/500 (30%) CXR had no radiographic abnormality. The estimated sensitivity, specificity, and AUC values for different findings were: pleural effusions (0.88, 0.77, 0.91), pulmonary edema (0.73, 0.80, 0.82), 183 consolidation (0.87, 0.76, 0.89), atelectasis (0.87, 0.70, 0.84), enlarged cardiac silhouette (0.70, 0.80, 0.80), and 54 pneumonia (0.78, 0.75, 0.84).

## CONCLUSION

DL based prototype can accurately detect radiographic findings such as consolidation, pneumonia, atelectasis, pleural effusion, and

enlarged cardiac silhouette (maximum AUC of 0.91 for pleural effusion). Performance of the prototype may have been limited by the JPEG image format and 8-bit compression of DICOM data.

#### CLINICAL RELEVANCE/APPLICATION

Deep learning based prototype can accurately detect and classify radiographic findings on frontal chest radiographs.

#### SSE05-05 Improving Diagnostic Performance of Deep Learning Radiographic Localization by Injecting Expert Knowledge

Monday, Dec. 2 3:40PM - 3:50PM Room: S102CD

##### Participants

Brian Hurt, MD,MS, San Diego, CA (*Presenter*) Consultant, Arterys Inc; Consultant, IBM Corporation

Andrew Yen, MD, San Diego, CA (*Abstract Co-Author*) Nothing to Disclose

Seth J. Kligerman, MD, Denver, CO (*Abstract Co-Author*) Speakers Bureau, Boehringer Ingelheim GmbH; Author, Reed Elsevier; Consultant, IBM Corporation

Albert Hsiao, MD, PhD, La Jolla, CA (*Abstract Co-Author*) Founder, Arterys, Inc; Consultant, Arterys, Inc; Shareholder, Arterys, Inc; Speaker, Bayer AG; Research Grant, Bayer AG; Speaker, General Electric Company; Research Grant, General Electric Company;

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#### PURPOSE

We explored a semantic segmentation approach to localize suspected foci of pneumonia and endotracheal tube placement, and tested the hypothesis that additional anatomic contextual information may further improve performance.

#### METHOD AND MATERIALS

A public data set comprised of 29K frontal chest radiographs was used to train multiple multi-channel U-net neural networks. Foci of pneumonia were represented by bounding box coordinates and converted to probability maps for model training. We developed custom software to draw free-form annotations as a method of injecting expert radiologist knowledge into model training. Pneumonia localization were trained on 25K and tested on 4K frontal radiographs. Two pneumonia models were trained: (a) without and (b) with thoracic cavity annotations. Endotracheal/Tracheostomy tube segmentation models were trained on 771 from the above dataset and tested on 291 private radiographs. Two models for tube tip and carina localization were trained: (a) without and (b) with central airways and tube annotations. Annotations and model training were performed by a physician post-doctoral research fellow. Pneumonia classifications and subsequent ROC/AUC values are derived from predicted heat maps. Points corresponding to the carina and tube tip are extracted from predicted heat-maps, and distance error between prediction and hand-labeled points are calculated.

#### RESULTS

AUC for detection of pneumonia was 0.861 and improved to 0.906 with concurrent training with the thoracic cavity annotation. Inclusion of central airways and tube entirety improved tube detection AUC from 0.610 to 0.894. Further, mean error in tube tip and carina localization were 19.7 and 13.3 mm, and improved to 10.2 and 6.4 mm with concurrent training with the central airways and the entirety of the tube.

#### CONCLUSION

Semantic segmentation is a feasible approach to localize anatomy, pathology, and hardware. Injecting concurrent anatomic contextual information using a multi-channel strategy can improve localization performance. This approach may enable radiologists to further improve performance of deep learning algorithms for use in clinical practice.

#### CLINICAL RELEVANCE/APPLICATION

Multiple deep learning approaches have been proposed to assist interpretation of chest radiographs. Deep learning-based semantic segmentation provides natural model transparency and may enable radiologists to inject expert knowledge.

#### SSE05-06 The Combination of Deep Learning Based Denoising and Iterative Reconstruction on Ultra-Low-Dose Chest CT: Image Quality and Lung-RADS Evaluation

Monday, Dec. 2 3:50PM - 4:00PM Room: S102CD

##### Participants

Akinori Hata, MD, Suita, Japan (*Presenter*) Support, Canon Medical Systems Corporation

Masahiro Yanagawa, MD, PhD, Suita, Japan (*Abstract Co-Author*) Nothing to Disclose

Tomo Miyata, MD, Suita, Japan (*Abstract Co-Author*) Nothing to Disclose

Yuriko Yoshida, Osaka, Japan (*Abstract Co-Author*) Nothing to Disclose

Osamu Honda, MD, PhD, Amagasaki, Japan (*Abstract Co-Author*) Nothing to Disclose

Noriyuki Tomiyama, MD, PhD, Suita, Japan (*Abstract Co-Author*) Nothing to Disclose

Noriko Kikuchi, Suita, Japan (*Abstract Co-Author*) Nothing to Disclose

Mitsuko Tsubamoto, MD, Suita, Japan (*Abstract Co-Author*) Support, Canon Medical Systems Corporation

#### PURPOSE

To assess the effect of the combination of the deep learning based denoising (DLN) and iterative reconstruction (IR) on the image quality and the Lung-RADS results on ultra-low-dose chest CT.

#### METHOD AND MATERIALS

Forty-one patients with 252 nodules were evaluated retrospectively. All patients underwent standard-dose CT (SDCT:  $6.46 \pm 2.28$  mSv) and ultra-low-dose CT (ULDCT:  $0.19 \pm 0.01$  mSv). SDCT was reconstructed using hybrid IR. ULDCT was reconstructed using hybrid IR (hIR) and model-based iterative reconstruction (MBIR). Post-processing DLN was performed on ULDCT images (hIR+DLN and MBIR+DLN). Two independent radiologists subjectively evaluated 4 ULDCT image sets (hIR, hIR+DLN, MBIR, and MBIR+DLN) on a

5-point scale (1=worst<2<3<4<5=best) in terms of noise, streak artifact, the visibility of nodule edge, the clarity of small vessels, the homogeneity of normal lung parenchyma, and overall image quality. In addition, two radiologists independently evaluated the nodules according to the LungRADS using the SDCT image set and the two post-processed ULDC image sets (hIR+DLD, MBIR+DLD). The subjective scores were analyzed using the Wilcoxon signed-rank test with the Bonferroni correction. The intra-observer agreement for the LungRADS category between SDCT and ULDC was evaluated using weighted kappa coefficients.

## **RESULTS**

In subjective image quality analysis, ULDC images with DLD showed significantly better scores than those without DLD ( $p \leq 0.001$ ) in terms of all items for both readers. MBIR+DLD showed the best scores among the ULDC images in terms of all items except for the homogeneity ( $p < 0.001$ ). In the LungRADS evaluation, hIR+DLD showed moderate agreement ( $\kappa = 0.420$  for reader1 and  $\kappa = 0.423$  for reader2) and MBIR+DLD showed moderate or good agreement ( $\kappa = 0.591$  for reader1 and  $\kappa = 0.663$  for reader2).

## **CONCLUSION**

DLD improved the image quality of both hybrid IR and MBIR images on ULDC. MBIR was more advantageous than hybrid IR in terms of image quality and LungRADS evaluation even using DLD.

## **CLINICAL RELEVANCE/APPLICATION**

Both deep learning based denoising (DLD) and MBIR may contribute to the clinical practice by the improvement of image quality on ultra-low-dose chest CT.

Printed on: 10/29/20



SSE06

## Emergency Radiology (Non-Trauma: Brain, Head and Neck, and Spine)

Monday, Dec. 2 3:00PM - 4:00PM Room: E353A

ER HN NR

AMA PRA Category 1 Credit™: 1.00  
ARRT Category A+ Credit: 1.00

FDA Discussions may include off-label uses.

### Participants

Suzanne T. Chong, MD, Ann Arbor, MI (*Moderator*) Nothing to Disclose  
Zachary S. Delproposto, MD, Ann Arbor, MI (*Moderator*) Nothing to Disclose

### Sub-Events

#### SSE06-01 Diagnostic Accuracy and Impact on Clinical Patient Management of an Ultrafast 5 Min/5 Sequences Brain MRI Protocol in Acute Neurological Emergencies

Monday, Dec. 2 3:00PM - 3:10PM Room: E353A

### Participants

Philipp M. Kazmierczak, MD, Munchen, Germany (*Presenter*) Nothing to Disclose  
Max Duhrsen, Munchen, Germany (*Abstract Co-Author*) Nothing to Disclose  
Maximilian Patzig, Munich, Germany (*Abstract Co-Author*) Nothing to Disclose  
Robert Forbrig, Munchen, Germany (*Abstract Co-Author*) Nothing to Disclose  
Matthias Klein, Munchen, Germany (*Abstract Co-Author*) Nothing to Disclose  
Clemens C. Cyran, MD, Munich, Germany (*Abstract Co-Author*) Research Grant, iThera Medical GmbH Speakers Bureau, Siemens AG  
Jens Rieke, MD, PhD, Berlin, Germany (*Abstract Co-Author*) Research Grant, Sirtex Medical Ltd Research Grant, Bayer AG  
Andreas Pomschar, MD, Munich, Germany (*Abstract Co-Author*) Nothing to Disclose  
Wolfgang G. Kunz, MD, Munich, Germany (*Abstract Co-Author*) Grant, Medtronic plc  
Daniel Pühr-Westerheide, MD, Munich, Germany (*Abstract Co-Author*) Nothing to Disclose  
Sophia Stoecklein, MD, Munich, Germany (*Abstract Co-Author*) Nothing to Disclose  
Olga Solyanik, MD, Munich, Germany (*Abstract Co-Author*) Nothing to Disclose

### PURPOSE

To investigate sensitivity, specificity, and impact on clinical patient management of an ultrafast (5 min/5 sequences) brain MRI protocol for the detection of intracranial pathologies in acute neurological emergencies.

### METHOD AND MATERIALS

449 consecutive emergency patients with acute non-traumatic neurological symptoms were evaluated for this IRB-approved prospective single center trial. 60 patients (30 female, 30 male, median age 61±19 years) with negative head CT were included and underwent emergency brain MRI at 3 Tesla subsequent to CT. MRI included the ultrafast protocol (Ultrafast-MRI; sag T1 GRE, ax T2 TSE, ax T2 TSE Flair, ax T2\* EPI-GRE, ax DWI SS-EPI; TA 5 min) and an equivalent standard-length protocol (TA 15 min), which served as reference standard. Two blinded board-certified neuroradiologists independently analyzed the MRI data sets with regard to image quality (1-non-diagnostic, 2-poor/substantial artifacts, 3-satisfactory, 4-good/minor artifacts, 5-excellent/no artifacts) and intracranial pathologies. Sensitivity and specificity for the detection of intracranial lesions were calculated accordingly.

### RESULTS

93 additional intracranial lesions (total: n=125; acute ischemia n=21, intracranial haemorrhage n=27, edema n=2, white matter lesion n=38, chronic infarction n=3, others n=2) were detected by Ultrafast-MRI (CT: n=32 lesions; standard-length protocol: n=133 lesions). Image quality was equivalent to the standard-length protocol (T2; Ultrafast-MRI: 3.95±0.221, standard-length protocol 4.02±0.227, p=0.083). Ultrafast-MRI demonstrated high diagnostic accuracy (sensitivity: 0.939 [0.881;0.972]; specificity 1.000 [0.895;1.000]) for the detection of intracranial pathologies and changed clinical patient management in 10 % (6/59).

### CONCLUSION

In 5 min, Ultrafast-MRI including 5 standard sequences allows for the time-optimized diagnostic workup in acute neurological emergencies at high sensitivity and specificity compared to a standard-length protocol, with relevant impact on clinical patient management.

### CLINICAL RELEVANCE/APPLICATION

Ultrafast-MRI represents a powerful and fast alternative to head CT for the detection and differential diagnosis of intracranial pathologies in acute neurological emergencies.

#### SSE06-02 Pitfalls of Automated ASPECTS: Initial Experience in a Tertiary Care Center

Monday, Dec. 2 3:10PM - 3:20PM Room: E353A

### Awards

Trainee Research Prize - Fellow

#### Participants

Shobhit Mathur, MD, Vancouver, BC (*Presenter*) Nothing to Disclose  
John P. Walsh, MBChB, Vancouver, BC (*Abstract Co-Author*) Nothing to Disclose  
Omar Metwally, MBChB, Vancouver, BC (*Abstract Co-Author*) Nothing to Disclose  
Maria Zhu, MSc, Vancouver, BC (*Abstract Co-Author*) Nothing to Disclose  
Nicolas Murray, MD, Vancouver, BC (*Abstract Co-Author*) Nothing to Disclose  
Savvas Nicolaou, MD, Vancouver, BC (*Abstract Co-Author*) Institutional research agreement, Siemens AG; Stockholder, Canada Diagnostic Centres

#### PURPOSE

To compare the performance of automated ASPECTS provided by two software applications in acute stroke

#### METHOD AND MATERIALS

The non-contrast CT head studies of 91 consecutive patients referred with clinical suspicion of acute stroke were reviewed retrospectively by two observers and ASPECTS readings were made, first in an independent blinded fashion and later in consensus. A blinded consensus reading was also made on follow-up CT or MRI study (available for 67 patients) performed within 7 days. The observers then noted the readings from the software, also noting the possible cause of differences from the consensus readings.

#### RESULTS

The consensus human readings on the initial studies showed substantial correlation with automated results on the same studies from software package 1 ( $r=0.613$ ,  $p<0.001$ ) and software package 2 ( $r=0.663$ ,  $p<0.001$ ). The consensus human readings on follow up studies showed moderate to poor correlation with automated results on initial studies from software package 1 ( $r=0.353$ ,  $p<0.001$ ) and software package 2 ( $r=0.428$ ,  $p<0.001$ ). Segmentation errors, presence of extra-axial collections, anatomic asymmetry and chronic infarcts were common causes of misreadings by the softwares.

#### CONCLUSION

In our initial experience, although automated ASPECTS from both the softwares showed good correlation with human readings in acute stroke, they were moderate-poor predictors of final infarct volume.

#### CLINICAL RELEVANCE/APPLICATION

ASPECTS is a valuable tool in evaluation of acute stroke studies. The suggestions highlighted here would help ongoing improvement in the emerging machine learning based software applications in acute stroke imaging.

#### SSE06-03 Clinical Utility of Material Decomposition Algorithm on Unenhanced Dual-Energy Computed Tomography in the Detection of Acute Ischemic Infarcts

Monday, Dec. 2 3:20PM - 3:30PM Room: E353A

#### Participants

Sadia R. Qamar, MBBS, Vancouver, BC (*Presenter*) Nothing to Disclose  
Nicolas Murray, MD, Vancouver, BC (*Abstract Co-Author*) Nothing to Disclose  
Bonnie Niu, BSc, Vancouver, BC (*Abstract Co-Author*) Nothing to Disclose  
Gordon T. Andrews, MD, Vancouver, BC (*Abstract Co-Author*) Nothing to Disclose  
Savvas Nicolaou, MD, Vancouver, BC (*Abstract Co-Author*) Institutional research agreement, Siemens AG; Stockholder, Canada Diagnostic Centres

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#### PURPOSE

To determine the value of Dual-energy unenhanced computed tomography compared to standard unenhanced computed tomography in the detection of acute ischemic stroke.

#### METHOD AND MATERIALS

We retrospectively studied 70 patients presenting to the emergency department (ED) with clinical signs and symptoms of acute ischemic stroke who underwent an initial dual-energy CT head without intravenous (IV) contrast within the therapeutic window of 4.5 hours followed by a standard CT head without IV contrast within the next 24 hours. Three material decomposition algorithm to exploit the differences in the energy spectra of gray matter and white matter in an attempt to better visualize the cytotoxic edema associated with acute ischemic stroke was used. Alberta Stroke Program Early CT (ASPECT) scores were assigned on both of these initial and follow up CT heads. The studies were reviewed independently by two board-certified radiologists, blinded to the clinical information and patient outcome. Sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV) were calculated.

#### RESULTS

Standard, brain edema and 24-hour ASPECT scores were calculated for 70 patients. Of these patients, 43 (61.4%) had acute infarctions. Three material decomposition algorithm with brain edema reconstructions were superior to predict the infarction volume keeping 24-hour follow-up standard noncontrast CT as a reference with ASPECTS score of 7.57 vs 7.6;  $p$ -value 0.05. Standard non-contrast CT head had a 80% sensitivity (95% confidence interval (CI), 51.3-95.7%), 73% specificity (95% CI, 42-94%), 80% PPV (95% CI, 51.3-95.7%), and 72.3% NPV (95% CI 51.7-95.66%). The DECT showed a 94.2% sensitivity (95% CI, 71.4-99.81%), 100% specificity (95% CI, 76.3-100%), 100% PPV (95% CI, 77.1-100%), and 92.3% NPV (95% CI 62.44-99.89%). The overall interobserver agreement was good (0.61-0.80).

#### CONCLUSION

DECT proves to provide a better estimate of the end-infarct volume when compared to the standard non-contrast CT head in acute ischemic stroke.

#### CLINICAL RELEVANCE/APPLICATION

Early detection of acute ischemic stroke is critical for the patient outcome. Non-contrast CT head is the initial imaging modality to estimate the infarct volume and assess prognosis. DECT with its three material decomposition application improves the visualization of edema in acute ischemic infarct compared to standard non-contrast CT head, thus improving diagnostic accuracy.

#### **SSE06-04 Capability of a New Model-Based Iterative Reconstruction for Brain CT to Diagnose Acute Ischemic Stroke: Multicenter Study**

Monday, Dec. 2 3:30PM - 3:40PM Room: E353A

##### **Participants**

Hidenori Mitani, Hiroshima, Japan (*Presenter*) Nothing to Disclose  
Fuminari Tatsugami, Hiroshima, Japan (*Abstract Co-Author*) Nothing to Disclose  
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Mathias Prokop, PhD, Nijmegen, Netherlands (*Abstract Co-Author*) Speakers Bureau, Bracco Group Speakers Bureau, Bayer AG Research Grant, Canon Medical Systems Corporation Speakers Bureau, Canon Medical Systems Corporation Research Grant, Siemens AG Speakers Bureau, Siemens AG Departmental spinoff, Thirona Departmental licence agreement, Varian Medical Systems, Inc  
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##### **For information about this presentation, contact:**

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##### **PURPOSE**

We investigated the clinical capability of a newly developed model-based iterative reconstruction (MBIR) for brain CT to diagnose acute ischemic stroke.

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

Of 211 patients admitted with suspected acute ischemic stroke at four participating institutes, 83 who had undergone brain CT within 24 hr post-onset and were diagnosed with acute ischemic stroke by diffusion-weighted MRI or follow up CT were enrolled. CT scanning was on a 320-detector CT instrument [Aquilion Genesis, Canon Medical Systems (CMS)]; 2-mm-thick slices were reconstructed with both hybrid IR [h-IR: AIDR 3D (FCXX), CMS] and newly-developed MBIR (Brain LCD, CMS). Two diagnostic radiologists consensually graded the visualization of ischemic areas (IAs) on all reconstructed images. Grade I = IA not visualized, grade II = IA barely visualized, grade III = IA visualized, and grade IV = IA clearly visualized. The contrast-to-noise ratio (CNR) of the IA vis-à-vis contralateral normal sites was calculated. The visualization grade and the CNR of scans subjected to MBIR and h-IR were compared using the Wilcoxon signed-rank test.

##### **RESULTS**

IA visualization grades I, II, III, and IV were assigned to 39-, 8-, 10-, and 26 of the 83 MBIR images, respectively, and to 40-, 16-, 13-, and 14 of the h-IR images. In 61 patients (73.5%) the visualization grade was the same with both reconstructions; in 22 (26.5%) it was higher with MBIR than h-IR. In no cases was h-IR superior to MBIR ( $p < 0.01$ ). The median CNR was 5.0 for MBIR [interquartile range (IQR) 2.6-8.5] and 1.2 (IQR 0.8-2.0) for h-IR ( $p < 0.01$ ).

##### **CONCLUSION**

The new MBIR algorithm was superior to h-IR with respect to IA visualization and the identification of low-density areas in patients with acute ischemic stroke.

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

MBIR improved the diagnostic ability of brain CT to identify low-density areas in patients with acute ischemic stroke.

#### **SSE06-05 One-Stop-Shop Imaging in Acute Ischemic Stroke: Clinical Application of Simultaneous Acquisition of Cardiac CT in a Potential Cardioembolic Stroke**

Monday, Dec. 2 3:40PM - 3:50PM Room: E353A

##### **Participants**

Sadia R. Qamar, MBBS, Vancouver, BC (*Presenter*) Nothing to Disclose  
Saira Hamid, MD, Vancouver, BC (*Abstract Co-Author*) Nothing to Disclose  
Gordon T. Andrews, MD, Vancouver, BC (*Abstract Co-Author*) Nothing to Disclose  
Savvas Nicolaou, MD, Vancouver, BC (*Abstract Co-Author*) Institutional research agreement, Siemens AG; Stockholder, Canada Diagnostic Centres

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##### **PURPOSE**

To demonstrate the usefulness of performing simultaneous cardiac CT in patients undergoing CT head/ CTA arch to the vertex for acute ischemic stroke.

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

We retrospectively analyzed one-year clinical data for all patients presenting with clinical suspicion of ischemic stroke categorized as hot stroke, per institutional policy. All of these patients underwent non-contrast CT head and multiphasic CT angiography from arch to the vertex as a standard hot stroke imaging protocol. This clinical data was further extracted for simultaneously performed

cardiac-gated coronary CTA during their initial presentation. Potential cardioembolic sources were identified and categorized into high and medium risk categories. Frequency and percentages were calculated. Furthermore, all of these positive stroke patients were evaluated for risk assessment based on (Coronary Artery Disease Reporting and Data System) CAD-RADS scoring system.

## RESULTS

A total of 5227 patients underwent hot stroke imaging with 1405 positive patients. Out of these, 110 patients (7.82%) patients had their cardiac-gated coronary CTA performed during their initial presentation. Potential cardioembolic sources were identified in 53/1405 (3.77%) patients. High-risk causes included; myocardial infarction 1(1.88%), left atrial thrombus 1 (1.88%) , infective vegetation 1 (1.88%), non-infective vegetation (marantic) 1 (1.88%), prosthetic cardiac valves 7 (13.2%). Medium-risk causes included; patent foramen ovale 11 (20.75%), atrial septal defect 1 (1.88%), mitral valve prolapse 1(1.88%), valvular calcifications 11 (20.75%), mitral annular calcifications 14 (26.41%), and enlarged left atrium 4 (7.54%) patients. Three patients had both valvular and mitral annular calcifications. CAD-RADS categories were as follows; 0 in 43 (81.15%), 1 in 3(5.66%), 2 in 4(7.54%), 3 in 2(3.77%) and 4 in 1 (1.88%) patients.

## CONCLUSION

We conclude that cardiac CT can reliably identify the potential sources in clinically suspected cardioembolic strokes and simultaneously provide the coronary artery risk assessment.

## CLINICAL RELEVANCE/APPLICATION

Identification of the potential embolic sources in suspected cardioembolic strokes is vital for reducing patient's morbidity and mortality due to its early and late complications. Simultaneous acquisition of the cardiac CT with stroke imaging can act as a one-stop shop to detect these cardioembolic sources in selected patients.

## SSE06-06 Fatal Intracerebral Hemorrhage Complicated With and Without Methamphetamine Poisoning: Can We Tell the Differences on PMCT?

Monday, Dec. 2 3:50PM - 4:00PM Room: E353A

### Participants

Maiko Yoshida, MD, Chiba, Japan (*Presenter*) Nothing to Disclose  
Yohsuke Makino, MD, Setagaya-ku, Japan (*Abstract Co-Author*) Nothing to Disclose  
Masatoshi Kojima, RT, Chibashi, Japan (*Abstract Co-Author*) Nothing to Disclose  
Takuro Horikoshi, MD, Chiba, Japan (*Abstract Co-Author*) Nothing to Disclose  
Hiroki Mukai, Chiba, Japan (*Abstract Co-Author*) Nothing to Disclose  
Shinya Hattori, MD, Chiba, Japan (*Abstract Co-Author*) Nothing to Disclose  
Hajime Yokota, MD, Chiba, Japan (*Abstract Co-Author*) Nothing to Disclose  
Hirotarō Iwase, Chiba, Japan (*Abstract Co-Author*) Nothing to Disclose

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## PURPOSE

The purpose of this study was firstly to assess the incidence of fatal hemorrhage complicated with methamphetamine (MA) poisoning and secondly to assess post-mortem CT (PMCT) feature of fatal intracerebral hemorrhage (ICH) with MA poisoning comparing its findings to those without MA poisoning in order to figure out whether the key findings exist to differentiate those 2 groups.

## METHOD AND MATERIALS

Consecutive medico-legal autopsy data from November 2011 through February 2018 (n=3044) were searched, yielding 80 cases with non-traumatic fatal hemorrhage. In all cases, toxicological examination was performed. Among 80 cases, ICHs located on basal ganglia and brain stem were extracted and comparison of findings was performed between 2 groups; ICH with MA poisoning and ICH without MA poisoning. The frequency, age distribution, types of hemorrhage and PMCT findings were compared. Two board-certified radiologists with forensic experiences interpreted PMCT images.

## RESULTS

; On MA poisoning group there were 9 ICH cases located on basal ganglia and brain stem (The median age was 51.88years), while there were 14 cases on non-MA poisoning group (The median age was 61.35years). There was statistically significant difference between the ages of those 2 groups (p=0.0094). On PMCT comparison, there were statistically significant differences on mid-line shift distance (mm) (only for basal ganglia) (p=0.0281) and volume of aortic valve calcification (p=0.0182), while there was no statistically significant difference on volume of hematoma, cardiothoracic ratio, circumference of ascending aorta and calcification of aortic wall.

## CONCLUSION

Forensic radiologists should be aware the possibility of ICH with MA poisoning if massive hemorrhage on PMCT is detected. Younger age, calcification of aortic valve and remarkable mid-line shift could be the key.

## CLINICAL RELEVANCE/APPLICATION

(dealing with Postmortem CT) "Using Postmortem CT with toxicological examination is recommended in the process of death investigation."

Printed on: 10/29/20



SSE07

## Gastrointestinal (Hepatobiliary)

Monday, Dec. 2 3:00PM - 4:00PM Room: S404CD

GI

AMA PRA Category 1 Credit™: 1.00  
ARRT Category A+ Credit: 1.00

FDA

Discussions may include off-label uses.

### Participants

Jason A. Pietryga, MD, Riverside, RI (*Moderator*) Consultant, Radiostics LLC  
Jonathan R. Dillman, MD, MSc, Cincinnati, OH (*Moderator*) Research Grant, Siemens AG; Research Grant, Guerbet SA; Travel support, Koninklijke Philips NV; Research Grant, Canon Medical Systems Corporation; Research Grant, Bracco Group

### Sub-Events

#### SSE07-01 Differential and Prognostic MRI Features of Gallbladder Neuroendocrine Tumors from Adenocarcinomas

Monday, Dec. 2 3:00PM - 3:10PM Room: S404CD

### Participants

Jae Seok Bae, MD, Seoul, Korea, Republic Of (*Presenter*) Nothing to Disclose  
Se Hyung Kim, MD, Seoul, Korea, Republic Of (*Abstract Co-Author*) Nothing to Disclose  
Jeongin Yoo, Seoul, Korea, Republic Of (*Abstract Co-Author*) Nothing to Disclose  
Joon Koo Han, MD, Seoul, Korea, Republic Of (*Abstract Co-Author*) Nothing to Disclose

### PURPOSE

To identify MRI features that are helpful for the differentiation between gallbladder (GB) neuroendocrine tumors (NETs) and adenocarcinomas (ADCs) and to evaluate their prognostic values.

### METHOD AND MATERIALS

Between January 2010 and November 2018, we recruited 63 patients with GB NETs (n=21) and ADCs (n=42) who underwent MRI. Two radiologists independently assessed MRI findings and reached a consensus. Univariate and multivariate analyses were performed to identify significant differential MRI features of GB NETs from ADCs. Cox proportional hazard model was used to find prognostic MRI findings for overall survival (OS).

### RESULTS

Compared to ADCs, NETs more frequently demonstrated the following MR features: well-defined margin, intact overlying mucosa, targetoid enhancement on contrast-enhanced images, and targetoid appearance on diffusion-weighted imaging (DWI) ( $P < 0.001$  for all). In addition, liver metastasis was more common ( $P < 0.001$ ) and had more conspicuous border ( $P = 0.045$ ). Lymph node (LN) metastasis tended to show higher N stage ( $P = 0.006$ ) and targetoid appearance on DWI ( $P = 0.001$ ). On quantitative analysis, the sizes of GB mass and metastatic LN in NETs was significantly larger than those of GB ADCs ( $P = 0.003$  and  $P = 0.022$ , respectively). Median and mean follow-up periods were 16.0 months (range, 1-62 months) and  $21.6 \pm 17.6$  months, respectively. GB NETs showed a significantly worse OS compared to ADCs (median OS, 12.0 months versus 44.0 months,  $P = 0.005$ ). Multivariate Cox regression analysis revealed that the presence of liver metastasis (hazard ratio (HR) 10.683, 95% confidence interval [CI]: 1.551-73.587) and a larger size of metastatic LN (HR 2.004, 95% CI: 1.189-3.377) were poor prognostic factors for OS.

### CONCLUSION

There are several differential MR features of GB NETs from ADCs. GB NETs showed a significantly worse OS compared to GB ADCs and the presence of liver metastasis and a larger size of metastatic LN were associated with poor OS.

### CLINICAL RELEVANCE/APPLICATION

Contrast-enhanced MRI including diffusion-weighted imaging could be helpful for the differentiation of GB NETs from GB ADCs as well as for the prediction of patients' prognosis.

#### SSE07-02 Spleen and Liver Volumetry in Primary Sclerosing Cholangitis: Comparison to MELD Score in Predicting Liver Function

Monday, Dec. 2 3:10PM - 3:20PM Room: S404CD

### Participants

Pegah Khoshpouri, MD, Baltimore, MD (*Presenter*) Nothing to Disclose  
Mohammadreza Shaghaghi, MD, Baltimore, MD (*Abstract Co-Author*) Nothing to Disclose  
Maryam Ghadimi, MD, Baltimore, MD (*Abstract Co-Author*) Nothing to Disclose  
Roya Rezvani Habibabadi, Baltimore, MD (*Abstract Co-Author*) Nothing to Disclose  
Bitra Hazhirkarzar, MD, Baltimore, MD (*Abstract Co-Author*) Nothing to Disclose  
Sanaz Ameli, MD, Baltimore, MD (*Abstract Co-Author*) Nothing to Disclose  
Mounes Aliyari Ghasabeh, MD, Baltimore, MD (*Abstract Co-Author*) Nothing to Disclose



Pallavi Pandey, MD, Baltimore, MD (*Abstract Co-Author*) Nothing to Disclose  
Ankur Pandey, MD, Baltimore, MD (*Abstract Co-Author*) Nothing to Disclose  
Amy Kim, MD, Baltimore, MD (*Abstract Co-Author*) Nothing to Disclose  
Ihab R. Kamel, MD, PhD, Baltimore, MD (*Abstract Co-Author*) Research Grant, Siemens AG

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**PURPOSE**

To determine if liver and spleen volumes can predict liver dysfunction as defined by encephalopathy, variceal bleeding, Hepatorenal syndrome, and liver-related death in PSC patients and to compare the value of these volumes to MELD in predicting outcome.

**METHOD AND MATERIALS**

This IRB-approved, retrospective single center study included 166 PSC patients with at least one liver imaging study (MR/CT) between 2000 and 2018. Total liver(T), right(R) and left(L) lobes, caudate(C) and spleen(S) volumes were measured. The volumetric parameters were compared between patients with and without liver dysfunction, which was an adverse outcome, using Mann-Whitney U test. Spearman's test was performed to correlate the volumes to MELD. We used ROC analysis to test the accuracy of volumetric parameters to predict developing an adverse outcome and multiple logistic regression to find its independent predictors. Pvalue<0.05 was considered statistically significant.

**RESULTS**

Our cohort included 97 (58%) males with mean age of 43, with no significant differences in age between patients with and without liver dysfunction. Among 166 patients, 35% didn't have adverse outcome, 14% were dead and 37%, 26%, and 3%, ended up with variceal bleeding, encephalopathy, and/or Hepatorenal syndrome, respectively. Patients with and without adverse outcome had significantly different absolute and ratio volumetry of S, L, and C (p<0.05). S, S/R, and ST/RR (n=155; 11 patients had splenectomy) with AUC of 0.729, 0.744, and 0.738, respectively, to differentiate patients with and without adverse outcome, correlated significantly with MELD with AUC of 0.714 (rho was 0.52, 0.53, and 0.53, respectively; p<0.001). S, L, C, L/T, C/T, S/T, S/L, S/R, ST/L2, ST/RR were potential predictors of adverse outcome in unadjusted univariate logistic model (p<0.05). In final adjusted model, ST/RR showed superior predictive value (OR=1.56; p=0.041) over MELD (OR=1.10; p=0.003).

**CONCLUSION**

Liver and spleen volumetric parameters could predict liver dysfunction in PSC. Using the volumes of T, R, and S could potentially improve the predictive value of MELD.

**CLINICAL RELEVANCE/APPLICATION**

MELD may fluctuate in patients with PSC due to recurrent cholangitis episodes. Increased MELD may result in un-necessary transplant workup, since it could be transient. Liver and spleen volumetry are less susceptible to transient fluctuations and may be better predictors for the need for liver transplantation.

**SSE07-03 Balanced Steady-State Free Precession MRCP is a Robust Alternative to Respiration-Navigated 3D Turbo-Spin-Echo MRCP**

Monday, Dec. 2 3:20PM - 3:30PM Room: S404CD

**Participants**

Felix C. Hasse, Heidelberg, Germany (*Presenter*) Nothing to Disclose  
Buket Selmi-Ozer, Heidelberg, Germany (*Abstract Co-Author*) Nothing to Disclose  
Hamed Albusaidi, Heidelberg, Germany (*Abstract Co-Author*) Nothing to Disclose  
Christian Rupp, Heidelberg, Germany (*Abstract Co-Author*) Nothing to Disclose  
Hans-Ulrich Kauczor, MD, Heidelberg, Germany (*Abstract Co-Author*) Nothing to Disclose  
Tim Weber, MD, Heidelberg, Germany (*Abstract Co-Author*) Nothing to Disclose

**PURPOSE**

Despite synchronization to respiration, respiration-navigated (RN) 3D turbo-spin-echo MRCP is limited by susceptibility to motion artifacts. Aim of this study was to assess the quality of pancreaticobiliary duct visualization of a non-RN MRCP alternative based on balanced steady-state free precession imaging (BSSFP) with overlapping slices compared with RN-MRCP.

**METHOD AND MATERIALS**

This is a prospective study on 50 consecutive patients receiving MRCP at 1.5T without final diagnosis of pancreaticobiliary duct disease. We performed an intraindividual comparison of coronal RN-MRCP (thickness, 1.5 mm; interval, 1.5 mm) with combined coronal (thickness, 4 mm; interval, 1.6 mm) and transverse (thickness, 6 mm, interval, 2.4 mm) BSSFP-MRCP. Image quality was scored by 3 readers for 6 pancreaticobiliary duct segments (3 pancreatic, 3 biliary) using a 6-point scale (1, not completely depicted, 6, entirely depicted with excellent details). A segment score of 3 or lower as assessed by at least 2 of 3 readers was defined to indicate insufficient segment visualization. Wilcoxon nonparametric tests and assessment of interrater agreement were used for statistical analysis.

**RESULTS**

Overall duct visualization averaged over all readers was scored with 4.5±1.1 for RN-MRCP (pancreatic, 4.1±0.5; biliary, 5.0±0.4) and 4.9±0.9 for combined coronal and transverse BSSFP-MRCP (pancreatic, 4.6±0.6; biliary, 5.1±0.6), respectively (p<0.001). The number of segments visualized insufficiently was 48/300 for RN-MRCP and 11/300 for BSSFP-MRCP (p<0.001). Segments visualized insufficiently in RN-MRCP had a mean score of 4.4±0.8 in BSSFP-MRCP. The segment most frequently visualized insufficiently was the pancreatic tail for both RN-MRCP and BSSFP-MRCP. Overall interrater agreement on sufficiency of duct visualization was 0.78 (RN-MRCP, 0.85; BSSFP-MRCP, 0.71). Mean acquisition time was 98% longer for RN-MRCP (198.0±98.7s) than for combined coronal and transverse BSSFP-MRCP (100.2±0.4s).

**CONCLUSION**

Non-RN BSSFP-MRCP with overlapping slices is a fast alternative to RN-MRCP frequently providing sufficient duct visualization when

RN-MRCP fails.

#### CLINICAL RELEVANCE/APPLICATION

As an option for patients with poor breathing compliance, pancreaticobiliary duct visualization can be improved with BSSFP-MRCP in 51% of the acquisition time of RN-MRCP.

#### SSE07-04 MRI in Primary Sclerosing Cholangitis: Retrospective Review in Understanding the Evolution and Related Complications

Monday, Dec. 2 3:30PM - 3:40PM Room: S404CD

##### Participants

Anirudh V. Nair, MBBS, Ottawa, ON (*Presenter*) Nothing to Disclose

Blair MacDonald, Ottawa, ON (*Abstract Co-Author*) Nothing to Disclose

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#### PURPOSE

To study the incidence of PSC precipitated malignancy. To study the spectrum of MR imaging features in patients with primary sclerosing cholangitis and the incidence of related complications.

#### METHOD AND MATERIALS

Retrospective analysis of 350 patients with known PSC in whom routine and targeted screening with MRI liver done in our institution in the past 15 years was included in the study. Two abdominal radiologist retrospectively reviewed MR images in consensus. Imaging findings on bile ducts, dominant strictures, pattern of involvement of intra/extra hepatic bile ducts, hepatic fibrosis, changes in liver morphology, varices, gall bladder abnormalities, cholangitis was studied. The incidence of PSC precipitated malignancies was ascertained.

#### RESULTS

The incidence of dominant stricture was 11.4% (40 cases), in whom the biopsy did not reveal any underlying malignancy. Incidence of overlap syndrome was 0.8 %, while there was background cirrhosis in 8.5% ;hepatic parenchymal fibrosis in 4.2% cases; large varices in 2.8% ; and there was associated infective exacerbation due to cholangitis in 2.2% of cases. The incidence of cholangiocarcinoma was 1.4% (5 cases), non-hodgkins lymphoma was 0.8% (3 cases), gall bladder carcinoma in 0.2% (1 case). The frequency of screening and resource allocation in performing a follow up MRI had an average interval period of 14 months.

#### CONCLUSION

Understanding spectrum of imaging findings and related complications is important for progressing further clinical management in cases related to PSC. Although there is no sufficient guidelines recommending the time interval of MRI liver follow up that is required, an annual follow up irrespective of clinical or biochemical worsening is useful in ascertaining the temporal evolution of the disease.

#### CLINICAL RELEVANCE/APPLICATION

(dealing with PSC) ' MRI liver with MRCP is an excellent tool to depict the temporal evolution of PSC and related complications "

#### SSE07-05 Prediction of Tumor Recurrence and Poor Survival after Surgery of Ampullary Adenocarcinoma Using Preoperative CT Imaging, Clinical, and Histopathological Findings

Monday, Dec. 2 3:40PM - 3:50PM Room: S404CD

##### Participants

Heera Yoen, MD, Seoul, Korea, Republic Of (*Presenter*) Nothing to Disclose

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Bo Yun Hur, Goyang, Korea, Republic Of (*Abstract Co-Author*) Nothing to Disclose

Su Joa Ahn, Seoul, Korea, Republic Of (*Abstract Co-Author*) Nothing to Disclose

Sun Kyung Jeon, MD, Seoul, Korea, Republic Of (*Abstract Co-Author*) Nothing to Disclose

Joon Koo Han, MD, Seoul, Korea, Republic Of (*Abstract Co-Author*) Nothing to Disclose

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

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#### PURPOSE

To predict tumor recurrence and poor survival in patients who underwent surgery for ampullary adenocarcinoma using preoperative CT imaging, clinical, and histopathological findings.

#### METHOD AND MATERIALS

In this retrospective study, 230 patients with ampullary adenocarcinoma who underwent preoperative CT and surgery were included. CT findings were assessed by two radiologists. Clinical characteristics and histopathological results such as CA19-9, CEA, T-, N-stage, histologic phenotypes; intestinal or non-intestinal (pancreatobiliary or mixed type), and resection status were investigated. Cox proportional hazard model and Kaplan-Meier method with log-rank test were used to find prognostic factors for recurrence free survival (RFS) and overall survival (OS). Also optimal cutoff value of tumor size was evaluated for oncologic outcomes and validated with internal cross validation

#### RESULTS

Median OS was 61.8 ± 37.4 and RFS was 54.3 ± 40.7 months. Tumor size on CT (odds ratio (OR) 1.045, 95% CI: 1.015-1.076, p=0.003), N-stage (OR 1.979, 95% CI: 1.271-3.081, p=0.003) and histologic differentiation (OR 2.437, 95% CI: 1.025-2.437 for

well-differentiated compared with moderate differentiation; OR 5.536, 95% CI 2.033-15.078 for moderate differentiation compared with poor differentiation,  $p < 0.05$ ) were important predictors of early recurrence. For poor survival, tumor size (OR 1.030, 95% CI: 1.001-1.061,  $p = 0.042$ ), papillary bulging (OR 0.633, 95% CI: 0.400-0.999,  $p = 0.05$ ), organ invasion (OR 1.855, 95% CI: 1.012-3.401,  $p = 0.046$ ) on CT scans, and N-stage (OR 2.808, 95% CI: 1.771-4.453,  $p < 0.001$ ) were important predictors of poor OS. Especially for tumor size, 2.65cm and 3.15cm were significant cutoff value for poor OS and RFS and it was validated internal cross validation ( $P < 0.001$ ). For tumor exceeding this cutoff value, median survival time were 22.5 months for OS and 8.4 months for RFS.

## CONCLUSION

Both preoperative CT findings and histopathological results are useful to predict oncologic outcomes. Especially preoperative CT findings including tumor size, papillary bulging, and organ invasion were important for prediction early recurrence and poor survival.

## CLINICAL RELEVANCE/APPLICATION

Combination of preoperative CT findings and histopathological results can be useful to predict patients' prognosis after surgery for ampullary adenocarcinoma. Especially for tumor size on CT, 2.65cm and 3.15cm were significant cutoff value for poor OS and RFS.

## SSE07-06 CT Findings and Outcomes of Acute Cholecystitis: Is Additional Imaging Necessary?

Monday, Dec. 2 3:50PM - 4:00PM Room: S404CD

### Participants

Daniel Lee, MD, Philadelphia, PA (*Presenter*) Nothing to Disclose

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## PURPOSE

To evaluate the positive predictive value of CT for diagnosing acute cholecystitis when used as a first line imaging evaluation for working up abdominal pain and to assess if additional imaging with ultrasound studies add value to the diagnosis.

## METHOD AND MATERIALS

CT imaging studies were evaluated in a retrospective study within a large US health system, which combines multiple academic centers with community centers. Final CT reports over a 25-month period were queried for abnormal gallbladder findings. Other relevant modalities performed within 24 hours of the initial CT were also included. Cases were tracked by chart review, and the clinical outcomes in each case were compiled to establish a final outcome or diagnosis. Surgical pathology or abnormal fluid aspirate analyses were treated as positive. Cases were stratified by the radiologist confidence level of each CT, and the positive and negative predictive values (PPVs and NPVs) were compared between different combinations of each modality.

## RESULTS

Of the 468 CT imaging studies meeting criteria, 192 were read as probable or highly probable for acute cholecystitis on CT. The PPV for acute cholecystitis was 48% when no ultrasound was performed, compared to 57% when ultrasound was performed, which amounted to an insignificant gain ( $P = 0.1936$ ). When subdivided into confidence levels, high confidence positive CTs demonstrated no significant change without ultrasound (67%) compared to ultrasound (65% in 'highly probable' impressions, 71% in 'probable' impressions). CT reads lower than 'highly probable' demonstrated potential gain from ultrasound; in the case of a 'probable' CT impression, PPV increased from 39% without ultrasound to 70% in the setting of a 'highly probable' ultrasound impression. In CT impressions negative for acute cholecystitis, there was no significant additive negative predictive value to ultrasound.

## CONCLUSION

Based on current clinical practices within a large health system, CT examinations with either high or low suspicion for acute cholecystitis demonstrated no significant diagnostic gain from additional imaging with ultrasound. However, additional imaging may be of benefit when CT interpretations are less definitive but still suspicious for acute cholecystitis.

## CLINICAL RELEVANCE/APPLICATION

This study identifies subclasses of CT interpretations regarding acute cholecystitis that would predict no additional diagnostic benefit from ultrasound imaging.

Printed on: 10/29/20



SSE08

## Gastrointestinal (Esophagus and Stomach)

Monday, Dec. 2 3:00PM - 4:00PM Room: S404AB

CT GI

AMA PRA Category 1 Credit™: 1.00  
ARRT Category A+ Credit: 1.00

FDA Discussions may include off-label uses.

### Participants

Erik Soloff, MD, Seattle, WA (*Moderator*) Research Grant, General Electric Company  
David J. Disantis, MD, Jacksonville, FL (*Moderator*) Nothing to Disclose

### Sub-Events

#### SSE08-01 Radiogenomics for Epigenomic Data: Estimated Serum MicroRNA-1246 From Contrast-Enhanced CT Can Predict Prognosis of Esophageal Squamous-Cell Carcinoma

Monday, Dec. 2 3:00PM - 3:10PM Room: S404AB

### Participants

Hajime Yokota, MD, Chiba, Japan (*Presenter*) Nothing to Disclose  
Isamu Hoshino, Chiba, Japan (*Abstract Co-Author*) Nothing to Disclose  
Yosuke Iwadate, Chiba, Japan (*Abstract Co-Author*) Nothing to Disclose  
Takashi Uno, Chiba, Japan (*Abstract Co-Author*) Nothing to Disclose

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### PURPOSE

Radiogenomics is a new field that provides clinically useful predictions of prognosis by linking the molecular characteristics such as genetic aberrations of malignant tumors with medical images. On the other hand, abnormal expression of serum microRNA has been reported as a prognostic factor of malignant and is thought to be a new biomarker. Using the technique of radiogenomics, we attempted to infer the degree of expression of microRNA in the serum of esophageal squamous-cell carcinoma (ESCC) patients.

### METHOD AND MATERIALS

Serum miR-1246 expressions in 92 ESCC patients were evaluated by qRT-PCR. A radiologist delineated the volume of interest (VOI) within each tumor region on contrast-enhanced CT images. Using morphology, histogram and texture analyses, 45 imaging features (IF) in the VOIs were extracted. Features were selected according to correlation analysis between miR-1246 and each IF. A prediction model for miR-1246 was constructed using linear regression of selected feature with 10-fold cross-validation. A threshold of miR-1246 dividing into high and low expression groups was defined with ROC analysis. Survival analyses were performed using the log-rank test and Cox regression.

### RESULTS

SHAPE\_Compacity and NGLDM\_Coarseness were selected as IF correlated with the expression of miR-1246 (real\_miR-1246) ( $r = 0.29$  and  $0.30$ ;  $p = 0.004$  and  $0.003$ ) and were used to construct a prediction model. When applying the calculated threshold of Real\_miR-1246 (=15.0) for the estimated miR-1246 expression (est\_miR-1246), there was a significant difference between high and low expression groups ( $p=0.003$ ) as well as real\_miR-1246 ( $p=0.001$ ). Real\_miR-1246 was an independent predictor for overall survival on the multivariate test, whereas est\_miR-1246 was also the same.

### CONCLUSION

The close relation between expression levels of miR-1246 and IF such as SHAPE\_Compacity and NGLDM\_Coarseness were observed. Est\_miR-1246 had similar power to predict prognosis of ESCC.

### CLINICAL RELEVANCE/APPLICATION

Radiogenomic can predict genomic/epigenomic data strongly related to prognosis with low cost. This approach might proceed to accomplish precision medicine.

#### SSE08-02 Esophageal Cancer: Dual-Energy Spectral CT Quantitative Parameters for Preoperative Diagnosis of Metastatic Lymph Nodes

Monday, Dec. 2 3:10PM - 3:20PM Room: S404AB

### Participants

Jian Zhou, Guangzhou, China (*Presenter*) Nothing to Disclose  
Shuiqing Zhou, Guangzhou, China (*Abstract Co-Author*) Nothing to Disclose  
Kongjia Luo, Guangzhou, China (*Abstract Co-Author*) Nothing to Disclose  
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Jietian Jin, Guangzhou, China (*Abstract Co-Author*) Nothing to Disclose

Lizhi Liu, Guangzhou, China (*Abstract Co-Author*) Nothing to Disclose  
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**PURPOSE**

To evaluate the diagnostic performance of quantitative parameters derived from dual-energy CT for the preoperative diagnosis of metastatic lymph nodes in participants with esophageal cancer.

**METHOD AND MATERIALS**

For this prospective study, dual-phase contrast agent-enhanced CT was performed in participants with esophageal cancer from June 2016 to May 2018. Quantitative dual-energy CT parameters were compared between metastatic and non-metastatic lymph nodes. The optimal cutoff value of metastatic node was determined using the receiver operating characteristic (ROC) curve analysis.

**RESULTS**

This study included 99 participants. A total of 51 lymph nodes were diagnosed as metastatic lymph nodes, and 45 lymph nodes were diagnosed as non-metastatic lymph nodes. Quantitative dual-energy CT parameters including iodine concentration (IC), normalized iodine concentration (ICN), slope of the spectral Hounsfield unit curve ( $\lambda$ Hu), normalized slope of the spectral Hounsfield unit curve ( $\lambda$ Hu-N) measured at venous phase were higher in metastatic than in non-metastatic lymph nodes ( $P < 0.01$ ). The combined diagnosis was the best predictor of metastatic lymph nodes, with a threshold of 0.558, thus demonstrating 88.2% sensitivity, 93.2% specificity, and 90.5% accuracy ( $P < 0.001$ ), with the area under ROC curve of 0.943.

**CONCLUSION**

Dual-energy CT is a complementary means for the preoperative identification of lymph nodes metastases in participants with esophageal cancer.

**CLINICAL RELEVANCE/APPLICATION**

Dual-energy CT could be used for the preoperative identification of lymph nodes metastases in participants with esophageal cancer.

**SSE08-03 Real-Time MRI for Assessment of Gastroesophageal Reflux Disease: Comparison to pH-Metry and Impedance**

Monday, Dec. 2 3:20PM - 3:30PM Room: S404AB

Participants

Lorenz Biggemann, Goettingen, Germany (*Presenter*) Nothing to Disclose  
Johannes Uhlig, Goettingen, Germany (*Abstract Co-Author*) Nothing to Disclose  
Ulrike Streit, MD, Goettingen, Germany (*Abstract Co-Author*) Nothing to Disclose  
Dirk Voit, Goettingen, Germany (*Abstract Co-Author*) Research collaboration, Siemens AG  
Martin Uecker, Goettingen, Germany (*Abstract Co-Author*) Research collaboration, Siemens AG  
Jens Frahm, PhD, Goettingen, Germany (*Abstract Co-Author*) Inventor, Real-Time MRI Method  
Joachim Lotz, MD, Goettingen, Germany (*Abstract Co-Author*) Nothing to Disclose  
Ali Seif Amir Hosseini, MD, Goettingen, Germany (*Abstract Co-Author*) Nothing to Disclose

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**PURPOSE**

To evaluate the diagnostic potential of real-time MRI for assessment of gastroesophageal reflux disease in patients with GERD-like symptoms compared to pH-metry and impedance.

**METHOD AND MATERIALS**

Patients who underwent real-time MRI and pH-metry between 2015–2018 were included in this study. Real-time MRI at 3 Tesla was achieved by highly undersampled radial FLASH acquisitions with iterative image reconstruction by regularized nonlinear inversion. Real-time MRI visualized transit of pineapple juice through the gastroesophageal junction at rest and during Valsalva maneuver. MRI results were compared to 24-hour pH-metry to assess acid reflux (following Lyon Consensus guidelines), as well as to impedance to assess non-acid reflux. A standard 2x2 table was chosen to calculate diagnostic performance measures.

**RESULTS**

Of 93 eligible patients, 91 patients with GERD-like symptoms fulfilled inclusion criteria (male n=49; female n= 42; median age 55y). One patient was excluded due to pH-metry probe defect and one due to diagnosis of achalasia on real-time MRI. All MRI studies were successfully completed without adverse events at a median examination time of 15 minutes. Using real-time MRI, reflux was detected in 60 patients (66%). pH-metry revealed reflux in 41 patients (45%), and impedance in 54 patients (59%). Compared to pH-metry as reference, real-time MRI demonstrated sensitivity 0.82 (0.67, 0.93), specificity 0.47 (0.33, 0.62) and PPV 0.55 (0.42, 0.68). Due to the high number of false positive readings in this setting, a second scenario with assessment of acid as well as non-acid reflux was considered. Here, the reference standard was either positive reflux on pH-metry (indicating acid reflux) or a high number of reflux episodes during impedance (indicating non-acid reflux). In this scenario, real-time MRI sensitivity was 0.78 (0.66, 0.87), specificity 0.67 (0.45, 0.84) and PPV 0.87 (0.75, 0.94).

**CONCLUSION**

Real-time MRI is a fast and safe imaging method for assessment of gastroesophageal reflux in patients with GERD-like symptoms. Considering its high positive predictive value, real-time MRI can accurately identify patients in which further invasive testing with pH-metry and impedance might be considered.

## CLINICAL RELEVANCE/APPLICATION

Real-time MRI is a novel imaging technique that allows for assessment of reflux in patients with GERD-like symptoms, showing a good correlation with established pH-metry and impedance measurement.

## SSE08-04 Stratification of Gastrointestinal Stromal Tumors: Evaluation of Data Mining and Radiomics Features

Monday, Dec. 2 3:30PM - 3:40PM Room: S404AB

### Participants

Isabella Martini, Rome, Italy (*Abstract Co-Author*) Nothing to Disclose  
Marco Rengo, MD, Rome, Italy (*Abstract Co-Author*) Nothing to Disclose  
Stefano Badia, Latina, Italy (*Abstract Co-Author*) Nothing to Disclose  
Simona Picchia, MD, Lazio, Italy (*Abstract Co-Author*) Nothing to Disclose  
Elsa Iannicelli, MD, Rome, Italy (*Abstract Co-Author*) Nothing to Disclose  
Andrea Laghi, MD, Rome, Italy (*Abstract Co-Author*) Speaker, General Electric Company; Speaker, Guerbet SA; Speaker, Bayer AG; Speaker, Bracco Group; Speaker, Merck & Co, Inc  
Federica Landolfi, MD, Rome, Italy (*Presenter*) Nothing to Disclose

### PURPOSE

To develop and validate a decision tree model, based on texture features extracted from contrast enhanced multi detector computed tomography (MDCT), to discriminate between high and low risk gastrointestinal stromal tumors (GISTs) according to Miettinen's classification

### METHOD AND MATERIALS

A population of 53 patients with proven GIST and subjected to MDCT of the abdomen were selected. All patients underwent surgical resection and histopathology was the gold standard. 30 texture features were extracted from MDCT images and 8 morphological features were identified by two expert radiologists. The population was split in two cohorts, one for training (32 patients) and one for validation (21 patients) of a random forest (RF) classifier. The training model was obtained after 100 iterations. All patients were stratified as higher risk (Miettinen's class moderate and high risk) or lower risk (Miettinen's class no risk, very low risk and low risk).

### RESULTS

The model based on RF classifier algorithm correctly classified 16 (80%) patients (validation cohort) with a mean absolute error of 0.34%. The AUC for the identification of higher risk patients was 0.845 while for lower risk was 0.815. True positive rate was 80% while false positive rate was 20% for both classes (Higher and lower risk).

### CONCLUSION

The RF model developed using texture and morphological features, obtained from MDCT images, provided a high accuracy (80%) for the identification of higher and lower risk patients according to Miettinen's classification. This approach can be considered as a potential tool for the non invasive staging of GISTs.

## CLINICAL RELEVANCE/APPLICATION

Texture analysis and morphological computed tomography features can be considered as a potential tools for the non invasive staging of GISTs

## SSE08-05 Noninvasive Evaluation of Esophageal Varices with Spleen Hemodynamics in Cirrhotic Patients: A Dual-Energy CT Study

Monday, Dec. 2 3:40PM - 3:50PM Room: S404AB

### Participants

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### PURPOSE

To evaluate noninvasively the degree of esophageal varices in cirrhotic portal hypertension patients with spleen hemodynamic parameters obtained using dual energy CT.

### METHOD AND MATERIALS

Fifty patients with portal hypertension due to cirrhosis were retrospectively selected. These patients all had esophageal varices (EV) confirmed by endoscopy. Fifteen liver transplant donors were selected retrospectively as the control group. All patients underwent contrast-enhanced dual energy CT (DECT) scans. The iodine content in spleen (IC-S) in the portal venous phase, the splenic volume (Vol-S), and the diameters of splenic vein (D-SV) were obtained by two experienced radiologists on a DECT post-processing workstation and the iodine volume of spleen (IV-S) was calculated using the following formula:  $IV-S = IC-S \times Vol-S$ . EV was classified into three groups according the results of endoscopy. The degree of Spearman correlation analysis was used to analyze the correlation between the EV degree and the above parameters. ANOVA was used to compare the differences of the above parameters among different EV groups. The ROC curve was used to analyze the diagnostic efficiency of the correlated parameters.  $P < 0.05$  was considered statistically significant.

### RESULTS

There were positive correlations between the EV degree and Vol-S, D-SV, and IV-S, with the correlation coefficient between EV degree and IV-S the highest ( $R=0.627$ ,  $P < 0.05$ ) among the three spectral CT parameters. The differences of the Vol-S, D-SV and

IV-S among different EV degree groups were statistically significant (all  $P < 0.05$ ). The ROC analysis showed that the area under the curve (AUC) with Vol-S, D-SV and IV-S were large. The diagnostic sensitivity and specificity were high using these parameters. The diagnostic specificity of using Vol-S was 96%.

## CONCLUSION

The parameters, Vol-S, D-SV and IV-S, obtained in DECT, could be used to evaluate the severity of EV noninvasively.

## CLINICAL RELEVANCE/APPLICATION

DECT parameters can be used to indicate the EV degree, predict the esophageal varices bleeding and learn the visceral hemodynamics.

## SSE08-06 Is Surveillance CT or Ultrasound Necessary for the Detection of Extragastric Recurrence After Curative Surgery for Early Gastric Carcinoma?

Monday, Dec. 2 3:50PM - 4:00PM Room: S404AB

### Participants

Jae Seok Bae, MD, Seoul, Korea, Republic Of (*Presenter*) Nothing to Disclose

Se Hyung Kim, MD, Seoul, Korea, Republic Of (*Abstract Co-Author*) Nothing to Disclose

Joon Koo Han, MD, Seoul, Korea, Republic Of (*Abstract Co-Author*) Nothing to Disclose

## PURPOSE

To evaluate the yield of follow-up abdomen CT and ultrasound (US) for the detection of extragastric recurrence after curative surgery for early gastric cancers (EGCs).

## METHOD AND MATERIALS

In this single-institutional retrospective study, we enrolled 407 patients who underwent radical surgery for EGCs between January and December 2010 and who underwent post-operative surveillance with CT, US, and/or gastroscopy. All patients were followed up until February 2019. The primary outcome was post-operative CT or US detection of extragastric recurrence (i.e., distant or lymph node metastasis) which was not discovered with endoscopy. The secondary outcome was CT and/or endoscopic detection of gastric recurrence.

## RESULTS

Mean and median follow-up periods were  $64.1 \pm 28.1$  months and 66.0 months (range, 0-106 months), respectively. From a total of 3808 post-operative CT (2351 examinations) and US (1457 examinations), extragastric recurrence was detected only in two patients, with an incidence of 0.5% (2/407). One patient had extragastric recurrence at duodenal stump which was detected on CT at 23 months after subtotal gastrectomy for EGC (pT1bN0, poorly differentiated). The other patient had liver metastasis which was detected on CT at 10 months after subtotal gastrectomy for EGC (pT1bN0, moderately differentiated). There was no gastric recurrence detected with post-operative CT or US examinations. From a total of 1901 post-operative endoscopic examinations, two gastric recurrences were detected. These two gastric recurrences were detected at 18 and 61 months after subtotal gastrectomy, respectively. One gastric recurrence developed remote to the anastomosis site and the other recurred tumor was detected around the anastomosis site. Both gastric recurred lesions showed identical histologic types to those of the initial tumors.

## CONCLUSION

Extragastric recurrence after curative surgery for EGC was very rare (0.5%, 2/407), but exclusively developed in patients with pT1b cancers. Therefore, post-operative surveillance with CT or US should be selectively performed in patients with a higher risk of recurrence.

## CLINICAL RELEVANCE/APPLICATION

Considering a radiation risk and cost-effectiveness, post-operative surveillance with CT or US in patients who received gastrectomy for EGCs should be selectively performed in patients with a higher risk of recurrence.

Printed on: 10/29/20



SSE09

## Gastrointestinal (Artificial Intelligence and Machine Learning)

Monday, Dec. 2 3:00PM - 4:00PM Room: N230B

AI CT GI

AMA PRA Category 1 Credit™: 1.00  
ARRT Category A+ Credit: 1.00

FDA Discussions may include off-label uses.

### Participants

Bhavik N. Patel, MD, Fremont, CA (*Moderator*) Speakers Bureau, General Electric Company; Research Grant, General Electric Company

Michael S. Gee, MD, PhD, Boston, MA (*Moderator*) Nothing to Disclose

### Sub-Events

#### SSE09-01 A Machine Learning Pipeline for Automatic Multi-Site-Vendor Quantitative MRI Analysis of the Liver

Monday, Dec. 2 3:00PM - 3:10PM Room: N230B

### Participants

Benjamin J. Irving, PhD, Oxford, United Kingdom (*Abstract Co-Author*) Employee, Perspectum Diagnostics Ltd  
Alexandre Triay Bagur, MSc, Oxford, United Kingdom (*Abstract Co-Author*) Employee, Perspectum Diagnostics Ltd ; Stockholder, Perspectum Diagnostics Ltd  
Darryl McClymont, PhD, Oxford, United Kingdom (*Abstract Co-Author*) Employee, Perspectum Diagnostics Ltd  
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Matt Kelly, PhD, Oxford, United Kingdom (*Abstract Co-Author*) Employee, Perspectum Diagnostics Ltd  
Michael Brady, Oxford, United Kingdom (*Presenter*) Founder and Chairman, Perspectum Diagnostics Ltd Founder and Chairman, Volpara Health Technologies Limited Founder, ScreenPoint Medical BV Chairman, Acuitas Medical Ltd Chairman, IRISS Medical Chairman, Colwiz

### PURPOSE

Quantitative MRI of the liver based on corrected T1, T2\* and PDFF enables characterisation of liver state by providing information about fibro-inflammation, iron, and liver fat. This is often difficult and time-consuming challenge to the Radiologist, not least because heterogeneous disease and artefacts such as motion and field inhomogeneities. With of non-alcoholic fatty liver disease, this is increasingly more important, and in order to achieve a high throughput we have developed a machine learning pipeline to generate and automatically analyse quantitative MRI scans of the liver.

### METHOD AND MATERIALS

We acquired 1347 MRI scans from 15 sites world-wide, including all major vendors at both 1.5T and 3T. All of the images were processed manually by trained clinical analysts who both performed manual delineation of the liver and selected regions of interest (ROIs) to quantify liver T1, T2\* and PDFF. Using these manually generated segmentation masks, we trained a U-Net based deep learning method to automatically delineate the liver. Regions that exhibited poor model fit and artefacts in the MRI image were automatically identified and excluded. Next, in order to mimic ROI analysis performed manually, the unsupervised mask-SLIC algorithm with a trained classifier was used to define and detect the best regions based on quality metrics. In each case, the automatically calculated T2\* value for the liver was used to produce an iron corrected T1 (cT1) map. Finally, a triaging step is used to identify low confidence cases for closer manual review.

### RESULTS

The manually-placed ROIs were compared to those placed automatically. The difference between manual and automatic was -0.02+/-4.8 ms (T2\*), 0.0+/-63 ms (cT1) and -0.1+/-1.9 % (PDFF). By automatically detecting poorer cases with triaging, the CI is reduced to -0.3+/-3.0 ms (T2\*), -5.8+/- 30.1 ms (cT1) and -0.2+/-1.1 % (PDFF). These results were similar to the inter-rater variability measured in a smaller trial (-0.6+/-2.12 ms (T2\*), 3.68+/-41.3 ms (cT1) and 0.48+/-1.77 % (PDFF)).

### CONCLUSION

The automatic processing pipeline (based on machine learning) yields results that compare closely to those generated by manual processing.

### CLINICAL RELEVANCE/APPLICATION

Automated analysis of quantitative maps has the potential to hugely increase the efficiency of evaluating challenging quantitative results, and to increase the viability of quantitative MRI analysis in standard clinical workflows.



## **SSE09-02 Development and Validation of a Deep Learning-Based Algorithm for Detecting Malignant Hepatic Lesions on Multi-Phase CT in Patients at High Risk for Hepatocellular Carcinoma**

Monday, Dec. 2 3:10PM - 3:20PM Room: N230B

### **Participants**

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Yoon Jin Lee, MD, Seongnam, Korea, Republic Of (*Abstract Co-Author*) Nothing to Disclose  
Namkug Kim, PhD, Seoul, Korea, Republic Of (*Abstract Co-Author*) Stockholder, Coreline Soft, Co Ltd; Stockholder, Anymedi, Inc

### **PURPOSE**

To develop and validate a deep-learning model for automatic detection of malignant hepatic lesions on multi-phase CT in patients at high risk for hepatocellular carcinoma (HCC).

### **METHOD AND MATERIALS**

In this retrospective study, 1350 multi-phase CT image series including pre-, arterial-, portal-, and delayed-phases in 1320 patients at high risk for HCC (1054 men and 296 women; mean age, 56.76 years; age range, 20-87 years) obtained between 2007 and 2016 were included. Focal hepatic lesions were labeled and annotated by five board-certified radiologists. Final diagnosis of focal hepatic lesions was confirmed either by pathologic results for suspicious malignant lesions or by follow-up imaging studies for benign lesions. The CT images were randomly split into a development set (761 CT series) and a validation set (589 CT series). The development set was further divided into 568 CT scans for training the deep learning based malignant hepatic lesion detection model and 193 CT scans for finding the operational parameter by using the jackknife alternative free-response receiver-operating characteristic (JAFROC) figure of merit (FOM) for per-lesion-based analysis. Diagnostic performances of the developed model were tested in the validation set as sensitivity and false positive (FP) rate per case.

### **RESULTS**

A total of 1348 focal hepatic lesions (462 benign lesions and 886 malignant nodules including 825 HCCs and 61 non-HCC malignancies) in the development set and 809 focal hepatic lesions (415 benign lesions and 394 malignant nodules including 377 HCCs and 17 non-HCC malignancies) in the validation set were labeled. The operational parameter was selected by the JAFROC FOM and applying less than 3 FPs criteria. The detection performance of malignant hepatic lesions was 89 % of sensitivity and 2.54 FP rate in the validation set.

### **CONCLUSION**

The deep learning-based system showed high diagnostic performance for detecting malignant hepatic lesions.

### **CLINICAL RELEVANCE/APPLICATION**

Deep-learning based detection system has potential to be a promising tool to help radiologists to accurately detect focal hepatic malignancies on multi-phase CT.

## **SSE09-03 Evaluating Appropriate Role of Artificial Intelligence in Preoperative Abdomen CT Assessment for Living Donor Liver Transplants (LDLT)**

Monday, Dec. 2 3:20PM - 3:30PM Room: N230B

### **Participants**

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### **PURPOSE**

In LDLT, assuring appropriate graft size via evaluation of liver and segmental volumes is a major predictor of safe, successful outcomes. The analysis comprises of two key steps: 1. Segmentation of liver and hepatic vascular structures, and 2. Liver Resection to calculate graft and remnant volumes. Here we aim to study preoperative LDLT assessment using 3 different approaches: A: Fully Manual (Hepatic anatomy is segmented by manual contouring followed by manual resection), B: AI with Manual Resection (Hepatic anatomy is automatically segmented using AI and a radiologist resects manually), and C: Fully Automated (Hepatic anatomy is automatically segmented and resected by AI with no radiologist intervention).

### **METHOD AND MATERIALS**

Our developed AI system comprised of 3 CNN models trained on 324 triphasic contrast-enhanced CTs and validated on 100 CTs from multiple institutions for liver and veins segmentation and middle hepatic vein (MHV) classification. For automated resection (C), we sample points from the MHV and IVC to draw a resection plane and return the graft and remnant volumes. 100 retrospective abdomen CT scans with preoperative analysis done were extracted from a large tertiary hospital. 6 studies were excluded due to incomplete information. On the remaining 94 CTs, the graft and remnant volumes were generated for A, B, and C. Intraoperative surgical weights were collected for comparison as ground truth.

## RESULTS

We measured the variance of graft volume for A, B, and C against intraoperative surgical weight. B has the least overall variance of 9.14%, followed by C (9.32%) and A (10.62%) on 94 cases. A close correlation (variance < 5%) with the weight was seen in 40 cases using C as compared to 39 cases using B and 32 cases using A. Fig 1 shows the boxplot of the variance of A, B, and C.

## CONCLUSION

Amongst the 3 approaches for LDLT analysis, AI with Manual Resection (B) and Fully Automated (C) give the best results, with B displaying the least overall variance.

## CLINICAL RELEVANCE/APPLICATION

While AI can automate routine mundane tasks such as hepatic structure segmentation, an AI system coupled with expert intervention is poised to deliver better outcomes in Liver Transplant Planning.

### SSE09-04 AI For Detecting Serrated Polyps in CT Colonography

Monday, Dec. 2 3:30PM - 3:40PM Room: N230B

#### Participants

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## PURPOSE

To evaluate the performance of AI in automated detection of serrated polyps in CT colonography (CTC).

## METHOD AND MATERIALS

A total of 101 CTC cases with biopsy-confirmed serrated polyps were collected from a prospectively acquired database of patients enrolled in a CTC screening program. The patients were prepared for the CTC examination with saline laxative and fecal tagging by 250 ml barium sulfate and 60 ml of iodine-based diatrizoate. The CTC data were acquired using a section collimation of 1.25 mm with 1-mm reconstruction interval, noise index of 50, 30-150 mA, and 120 kVp. Polyps were detected from the CTC datasets automatically by use of an AI algorithm that was designed to detect the contrast-coating phenomenon of serrated polyps in combination with a 3D-convolutional neural network. For pilot evaluation, the detection accuracy of the AI algorithm was evaluated by use of 10-fold per-patient cross validation.

## RESULTS

There were 144 serrated polyps  $\geq 6$  mm in size: 76 polyps were  $\geq 10$  mm and 68 polyps were 6-9 mm in size. Sixty-six (46%) of the polyps were flat lesions. Contrast coating was visible on 131 (91%) of the polyps. The average per-polyp detection sensitivity was  $93 \pm 7\%$  at  $0.8 \pm 1.8$  false-positive (FP) prompts per patient on average. The average per-patient sensitivity for polyps  $\geq 10$  mm (for polyps 6-9 mm) was  $94 \pm 9\%$  ( $96 \pm 7\%$ ) at  $0.1 \pm 0.2$  ( $0.6 \pm 1.9$ ) FPs per patient on average.

## CONCLUSION

The contrast coating of serrated polyps provides an effective biomarker for AI to detect serrated polyps at a high sensitivity in CTC.

## CLINICAL RELEVANCE/APPLICATION

Serrated polyps were recently discovered to represent a new pathway into colorectal cancers. Current CAdE systems have not been designed to detect serrated polyps.

### SSE09-05 Machine Learning-Based Ultrasonics Improved Diagnostic Performance in Differentiating Focal Nodular Hyperplasia and Atypical Hepatocellular Carcinoma

Monday, Dec. 2 3:40PM - 3:50PM Room: N230B

#### Participants

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## PURPOSE

To investigate whether machine learning-based ultrasonics of contrast enhanced ultrasound (CEUS) can improve the diagnostic performance in differentiation of focal nodular hyperplasia (FNH) and atypical hepatocellular carcinoma (aHCC).

## METHOD AND MATERIALS

A total of 226 focal liver lesions, including 107 aHCC and 119 FNH underwent CEUS, were reviewed retrospectively. For machine

learning-based ultrasonics, 3,132 features were extracted from images of baseline, arterial and portal phases respectively. An ultrasonics signature was generated by using the least absolute shrinkage and selection operator (LASSO) logistic regression model. Predictive model was developed using the support vector machine trained with following groups: (i) ultrasonics features, (ii) radiologist's score, (iii) combination of ultrasonics and radiologist's score. The area under the curve (AUC) of operating characteristic was used to explore their performances. The clinical usefulness was assessed by decision curve analysis (DCA).

## RESULTS

Fourteen ultrasonics features were selected to build an ultrasonics signature, and they presented good performance in the differentiation of FNH and aHCC with an AUC of 0.860, sensitivity of 76.6%, and specificity of 79.0%. The model trained with combination of ultrasonics and radiologist's score had a significantly higher AUC (0.927) than radiologist's score (AUC: 0.840,  $P < 0.001$ ). Adding an ultrasonics signature into radiologist's feature score significantly improves the accuracy of the model in differentiating FNH from aHCC. DCA demonstrated that the combination of ultrasonics and radiologist's score model had the highest net benefit compared with both the other models.

## CONCLUSION

The machine learning-based ultrasonics is as good as the staff radiologist in predicting the differential diagnosis of FNH and atypical HCC. Incorporating ultrasonics signature into radiologist's score improves the diagnostic performance in FNH and aHCC.

## CLINICAL RELEVANCE/APPLICATION

Adding an ultrasonics signature into radiologist's feature score can significantly improve the accuracy of the model in discrimination of FNH and aHCC.

## SSE09-06 Texture Analysis and Machine Learning for Quantification of Liver Fibrosis in MRI: Correlation with MR Elastography and Histopathology

Monday, Dec. 2 3:50PM - 4:00PM Room: N230B

### Participants

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## PURPOSE

To assess the diagnostic accuracy of texture analysis (TA) derived parameters of T1w in-phase (ip) and T2w fat-saturated (fs) images in comparison to MR elastography (MRE) for the diagnosis of liver fibrosis using a machine learning approach.

## METHOD AND MATERIALS

Routine liver MRIs including MR elastography (MRE) of 79 patients (mean age 48 years, range 18 - 71) with suspected or known chronic liver disease, performed between 2015 and 2018, were retrospectively analyzed. Two readers performed TA measurements using an open-source software (MaZda, v. 3.20). Gray-level normalization was performed with the TA software by rescaling the histogram data to fit within  $\mu$ -gray-level mean  $\pm$  3 standard deviations. The regions-of-interest were set manually on axial T1w ip and T2w fs images according to the MRE analysis by two independent readers. Histopathology of liver biopsy (n=78) or resection (n=1) served as reference standard. The patients were categorized into no or low grade fibrosis (0-2) and advanced fibrosis (3-4) groups. The data was split in a 2/3 ratio of model derivation and 1/3 ratio for validation. Machine learning based prediction of liver fibrosis was evaluated by calculating the AUC using a support vector machine (SVM) combined with previously implemented principal component analysis (PCA).

## RESULTS

For feature selection, TA features with an intraclass correlation coefficient  $< 0.8$  were excluded from further analysis. For further dimensional reduction PCA with two principal components was implemented. On axial T1w ip, a classification accuracy of 92% and 75% for fibrosis groups 0-2 and 3-4 was achieved, respectively, with K=10 folds using an SVM radial basis function (RBF) kernel. On axial T2w fs, a classification accuracy of 62% for both fibrosis groups (0-2 and 3-4) was achieved. The AUC for TA on T1w ip was similar to MRE (0.82 vs. 0.92,  $P=0.4066$ ), while the AUC for T2w fs was significantly lower compared to MRE (0.57,  $p=0.0075$ ).

## CONCLUSION

Liver fibrosis levels can be assessed with TA-derived parameters of T1w ip images using a TA and machine learning approach with similar accuracy compared to MRE.

## CLINICAL RELEVANCE/APPLICATION

T1w ip images, which are part of routine liver MRI, can serve as an alternative to assess liver fibrosis levels when MRE is not available.

Printed on: 10/29/20



SSE10

## Gastrointestinal (Small Bowel, Crohn Disease)

Monday, Dec. 2 3:00PM - 4:00PM Room: N229

GI

AMA PRA Category 1 Credit™: 1.00  
ARRT Category A+ Credit: 1.00

### Participants

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### Sub-Events

#### SSE10-01 Comparison of a Simplified MR Index of Activity With and Without Gadolinium for Assessing Luminal Disease and Therapeutic Response in Patients with Crohn's Disease

Monday, Dec. 2 3:00PM - 3:10PM Room: N229

### Participants

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### PURPOSE

Recent concerns on repeated use of gadolinium (Gd) increased the interest in determining if it could be avoided to assess inflammation in Crohn's disease (CD). The aim of this study is to compare the accuracy and the reliability of MRE for detecting activity and response to treatment using a simplified MRE index with and without Gd-enhanced sequences.

### METHOD AND MATERIALS

We prospectively included patients with CD that presented at least one intestinal segment with active and severe inflammation at endoscopy (segmental CDEIS >8.5 or presence of ulcers). The accuracy of the simplified MaRIA (sMaRIA) and its responsiveness was determined at baseline and after 46 weeks of treatment with biological drugs. Endoscopy (CDEIS) was considered the gold standard. The sMaRIA was read independently by two readers, at first using non-Gd-enhanced sequences (set 1: T2-w and DWI), and after 1 month of washout using the full set of images (set 2: T2-w, DWI and T1-Gd-enhanced images). An adjudicator solved differences between readers.

### RESULTS

Data from 50 patients at baseline were available and 270 intestinal segments were explored by both MRE and ileocolonoscopy. Of them, 39 patients had MRE and ileocolonoscopy at week 46. On a segment-by-segment analysis, at baseline, both sets 1 and 2 had similar sensitivity (86% vs. 89%;  $p=0.6$ ) and specificity for detecting activity (92% vs. 93%;  $p=0.6$ ) and similar sensitivity (87% vs. 85%;  $p=0.99$ ) and specificity (95% vs. 94%;  $p=0.5$ ) for detecting severe inflammation. Both sets were similarly accurate for detecting endoscopic ulcer healing (sMaRIA <2) after 46 weeks of treatment (85% vs. 91%  $p=0.45$ ). Intraclass-correlation between set 1 and set 2 were similar at baseline (0.82 vs. 0.85  $p=0.45$ ) and also after treatment (0.74 vs. 0.67  $p=0.13$ ). The correlation of magnitude of changes between CDEIS and sMaRIA was moderate and significant using both sets ( $r=0.73$  [95IC: 63-82];  $p<0.001$  for set 1; and  $r=0.69$  [95IC: 56-79];  $p<0.001$  for set 2).

### CONCLUSION

The sMaRIA can be applied without the use of gadolinium maintaining high accuracy and reliability for both detection and grading luminal inflammation and therapeutic response.

### CLINICAL RELEVANCE/APPLICATION

In patients with Crohn's disease MRE without the use of gadolinium may detect active luminal disease and changes after treatment maintaining high accuracy and reliability.

#### SSE10-02 Role of Supplementary Anal Imaging in Magnetic Resonance Enterography in Crohn's Patients Not Suspected to Have Perianal Fistula

Monday, Dec. 2 3:10PM - 3:20PM Room: N229

### Participants

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## PURPOSE

To prospectively evaluate the role of brief anal scan supplementary to magnetic resonance enterography (MRE) in Crohn's disease (CD) patients not suspected to have perianal fistula.

## METHOD AND MATERIALS

Between June 2012 and December 2017, we added a brief anal scan to MRE in 451 consecutive adults who were diagnosed with or suspected of CD and were not suspected to have perianal fistula. Images were examined for the presence of perianal tracts; if present, colorectal surgeons reexamined the patient. Patients were followed-up to determine if and when they underwent surgery for perianal fistula/abscess. The diagnostic yield of anal MR imaging for detecting perianal tracts, associated factors, and natural history of MR-detected asymptomatic perianal tracts were determined. Multivariable analysis was performed.

## RESULTS

A total of 440 CD patients (mean age $\pm$ SD, 29.6 $\pm$ 8.9 years; 345 men and 95 women) were analyzed. On anal MR, 12% (53 patients; 95% CI, 9.3-15.4%) showed perianal tracts. Reexamination by the surgeons was unremarkable and required no additional treatments in all patients. The tracts were mostly single unbranched (83%), inter-sphincteric (72%), and showing a linear dark signal at the tract margin (79%). Younger age at MRE, female sex, and higher CD activity index score were independently associated with detection of perianal tracts on anal MR. Presence of MR-detected asymptomatic tracts was an independent risk factor for future surgery for perianal fistula/abscess: 17.8% cumulative incidence at 37 months and an adjusted hazard ratio of 3.457 (95% CI, 1.103-10.836;  $P=0.033$ ).

## CONCLUSION

The diagnostic yield of supplementary anal MR was 12%. The MR-detected asymptomatic tracts did not require additional treatments, mostly showed findings of chronicity or healing, but were an independent risk factor for future anal surgery.

## CLINICAL RELEVANCE/APPLICATION

The supplementary anal MR may have a role in the early identification of CD patients who are at risk of perianal complications and may help direct more attention to their management.

## SSE10-03 A Novel Diffusion Kurtosis Imaging-Based Nomogram for Assessment of Bowel Fibrosis in Patients with Crohn's Disease

Monday, Dec. 2 3:20PM - 3:30PM Room: N229

### Participants

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## PURPOSE

To develop a prediction model based on magnetic resonance imaging (MRI) variables for individualized assessment of bowel fibrosis in patients with Crohn's disease (CD) using surgical histopathology as a reference standard.

## METHOD AND MATERIALS

Thirty-one consecutive patients (eighty-one bowel specimens) with CD undergoing conventional MRI and diffusion kurtosis imaging (DKI; b values, 0-2000 s/mm<sup>2</sup>) preoperatively were recruited as a test set. We observed T2-weighted signal intensity and enhancement pattern on conventional MRI, and measured the apparent diffusion coefficient (ADC) from monoexponential model, apparent diffusional kurtosis (Kapp), and apparent diffusion for non-Gaussian distribution (Dapp) from non-Gaussian DKI model. Histologic fibrosis was graded as non-to-mild and moderate-to-severe. Multivariate logistic regression analysis was performed to identify risk factors to be included into the nomogram to characterize the degree of bowel fibrosis. Its performance was validated on nine new patients (eighteen bowel specimens) with CD.

## RESULTS

Significant differences in Kapp ( $P<0.001$ ), Dapp ( $P<0.001$ ), and ADC ( $P<0.001$ ) were found between non-to-mildly and moderately-to-severely fibrotic bowel walls but not in T2WI signal intensity ( $P=0.210$ ) or enhancement pattern ( $P=0.748$ ). A strong correlation of histologic fibrosis scores with Kapp ( $r=0.604$ ,  $P<0.001$ ) was found, which was followed by Dapp ( $r=0.491$ ,  $P<0.001$ ) and ADC ( $r=-0.270$ ,  $P=0.015$ ). Independent factors derived from multivariate logistic regression analysis to assess degree of bowel fibrosis were Kapp, Dapp on DKI. Internal and external validation revealed good performance of the nomogram with concordance index of 0.901 (95% confidence interval 0.824-0.978) and 1.000, respectively, for differentiating non-to-mild from moderate-to-severe fibrosis. The calibration plot reveals a strong agreement between actual and predicted probability of bowel fibrosis.

## CONCLUSION

We developed and validated a DKI-based prediction model for the non-invasive assessment of bowel fibrosis in patients with CD. This tool is helpful for individualized treatment decision-making.

## CLINICAL RELEVANCE/APPLICATION

The DKI-based prediction model can noninvasively assess bowel fibrosis in patients with CD and is beneficial to individualized treatment decision-making.

#### **SSE10-04 Quantification of Crohn's Disease Activity Using Semiautomated Dual-Energy CT Enterography Derived Iodine Density: Correlation with Crohn's Disease Activity Index (CDAI)**

Monday, Dec. 2 3:30PM - 3:40PM Room: N229

##### **Participants**

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##### **PURPOSE**

To correlate iodine density derived from dual-energy CT enterography (DECTE) with clinical Crohn's disease (CD) activity.

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

Twenty patients with CD, imaged with DECTE from 2/2016-5/2018, and available CDAI determinations were retrospectively identified. Using prototype software, 8 manual contours spaced at 45 degree increments were drawn along the mucosa of the entire length of affected bowel segments on curved MPRs created from low kV data (80kV n=17, 90kV n=3). These were then superimposed on the corresponding 150kV data for iodine density calculation at each point along the contours. The software allows the determination of iodine density at specific points, the percentage of iodine density values in specified ranges (1-2mg I/mL, 2-3mg I/mL, etc) and average iodine density along the entire affected segment. Average iodine density across each entire segment was compared to CDAI values. Patient specific iodine density histograms showing percentage of iodine density values within the affected segment were created.

##### **RESULTS**

Sixteen patients had clinically active CD (CDAI>150); 4 patients had clinically inactive CD. 13/16 clinically active patients had the greatest percentage of elevated iodine density within the affected segment at least 2-3 mg I/mL with 2 patients in the 3-4 mg I/mL range (average iodine density 2.35±1.0mg/mL). Three clinically active patients had the highest percentage of iodine density only within the 1-2 mg I/mL range, indicating radiologically quiescent disease (average iodine density 1.43±0.49mg/mL, P=0.0016). Two clinically inactive patients had peak iodine density 2-3mg I/mL, indicating radiologically active disease (average iodine density 2.29±0.61mg/mL, compared with 1.84±1.44mg/mL for radiologically inactive disease P=0.18). The average iodine density of active and inactive appearing CD involved bowel were 2.34±0.36mg/mL and 1.60±0.30mg/mL, respectively (P=0.0006). Iodine density maps demonstrated heterogeneous involvement, discriminating between segments with similar average iodine density values. Median effective dose was 4.56±1.68 (2.03-8.12) mSv.

##### **CONCLUSION**

Iodine density from DECTE can be used as a biomarker of CD activity. The distribution of iodine density provides additional information about disease activity and complements clinical indices such as CDAI.

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

Average and regional iodine density from DECTE can be used as a biomarker of CD activity.

#### **SSE10-05 Evaluating the Inflammatory Activity in Crohn's Disease Using Magnetic Resonance Diffusion Kurtosis Imaging**

Monday, Dec. 2 3:40PM - 3:50PM Room: N229

##### **Participants**

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##### **PURPOSE**

To explore the feasibility of diffusion kurtosis imaging(DKI) for evaluating inflammatory activity in Crohn' s disease(CD).

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

In all, 51 CD patients were included, who were performed with consecutive enteroscopy, MR and DKI(b values = 0 - 2000 mm<sup>2</sup>/s). The lesions of bowel segments were graded as inactive(0-2), mild(3-6), and moderate-severe group(>6) based on simplified endoscopic activity score for Crohn's disease(SES-CD). To compare the ability of the parameters of DKI and DWI in grading different activity lesions.

##### **RESULTS**

127 bowel segments including inactive(15), mild(45) and moderate-severe(67) were analyzed. ADC( $r = -0.627$ ,  $P < 0.001$ ), Dapp( $r = -0.381$ ,  $P < 0.001$ ) and Kapp( $r = 0.641$ ,  $P < 0.001$ ) were correlated with SES-CD. These parameters were significantly different among the three groups(all  $P < 0.001$ ). ROC analysis found ADC had the highest accuracy(AUC = 0.884,  $P < 0.001$ ) to differentiate inactive from active group with the threshold at  $0.865 \times 10^{-3}$  mm<sup>2</sup>/s, which was slightly higher than Kapp(AUC = 0.867,  $P < 0.001$ ) with the threshold at 0.645, and was obviously higher than Dapp(AUC = 0.726,  $P = 0.005$ ). Similarly, ADC also had the highest accuracy(AUC = 0.846,  $P < 0.001$ ) to differentiate inactive-mild from moderate-severe group with the threshold at  $0.825 \times 10^{-3}$  mm<sup>2</sup>/s, and minimally higher than Kapp(AUC = 0.843,  $P < 0.001$ ) with the threshold at 0.695, and obviously higher than Dapp(AUC = 0.690,  $P < 0.001$ ).

## CONCLUSION

DKI is feasible and comparable to conventional DWI for the evaluation of inflammatory activity in CD.

## CLINICAL RELEVANCE/APPLICATION

DKI, as a method for non-invasive non-invasive assessment of free diffusion of water molecules, is not only applied to grade lesions activity about Crohn's disease, but able to provide more useful information about lesion. What's more, DKI, the same as DWI, can be an alternative to contrast-enhanced for pediatric patients or renal failure patients.

## SSE10-06 Interobserver Variation in the Interpretation of Enteric Ultrasound for Crohn's Disease

Monday, Dec. 2 3:50PM - 4:00PM Room: N229

### Participants

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## PURPOSE

Quantifying interobserver variability is an important part in evaluating medical imaging. To date there has been little research into interobserver variability in enteric ultrasound (US) across multiple observers

## METHOD AND MATERIALS

The study utilised patients recruited to a prospective trial comparing the diagnostic accuracy of MRE and US for CD (newly diagnosed or relapsing) across 8 hospitals. A construct reference standard (multidisciplinary panel diagnosis) was used in the trial, incorporating 6 months of patient follow up. 38 patients (11 new diagnosis, 27 relapse) from 2 recruitment sites underwent repeat US examinations on the same day performed by 2 practitioners from a pool of 7. Practitioners were blinded to each other's interpretation, patient's symptoms and previous disease history, and documented the presence and location of small bowel and colonic disease. Data was analysed separately for the new diagnosis and relapse cohorts. Interobserver variability was measured using percentage agreement with the consensus reference standard across the 2 reads, grouped as disease positive or negative. Prevalence adjusted bias adjusted kappa (PABAK) was also reported. Agreement between the radiologists irrespective of agreement with the reference standard was also calculated.

## RESULTS

In the new diagnosis cohort, the overall percentage agreement for small bowel disease presence against the consensus reference was 82% (52-95% (95%CI)) with a kappa coefficient ( $\kappa$ ) of 0.64, (substantial agreement). Agreement for colonic disease presence was 64%,  $\kappa$  of 0.27 (fair agreement). In the relapse cohort, agreement for small bowel disease presence was 81%,  $\kappa$  of 0.63 (substantial agreement). Agreement for colonic disease presence was 78%,  $\kappa$  of 0.56 (moderate agreement). Simple agreement between practitioners was higher when disregarding correspondence with the consensus reference, (84% and 87% for small bowel and colonic disease presence respectively).

## CONCLUSION

Based on data from a multi-reader, multicenter prospective trial, there is substantial agreement between practitioners for the presence of small disease against an independent standard of reference

## CLINICAL RELEVANCE/APPLICATION

Compared to an independent standard of reference there is substantial agreement between practitioners for the presence of small bowel disease on US, supporting wider dissemination.

Printed on: 10/29/20



SSE11

## Genitourinary (New Techniques in Pelvic Imaging)

Monday, Dec. 2 3:00PM - 4:00PM Room: S502AB

GU

AMA PRA Category 1 Credit™: 1.00  
ARRT Category A+ Credit: 1.00

### Participants

Harriet C. Thoeny, MD, Fribourg, Switzerland (*Moderator*) Nothing to Disclose  
Claudia P. Huertas, MD, Medellin, Colombia (*Moderator*) Nothing to Disclose

### Sub-Events

#### SSE11-01 CT Virtual Hysterosalpingography: Impact on Radiation Dose and Discomfort Regarding Physicians Experience in Performing the Study

Monday, Dec. 2 3:00PM - 3:10PM Room: S502AB

### Participants

Patricia M. Carrascosa, MD, Buenos Aires, Argentina (*Abstract Co-Author*) Research Consultant, General Electric Company  
Carlos Capunay, MD, Buenos Aires, Argentina (*Presenter*) Nothing to Disclose  
Jimena B. Carpio, MD, Buenos Aires, Argentina (*Abstract Co-Author*) Nothing to Disclose  
Mariano Baronio, Buenos Aires, Argentina (*Abstract Co-Author*) Nothing to Disclose

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### PURPOSE

CT-Virtual hysterosalpingography (CT-VHSG) is a good non-invasive method to evaluate the complete gynecologist system. It allows to detect intraluminal pathology in the cervix, uterus and fallopian tubes. The image acquisition lasts few seconds and it does not produce discomfort in the majority of the patients. The objective of this paper is to determine the importance of the physicians experience in performing CT-VHSG regarding radiation dose and discomfort.

### METHOD AND MATERIALS

A group of women with infertility were studied with 64,128 and 256 Multi-detector CT scanners. Technical parameters were slices 0.6 mm width, mAs: 100-200, kV: 80-120, scan length:10 cm. They were adapted according to patients size . Half of the patients were performed by a 4th year resident (Group A) and the other half by an experienced radiologist (> 10 years) (Group B). Different issues were evaluated: • Level of discomfort classified in 4 grades: no discomfort, mild, moderate or severe discomfort. • Total number of acquisitions to perform an accurate diagnosis. • Total radiation dose received by the patients. • Total duration time since the patient enters until she leaves the CT room • Patients containment during the procedure by the physician: they were asked to answer if they felt emotionally comprehended.

### RESULTS

Patients of Group A presented higher number of scans (2,6) to perform an adequate diagnosis giving more radiation dose to the patients ( 1,3 mSv). Eighty percent presented no or mild discomfort and only 65% replied that they felt a good containment during the procedure. Total time to perform the study: 28+/- 11 minutes Contrary patients from Group B ninety one percent had no or mild discomfort during the procedure. A mean of 1,3 acquisitions were performed per patient with a mean radiation dose of 0,52 mSv. Regarding containment during the study 92% considered being emotionally comprehended. Total time to perform the study 22+/- 6 minutes.

### CONCLUSION

It is important the physicians experience to perform the CT-VHSG Experienced radiologists performed a better tolerated study (no or mild discomfort in the majority of the patients), gave significant lower radiation dose and carried out a quicker study. Additionally and very important, patients answered in a higher percentage they felt emotional supported during the complete procedure.

### CLINICAL RELEVANCE/APPLICATION

CT-Virtual hysterosalpingography as a method to evaluate the gynecologist system.

#### SSE11-02 Combination Between the Retrograde Urethrogram and the Virtual Urethroscopy as Urethral Structure Screening Profile: An Inexpensive Imaging Diagnostic Tool Compared to the Urological Urethroscopy in the Evaluation of the Male Anterior Urethra

Monday, Dec. 2 3:10PM - 3:20PM Room: S502AB

### Participants

Ching Hsien Huang Liu, MD, Santo Domingo, Dominican Republic (*Presenter*) Nothing to Disclose  
Mario J. Hidalgo, MD, Santo Domingo, Dominican Republic (*Abstract Co-Author*) Nothing to Disclose

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## **PURPOSE**

To analyze the feasibility of the combination of the retrograde urethrogram and the virtual urethroscopy (urethral ultrasound) as urethral stricture screening profile due to their inexpensive cost compared to the urological urethroscopy, furthermore, in order to avoid the use of the invasive urethroscope as the initial diagnostic imaging tool.

## **METHOD AND MATERIALS**

A total of 21 patients were included. The correlation of the localization between two methods was carried out. We also analyzed the feasibility of the measurement about the spongiofibrosis's extension and the resulted stenosis percentage.

## **RESULTS**

9 of 21 patients presented findings of urethral stricture with a total of 10 strictures. Significant correlation was found between both modalities regarding the localization of the narrowing in the anterior urethra, there was a correlation in 100% of the cases of the anterior urethra stricture (95% confidence level,  $p < 0.05$ ). It was evidenced that 100% of the cases of the anterior urethra narrowing detected by conventional retrograde urethrogram, all showed spongiofibrosis with the realization of urethral ultrasound. We realized, that the measured diameter of the permeable portion of the affected lumen can be converted to the French catheter scale in order to avoid the use of the invasive urethroscope for the measurement.

## **CONCLUSION**

The urethral stricture screening profile is useful as the initial approach and follow-up for patients with diagnosis or suspicion of urethral stricture.

## **CLINICAL RELEVANCE/APPLICATION**

The urethral stricture screening profile is a minimally invasive and inexpensive tool compared to the invasive urethroscope as a diagnostic tool. That means, the conventional urethroscope as an invasive diagnostic tool, should not have any major diagnostic role in the anterior urethra narrowing until the patient makes the decision to accept any surgical intervention in order to evaluate the urethral mucosa.

## **SSE11-03 Clinical Role of Translabial Ultrasound in Midurethral Mesh Complications**

Monday, Dec. 2 3:20PM - 3:30PM Room: S502AB

### **Participants**

Pei-Shan Yang, MD, Toronto, ON (*Abstract Co-Author*) Nothing to Disclose  
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Sender Herschorn, MD, Toronto, ON (*Abstract Co-Author*) Nothing to Disclose  
Phyllis Glanc, MD, Toronto, ON (*Presenter*) Nothing to Disclose

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## **PURPOSE**

To determine if transperineal or translabial ultrasound assists in clinical management, surgical decision and planning in patients with midurethral sling complications.

## **METHOD AND MATERIALS**

This is a retrospective study enrolling consecutive patients who underwent midurethral sling insertion, presented to urology clinic for urologic symptoms, and received translabial ultrasound. The presenting symptoms, including pain, dysuria, dyspareunia, recurrent urinary tract infection, urinary frequency, urinary urgency and nocturia were documented. This descriptive data also includes the postoperative outcome (pain, incontinence), location of erosion in the operative finding to determine if translabial ultrasound assisted in clinical management, surgical decision and planning..

## **RESULTS**

48 patients were identified from 2010 - 2018 inclusive with midurethral sling complications. 26 patients had retropubic procedure, 14 patients had transobturator procedure, 2 patient had both and 6 patients were unable to recall their surgical history. More than half of our patients suffered from pain, recurrent urinary infection, urinary urgency, nocturia and urinary incontinence. 36 patients underwent surgery, 23 erosions were found at urethra(11), bladder(6) and vagina(6). 25 patients were pain-free after the surgery. In chart review, 25 ultrasound studies helped with surgical decision, furthermore 17 ultrasound studies were of assistance in identifying the location of the complication

## **CONCLUSION**

Translabial ultrasound is helpful in clinical and surgical planning in patients with midurethral sling related complications.

## **CLINICAL RELEVANCE/APPLICATION**

Translabial ultrasound is important to perform prior to clinical and surgical planning for patients with midurethral sling complications.

## **SSE11-04 Endometrial Total Choline Levels on 1H MR Spectroscopy Predict High-Risk Group for Nodal Metastasis and Reflect Underlying Tissue Choline Metabolism**

Monday, Dec. 2 3:30PM - 3:40PM Room: S502AB

### **Participants**

Gigin Lin, MD, Taoyuan, Taiwan (*Presenter*) Nothing to Disclose  
Shang-Yueh Tsai, Taipei, Taiwan (*Abstract Co-Author*) Nothing to Disclose  
Chiao-Yun Lin, Taoyuan, Taiwan (*Abstract Co-Author*) Nothing to Disclose

Ren-Chin Wu, Taoyuan, Taiwan (*Abstract Co-Author*) Nothing to Disclose  
Chyong-Huey Lai, Taoyuan, Taiwan (*Abstract Co-Author*) Nothing to Disclose

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#### **PURPOSE**

To investigate and characterize the values of endometrial total choline levels on 1H MR spectroscopy in predicting high-risk group for nodal metastasis, with tissue metabolomics and biochemistry corroboration.

#### **METHOD AND MATERIALS**

1H MR spectroscopy using external phase array coil was prospectively conducted in 353 consecutive endometrial cancer patients at 3 Tesla (T) to evaluate tumor choline levels in vivo ( $\delta$  3.2 ppm), according to their nodal metastasis status (n=10, 11, 236 in stage N2, N1, N0, respectively). Endometrial tumors were further analyzed (n=81) using a 600MHz high-resolution nuclear magnetic resonance (NMR) system to correlate the tissue levels of choline-related metabolites-free choline, phosphocholine (PC) and glycerophosphocholine (GPC). We corroborated the expression of a key enzyme in choline metabolism-endometrial carcinoma differential 3 (EDI3). Statistical methods included Mann-Whitney U test, Kruskal-Wallis H test, logistic regression and Pearson's correlation. A P value < 0.05 was considered a significant statistical difference.

#### **RESULTS**

Total choline levels were significantly higher in endometrial cancers with nodal metastasis (N2: 14.93 $\pm$ 6.23mM, N1: 6.20 $\pm$ 2.42mM, N0: 6.04 $\pm$ 0.60mM, mean  $\pm$  standard error of mean, P = .039), measured using in vivo MR spectroscopy. Elevated choline levels on MR spectroscopy significantly increased the risk of para-aortic lymph node metastasis (odds ratio 1.06; 95% confidence interval 0.99-1.13, P = .046). Changes of choline on MR spectroscopy significantly correlated with the tissue levels of GPC (r = 0.322 P = .002), but not PC (P = .588) nor free choline (P = .697). The key enzyme in choline metabolism EDI3 overexpressed in tumors from endometrial cancer with nodal metastasis (P = .040).

#### **CONCLUSION**

Increased endometrial total choline levels on 1H MR spectroscopy depicted high-risk cancer group for nodal metastasis, supported by increased tissue GPC levels and overexpression of EDI3.

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

MR spectroscopy using external phase array coil has potentials to add dimensions of clinical phenotyping to guide treatment and predicting nodal metastasis for women diagnosed with endometrial cancer.

#### **SSE11-05 Characterization of Brown Adipose Tissue in PCOS Patients by Z-Spectrum Imaging (ZSI)**

Monday, Dec. 2 3:40PM - 3:50PM Room: S502AB

#### **Participants**

Li Li, Wuhan, China (*Presenter*) Nothing to Disclose  
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Jicheng Fang, Wuhan, China (*Abstract Co-Author*) Nothing to Disclose  
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Kejia Cai, PhD, Chicago, IL (*Abstract Co-Author*) Nothing to Disclose

#### **PURPOSE**

Given that the majority of patients with polycystic ovary syndrome (PCOS) demonstrate obesity and chronic insulin resistance and targeting brown fat represents a novel treatment strategy for metabolic diseases, the purpose of the study is to characterize brown adipose tissue (BAT) in PCOS patients in comparison to healthy subjects using MR Z-spectral imaging (ZSI).

#### **METHOD AND MATERIALS**

ZSI data were collected on 19 normal control females (NCF, 24-34 years old), 17 males (NCM, 22-35years old), and 13 PCOS patients (female, 20-33 years old) with a CEST saturation pulse of 1  $\mu$ T, 200 ms long and fast spin echo readout. Z-spectral data were fitted with multiple Lorentzian curves to quantify the direct saturation of water and fat. Fat water fraction (FWF) maps were then computed based on the fitted amplitudes of water and fat direct saturation. FWF thresholds were prescribed for the differentiation and segmentation of white adipose tissue (WAT), BAT, or Muscle (Figure). At last, two parameters were extracted from the analysis: the average FWF value within the segmented BAT (FWF(BAT)) and the fraction of BAT over the total fat depot, defined as BATf=BATarea/ (BATarea+WATarea). The two parameters were compared among the 3 study groups and correlated to subjects' BMI.

#### **RESULTS**

FWF(BAT) correlated linearly with BMI in healthy subjects, whereas there was an inverse correlation between BATf and BMI (Figure). The PCOS group had higher FWF(BAT) than the NCF group (P<0.001), while the BATf of the PCOS group was smaller than the controls (P<0.001). The FWF(BAT) of the NCF group was found to be higher than the NCM group (P<0.05), while there was no significant difference between male and female in BATf (Figure).

#### **CONCLUSION**

Normal subjects with higher BMI show less BATf and have increased FWF(BAT), indicating relatively higher level of metabolic passive WAT depot and relatively reduced metabolism in their BAT depots. PCOS patients have the least BATf and the highest FWF(BAT), suggesting decreased BAT mass and function in PCOS.

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

MR Z-spectral imaging has been demonstrated to noninvasively identify and characterize BAT mass and function in PCOS patients,

providing insights on the comorbidities mechanism, diagnosis, and treatment of PCOS.

## **SSE11-06 Comparative Role of Retrograde Urethrography (RGU) and Sonourethrography (SUG) in Anterior Urethral Structures**

Monday, Dec. 2 3:50PM - 4:00PM Room: S502AB

### **Participants**

Neha Jain, MD, New Delhi, India (*Presenter*) Nothing to Disclose

Rajul Rastogi, MD, Greater Noida, India (*Abstract Co-Author*) Nothing to Disclose

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### **PURPOSE**

Sonourethrography (SUG) has starting earning clinical acceptance over Retrograde Urethrography (RGU) recently for evaluation of anterior urethral strictures. Conspicuous delineation of stricture as well as periurethral region is possible with SUG obviating radiation exposure. Urethral management primarily depends upon site & length of stricture, presence or absence of spongiofibrosis and distraction of urethral segments. Hence, this prospective pilot study aims for determining: • Comparative role of RGU & SUG in evaluation of anterior urethral strictures. • Comparative role of RGU & SUG in predicting management of anterior urethral strictures

### **METHOD AND MATERIALS**

Fifteen patients with suspected anterior urethral strictures referred to our department were evaluated by RGU after instilling optimal amounts of non-ionic contrast agent per urethram followed by filming at 45 degrees oblique position with the ipsilateral lower limb flexed at hip & knee joints and penis stretched parallel to leg. SUG was performed with a high-resolution, linear-array transducer through penile & transperineal technique after instillation of sterile gel per urethram followed by soft, penile tip clamp. Data related to site & length of stricture, presence or absence of spongiofibrosis and any other associated abnormality will be recorded in both RGU & SUG.

### **RESULTS**

SUG detected spongiofibrosis in addition to the accurate length of stricture required for management in 5 patients out of fifteen affecting the mode of management

### **CONCLUSION**

SUG is an accurate imaging tool in anterior urethral strictures that not only complements RGU but also affect the mode of management thus affecting the prognosis of the patient, hence should be a routine procedure in all patients with positive findings on RGU

### **CLINICAL RELEVANCE/APPLICATION**

Since SUG is an effective tool for evaluating anterior urethral strictures in males, it should be performed routinely prior to decision making for the mode of management thus reducing the morbidity associated with the disease

Printed on: 10/29/20



SSE12

## Genitourinary (Scrotum and Bladder)

Monday, Dec. 2 3:00PM - 4:00PM Room: S505AB

GU

AMA PRA Category 1 Credit™: 1.00  
ARRT Category A+ Credit: 1.00

FDA

Discussions may include off-label uses.

### Participants

Rosa Maria Alanis Salazar, MD, Guadalupe, Mexico (*Moderator*) Nothing to Disclose  
Sebastian Feuerlein, MD, Tampa, FL (*Moderator*) Nothing to Disclose

### Sub-Events

#### SSE12-01 Qualitative and Quantitative Multiparametric Ultrasound Evaluation of Focal Testicular Lesions

Monday, Dec. 2 3:00PM - 3:10PM Room: S505AB

### Participants

Dean Y. Huang, FRCR, London, United Kingdom (*Presenter*) Nothing to Disclose  
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Eleni Konstantatou, MD, MSc, Patras, Greece (*Abstract Co-Author*) Nothing to Disclose  
Filippo Pesapane, MD, Milan, Italy (*Abstract Co-Author*) Nothing to Disclose  
Nicholas Beckley-Hoelscher, London, United Kingdom (*Abstract Co-Author*) Nothing to Disclose  
Kirsten M. Christensen-Jeffries, PhD, London, United Kingdom (*Abstract Co-Author*) Nothing to Disclose  
Robert J. Eckersley, PhD, London, United Kingdom (*Abstract Co-Author*) Nothing to Disclose  
Maria E. Sellars, MD, FRCR, London, United Kingdom (*Abstract Co-Author*) Speaker, Bracco Group; Speaker, Samsung Electronics Co, Ltd  
Paul S. Sidhu, MRCP, FRCR, London, United Kingdom (*Abstract Co-Author*) Speaker, Koninklijke Philips NV; Speaker, Bracco Group; Speaker, Hitachi, Ltd; Speaker, Siemens AG; Speaker, Samsung Electronics Co, Ltd; Advisory Board, Samsung Electronics Co, Ltd; Advisory Board, Itreas Ltd

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### PURPOSE

To evaluate the diagnostic accuracy of multiparametric ultrasonography (MP-US), consisting of gray-scale US, color Doppler US (CDUS), strain elastography (SE), and contrast-enhanced US (CEUS) in the assessment of focal testicular lesions.

### METHOD AND MATERIALS

166 MP-US examinations for testicular focal lesions performed between 2009 and 2017 were analysed. SE was performed to assess tissue elasticity, and hard lesions were defined as malignant. CDUS and CEUS were performed to determine lesion vascularity. Avascular lesions were defined as benign. Qualitative and quantitative CEUS assessments with time-intensity curves analysis were performed for vascular lesions. Histopathologic results or follow-up of a minimum of 6 months served as reference standards. Sensitivity, specificity, and positive and negative predictive values, and accuracy of benign or malignant classification were calculated.

### RESULTS

Of the 166 MP-US examinations, 108 revealed benign (lesions size = 10.66 +/- 10.15 mm) and 58 malignant (lesion size = 23.82 +/- 14.01mm) diagnosis. Single-modality sensitivities, specificities, PPV, NPV and classification accuracies were 91.38%, 52.78%, 50.96%, 91.94%, and 66.27% for CDUS; 100%, 42.59%, 48.33% and 100% and 62.65% for CEUS; 86.96%, 35.90%, 44.44%, 82.35% and 54.84% for SE respectively. Used in combination, MP-US improved accuracy of classification to 70.16%. The feature of prolonged hyperenhancement on qualitative CEUS assessment is statistically significant ( $p = 0.012$ ) in differentiating seminoma and Leydig cell tumors (LCT), the two largest histological sub-types of benign and malignant vascular neoplasms. Quantitative CEUS analysis reveals a more rapid inflow rate for LCT when compared to seminoma ( $p = 0.002$ ).

### CONCLUSION

We demonstrated that used in combination, advanced US techniques improved accuracy of classification. In addition, the additional features of absence of prolonged enhancement and a more rapid inflow on qualitative and quantitative CEUS further differentiate between benign vascular LCT and malignant seminoma.

### CLINICAL RELEVANCE/APPLICATION

Multiparametric US improves accuracy of pre-operative classification of testicular lesions for avoiding unnecessary orchiectomies and for testis-sparing strategies to be implemented.

#### SSE12-02 The Value of Whole Tumors Volume-Based ADC Histogram Analysis for Differential Diagnosis in Testicular Germ Cell Tumors

#### Participants

Qianqian Chen, Zhengzhou, China (*Presenter*) Nothing to Disclose  
Zhang Yan, Zhengzhou, China (*Abstract Co-Author*) Nothing to Disclose  
Cheng Jingliang, Zhengzhou, China (*Abstract Co-Author*) Nothing to Disclose  
Bai Jie, Zhengzhou, China (*Abstract Co-Author*) Nothing to Disclose  
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#### PURPOSE

Germ cell tumors are the most common tumors in the testis, which are further divided into seminoma and nonseminogenic germ cell tumors, which are quite different in metastasis, treatment, and prognosis. seminoma is very sensitive to radiotherapy and chemotherapy, most prognosis is good. Nonseminogenic germ cell tumor is more invasive than seminoma, and which has poor response to radiotherapy. Purpose of this study to is explore the value of whole tumors apparent diffusion coefficient (ADC) gray histogram analysis or differential diagnosis in testicular germ cell tumors.

#### METHOD AND MATERIALS

The date of 43 patients pathologically confirmed of testicular germ cell tumors was analysis retrospectively. Among them, there were 22 cases of seminomas germ cell tumors, 21cases of nonseminomatous germ cell tumors(NSGCTs)(5 cases of mixed germ cell tumors, 6 cases of Embryonal carcinoma, 2 cases of Yolk sac tumors, 8 cases of Mature teratoma). Retrospectively draw the region of interest(ROI)in the ADC maps of two groups on each layer of tumor level by using Mazda software and analyze the gray histogram, including mean, variane, kurtosis, skewness, pere.01%, pere.10%, pere.50%, pere.90%, pere.99%. The statistical analysis was performed on the histogram parameters to find out the different characteristics between the two groups, and the ROC curve was drawn to evaluate its diagnostic efficacy for two groups tumors.

#### RESULTS

Through histogram analysis of 9 parameters, these 7 parameters were statistically significant (all  $p < 0.05$ ), including mean, variane, kurtosis, pere.10%, pere.50%, pere.90%, pere.99%.The largest AUC of the ROC curve to differentiate two groups was pere.10%, the AUC was 0.866, the sensitivity was 81.0%, the specificity was 90.9%.

#### CONCLUSION

The ADC gray histogram analysis based whole tumors is helpful for the diagnosis to preoperatively differentiate seminomas from NSGCTs.

#### CLINICAL RELEVANCE/APPLICATION

MRI features has become the primary method for preoperative diagnosis of testicular germ cell tumors. However, testicular seminoma is similar to nonseminogenic germ cell tumor in MRI manifestations. For example, the age of onset, tumor capsules, the characteristics of uniform signal and uneven enhancement. The global histogram analysis can reflect the overall data of each layer of the lesion ROI, which can better reduce the sampling error caused by delineating the local global ROI, which may be more reliable and accurate.

#### SSE12-03 Value of Dixon-MRI in the Localization of Non Palpable Undescended Testes with Laparoscopic Correlation - A Preliminary Study

Monday, Dec. 2 3:20PM - 3:30PM Room: S505AB

#### Participants

Mohamed S. Shaaban, Alexandria, Egypt (*Presenter*) Nothing to Disclose  
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Baher S. Louka, Alexandria, Egypt (*Abstract Co-Author*) Nothing to Disclose  
Shadia Abo Seif, Alexandria, Egypt (*Abstract Co-Author*) Nothing to Disclose

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#### PURPOSE

To study the potential value of Dixon MRI in localization of the non-palpable undescended testes and correlation with the laparoscopy

#### METHOD AND MATERIALS

This is a prospective study conducted upon patients with non-palpable undescended testes referred to the MRI unit to localize the undescended testes in the period between August 2018 and April 2019. Each patient was subjected to 3T MRI examination including conventional sequences of T1 TSE, T2 TSE, STIR, and DWI, in addition to T2 DIXON sequence with generated in-phase/out-of-phase, fat only, and water only images. Images were reviewed by two independent radiologists for the location of the undescended testes in Dixon images and conventional MRI each separated. Laparoscopic exploration was done for all patients to determine the site of the testes.

#### RESULTS

The current study was conducted upon 15 patients. Ages ranged from 2 months to 26 years. Eight patients had clinically non-palpable testes on the left side (47.1%), 6 had non-palpable testes on the right side (35.3%), and 3 patients had non palpable testes bilaterally (17.6%), giving a total of 20 non-palpable undescended testes. Laparoscopy could not localized 4 testes (20%), while 5 testes were found in the pelvis (25%), 5 testes were found in the right inguinal region (25%), 4 testes were found in the left inguinal region (20%) and 2 ectopic testes in the scrotal neck (10%). Conventional MRI was able to correctly localize 11 testes (55%) but failed to localize 9 (45%). The located testes were 4 in the left inguinal region (20%), 4 in the right inguinal region

(20%), 2 in the left scrotal neck (10%), and one intra-pelvic testis (5.0%). On Dixon technique using water-only and fat-only images; 4 were not detected (20%), the located testes were 5 intra-pelvic (25.0%), 5 right inguinal (25%), 4 left inguinal (20.0%), and 2 in the scrotal neck (10%). Using laparoscopy as gold-standard, conventional MRI had a sensitivity of 68.7%, Specificity of 100%, NPV of 44.4%, PPV 100%, and accuracy of 75%. On the other hand, Dixon technique scored 100% in its sensitivity, specificity, NPV, PPV, and accuracy.

## CONCLUSION

Dixon technique is a promising tool for more accurate localization of the non-palpable undescended testes compared to the conventional MRI

## CLINICAL RELEVANCE/APPLICATION

Dixon technique offers potential increase in the accuracy of MRI in the localization of undescended testes

### SSE12-04 Implementation of mpMRI and VI-RADS for High-Risk Non-Muscle Invasive Bladder Cancer (NMIBC) Candidate for Secondary Trans-Urethral Resection (Re-TURBT): Preliminary Results from a Prospective Single-Center Experience

Monday, Dec. 2 3:30PM - 3:40PM Room: S505AB

#### Participants

Martina Pecoraro, MD, Roma, Italy (*Presenter*) Nothing to Disclose  
Francesco del Giudice, Roma, Italy (*Abstract Co-Author*) Nothing to Disclose  
Stefano Cipollari, Rome, Italy (*Abstract Co-Author*) Nothing to Disclose  
Riccardo Campa, MD, Roma, Italy (*Abstract Co-Author*) Nothing to Disclose  
Carlo Catalano, MD, Rome, Italy (*Abstract Co-Author*) Nothing to Disclose  
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## PURPOSE

To prospectively evaluate the use of mpMRI with VI-RADS to identify patients with high-risk NMIBC could potentially avoid unnecessary Re-TURBT.

## METHOD AND MATERIALS

Two-hundred and twenty-two patients with newly suspected bladder lesions (at ultrasound, CT scan and/or cystoscopy) were prospectively enrolled and underwent mpMRI before Photodynamic Diagnosis (PDD) assisted TURBT. All patients eligible for Re-TURBT with high-risk NMIBC, absence of carcinoma in situ at multiple random intraoperative biopsies and absence of upper urinary tract lesions at preoperative CT scan were included in the study. Exclusion criteria were: diagnosis of muscle-invasive bladder cancer (MIBC) at first TURBT, low-risk NMIBC, absence of detrusor muscle in TURBT specimen, incomplete or doubt about completeness during initial resection, non-urothelial carcinomas. Correlation analysis was performed to compare results of TURB and Re-TURBT with VI-RADS score of pre-operative mpMRI.

## RESULTS

Thirty nine (17.4%) patients with MIBC, 67 (30%) with low-risk NMIBC, 16 (7.1%) with no detrusor in the specimen and 6 (2.6%) with incomplete or doubtful resection were excluded. A total of 95 high-risk NMIBCs who underwent TURBT and Re-TURBT were included in the final analysis. Median age was 63 (range 45 - 68). At Re-TURBT 84 (88.4%) patients revealed absence of cancer in the specimen and among them 81 (96.4%) were diagnosed with VI-RADS 1-2 lesions. Among the 8 (8.4%) patients diagnosed as MIBC, 7 (87.5%) were diagnosed with preoperative VI-RADS 3-5. Four (4.2%) showed persistent high-risk disease, all of whom presenting at first TURBT with multifocal and large tumor dimensions (i.e. > 3cm). A good correlation was demonstrated (Pearson's  $r = 0,71$ ,  $p < 0.05$ ) between preoperative VI-RADS score and re-TURBT histological reports.

## CONCLUSION

Implementation of mpMRI in the pre-TURBT setting is reliable in differentiating MIBC from NMIBC. Selected patients with high-risk NMIBC and VI-RADS score 1-2 have a low risk of being understaged and could therefore avoid Re-TURBT.

## CLINICAL RELEVANCE/APPLICATION

The use of Multiparametric MRI and the VI-RADS score might further stratify the category of high risk patients with non invasive bladder cancer that should undergo Re-TURBT.

### SSE12-05 Radiomics Prediction of Detrusor Muscle Invasion in Bladder Cancer Based on Multiparametric MR Imaging

Monday, Dec. 2 3:40PM - 3:50PM Room: S505AB

#### Participants

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## PURPOSE

To explore a radiomics approach for the preoperative prediction of muscle invasion in bladder cancer (BCa).

## METHOD AND MATERIALS

This retrospective study involved 121 BCa patients from two clinical centers with different MR scanners. The datasets from one of the two centers were used for model training and the other for independent testing. A total of 1404 features were extracted from the largest possible tumorous regions of interest (ROIs) by manual delineation in preoperative multiparametric MR images, including T2-weighted (T2W), diffusion-weighted (DW) and apparent diffusion coefficient (ADC) images. Support vector machine-based recursive feature elimination (SVM-RFE) approach was used to determine an optimal feature subset with the training group to construct a model for predicting muscle invasion of BCa. Then the performance of the proposed model was quantitatively evaluated by the testing group.

## RESULTS

Of the 1404 features extracted from T2W, DW and ADC images, an optimal subset containing 31 features was selected and confirmed with the best area under the curve (AUC) of receiver operating characteristic, which consists of 11 features from T2W images, 13 features from DW images and 7 features from ADC maps, and used to construct the prediction model. Its averaged accuracy and AUC after 100-round classifications with 10-fold cross-validation were 93.31%, 0.9778 (95% CI: 0.9771, 0.9782) in the training group, and 88.10%, 0.9475 (95% CI: 0.9463, 0.9486) in the validation group, respectively.

## CONCLUSION

With the radiomics signature selected from multiparametric MRI features, especially the features from DW images, the proposed prediction model is an effective tool for preoperative prediction of muscle invasion in BCa patients.

## CLINICAL RELEVANCE/APPLICATION

Clinical management of bladder cancer is mainly determined on the basis of distinguishing non-muscle invasive (stage T1 or lower) from muscle invasive ones (stage T2 or higher) because the treatment options differ considerably. MRI is the best imaging modality for the noninvasive evaluation before surgery. With the radiomics signature selected from multiparametric MRI features, a prediction model can be established, which can be used as an effective tool for preoperative prediction of muscle invasion in BCa patients.

## SSE12-06 MDCT Urography for Prediction of Pathologic Complete Response after Neoadjuvant Chemotherapy in Muscle-Invasive Bladder Cancer: Diagnostic Performance Using 5-Point Grade and Comparison with RECIST Criteria

Monday, Dec. 2 3:50PM - 4:00PM Room: S505AB

### Participants

Sejin Choi, MD, Seoul, Korea, Republic Of (*Presenter*) Nothing to Disclose  
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## PURPOSE

The purpose of this study was to investigate imaging criteria based on urothelial phase CT (UP CT) for evaluation of the complete response after neoadjuvant chemotherapy (NACT) in patients with muscle-invasive bladder cancer (MIBC) and to compare its diagnostic performance with the current response evaluation criteria in solid tumors (RECIST).

## METHOD AND MATERIALS

A total of 50 patients were included who underwent NACT and subsequent radical cystectomy for MIBC between January 2017 and February 2019. UP CT findings after NACT were divided into five grades [UP grades] as follows: grade 1, no bladder wall thickening or inner layer enhancement; grade 2, thin inner layer enhancement without bladder wall thickening; grade 3, inner layer enhancement with low-attenuated wall thickening; grade 4, enhancing wall thickening; and grade 5, nodular enhancement or enhancing soft tissue. Two radiologists independently evaluated UP grades. An experienced reader separately assessed the treatment response per RECIST criteria. Area under the Receiver-operating-characteristic curve (AUC) was used to evaluate the diagnostic performance of UP grades and RECIST criteria to predict complete pathologic response. To determine the optimal cutoff of the UP grades, sensitivity, specificity, PPV, NPV, and accuracy were assessed. Interreader agreement of UP grades was assessed using a weighted kappa coefficient.

## RESULTS

Sixteen patients (32%) were confirmed as pathologic complete response. The AUCs of UP grades were 0.89 (95% CI, 0.77, 0.96) and 0.87 (95% CI, 0.75, 0.95) in both readers, which showed a significant increase over the AUC of RECIST criteria (0.65; 95% CI, 0.50, 0.78). Using grade 1 or 2 as a criterion of clinical complete response, the sensitivity, specificity, PPV, NPV, and accuracy were 75.0%, 85.3-88.2%, 70.6-75.0%, 87.9-88.2%, and 82.0-84.0% in both readers. Interreader agreement for UP grade was substantial ( $K=0.78$ ).

## CONCLUSION

Grading system using UP CT may show better diagnostic performance than the conventional size-based RECIST criteria with high interreader agreement. No or thin inner layer enhancement without bladder wall thickening may indicate pathologically complete response after NACT in MIBC.

## CLINICAL RELEVANCE/APPLICATION

A grading system based on urography CT can be useful for assessment of treatment response following neoadjuvant chemotherapy.







SSE13

## Health Service, Policy and Research (Trends and Utilization)

Monday, Dec. 2 3:00PM - 4:00PM Room: E261



AMA PRA Category 1 Credit™: 1.00  
ARRT Category A+ Credit: 1.00

### Participants

Jonathan James, BMBS, Nottingham, United Kingdom (*Moderator*) Nothing to Disclose  
Aran M. Toshav, MD, New Orleans, LA (*Moderator*) Speakers Bureau, Koninklijke Philips NV  
Kathryn Lowry, MD, Seattle, WA (*Moderator*) Research Grant, General Electric Company

### Sub-Events

#### SSE13-01 Medical Radiation Exposure of Patients in the United States

Monday, Dec. 2 3:00PM - 3:10PM Room: E261

### Participants

Mahadevappa Mahesh, PHD, Baltimore, MD (*Presenter*) Nothing to Disclose  
Fred A. Mettler JR, MD, Albuquerque, NM (*Abstract Co-Author*) Nothing to Disclose  
Richard Vetter, PhD, Rochester, MN (*Abstract Co-Author*) Nothing to Disclose  
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David Spelic, PhD, Copley, OH (*Abstract Co-Author*) Nothing to Disclose  
Jennifer Elee, West Monroe, LA (*Abstract Co-Author*) Nothing to Disclose  
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### PURPOSE

This work reports the medical radiation exposure of patients in the United States. The report is an update 10 years after the publication of NCRP report 160 (2009) and is focused on 2016 data for radiation doses to patients from medical exposures.

### METHOD AND MATERIALS

Data on the type & number of procedures were obtained from a number of sources including commercial surveys, the US Medicare billing data, & other governmental & regulatory agencies, professional societies & published literature. Data on effective dose (E) per procedure were obtained from UK National Radiation Protection Board, International Commission on Radiological Protection (ICRP), American College of Radiology, State & Federal surveys & peer-reviewed literature. E was used as a dose metric & since E requires use of "tissue weighting factors" (wt) defined by ICRP Publications 60 (1990) and 103 (2007), E was computed using wt based on ICRP 60 & 103 to allow for comparison with previous reports. E-60 was computed for 2006 data & 2016 data & E-103 was computed for 2016 data for various sources of medical radiation. The collective effective dose (S) was estimated using different ICRP wt values, referred to as S-60 & S-103, & represented as percentages of collective doses for various modalities.

### RESULTS

The largest contributor of collective dose is CT. In 2016, there were nearly 84 million CT scans (25% higher than the previous report). The US population was 323 million in 2016, so the estimated annual individual effective dose (E-US 60 and E-US 103) from CT was ~1.4 to 1.5 mSv. In 2016, there were nearly 13.5 million nuclear medicine procedures (20% decrease from previous report). The estimated E-US 60 and E-US 103 from nuclear medicine was ~0.41 to 0.32 mSv. Collective effective dose (S) was also computed for radiography & fluoroscopy & for cardiac and non-cardiac interventional fluoroscopy.

### CONCLUSION

The 2016 estimates for S & E-US indicate a decline of ~15-20% from 885,000 (2006) to 717,000 & 755,000 person-Sv (S-103 & S-60) and approximately from 3.0 (2006) to 2.3 & 2.2 mSv (E-US 60 & E-US 103) respectively.

### CLINICAL RELEVANCE/APPLICATION

This report provides insight into the radiation exposure of patients in the United States and describes changes compared to the previous decade. These changes may be due to radiation dose optimization efforts, technological innovations and education and awareness about patient exposure.

#### SSE13-02 Trends and Independent Predictors of Imaging Utilization in Stroke: A Nationwide Analysis of

## Emergency Department and Inpatient Encounters between 2006 and 2014

Monday, Dec. 2 3:10PM - 3:20PM Room: E261

### Awards

#### Trainee Research Prize - Resident

#### Participants

Anna Trofimova, MD, PhD, Atlanta, GA (*Presenter*) Nothing to Disclose  
Richard Duszak JR, MD, Atlanta, GA (*Abstract Co-Author*) Nothing to Disclose  
Sydney Cohen, Atlanta, GA (*Abstract Co-Author*) Nothing to Disclose  
Gelareh Sadigh, MD, Atlanta, GA (*Abstract Co-Author*) Nothing to Disclose

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### PURPOSE

To assess nationwide trends and independent predictors of neuroimaging utilization in stroke patients during emergency department (ED) and inpatient encounters between 2006 and 2014.

### METHOD AND MATERIALS

The largest U.S. all-payer ED and inpatient encounter databases (The Healthcare Cost and Utilization Project Nationwide Emergency Department Sample and National Inpatient Sample) were used to identify ED and inpatient visits with a primary diagnosis of cerebral artery occlusion between 2006 and 2014. Longitudinal trends and independent predictors of neuroimaging utilization were determined using logistic regression.

### RESULTS

An estimated total of 3,075,906 ED (mean age 70.4; 52.6% female) and 3,021,099 inpatient (mean age 70.9; 53.5% female) weighted cohorts were identified. Urban settings accounted for 47.3% of ED and 33.1% of inpatient encounters. Neuroimaging tests were performed in 8.5% of ED and 9.4% of inpatient encounters. In the ED setting, the most commonly performed imaging test was a non-contrast CT head (8.2%), followed by brain MRI (1.2%). In the inpatient setting, head CT was performed in 4.7% and brain MRI in 6.7% of encounters. Utilization of neuroimaging tests in the ED increased from 2006 (14,685, 4.5%) to 2014 (53,174, 13.9%). Imaging utilization in the inpatient setting was highest in 2007 (12.6%) and lowest in 2014 (7.3%). Independent predictors of higher ED imaging utilization were year after 2010 (OR 2.2); weekend admission (OR 1.1); private insurance (OR 1.2). Independent predictors of higher inpatient imaging utilization were non-elective admission (OR 1.7) and urban location (OR 1.3). Independent predictors of lower imaging utilization in both groups were: age > 55 (OR 0.8 (ED) and 0.9 (inpatient)) and female gender (OR 0.9 (ED and inpatient)). Urban location was an independent predictor of lower ED imaging utilization (OR 0.6). (All  $p < 0.05$ ).

### CONCLUSION

In the setting of stroke, patterns of imaging utilization and their predictors differed between the ED and inpatient settings. In 2014, imaging utilization in the ED was highest (13.9%), but lowest in the inpatient setting (7.3%), suggesting that imaging is increasingly being "frontloaded" earlier in stroke care.

### CLINICAL RELEVANCE/APPLICATION

Further research is needed to identify drivers of disparities and changing imaging utilization in the setting of stroke.

### SSE13-03 National Trends in Modalities of Entry to Colorectal Cancer Screening - What is the Current Application of CT Colonography?

Monday, Dec. 2 3:20PM - 3:30PM Room: E261

#### Participants

Jina Pakpoor, MD, Baltimore, MD (*Presenter*) Nothing to Disclose  
Andrew Harris, BS, Baltimore, MD (*Abstract Co-Author*) Nothing to Disclose  
Micheal Raad, MD, Baltimore, MD (*Abstract Co-Author*) Nothing to Disclose  
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Joseph Canner, Baltimore, MD (*Abstract Co-Author*) Nothing to Disclose  
Bashar Safar, MD, Baltimore, MD (*Abstract Co-Author*) Nothing to Disclose  
Chady Atallah, MD, Baltimore, MD (*Abstract Co-Author*) Nothing to Disclose

### PURPOSE

Colorectal cancer is the third leading cause of cancer-related deaths in the US population. However, despite effective screening options, nearly one-in-three eligible adults have not undergone screening. Given the potential implications on assessments of policy efficacy and targeted educational initiatives, we aimed to determine the current national trends in first-time colorectal cancer screening in the outpatient setting.

### METHOD AND MATERIALS

Using a National Commercial Claims database, we identified the first outpatient visit of commercially insured patients between 50-55 years of age across all US states between 2010 and 2016. These were identified by ICD9 code V76.51 or ICD-10 code Z12.11 (screening for malignant neoplasms of colon). Patients with family history of gastrointestinal neoplasm and/or personal history of colonic polyps were excluded. Logistic regression analysis was used to estimate the annual change in the rate of imaging before and after controlling for covariates.

### RESULTS

896,789 individual first time patient encounters met inclusion criteria. Mean age 55, 52% were female. Across the study time period, 616,789 (68%) patients underwent colonoscopy as their screening modality. 277,147 (31%) patients underwent a fecal test, 2,166

(0.24%) underwent sigmoidoscopy, and only 678 (0.08%) underwent CT Colonography. The use of colonoscopy significantly increased over time, whereas the use of fecal testing decreased ( $p < 0.001$ ). The use of CT colonography did not significantly change.

## CONCLUSION

We found that the use of colonoscopy as the initial colorectal cancer screening modality represents the majority of screening and significantly increased with time in our national population sample. In contrast, the use of fecal tests decreased. The relative use of CT colonography has remained stable and represents less than 1% of initial screening, likely due to continued challenges for insurance coverage and fear of radiation.

## CLINICAL RELEVANCE/APPLICATION

Improving public awareness and commercial insurance coverage of CT colonography is required to increase its use and screening rates for persons who do not wish to undergo an invasive colonoscopy.

## SSE13-04 Associations Over Time Between Paid Medical Malpractice Claims and Imaging Utilization in the United States

Monday, Dec. 2 3:30PM - 3:40PM Room: E261

### Participants

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Sydney Cohen, Atlanta, GA (*Abstract Co-Author*) Nothing to Disclose  
Richard Duszak JR, MD, Atlanta, GA (*Abstract Co-Author*) Nothing to Disclose

## PURPOSE

Little research has evaluated the association between medical imaging and the medicolegally unpredictable environment in the United States. This study explores state level relationships over time between the incidence and amount paid for malpractice claims and Medicare imaging utilization and spending in the United States.

## METHOD AND MATERIALS

Using claims data from a 5% national sample of Medicare beneficiaries for years 2004-2016, we calculated population-adjusted annual Medicare imaging utilization and spending by state. For each year and state, we calculated a population-adjusted lagged three-year rolling average paid malpractice claims frequency and payout amount using data from the National Practitioner Data Bank. Associations between paid malpractice claims and imaging utilization were assessed using a multivariate regression analysis with a log-log specification controlling for a secular trend and state effects.

## RESULTS

Between 2004 and 2016, Medicare fee-for-service imaging utilization and spending declined by 31.1% and 34.1%, respectively (from 418,618 to 288,559 examinations and \$27,954,457 to \$18,428,151 USD per 100,000 beneficiaries). Overall paid malpractice claims and payouts declined 46.9% and 29.3%, respectively (from 5.37 to 2.85 claims and \$1,488,243 to \$1,051,537 USD per 100,000 population). After controlling for secular trends, imaging utilization and spending were both positively associated with paid malpractice claims and payouts. Each 1% increase in paid malpractice claims was associated with a 0.14% increase in imaging utilization ( $p = 0.0001$ ) and a 0.10% increase in imaging spending ( $p = 0.0015$ ). Moreover, each 1% increase in malpractice payouts was associated with a 0.07% increase in imaging utilization ( $p = 0.0015$ ) and a 0.07% increase in imaging spending ( $p = 0.0015$ ).

## CONCLUSION

In recent years, Medicare imaging utilization and paid medical malpractice claims in the United States have both declined. Imaging utilization and spending are positively correlated with rates of paid malpractice claims and associated payouts.

## CLINICAL RELEVANCE/APPLICATION

The use of medical imaging is positively correlated with paid malpractice claims, supporting the contention that physicians utilize medical imaging as a "defensive medicine" strategy in the United States.

## SSE13-05 Risk of Anaphylactoid Reactions to Iopromide After Intra-Arterial versus Intra-Venous Administration: A Nested Case-Control Analysis of 133,331 Patients

Monday, Dec. 2 3:40PM - 3:50PM Room: E261

### Participants

Jan Endrikat, Berlin, Germany (*Presenter*) Researcher, Bayer AG  
Alexander Michel, MD, PhD, Basel, Switzerland (*Abstract Co-Author*) Employee, Bayer AG  
Ralf Koelbach, MS, Berlin, Germany (*Abstract Co-Author*) Employee, PAREXEL International Corporation  
Philipp Lengsfeld, PhD, Berlin, Germany (*Abstract Co-Author*) Employee, Bayer AG  
Kai Vogtlaender, PhD, Wuppertal, Germany (*Abstract Co-Author*) Employee, Bayer AG

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## PURPOSE

To better understand the pathomechanisms of anaphylactoid reactions: Nested-case control analysis of 133,331 patients comparing intra-arterial (i.a.) with intra-venous (i.v.) to administration.

## METHOD AND MATERIALS

Four observational studies were pooled. Almost half of the study population (48.1%) was from Europe, and one quarter each from China (27.6%) and other Asia countries (24.1%). All patients received iopromide either i.a. or i.v. for angiographic procedures

(mostly cardioangiography) or contrast enhanced computed tomography. A nested case-control analysis, including a multivariate logistic regression model, was performed. Cases were defined as patients with typical and unequivocal anaphylactoid reactions, controls were patients without any recorded reactions. The primary target variable was the Odds ratio of having an anaphylactoid reaction after i.a. vs. i.v. administration.

## RESULTS

A total of 133,331 patients met the inclusion criteria, 27,871 and 105,460 patients received iopromide i.a. or i.v., respectively. For 822 patients anaphylactoid reactions were recorded, 132,509 patients served as controls. Major risk factors for anaphylactoid reactions were i.v. injection (vs. i.a.), age 18- <50 years (vs.  $\geq 65$  years), history of allergy or previous contrast media reaction (all  $p < 0.001$ ) and bronchial asthma ( $p = 0.005$ ). A total of 56 patients (0.2%) and 766 patients (0.7%) were recorded with anaphylactoid reactions after i.a. or i.v. administration, respectively ( $p < 0.0001$ ). Adjusted Odds ratio (i.a. vs. i.v.) was 0.23 (95 % C.I. 0.16 - 0.32).

## CONCLUSION

Anaphylactoid reactions to iopromide were significantly less frequently recorded after i.a. administrations. This could likely be related to the delayed and diluted arrival of the contrast medium in the lungs.

## CLINICAL RELEVANCE/APPLICATION

This study confirmed the hypothetical lower risk of anaphylactoid reactions after i.a. vs. i.v. administration of iodine contrast agents.

## SSE13-06 Which Radiology Subfield has the Greatest Amount of Specialization? A Generalizable Method for Quantifying Specialization within Radiology, and Its Results

Monday, Dec. 2 3:50PM - 4:00PM Room: E261

### Participants

Brian Haas, MD, San Francisco, CA (*Presenter*) Nothing to Disclose  
David McCoy, San Francisco, CA (*Abstract Co-Author*) Nothing to Disclose  
Brian Trinh, MD, San Francisco, CA (*Abstract Co-Author*) Nothing to Disclose  
Evan D. Calabrese, MD, PhD, San Francisco, CA (*Abstract Co-Author*) Private interest, Qspin LLC  
Howard P. Forman, MD, New Haven, CT (*Abstract Co-Author*) Nothing to Disclose

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## PURPOSE

To develop methodology to measure specialization within radiology, and to apply it to Medicare claims data to study specialization.

## METHOD AND MATERIALS

The IRB approved this study under exempt review. We accessed the Medicare Physician and Other Supplier Public Use File for 2015, and searched for all diagnostic radiologists. All diagnostic radiology CPT codes were mapped into one or more subfields according to conventional anatomic designations: abdominal and pelvic, breast, chest, musculoskeletal, and neurologic. Within each subfield, a bundle of "advanced imaging" studies was designated, which consisted of those studies that benefit the most from a specialist interpretation. Each radiologists' total work RVU (wRVU) and wRVU within each radiology subfield were calculated, and based on these calculations, radiologists were labeled as either a specialist or a non-specialist for each subfield. The labeling of radiologists as specialists was done by comparing each radiologist's wRVU in a subfield against the average of radiologists who spend about 30% of their wRVU in that subfield. Finally, the percent of "advanced imaging" wRVU interpreted by a specialist versus a non-specialist in each subfield was calculated. Code for querying the database and statistics were performed in Python.

## RESULTS

A total of 28,851 radiologists billed Medicare for 48,431,278 wRVU in calendar year 2015. Of this wRVU, 96.67% falls within one of the areas of specialization. The number of specialists within each subfield varied from a high of 9,437 (33% of all radiologists) in abdominal and pelvic to a low of 1,559 (5% of all radiologists) in musculoskeletal. The amount of specialization is greatest within neuroradiology (84% of advanced imaging wRVU read by specialists), followed by abdominal and pelvic (78%), breast (55%), musculoskeletal (37%), and lastly chest (31%).

## CONCLUSION

It is possible to measure specialization within radiology with generalizable methodology that can be applied broadly across all subfields in radiology. This methodology demonstrates that specialization within radiology is greatest in neuroradiology and least in chest radiology.

## CLINICAL RELEVANCE/APPLICATION

We describe a method for measuring degree of specialization of the radiology marketplace. The methods can be used to assess individual radiology practices, or regional or national samples.

Printed on: 10/29/20



SSE14

## Informatics (Artificial Intelligence: Triage, Screening, Quality)

Monday, Dec. 2 3:00PM - 4:00PM Room: S406B

AI IN SQ

AMA PRA Category 1 Credit™: 1.00  
ARRT Category A+ Credit: 1.00

### Participants

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Synho Do, PhD, Boston, MA (*Moderator*) Nothing to Disclose  
Neil Tenenholtz, PhD, Boston, MA (*Moderator*) Employee, Microsoft Corporation

### Sub-Events

#### SSE14-01 Automated AI Detection and Measurement of Midline Shift on Head CT Scans in an Emergency Teleradiology Set Up: Its Contribution to Critical Value Communication

Monday, Dec. 2 3:00PM - 3:10PM Room: S406B

### Participants

S S. Jayadeepa, MBBS, MD, Bangalore, India (*Presenter*) Nothing to Disclose  
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### CONCLUSION

The immediate detection and accurate measurement of midline shift on head CT examinations is key to prompt patient triage and management in the emergency setting. An AI algorithm demonstrated promising results in both detection and quantification of midline shift, thereby allowing for prioritization of radiologist review, accelerated critical value communication and enhanced patient care.

### Background

To evaluate the efficiency of an artificial intelligence (AI) program using complex neural networks and deep learning algorithms for the detection and measurement of midline shift on non-contrast computed tomography examination of the head. Also, to determine feasibility of deploying such an algorithm in the emergency Teleradiology setup to promote earlier detection and facilitate work flow prioritization.

### Evaluation

The retrospective study was HIPAA compliant and performed with the approval of the institutional review board. A representative sample set of curated data comprising 163 non-contrast pre-operated noncontrast computed tomography examination of the head were used for validation constituted by 93 cases positive for midline shift and 70 cases negative for midline shift. AI throughput was processed with convolutional neural network for midline shift detection and measurement.

### Discussion

AI tool demonstrated, for the midline shift detection model, accuracy at 95.15% with sensitivity of 92.63%(88 out of 93), (confidence interval CI-85.41%-96.99%) and specificity of 98.57%(69 out of 70)(CI-92.3%-99.96%), with area under the receiver operating characteristic curve(AUC) of 0.956. AI tool demonstrated, for the midline shift measurement model compared to radiologist ground truth reports, accuracy at 91.41% with sensitivity of 91.95%(80 out of 93) (confidence interval CI-84.12%-96.7%) and specificity of 90.79%(69 out of 70)(CI-81.94% to 96.22%), with area under the receiver operating characteristic curve(AUC) of 0.914.

#### SSE14-02 Utilizing Machine Learning to Improve ED and In-Patient Throughput in Cases of Acute Intracranial Hemorrhage by Non-Contrast Head CT

Monday, Dec. 2 3:10PM - 3:20PM Room: S406B

### Participants

Melissa A. Davis, MD, Atlanta, GA (*Presenter*) Stockholder, Nines Radiology  
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Paul Cedeno, MD, New Haven, CT (*Abstract Co-Author*) Nothing to Disclose  
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Vahe M. Zohrabian, MD, Norwalk, CT (*Abstract Co-Author*) Nothing to Disclose

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## CONCLUSION

Increases in patient volume have been accompanied by increases in ED and inpatient imaging volume, which have led to higher demands for shorter report TAT in an effort to streamline throughput and decrease healthcare expenditures. Integrating a ML software tool in the radiologist workflow allows for more rapid diagnosis and reporting of acute pathologies, which can enhance triage of patients to the appropriate level of care.

## Background

From order scheduling to report generation, ML is slowly revolutionizing radiology work processes. Demonstrating how algorithms ultimately add value and improve patient outcomes remains of importance. Here, we determine the impact on throughput of a ML platform in cases of acute intracranial hemorrhage (ICH) by non-contrast head CT at a large, busy tertiary care center. We hypothesize that utilization of ML software trained to detect ICH leads to a reduction in report turnaround time (TAT) and length of stay (LOS) in both ED and in-patient populations.

## Evaluation

A ML platform based on a convolutional neural network model was incorporated across CT scanners at 2 imaging sites in January 2018. Report TAT and LOS were derived for reports and patients, respectively, between July 2017 and December 2017 (pre-ML) and compared to those between January 2018 and June 2018 (post-ML). 26,249 cases were evaluated in 2017 (pre-ML) and 25,544 cases in 2018 (post-ML). Report TAT decreased from 53 min to 46 min for head CT cases positive for ICH ( $p < .001$ ). In-patient LOS for positive cases decreased from 9950 min to 8870 min ( $p > .05$ ). ED LOS decreased from 567 min to 508 min ( $p < .001$ ).

## Discussion

The rapid detection of ICH in patients with acute neurological symptoms is critical and delays in diagnosis are costly. Here, we demonstrate that adoption of a ML software platform was associated with a statistically significant decrease in report TAT for cases positive for ICH as a function of the software prioritizing those scans for radiologist interpretation. The implementation of a ML platform was also associated with a statistically significant decrease in LOS for ED patients, but not for inpatients, presumably as those patients with ICH were expeditiously transferred out of the ED.

## SSE14-03 Contemporaneous Use of AI as The Third Eye In a Teleradiology Setup for CT Evaluation of Subtle Intracranial Hemorrhages in An Emergency Teleradiology Setup

Monday, Dec. 2 3:20PM - 3:30PM Room: S406B

### Participants

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Anjali Agrawal, MD, Delhi, India (*Abstract Co-Author*) Nothing to Disclose  
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## CONCLUSION

Contemporaneous use of AI as a second reader on critical scans holds promising results towards improvised patient care by increasing the accuracy rates of reading radiologists in a teleradiology setup.

## Background

With increasing workloads in radiology, the number of scans reported by teleradiologists is ever increasing. AI as the third eye may enhance accuracy on critical scans in a teleradiology setup to optimize work efficiency. The aim of this study was to evaluate if AI algorithm can help reduce errors in evaluation of subtle critical findings such as intracranial hemorrhages in head CT scans in an emergency teleradiology setup.

## Evaluation

Retrospective analysis of 22 cases of intracranial hemorrhages missed by the radiologists from a denominator of 50,782 CT heads read in an emergency teleradiology setup were selectively run through AI models designed specifically for detection of intracranial hemorrhage. We then compared this bleed detection AI model with an enhanced model designed specifically to detect small and subtle hemorrhages for improved accuracy.

## Discussion

The AI algorithm was able to pick up intracranial hemorrhages 11 out of 22 missed bleed critical scans with 59.62% sensitivity and 91.07% specificity, and accuracy of 89.8% accuracy with an AUC of 0.753 on slice-wise detection of the routine bleed detection model. The AI algorithm demonstrated higher sensitivity at detection of subtle intracranial hemorrhages at 14 out of 22 critical scans with an AUC of 0.789, 69.23% sensitivity and 88.64% specificity, and slightly decreased accuracy at 87.85%, due to increased false positives as a trade-off on the enhanced bleed detection model. The performance of bleed detection model was also run against a random selection of 367 pre-operated, non-contrast head CTs with accuracy for ICH at 91.55% with sensitivity of 93.16% (150 out of 161) (confidence interval CI-88.10% to 96.64%) and specificity of 90.29% (186 out of 206) (CI-85.40% to 93.97%), with area under the receiver operating characteristic curve (AUC) of 91.55% (88.22% to 94.19%).

## SSE14-04 Utility of Artificial Intelligence Tool as a Prospective Radiology Peer Reviewer -Detection of Unreported Intracranial Hemorrhage

Monday, Dec. 2 3:30PM - 3:40PM Room: S406B

### Participants

Balaji Rao, MBBS, FRCR, New Haven, CT (*Abstract Co-Author*) Nothing to Disclose  
Vahe M. Zohrabian, MD, Norwalk, CT (*Abstract Co-Author*) Nothing to Disclose  
Paul Cedeno, MD, New Haven, CT (*Abstract Co-Author*) Nothing to Disclose  
Atin Saha, MD, New Haven, CT (*Presenter*) Nothing to Disclose  
Jay K. Pahade, MD, Southport, CT (*Abstract Co-Author*) Consultant, General Electric Company  
Melissa A. Davis, MD, Atlanta, GA (*Abstract Co-Author*) Stockholder, Nines Radiology

## CONCLUSION

AI solution can serve as a prospective peer review tool for non-contrast head CT scans to identify ICH and thus decrease false negatives.

## Background

Misdiagnosis of intracranial hemorrhage (ICH) can adversely impact patient outcome. Increasing workload on the radiologists may increase the chance of error and compromise quality of care provided by the radiologists.

## Evaluation

We used a FDA approved artificial intelligence (AI) solution based on convolutional neural network (CNN) to assess the prevalence of ICH in scans which were reported as negative for ICH. We retrospectively applied the AI solution to all consecutive non-contrast computed tomography (CT) head scans performed at 6 imaging sites affiliated to our institution. In the 6565 non-contrast CT head scans, which met the inclusion criteria, 5585 scans were reported to have no ICH ("negative-by-report" cases). We applied AI solution to these "negative-by-report" cases. AI solution suggested there were ICH in 28 of these scans ("negative-by-report" and "positive-by-AI solution"). After consensus review by three neuroradiologists, 16 of these scans were found to have ICH which was not reported (missed diagnosis), with false negative rate of radiologists for ICH detection at 1.6%.

## Discussion

Our study demonstrates that AI solution can help radiologists to diagnose ICH and thus decrease error rate.

## SSE14-05 Diagnostic Assessment of a Deep Learning System For Detecting Missed Pulmonary Nodules On Computed Tomography

Monday, Dec. 2 3:40PM - 3:50PM Room: S406B

### Participants

Kueian Chen, Taoyuan, Taiwan (*Presenter*) Nothing to Disclose  
Balamuralidhar Vanniarajan, MSc, Singapore, Singapore (*Abstract Co-Author*) Nothing to Disclose  
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Pieh-Hsu Wang, MD, Taoyuan, Taiwan (*Abstract Co-Author*) Nothing to Disclose  
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## CONCLUSION

Use of DLS-assisted automated detection as a second reader for missed pulmonary nodules on computed tomography (CT) may potentially enhance the performance of radiologists.

## Background

We aim to evaluate the diagnostic performance of a deep learning system (DLS) for automated detection of missed pulmonary nodules on computed tomography (CT) as a second reader to enhance the performance of radiologists.

## Evaluation

This single-center retrospective study screened 21150 consecutive chest CT studies from September 2018 to February 2019. Axial chest CT images were transferred to the DLS for automated detection of pulmonary nodules if the associated report was negative. Pulmonary nodules detected by the DLS but not mentioned in the initial radiology report were flagged. Flagged images were then reviewed by four board-certificated radiologists with five years of experience. All flags were scored according to ACR RADPEER 2016 scoring guidelines. Nodules marked as score 2 ("understandable miss") or 3 ("should not be missed") were then separated as clinically insignificant (2a or 3a) or clinically significant (2b and 3b) in accordance with Fleischner 2017 guideline for pulmonary nodules. The miss rate was defined as the total number of studies receiving score 2 or 3, divided by total screened studies.

## Discussion

Among 140 studies flagged by the DLS, 73 (52 %) were confirmed by radiologist review, and further categorized as 2a in 33 studies (24 %), 2b in 13 studies (9 %), 3a in 14 studies (10 %), and 3b in 13 studies (9%). For identifying clinically significant findings (2b/3b), the system's overall specificity was 18%. Missed pulmonary nodules were identified in 0.3% of total chest CT scans, and one-third of these had clinical implications.

## SSE14-06 Using Out of Distribution Detection to Fix Nearly All AI Models in Medical Imaging

Monday, Dec. 2 3:50PM - 4:00PM Room: S406B

### Participants

David Eng, Stanford, CA (*Presenter*) Founder, Bunkerhill Health  
Nishith Khandwala, Palo Alto, CA (*Abstract Co-Author*) Founder, Bunkerhill Health  
Daniel L. Rubin, MD, Stanford, CA (*Abstract Co-Author*) Consultant, F. Hoffmann-La Roche Ltd

## PURPOSE

Nearly all AI models for medical imaging behave unpredictably and fail silently on input data dissimilar from data used to train them, which hampers their safe clinical use. To address this problem, we introduce a simple modification to the standard AI training procedure that teaches AI models to produce confidence estimates along with their original task predictions, which radiologists can use to determine how reliable the AI model believes its task predictions to be.

## **METHOD AND MATERIALS**

Our approach separates the AI model output into task and confidence components. We use the original loss for the task term, but introduce a new loss that encourages the model to ask for hints on inputs for which it has lower confidence. This modification produces models with higher confidence for inputs resembling the training set ('in distribution') and lower confidence otherwise ('out of distribution') at inference time. To evaluate our approach, we trained AI models for two previously studied tasks: chest abnormality detection and bone age estimation. For each task, we reused previous model architectures for the task prediction and introduced our approach to the training procedure for the confidence estimate.

## **RESULTS**

For both tasks, our approach successfully distinguished between unseen 'in distribution' and 'out of distribution' inputs ( $p < 0.05$ ). For our classifier that predicts normal or abnormal on AP/PA chest radiographs, our confidence estimate yields AUC of 0.76 for filtering lateral view chest radiographs and 0.86 for filtering out upper extremity radiographs, while maintaining a task AUC of 0.89, which does not differ significantly from the AI model trained without the confidence term ( $p = 0.38$ ). For our regressor that predicts bone age from hand radiographs, our confidence estimate yields an AUC of 0.997 for filtering out other upper extremity radiographs, while maintaining a task MAD of 5.6 months, which does not differ significantly from the model trained without the confidence term ( $p = 0.34$ ).

## **CONCLUSION**

Our promising results in two clinical tasks suggest that our approach could enable radiologists to determine when AI models for medical imaging are likely to produce correct or incorrect predictions.

## **CLINICAL RELEVANCE/APPLICATION**

Similar to how rads express uncertainty when interpreting outside their specialty, our method permits AI models to express uncertainty on inputs outside of the narrow task for which they were trained.

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SSE15

## Musculoskeletal (Accelerated Imaging)

Monday, Dec. 2 3:00PM - 4:00PM Room: N228

MR MK

AMA PRA Category 1 Credit™: 1.00  
ARRT Category A+ Credit: 1.00

FDA Discussions may include off-label uses.

### Participants

Christian W. Pfirrmann, MD, MBA, Forch, Switzerland (*Moderator*) Nothing to Disclose  
Naveen Subhas, MD, Shaker Heights, OH (*Moderator*) Research support, Siemens AG

### Sub-Events

#### SSE15-01 Acceleration in Knee MRI: Compressed Sensing for 2D and 3D Applications

Monday, Dec. 2 3:00PM - 3:10PM Room: N228

### Participants

Grischa Bratke, MD, Cologne, Germany (*Presenter*) Nothing to Disclose  
Stefan Haneder, MD, Cologne, Germany (*Abstract Co-Author*) Nothing to Disclose  
Robert Rau, Cologne, Germany (*Abstract Co-Author*) Nothing to Disclose  
Nuran Abdullayev, MD, Cologne, Germany (*Abstract Co-Author*) Nothing to Disclose  
Lisa Brueggemann, Bergisch-Gladbach, Germany (*Abstract Co-Author*) Nothing to Disclose  
David C. Maintz, MD, Koln, Germany (*Abstract Co-Author*) Nothing to Disclose  
Kilian Weiss, PhD, Hamburg, Germany (*Abstract Co-Author*) Employee, Koninklijke Philips NV

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### PURPOSE

Compressed sensing (CS) allows to accelerate 2D and 3D scans promising higher acceleration factors than previous parallel imaging techniques. This study evaluated potential clinical acceleration factors of SENSE and Compressed SENSE (combination of Compressed Sensing and SENSE) for a fat saturated 2D sagittal and 3D PD sequence in the knee.

### METHOD AND MATERIALS

Twenty-one healthy volunteers were scanned with a 3T scanner (Ingenia, Philips, Best, Netherland). All received a standard, commercially available sagittal, fat saturated 2D PD (SENSE 1.4) and three CS (CS2, CS3, CS5) and the time-equivalent SENSE accelerations. The 3D sequence (SENSE 2.0) was acquired with four CS (CS6, CS8, CS10 and CS15) and the equivalent SENSE factors. The images were rated by three independent readers (two radiologists and one orthopedic surgeon) with at least 5 years of experience in MRI imaging regarding diagnostic certainty and overall image impression on a 5-Point-Likert-scale. The non-parametric subjective scoring was analyzed with the Friedmann test for statistical significance and the Dunn's test for post-hoc analysis.

### RESULTS

The standard sequences lasted for 221 seconds (2D) and 384 s (3D). The scan time decreased with increasing CS factor (2D CS2: 145 s, 2D CS3: 95 s, 2D CS5: 57 s, 3D CS6: 293 s, 3D CS8: 220 s, 3D CS10: 176 s, 3D CS15: 119 s). The 2D standard sequence was rated best for diagnostic certainty and overall image impression with an average of  $4.95 \pm 0.21$  and  $4.78 \pm 0.42$ , statistical superior in both parameters for all sequences (all  $p < 0.05$ ) except for 2D CS2, 2D S2 and 3D standard. The 3D standard performed only better than 3D CS15 regarding the 3D CS sequences but better than all 3D SENSE accelerations except for the lowest (SENSE 2.2). The post-hoc analysis showed only significant differences for the fast 3D accelerations of CS10 vs. S2.9 ( $p < 0.0001$ ) and CS15 vs. S3.5 ( $p = 0.0002$ ).

### CONCLUSION

Compressed Sensing can significantly decrease (34% for 2D and 54% for 3D) the scan time for PD sequences of a knee MRI with unchanged diagnostic certainty and overall image impression compared to the clinical reference. The new technique proved especially valuable for fast 3D accelerations.

### CLINICAL RELEVANCE/APPLICATION

The application of Compressed Sensing can increase the patient compliance and can reduce healthcare cost for MR imaging due to significant decreased scan times.

#### SSE15-02 Next-Generation 5-Min Knee MRI with Combined Simultaneous Multislice and Parallel Imaging Acceleration: Ready for Prime Time?

Monday, Dec. 2 3:10PM - 3:20PM Room: N228

### Participants

Filippo del Grande, MD, Lugano, Switzerland (*Presenter*) Speaker, Siemens AG; Speaker, Bayer AG; Institutional research collaboration and reference center, Siemens AG;

Ali Rashidi, Baltimore, MD (*Abstract Co-Author*) Nothing to Disclose

Miho Tanaka, Baltimore, MD (*Abstract Co-Author*) Nothing to Disclose

Jan Fritz, MD, Baltimore, MD (*Abstract Co-Author*) Institutional research support, Siemens AG; Institutional research support, Johnson & Johnson; Institutional research support, Zimmer Biomet Holdings, Inc; Institutional research support, Microsoft Corporation; Institutional research support, BTG International Ltd; Scientific Advisor, Siemens AG; Scientific Advisor, General Electric Company; Scientific Advisor, BTG International Ltd; Speaker, Siemens AG; Patent agreement, Siemens AG

## PURPOSE

2-fold parallel imaging (PI) acceleration can realize 5-min 2D FSE MRI of the knee, but the associated signal loss may require compromises in image quality and anatomical coverage. In contrast, 2-fold simultaneous multi-slice (SMS) acceleration is near signal neutral. Advances in pulse sequence design now allow for the combined use of PI and SMS to enable 4-fold-accelerated 2D FSE, which can achieve fast MRI with higher image quality and improved coverage. We compared traditional 2-fold PI- and novel 4-fold SMS-PI-accelerated 2D FSE MRI of the knee for the detection of internal derangement.

## METHOD AND MATERIALS

Following IRB approval and informed consent, 25 symptomatic patients [12 women, 13 men; age 44 (18-64) years] prospectively underwent 1.5T MRI of the knee, including a 2-fold PI-accelerated 5-min 2D FSE MRI protocol, and a 4-fold SMS-PI-accelerated 5-min 2D FSE MRI protocol with higher spatial resolution, higher anatomic coverage, smaller inter-slicer gaps, improved suppression of vascular flow artifacts, and stronger and more homogenous fat suppression. Both protocols included sagittal PD, sagittal PDFS, coronal T1, coronal T2FS, axial PDFS sequences. Two MSK radiologists independently assessed image contrast, noise, artifacts, structural visibility, and abnormalities. Non-parametric comparison, kappa agreement, and interchangeability tests were applied.

## RESULTS

The inter-reader reliability ( $\kappa=0.681$ ) was good. 5-min SMS-PI MRI of the knee had better image contrast ( $p<0.001$ ), less noise, ( $p<0.001$ ), better structural visibility ( $p<0.001$ ), and no flow or aliasing artifacts ( $p=0.657$ ). There was unidirectional interchangeability in favor of SMS-PI MRI for the diagnosis of meniscal tears and cartilage defects, and bidirectional interchangeability for anterior cruciate and collateral ligament tears, tendon tears, bone marrow edema pattern, and fractures.

## CONCLUSION

Combined, 4-fold-accelerated SMS-PI 2D FSE enables artifact-free 5-min MRI of the knee with higher image quality, better visibility of anatomic structures, and possibly better detectability of cartilage defects and meniscal tears than 2-fold PI-accelerated 5-min 2D FSE MRI of the knee.

## CLINICAL RELEVANCE/APPLICATION

The validation of short knee MRI protocols without image degradation are essential to increase MR efficiency in clinical practice.

## SSE15-03 Comparison of Modulated Flip Angle in Refocused Imaging with Extended Echo Trains with Compressed Sensing (CS-MATRIX) and Conventional Two-Dimensional Sequences on Knee Imaging

Monday, Dec. 2 3:20PM - 3:30PM Room: N228

### Participants

Zhanhao Mo, Changchun, China (*Presenter*) Nothing to Disclose

Lin Liu, Changchun, China (*Abstract Co-Author*) Nothing to Disclose

Zhongwen Lv, Chang Chun, China (*Abstract Co-Author*) Nothing to Disclose

He Sui, MD, MD, Changchun, China (*Abstract Co-Author*) Nothing to Disclose

Yongming Dai, Shanghai, China (*Abstract Co-Author*) Nothing to Disclose

Xuanyi Zhou, Shanghai, China (*Abstract Co-Author*) Nothing to Disclose

## PURPOSE

To evaluate and compare the image quality and diagnostic agreement of an isotropic 3D fast spin echo (FSE) sequence, which employs modulated flip angle technique in refocused imaging with extended echo trains with compressed sensing (CS-MATRIX), to conventional 2D sequences for knee at 3T.

## METHOD AND MATERIALS

Forty-four knees from 42 symptomatic patients (mean age:  $43.5\pm 14.9$  years) were examined on a 3T MR scanner (uMR780, United Imaging Healthcare, Shanghai, China) with 2D T2-weighted fat suppressed (T2-fs) sequence, proton density-weighted (PD) sequence and isotropic 3D CS-MATRIX sequence. A four-point scale (4=Excellent, 3=Good, 2=Acceptable, 1=Poor; based on clarity of anatomical structures, noise and artifacts) was employed to assess image quality subjectively, then the scores of 2D and 3D CS-MATRIX sequences were compared utilizing Wilcoxon signed-rank test. Furthermore, Kappa statistics were used to evaluate diagnostic agreement between 2D and 3D CS-MATRIX sequences for detecting multiple types of knee joint pathologies.

## RESULTS

For image quality, no significant difference in scoring was found between 3D CS-MATRIX T2-fs and 2D T2-fs sequences (mean score= $3.29\pm 0.63$  and  $3.34\pm 0.68$ ,  $p=0.715$ ), however, the scores of images obtained from 2D PD was significantly higher than those of 3D CS-MATRIX PD sequence (mean score= $3.84\pm 0.37$  and  $3.57\pm 0.50$ ,  $p<0.05$ ). In diagnostic agreement evaluation, there was a very good agreement between 3D CS-MATRIX and 2D sequences for detecting cartilage lesions ( $\kappa=1.000$ ), and bone marrow edemas ( $\kappa=0.955$ ). Moreover, the diagnostic agreement was good to very good in grading evaluation of medial and lateral menisci tears ( $\kappa=0.748$ ,  $\kappa=0.936$ ), as well as of anterior and posterior cruciate ligaments tears ( $\kappa=0.725$ ,  $\kappa=1.000$ ).

## CONCLUSION

The 3D CS-MATRIX sequences allow for faster knee imaging over conventional 2D sequences, while yielding much the same image quality as 2D T2-fs sequences. In addition, 3D CS-MATRIX sequences could present similar diagnostic value in evaluating lesions in cartilage, bone marrow, menisci and cruciate ligaments as 2D sequences.

## CLINICAL RELEVANCE/APPLICATION

3D CS-MATRIX sequence has become a non-invasive technique for evaluating knee joint lesions, while providing higher time-efficiency than 2D sequences in magnetic resonance imaging.

### SSE15-04 Highly Accelerated 2D Spine Imaging Using Compressed Sensing: Evaluation of Scan Time and Subjective Image Quality

Monday, Dec. 2 3:30PM - 3:40PM Room: N228

#### Participants

Grischa Bratke, MD, Cologne, Germany (*Presenter*) Nothing to Disclose  
Christoph Kabbasch, Cologne, Germany (*Abstract Co-Author*) Nothing to Disclose  
Robert Rau, Cologne, Germany (*Abstract Co-Author*) Nothing to Disclose  
Stefan Haneder, MD, Cologne, Germany (*Abstract Co-Author*) Nothing to Disclose  
David C. Maintz, MD, Koln, Germany (*Abstract Co-Author*) Nothing to Disclose  
Kilian Weiss, PhD, Hamburg, Germany (*Abstract Co-Author*) Employee, Koninklijke Philips NV

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#### PURPOSE

Imaging of the spine, with 2D as the clinical standard, is the most common examination for MRI and its duration has a large impact on the clinical scan schedule and healthcare costs. Due to susceptibility to field inhomogeneities and motion artifacts of the bowel and aorta acceleration techniques remain challenging for sagittal sequences, resulting in comparable low net acceleration factors. The new acceleration technique Compressed Sensing promises higher acceleration factors. In this study Compressed SENSE (combination of Compressed Sensing and SENSE) was evaluated for accelerated sagittal T2 imaging of the lumbar spine using gradient echo (GE) and turbo spin echo (TSE) based prescans.

#### METHOD AND MATERIALS

All scans were performed on a 3T scanner (Ingenia, Philips, Best, Netherland). Sixteen patients received the standard spine protocol including a sagittal T2 sequence (SENSE factor 1.4, 266 seconds) and three different CS acceleration factors (CS2: 172s, CS3: 109s and CS4: 78s). An additional TSE prescan (35s) was acquired to compare the reconstructions based on the common GE and the TSE prescan. The images were rated by two independent readers (experts in musculoskeletal and neuroradiology) regarding diagnostic certainty and overall image impression on a 5-Point-Likert-scale. The non-parametric subjective scoring was analyzed with the Friedmann test for statistical significance and the Dunn's test for post-hoc analysis.

#### RESULTS

The diagnostic certainty ( $4.75 \pm 0.41$ ) and overall image impression ( $4.63 \pm 0.50$ ) were rated highest for the CS2 with a TSE prescan (TSE CS2) although not with a statistically significant difference to the standard T2 ( $4.72 \pm 0.41$  and  $4.56 \pm 0.51$ ). The standard T2 showed significant better overall image impression compared to the CS3 ( $p < 0.0001$ ) and CS4 ( $p < 0.0001$ ) accelerations with GE prescan while none of the TSE prescan sequences or the CS2 with GE prescan was significant worse.

#### CONCLUSION

The combination of the standard T2 with the GE prescan (266s) offered unchanged diagnostic certainty and overall image impression than CS2 with the GE prescan (172s) or CS4 with the TSE prescan (112s).

## CLINICAL RELEVANCE/APPLICATION

Compressed Sense with the GE prescan (-35%) and especially with a TSE prescan (-58%) drastically reduces the scan time for the sagittal T2 sequence with unchanged subjective scoring. Similar reductions for additional sagittal scans (T1, T2 fat saturated) within the protocol should be feasible.

### SSE15-05 Compressed Sensing-Sensitivity Encoding (CS-SENSE) Accelerated MR Brachial Plexus Imaging: Reduced Scan Time without Reduced Image Quality

Monday, Dec. 2 3:40PM - 3:50PM Room: N228

#### Participants

Xiangchuang Kong, Wuhan, China (*Presenter*) Nothing to Disclose  
Tianjing Zhang, MS, Guangzhou, China (*Abstract Co-Author*) Nothing to Disclose  
Zhuang Nie, Wuhan, China (*Abstract Co-Author*) Nothing to Disclose  
Wenliang Fan, BMedSc, PhD, Wuhan, China (*Abstract Co-Author*) Nothing to Disclose  
Qing Fu, MS, MS, Wuhan, China (*Abstract Co-Author*) Nothing to Disclose

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#### PURPOSE

3D Contrast-enhanced nerve-view Imaging provides very high clinical value for brachial plexus nerve trauma, tumor etc. However, relatively long acquisition time (above 10min) limits its clinical application. The aim of this study was to reduce the scan time of 3D Nerve-view using Compressed Sensing-Sensitivity Encoding (CS), and evaluate the image quality and capability of diagnosis of accelerated 3D Nerve-view sequences.

#### METHOD AND MATERIALS

In a consecutive cohort of 15 patients with suspected disease of brachial plexus underwent MR studies. 3D Nerve-view sequences with 6 different CS accelerating factors (4, 6, 8, 10, 15, 20), and a traditional 3D Nerve-view with 2-fold parallel imaging (sense) as a clinical reference were obtained on a 3T scanner (Ingenia CX, Best, Philips Healthcare). Images were graded by 2 experienced radiologists in MR neurography for image quality (scale of 1 to 5). An Objective quantification analysis of SNR and CNR were also

performed. Beyond that, the similarity between images of the 3D standard sequence and the accelerated sequences was evaluated using the pixelwise root mean square error (RMSE) and structural similarity index (SSIM). The scan time of each sequence were measured. An analysis of variance with repeated measurements and the Friedman test was used to test for potential difference between the sequences.

## RESULTS

The mean values of the RMSE ranged from  $73.38 \pm 15.91$  for CS 8 to  $234.66 \pm 43.56$  for CS 10, while SSIM was highest for CS 4 with  $95.11\% \pm 2.23\%$  and lowest for CS 20 with  $87.90\% \pm 5.32\%$ . The scan time using sense2, CS2,4,6,8,10,15,20 is 11min09s, 5min50s, 3min55s, 2min56s, 2min23s, 1min35s, 1min13s respectively. The two radiologists evaluated all images and mean scored  $4.1 \pm 0.3$  with CS factor below 8. There is no statistical difference in the contrast between the brachial plexus and the surrounding tissue between CS factor 4-8, and the lesion display of the brachial plexus has no statistical difference. The images of CS factor above 8 have no diagnosis value.

## CONCLUSION

In conclusion, CS-3D Nerve-view with factor 8 offer equilibrium between comparable clinical diagnostic quality with less scan time (2min56s)

## CLINICAL RELEVANCE/APPLICATION

CS-3D Nerve-view with factor 8 offer equilibrium between comparable clinical diagnostic quality with less scan time, which potentially increasing the productivity of MR scanners.

## SSE15-06 Compressed Sensing SEMAC MRI of Hip and Knee Arthroplasty Implants at 1.5T and 3T Field Strengths: An Intra-Subject Comparison Study

Monday, Dec. 2 3:50PM - 4:00PM Room: N228

### Participants

Iman Khodarahmi, MD, PhD, New York, NY (*Presenter*) Nothing to Disclose

John A. Carrino, MD, MPH, New York, NY (*Abstract Co-Author*) Research Consultant, Pfizer Inc; Research Consultant, Image Analysis Group (IAG); Research Consultant, Image Biopsy Lab; Research Consultant, Simplify Medical; ; ;

Jan Fritz, MD, Baltimore, MD (*Abstract Co-Author*) Institutional research support, Siemens AG; Institutional research support, Johnson & Johnson; Institutional research support, Zimmer Biomet Holdings, Inc; Institutional research support, Microsoft Corporation; Institutional research support, BTG International Ltd; Scientific Advisor, Siemens AG; Scientific Advisor, General Electric Company; Scientific Advisor, BTG International Ltd; Speaker, Siemens AG; Patent agreement, Siemens AG

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## PURPOSE

Metal artifact reduction MRI of metallic arthroplasty implants at 1.5T field strength has inherently lower susceptibility artifacts than at 3T field strength. However, 3T MRI offers higher signal-to-noise and contrast-to-noise ratios, and allows for higher spatial resolution. In this study, we tested the hypothesis that compressed-sensing (CS) accelerated slice-encoding-for-metal-artifact-correction (SEMAC) MRI of hip and knee arthroplasty implants can generate similar image quality and visibility of periprosthetic abnormalities at 1.5 and 3T field strengths.

## METHOD AND MATERIALS

Thirty patients with symptomatic hip (15) and knee (15) arthroplasty implants were included in this IRB-approved study after giving informed written consent. Each patient underwent consecutive 1.5 and 3T MRI using previously optimized protocols consisting of PD-weighted and STIR CS-SEMAC turbo spin echo pulse sequences in coronal (hip) or sagittal (knee) planes. The 3T protocols utilized 25 SEMAC encoding steps while the 1.5 T protocols used 19 SEMAC encoding steps. The 3T protocols had higher spatial resolution. Each pulse sequence took 4-5 min. Paired PD-weighted and STIR image datasets were separated, anonymized and randomly reassigned. Two musculoskeletal radiologists qualitatively evaluated image quality and the presence of six periprosthetic abnormalities independently. Wilcoxon test, Kendall W agreement, and substitutability testing were applied.

## RESULTS

Image quality of hip and knee studies were over all good with slight non-significant (hip,  $p=0.21$  / knee,  $p=0.33$ ) dominance of 1.5T over 3T. Reader agreements were moderate to very good (W range, 0.53-0.81). Inter-method agreement was overall good (W, 0.67/0.71). For each joint, substitution analysis demonstrated that the higher resolution but slightly longer 3T CS-SEMAC could replace the lower spatial resolution, but faster 1.5T CS-SEMAC technique ( $p$ -value range, 0.41-0.94) in diagnosing the six abnormalities, including periprosthetic osteolysis, synovitis, bone marrow edema, fractures, tendon tears, and extra-capsular collections.

## CONCLUSION

With the use of optimized pulse sequence parameters, 3T CS-SEMAC can generate high-resolution MR images with similar degrees of metal artifact reduction and detection of periprosthetic abnormalities compared to 1.5T CS-SEMAC.

## CLINICAL RELEVANCE/APPLICATION

3T CS-SEMAC has the potential to generate high-resolution MR images without diagnostic compromise.

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SSE16

## Musculoskeletal (Arthritis and Cartilage)

Monday, Dec. 2 3:00PM - 4:00PM Room: N227B



AMA PRA Category 1 Credit™: 1.00  
ARRT Category A+ Credit: 1.00

### Participants

Andrew J. Grainger, MD, Leeds, United Kingdom (*Moderator*) Consultant, Levicept Ltd; Director, The LivingCare Group;  
Kambiz Motamedi, MD, Los Angeles, CA (*Moderator*) Nothing to Disclose

### Sub-Events

#### SSE16-01 Spondyloarthropathy: Improved Sensitivity by Combining UTE with Conventional MRI

Monday, Dec. 2 3:00PM - 3:10PM Room: N227B

### Participants

Yeong Sang Hong, Gwangju, Korea, Republic Of (*Presenter*) Nothing to Disclose  
Eun Hae Park, MD, Jeonju-si, Korea, Republic Of (*Abstract Co-Author*) Nothing to Disclose  
Donghun Kim, Kwangju, Korea, Republic Of (*Abstract Co-Author*) Nothing to Disclose  
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Donghan Shin, Jeonju-si, Korea, Republic Of (*Abstract Co-Author*) Nothing to Disclose

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### PURPOSE

To evaluate whether the combination of ultrashort TE (UTE) sequences and conventional magnetic resonance imaging (MRI) helps to increase diagnostic performance in the diagnosis of spondyloarthropathy compared with those achieved by using each MRI technique alone.

### METHOD AND MATERIALS

The study included 22 sacroiliac joint (SIJ) MRI from 11 spondyloarthropathy (SpA) patients and 52 SIJ MRI from 27 patients without SpA. Three sets of images (UTE only, conventional MR only, combined UTE and conventional MRI) were analyzed independently by 3 reviewers (2 musculoskeletal radiologists, 1 unexperienced radiologist) to diagnose SpA based on bone marrow edema (BME), erosion, sclerosis, and ankyloses. For SpA patients, patient grouping was subdivided to those with BME and those without BME. Diagnostic accuracy, sensitivity, specificity, and positive and negative predictive values were calculated. In those 16 patients with CT, the Pearson correlation test was performed.

### RESULTS

The overall sensitivity was significantly higher for the combined set (92.3%) in the group without BME than those for the conventional MRI-only (89.5%) or UTE-only (81.7%) sets ( $P < 0.05$ ). However, in the group with BME, the UTE-only set showed lower sensitivity (83.8%) compared with the combined (93.3%) and conventional MRI (93.4%) sets ( $P = 0.62$ ). All reviewers did not show a significant difference in specificity for the 3 sets in both groups. The Pearson coefficient of correlation between erosion in UTE and erosion in CT was 0.71 ( $p < 0.001$ ).

### CONCLUSION

UTE provides CT-like images, allowing good depiction of erosion; a combination set of UTE and conventional MRI showed better sensitivity in the diagnosis of SpA, especially in those without BME.

### CLINICAL RELEVANCE/APPLICATION

Recently, BME of the SIJ are reported to be nonspecific findings in SIJ MRI, leaving osseous erosion to be important finding. With UTE providing CT-like imaging, this will help detect early erosion, resulting better diagnosis of SpA.

#### SSE16-02 Are Undifferentiated Arthritis and Pre-Rheumatoid Arthritis Associated with the Longitudinal MRI Features of Knee Osteoarthritis Structural Damage?

Monday, Dec. 2 3:10PM - 3:20PM Room: N227B

### Participants

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**PURPOSE**

Shared inflammatory pathophysiology of osteoarthritis (OA) and inflammatory joint diseases such as Rheumatoid Arthritis (RA) have been suggested previously. Undifferentiated arthritis (UA) and Pre-RA are considered as early stage inflammatory arthropathy before the diagnosis of RA based on clinical criteria; However, UA may persist without ultimate progression to RA. We aimed to investigate the association between knee OA structural damage worsening and clinically defined UA/Pre-RA using 3T-MRI measurements.

**METHOD AND MATERIALS**

This was an IRB-approved and HIPAA-compliant study of 600 subjects from the FNIH project. At the baseline visit, subjects with physician-diagnosed RA were excluded. Participants with any signs of arthritis, but not diagnosed RA, were assessed by connective tissue disease RA screening questionnaire and knee radiography. After exclusions of possible RA subjects (using questionnaire/radiography), the remaining were regarded as UA. Any of the UA-(control) or UA+ subjects who have developed RA in follow-up visits were categorized as Pre-RA. Baseline and 24-month semi-quantitative MRI OA Knee Score (MOAKS) measures of study groups were extracted and analyzed. Logistic regression model, adjusted for age, sex, BMI, and smoking status was used to assess the association between UA/pre-RA and baseline/worsening of MRI-based OA-related structural damages including cartilage thickness/surface scores, Hoffa-synovitis, and effusion-synovitis.

**RESULTS**

Presence of UA was associated with nearly significant structural damage in cartilage surface/thickness scores of whole knee (OR (95%CI): 1.73(0.94-3.1) and 1.73(1.0-3.04)), especially in patellofemoral joint (OR: 2.05(1.16-3.62) and 1.76(0.99-3.07)). In longitudinal assessment, presence of UA was significantly associated with 24-month worsening of lateral tibiofemoral cartilage damage (OR: 2.46(1.1-5.07)). Pre-RA was not significantly related to cartilage damage after adjustments. There was also no association between UA/pre-RA and knee Hoffa-synovitis/effusion-synovitis.

**CONCLUSION**

Positive history of UA is associated with the concurrent knee joint cartilage defects at baseline, and its worsening over 24-months.

**CLINICAL RELEVANCE/APPLICATION**

Knee OA characteristic cartilage defects are probable in UA subjects despite absence of knee effusion/synovitis. This finding warrant further investigations for altered OA outcomes in subjects with UA but not definitive RA diagnosis.

**SSE16-03 Diagnostic Performance of Texture Analysis for Differentiation of Inflammation versus Degeneration in the Sacroiliac Joints**

Monday, Dec. 2 3:20PM - 3:30PM Room: N227B

**Participants**

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**PURPOSE**

to investigate the performance of texture analysis (TA) for differentiation of inflammation from degeneration in sacroiliac joints (SIJ).

**METHOD AND MATERIALS**

MR images of SIJ from patients with clinically established ankylosing spondyloarthritis (AS), degenerative changes and healthy individuals (30 patients each) were analyzed retrospectively. Two residents blinded to each other rated typical structural and inflammatory changes on a four-point Likert scale and categorized patients into different groups, using paracoronal sets of TIRM, T1w and T1w fat-sat contrast enhanced (T1wCE) images. Additionally, same-sized regions of interest were placed into pathologic (where applicable) or random healthy spots of SIJ. TA was performed with opensource software (MaZda). Logistic regression with ten-fold cross validation was applied to detect relations with clinical labels. Standard statistical testing was applied for interreader agreements (IA) and regarding distribution of qualitative and TA findings among the clinical categories.

**RESULTS**

Moderate IA was present for categorization into different groups ( $k=.40$ ). Qualitative ratings showed weak to moderate IA, but cumulative qualitative scores differed significantly among patient categories ( $p<.001$ ). TA showed perfect IA ( $k>.80$ ) for 203, 194 and 210 features in TIRM, T1w & T1wCE, respectively. TA outperformed qualitative evaluation for differentiation between AS vs. non-AS (AUC=.89 vs. .75 for TA vs. qualitative) and between AS vs. degeneration (AUC=.91 vs. .66). MR sets showed different impact on TA based differentiation of AS vs. non-AS with AUCs of .74, .76 and .81 for TIRM, T1w and T1wCE.

**CONCLUSION**

TA improves accuracy in differentiation of AS from degeneration in the SIJ. Its performance is predominantly determined by T1wCE images.

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

Determining the aetiology of chronic and acute changes in the sacroiliac joints is an everlasting difficulty in clinical and radiological routine. This work presents a quantitative approach that may help in valid identification of patients with axial spondylarthritis from the remainders, which would imply an impact on further patient management and conservative treatment.

#### **SSE16-04 Quantitative MR Blood Perfusion Patterns of Infrapatellar Fat Pad T2 Hyperintense Lesions on Unenhanced MR in Patients with and without Knee Osteoarthritis**

Monday, Dec. 2 3:30PM - 3:40PM Room: N227B

##### **Participants**

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#### **PURPOSE**

Infrapatellar fat pad (IPFP) T2 hyperintense lesions on unenhanced MR are an important imaging feature of knee osteoarthritis (OA) and are thought to represent inflammation. These lesions are very common, though, also in non-OA subjects, and may not always be linked to inflammation. This leads to the hypothesis that IPFP lesions may have different pathophysiological subtypes. The aim of this study was to evaluate quantitative blood perfusion parameters within T2 hyperintense lesions in patients with knee OA, with patellofemoral pain (PFP) (supposed precursor of OA), and in control subjects.

#### **METHOD AND MATERIALS**

43 healthy controls, 35 patients with PFP and 22 patients with knee OA were included. All underwent MRI including T2-mapping and dynamic contrast enhanced (DCE)-MRI. Image registration was used to correct for motion. If present, hyperintense T2 lesions in the IPFP were delineated on T2 maps using Horos software (Horosproject.org, USA). A second region was drawn in an adjacent area without T2 signal intensity alteration. Quantitative perfusion parameters (K<sub>trans</sub>, V<sub>e</sub>, V<sub>p</sub>) were extracted by fitting the extended Tofts' pharmacokinetic model where K<sub>trans</sub> represents the inflow, V<sub>e</sub> the extravascular extracellular space and V<sub>p</sub> vascular fraction of the region. A paired Wilcoxon-signed-rank test was used to compare regions with and without T2 lesions within subjects for each subgroup.

#### **RESULTS**

IPFP T2 hyperintense lesions were present in 14 controls, 13 PFP patients and 16 knee OA patients. Perfusion parameters were not statistically significantly different between areas with and without a T2 lesion within controls and PFP patients. In knee OA patients, the lesions demonstrated statistically significantly higher values of K<sub>trans</sub> and V<sub>e</sub> compared to an area without a lesion. Remarkably, all regions drawn in knee OA demonstrated higher perfusion parameters, including V<sub>p</sub>, compared to the other groups.

#### **CONCLUSION**

IPFP T2 hyperintense lesions are non-specific. In contrast to morphologically similar lesions in PFP patients and controls in knee OA patients IPFP hyperintense lesions are associated with higher perfusion, suggesting inflammation and neo-angiogenesis.

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

OA has a tremendous societal burden, but the pathophysiology remains unknown. Quantitative DCE-MRI can serve as a method to unravel certain aspects of the pathophysiology of OA.

#### **SSE16-05 Radiographic Hand Osteoarthritis and Its Association with Worsening of MRI-Based Tibiofemoral Osteoarthritis-Related Structural Damage**

Monday, Dec. 2 3:40PM - 3:50PM Room: N227B

##### **Participants**

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Shadpour Demehri, MD, Baltimore, MD (*Abstract Co-Author*) Research support, General Electric Company; Research Grant, Carestream Health, Inc; Consultant, Toshiba Corporation

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#### **PURPOSE**

To determine whether the presence of hand osteoarthritis (OA) is associated with radiographic knee OA progression (over 48-months) and MRI-based knee OA structural damage worsening (over 24-months).

## METHOD AND MATERIALS

600 subjects from the Foundation for the National Institute of Health (FNIH) project which is an IRB approved HIPAA compliant study were included (one index knee and hand in each subject). Baseline hand radiography of all subjects was measured for the presence of hand OA (modified Kellgren and Lawrence (mKL) grade >2 in each hand joints). Baseline and follow-up knee radiographic measurements and MRI OA Knee Score (MOAKS) variables for cartilage damage, bone marrow lesions, osteophytes, effusion, and Hoffa-synovitis as well as MRI-based knee periarticular bone area measurements were extracted. The association between the presence of hand OA (presence vs. absence of hand OA in each hand joint) and 48-months radiographic knee OA progression (>0.7mm reduction in medial tibiofemoral joint space width) as well as 24-months change in knee MOAKS and periarticular bone measurements were analyzed using regression model (adjusted for age and sex).

## RESULTS

Presence of any carpometacarpal (CMC) OA (OR 95%CI: 1.58(0.96-2.62)) and overall hand OA (presence of any mKL>2 in all hand joints) (OR 95%CI: 1.44(0.97-2.07)) was associated with 48-month radiographic knee OA progression (approached but not reached significance). In comparison with controls, subjects with hand OA showed higher odds of worsening tibial/femoral cartilage damage (OR 95%CI: 1.38(0.95-2.01) and 1.79(1.24-2.58)) and femoral periarticular bone area expansion (Beta 95%CI: 10.54(1.40-19.69)) over 24-months. CMC OA and 24-months worsening of MRI-based tibiofemoral cartilage damage and periarticular bone area expansion were also showed approached significant associations.

## CONCLUSION

Presence of hand OA, especially in CMC joint, is associated with longitudinal MRI-based knee OA-related structural damage worsening including tibial/femoral cartilage damage and periarticular bone area expansion.

## CLINICAL RELEVANCE/APPLICATION

Hand OA (specifically CMC OA), as a marker of generalized OA, may be considered a predictor of more rapid progression of knee OA compared to patients without hand OA, which might be of relevance for inclusion in clinical trials of disease modifying OA drug development.

## SSE16-06 Assessment of the Angular Dependence of Multicomponent Driven Equilibrium Single Pulse Observation of T1 and T2 (mcDESPOT) in Patellar Cartilage Samples

Monday, Dec. 2 3:50PM - 4:00PM Room: N227B

### Participants

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## PURPOSE

To evaluate the magic angle sensitivity of Multicomponent and Single-component parameters of Multicomponent Driven Equilibrium Single Pulse Observation of T1 and T2 (mcDESPOT) in imaging the cadaveric human patellar cartilage samples on a clinical 3T scanner.

## METHOD AND MATERIALS

mcDESPOT was prospectively performed on 3 human patellar cartilage samples. Imaging parameters were: FOV=4cm, slice thickness=0.5mm, rBW=125kHz, SPGR TR/TE=11.6ms/3.1ms, IR-SPGR TR/TE=9ms/3.1ms, TI=450ms, SSFP TR/TE=12.2ms/6.1ms, SPGR FA=3,4,5,6,7,9,13,18°, SSFP FA=2,5,10,15,20,30,40,50°; IR-SPGR FA=5°, matrix=160×160×26, and total scan time=21min. The imaging was performed three times, each with a different orientation (0°, 55°, and 90° relative to B0). Regional analysis (superficial/middle/deep layer and global) was applied. Single-component T1/T2 relaxation time (T1/T2 Single) and the corresponding T1/T2 proton density (T1/T2 PD), multicomponent T1/T2 relaxation times of the fast relaxing water component (T1f/T2f) and of the slow relaxing water component (T1s/T2s), and fraction of the fast relaxing water component (Ff) were measured, and their angular dependence were analyzed.

## RESULTS

Figure 1 shows T1 single values which show the smallest magic angle effect with 5.1% decrease from 1644.5 ms at 0° to 1562.3 ms at 55°. Ff values show a decreased magic angle effect with 48.4% decrease from 15.5 % at 0° to 8.0% at 55°. T2f values show the largest magic angle effect with 200.0% increase from 9.5 ms at 0° to 27.3 ms at 55°. Different degrees of magic angle effect were also observed for T1s, T1f, T1PD, T2PD, T2s and T2 single with a decrease of 19.5%, 26.3%, and increased of 38.4%, 42.2%, 79.3%, 181.8% respectively, by rotating the cartilage samples from 0 to 55 degrees relative to the B0 field. The values of Ff decrease from the deep layer to the superficial layer for all angular orientations. T2f and Ff maps show increased T2f and decreased Ff in patellar cartilage by rotating the cartilage samples from 0 to 55 degrees relative to the B0 field, and the changes in T2f are more obvious than those in Ff.

## CONCLUSION

T1, T1s, T1f, T1PD, T2PD, and Ff show much reduced magic angle effect as compared to T2, T2s and T2f. Ff provides reduced magic angle sensitivity in the evaluation of cartilages as compared to T2, T2s and T2f.

## CLINICAL RELEVANCE/APPLICATION



Ff is less sensitive to the magic angle effect than T2, T2s and T2f, and may provide more accurate diagnosis for early OA.

Printed on: 10/29/20



SSE17

## Nuclear Medicine (Cardiovascular PET)

Monday, Dec. 2 3:00PM - 4:00PM Room: S403A

CA NM VA

AMA PRA Category 1 Credit™: 1.00  
ARRT Category A+ Credit: 1.00

FDA Discussions may include off-label uses.

### Participants

Peter S. Conti, MD, PhD, Los Angeles, CA (*Moderator*) Consultant, Canon Medical Systems Corporation; Consultant, Bayer AG; Consultant, Lantheus Medical Imaging, Inc;  
Don C. Yoo, MD, Lexington, MA (*Moderator*) Consultant, inviCRO, LLC

### Sub-Events

#### SSE17-01 To Evaluate the Role of 18F-FDG PET/CT in Prosthetic Vascular Graft Infection

Monday, Dec. 2 3:00PM - 3:10PM Room: S403A

### Participants

Sikandar M. Shaikh, DMRD, Hyderabad, India (*Presenter*) Nothing to Disclose

### PURPOSE

Graft infection after prosthetic vascular reconstruction is an uncommon nowadays due to utmost spot surgical care however severe complication. The clinical presentation is often subtle and nonspecific and may occur long after surgery. Although defining a prosthetic vascular graft infection can be difficult, early diagnosis and treatment are important because of the relatively high rates of amputation and death. The present study assessed the role of PET/CT using 18F-FDG for the diagnosis of vascular graft infections

### METHOD AND MATERIALS

Nineteen patients (15 men and 4 women; age range, 44-71 y) with suspected vascular graft infection underwent 18F-FDG PET/CT. The performance of PET/CT for the diagnosis of an infectious process and its localization to the graft or soft tissues was assessed. The final diagnosis was based on histopathologic findings and microbiologic assays obtained at surgery or on clinical and imaging follow-up.

### RESULTS

PET/CT detected foci of increased 18F-FDG uptake suspected as infection in 14 patients and localized these findings to the graft in 8 patients. Vascular graft infection was confirmed in 7 of these patients (88%). PET/CT excluded graft involvement in 5 patients, and in 5 (91%) of these 5, long-term follow-up further confirmed that the infectious process was limited to surrounding soft tissues only. No abnormal 18F-FDG uptake was found in any of the 6 patients with no further evidence of infection. PET/CT had a sensitivity of 93%, specificity of 91%, positive predictive value of 88%, and negative predictive value of 96% for the diagnosis of vascular graft infection.

### CONCLUSION

18F-FDG PET/CT is a reliable noninvasive imaging modality for the diagnosis of vascular graft-related infection. The precise anatomic localization of increased 18F-FDG uptake provided by PET/CT enables accurate differentiation between graft and soft-tissue infection.

### CLINICAL RELEVANCE/APPLICATION

Thus 18F-FDG PET/CT is a reliable noninvasive imaging modality for the diagnosis of vascular graft-related infection

#### SSE17-02 Usefulness of <sup>11</sup>C-PiB PET/CT for Diagnosing Cardiac Amyloidosis

Monday, Dec. 2 3:10PM - 3:20PM Room: S403A

### Participants

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### PURPOSE

<sup>11</sup>C-Pittsburgh compound B (PiB) has been promising PET tracer for evaluating amyloid deposition in myocardium. The purpose of this study was to investigate the usefulness of PiB PET/CT for the detection of cardiac amyloidosis using retention index (RI)

images and standardized uptake value (SUV) images.

## METHOD AND MATERIALS

PiB PET/CT studies were performed in 12 patients with cardiac amyloidosis (ATTR: 5, AL: 5, AA: 1 and unknown: 1) and 6 patients without cardiac amyloidosis. A 30-min dynamic emission scan of the heart was obtained immediately after bolus injection of PiB. The RI was calculated as the mean PiB radioactivity concentration between 15 and 25 min after injection divided by the integral of the arterial time-activity curve between 0 and 20 min after injection. The SUV images (at 10-20 min and 20-30 min) were reconstructed. RI and SUV images were visually evaluated. SUV images were also semiquantitatively evaluated using myocardium-to-blood pool ratio (MBR).

## RESULTS

PiB uptake was visually evident in all 12 patients with cardiac amyloidosis on RI image, in 11/12 patients on 10-20min SUV image and in 7/12 patients on 20-30min SUV image. Myocardial PiB uptake was not observed in all 6 patients without cardiac amyloidosis on both SUV and RI images. The mean ( $\pm$ SD) value of MBR in cardiac amyloidosis on SUV images at 10-20 min and 20-30 min was significantly higher ( $2.01\pm 0.78$  and  $1.70\pm 0.75$ , respectively) than that of patients without cardiac amyloidosis ( $1.07\pm 0.13$  and  $0.92\pm 0.14$ , respectively) ( $p=0.010$  and  $0.024$ ). With a cutoff MBR of 1.5 on 10-20min SUV image, the sensitivity and specificity were 100% and 92%, respectively. The mean ( $\pm$ SD) value of MBR in AL type cardiac amyloidosis patients on SUV images at 10-20 min and 20-30 min was higher ( $2.36\pm 1.12$  and  $1.98\pm 1.10$ , respectively) than that of ATTR type cardiac amyloidosis patients ( $1.88\pm 0.18$  and  $1.65\pm 0.20$ , respectively), however, there were no significant differences between two types of cardiac amyloidosis.

## CONCLUSION

These preliminary results indicate that PiB PET/CT using RI images and SUV images were likely to be a useful imaging modality for cardiac amyloidosis.

## CLINICAL RELEVANCE/APPLICATION

PiB PET/CT using RI images and SUV images were likely to be a useful imaging modality for diagnosing cardiac amyloidosis.

### SSE17-03 Varying Correlation between Inflammation and Microvascularization in Carotid Atherosclerotic Plaques with Hybrid $^{18}\text{F}$ -FDG PET/MR

Monday, Dec. 2 3:20PM - 3:30PM Room: S403A

#### Participants

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## PURPOSE

Hallmarks of vulnerable atherosclerotic plaques are inflammation that can be quantitatively assessed with  $^{18}\text{F}$ -fluorodeoxyglucose positron emission tomography ( $^{18}\text{F}$ -FDG-PET), and increased neovascularization that can be evaluated by dynamic contrast-enhanced magnetic resonance imaging (DCE-MRI). It remains unclear whether these parameters are correlated or represent independent imaging parameters. This study determines to investigate the correlation between inflammation and neovascularization in atherosclerotic carotid plaques by performing hybrid  $^{18}\text{F}$ -FDG PET/MR.

## METHOD AND MATERIALS

Twenty-five patients with transient ischemic attack or minor stroke in the carotid territory and ipsilateral carotid artery stenosis of 30% to 69% were included. All patients underwent hybrid PET/MR a median of 180 min after injection of  $^{18}\text{F}$ -FDG.  $^{18}\text{F}$ -FDG standard uptake values with target/background ratio (TBR) were determined. Neovascularization was quantified by transfer constant (Ktrans). Spearman rank correlation coefficients between TBR and Ktrans were calculated.

## RESULTS

Results: The correlation between TBR and Ktrans was only marginal in the whole study sample ( $r=0.25$ ,  $p=0.043$ ). The two variables correlated with each other in the symptomatic plaques ( $r=0.71$ ,  $p=0.013$ ), but were independent in the asymptomatic plaques ( $r=0.03$ ,  $p=0.473$ ). Neither TBR nor Ktrans was significantly higher in the symptomatic plaques, but both showed inverse relationships with time since last cerebrovascular ischemic event ( $r=-0.92$  and  $-0.74$  for TBR and Ktrans, respectively).

## CONCLUSION

The correlation between inflammation and microvascularization in carotid atherosclerotic plaques with hybrid  $^{18}\text{F}$ -FDG PET/MR varied with clinical conditions, pointing to a complex interplay between macrophages and neovessels under different pathophysiological conditions. The moderate correlation shown only in symptomatic plaques indicates the presence of acute plaque inflammation with increased metabolic activity and cytokine production by inflammatory cells. Hybrid  $^{18}\text{F}$ -FDG PET/MR systems can help to evaluate the correlation between inflammation and microvascularization in carotid atherosclerotic plaques.

## CLINICAL RELEVANCE/APPLICATION

Hybrid  $^{18}\text{F}$ -FDG PET/MR systems can help to evaluate the correlation between inflammation and microvascularization in carotid atherosclerotic plaques and this exam is recommended when the underlying cause of such a lesion is unclear.

### SSE17-04 Brown Fat Activation Demonstrated on FDG PET/CT Predicts Favorable Lipid Profile and Reduced Risk of Diabetes

Monday, Dec. 2 3:30PM - 3:40PM Room: S403A

## Participants

Sonya Y. Park, MD, Seoul, Korea, Republic Of (*Presenter*) Nothing to Disclose

## PURPOSE

Brown adipose tissue (BAT) plays a key role in energy homeostasis, conferring protection against diet-induced obesity, and has even been suggested as a potential target for the treatment of obesity and metabolic syndrome. The purpose of this study was to compare the metabolic outcomes (lipid profile and diabetes) of patients with and without BAT activity on FDG PET/CT.

## METHOD AND MATERIALS

PET/CT exams from 1834 breast cancer patients were retrospectively reviewed for bilateral symmetric elongated FDG activity in the neck and chest, typical of BAT activation. To account for temperature changes in the environment, patients with BAT activity and those who underwent PET/CT exams on the same day (but without BAT activity) were included in the study. Blood glucose, lipid profile and presence of diabetes at baseline and last clinical follow-up (mean follow-up of 57 months) were recorded. Comparison of the groups with and without BAT activity was done using Mann Whithney U-test. Development of diabetes was analyzed with respect to the other clinical variables using Cox proportional hazard model.

## RESULTS

1.1% (20/1834) of the patients who underwent PET/CT demonstrated BAT activation, and 119 patients were analyzed for comparison as the group without BAT activity. The group with BAT activity showed significantly lower age (mean 41.8 vs. 53.7,  $p < 0.001$ ), BMI (mean 22.0 vs. 23.6,  $p = 0.049$ ), blood glucose (mean 90.3 vs. 109.3,  $p = 0.029$ ) and total cholesterol (mean 169.4 vs. 190.4,  $p = 0.029$ ) than the group without. At last clinical follow-up, the group with BAT activity showed little change in terms of triglyceride and total cholesterol levels, but increased HDL (mean 45.5 to 60.8) and decreased LDL (mean 115.5 to 85.6). Presence of BAT activity was the only statistically significant predictor for diabetes on Cox regression ( $p = 0.014$ ), with a hazard ratio of - 9.007.

## CONCLUSION

Patients with BAT activity demonstrated the characteristic traits of lower age, BMI, blood glucose and total cholesterol at baseline, and showed a favorable change in lipid profile on follow-up. The hazard for this group was also lower than for the group without BAT activity in terms of diabetes, further suggesting the role of brown fat in lipoprotein metabolism.

## CLINICAL RELEVANCE/APPLICATION

Mention of brown adipose tissue activity is recommended when visualized on FDG PET/CT, due to the added information it offers regarding lipoprotein metabolism.

## SSE17-05 Assessment of Aortic Involvement in Takayasu Arteritis with FDG PET during the Immunosuppressive Therapy

Monday, Dec. 2 3:40PM - 3:50PM Room: S403A

## Participants

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## PURPOSE

F-18 fluorodeoxyglucose (FDG) positron emission tomography (PET) is a promising technique for the diagnosis of Takayasu arteritis (TAK). The severity of FDG uptake in the aortic wall is often evaluated by the comparison with liver uptake; whereas, the FDG uptake in the liver has been discussed to be affected by prednisone (PSL) and tocilizumab (TCZ), which are the common treatment of TAK. Moreover, the optimal evaluation of aortic involvement with FDG PET in TAK during the immunosuppressive therapy (IST) has not been established enough. The aim of this study was to elucidate the influence of PSL and TCZ on liver FDG uptake and to find out the appropriate assessment of FDG uptake in the aortic wall in TAK patients during IST.

## METHOD AND MATERIALS

Twenty-five consecutive TAK patients during IST were examined with FDG PET. We excluded 6 patients with a history of total arch replacement. Of 19 patients, 11 patients were treated with only PSL (PSL group) and 8 patients received TCZ with/without PSL (TCZ group). First, the maximum standardized uptake value (SUVmax) of the aortic wall, liver, and lumen blood pool was calculated. Next, the aortic wall to liver FDG uptake ratio [target-to-liver uptake ratio (TLR)] and the aortic wall to lumen ratio [target-to-background ratio (TBR)] were determined. Furthermore, TLR and TBR were compared between the patients remaining symptoms (Active,  $n = 12$ ) and the patients with no clinical complaint (Inactive,  $n = 7$ ).

## RESULTS

First, SUVmax in the liver was significantly lower in TCZ group than PSL group ( $2.36 \pm 0.15$  vs.  $3.08 \pm 0.13$ ,  $p < 0.01$ ). Secondly, there was no significant difference in TLR between Active and Inactive; on the other hand, TBR was significantly higher in Active than Inactive ( $1.45 \pm 0.07$  vs.  $1.14 \pm 0.09$ ,  $p = 0.01$ ). Based on ROC curve analysis, the optimal TBR cut-off value for detecting active inflammation in the aortic wall was 1.35 with the sensitivity of 72% and specificity of 100%.

## CONCLUSION

Since liver FDG uptake was susceptible to IST, the comparison with the liver uptake might not be recommended for the assessment of persistence or recurrence of aortic involvement with FDG PET. TBR is more appropriate to evaluate the aortic involvement in TAK during IST.

## CLINICAL RELEVANCE/APPLICATION

IST for TAK affects the FDG distribution in the liver. For the assessment of aortic involvement in TAK during IST, it is more appropriate to compare the FDG uptake in the aortic wall with the lumen blood pool.

## SSE17-06 Vulnerable Plaque Features Can Be Detected in Carotid Plaques with Hybrid 18<sup>F</sup>-FDG PET/MR Imaging

Monday, Dec. 2 3:50PM - 4:00PM Room: S403A

### Participants

Yue Zhang, MD, Beijing, China (*Presenter*) Nothing to Disclose  
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### PURPOSE

To investigate morphological and biological features of vulnerable carotid atherosclerotic plaques in patients with known increased risk of atherosclerosis with hybrid 18F-FDG PET/MR imaging.

### METHOD AND MATERIALS

Sixteen patients with known increased risk of atherosclerosis underwent hybrid PET/MR of the carotid arteries after injection of 18F-FDG. PET/MR was performed a median of 180 min after injection. American Heart Association (AHA) lesion type and plaque composition were determined on consecutive MRI axial sections in both carotid arteries. 18F-FDG uptake in carotid arteries was quantified using maximum standardized uptake values (SUVmax) and tissue to background ratio (TBR) on corresponding PET sections.

### RESULTS

The prevalence of complicated atherosclerotic plaques (AHA lesion type VI) detected with high-resolution MRI was significantly higher in the carotid artery ipsilateral to the ischemic stroke as compared to the contralateral side (31 vs 0 %;  $p=0.006$ ). Atherosclerotic plaques classified as vulnerable with MRI (AHA lesion type VI) were associated with higher 18F-FDG uptake in comparison with other AHA lesions (SUVmax=3.31±1.13 vs 1.61±0.68 and 0.91±0.37; TBR=3.21±1.04 vs 1.56±0.53 and 0.88±0.26, respectively;  $p<0.001$ ).

### CONCLUSION

Morphological and biological features of vulnerable plaques can be detected with 18F-FDG PET/MR in patients with known increased risk of atherosclerosis. Hybrid 18F-FDG PET/MR systems might help in the evaluation of patients with vulnerable carotid atherosclerotic plaques.

## CLINICAL RELEVANCE/APPLICATION

Hybrid 18F-FDG PET/MRI systems can help in the evaluation of patients with vulnerable carotid atherosclerotic plaques.

Printed on: 10/29/20



SSE18

## Neuroradiology (Epilepsy/Metabolism/Infection)

Monday, Dec. 2 3:00PM - 4:00PM Room: S401CD



AMA PRA Category 1 Credit™: 1.00  
ARRT Category A+ Credit: 1.00

### Participants

Diana M. Gomez-Hassan, MD, PhD, Ann Arbor, MI (*Moderator*) Nothing to Disclose  
Christopher T. Whitlow, MD, PhD, Winston-Salem, NC (*Moderator*) Nothing to Disclose

### Sub-Events

#### SSE18-01 Functional Brain Connectivity in Periventricular Nodular Heterotopia

Monday, Dec. 2 3:00PM - 3:10PM Room: S401CD

### Participants

Sidney Krystal, MD, Paris, France (*Presenter*) Nothing to Disclose  
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Julien Savatovsky, MD, Saint Mandé, France (*Abstract Co-Author*) Nothing to Disclose  
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### PURPOSE

Periventricular nodular heterotopia (PNH) consists of ectopic grey matter nodules accumulation, corresponding to small epileptogenic foci. Network analysis have been widely used to characterize brain network organization and changes in epileptic brains. Our objectives were to analyse network alterations in PNH.

### METHOD AND MATERIALS

16 PNH patients and 32 healthy controls matched to age and gender underwent a resting-state functional 3T-MRI. We first assessed the relevance of heterotopic nodules' signal by computing the amplitudes of low-frequency fluctuations (ALFF). Then, we analysed the nodular-cortical connectivity with respect to cortico-cortical connectivity. We analysed the relationships between nodular connectivity and geodesic distance to nodule as well as resting-state networks. Finally, from cortico-cortical functional connectivity matrices, network features such as clustering coefficient (CC) and path length (PL) were computed and compared between PNH patients and controls, based on graph theory.

### RESULTS

In heterotopic nodules, ALFF was significantly higher than in white matter: 0.30 vs 0.01 ( $p < 0.001$ ), and lower than in grey matter: 0.30 vs 0.54 ( $p < 0.001$ ). Functional connectivity between heterotopic nodules and grey matter was significantly lower with respect to cortico-cortical connectivity. Nodular-cortical connectivity was significantly anti-correlated to geodesic distance to nodule ( $p = 0.01$ ), and heterotopic nodules were mostly connected to the visual, the dorsal attention and the ventral attention networks. When comparing to controls, functional connectivity was significantly decreased in PNH patients ( $p = 0.02$ ), with a decreased small-world organization: decrease in CC ( $p = 0.03$ ) and increase in PL ( $p = 0.01$ ).

### CONCLUSION

We found for the first time whole-brain network changes in PNH, such as decrease in small-world organization, which could explain decrease in information processing speed encountered in those patients. We also analysed functional connectivity between heterotopic nodules and neocortex, that could explain the functional impact of nodules' surgical resection. Our results are consistent with studies in other focal seizures etiologies, and allow a better understanding of epileptogenicity in PNH.

### CLINICAL RELEVANCE/APPLICATION

Resting-state functional MRI and graph theory are useful to explain epileptogenicity and should be more widely used to understand pathophysiological mechanisms in focal epilepsy.

#### SSE18-02 Cortical Thickness Changes in Newly Diagnosed MRI Negative Pediatric Generalized Epilepsy Patients

Monday, Dec. 2 3:10PM - 3:20PM Room: S401CD

### Participants

Mohamed H. Elgendy, MD, Stony Brook, NY (*Presenter*) Nothing to Disclose  
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Emilio Garrido Sanabria, MD, PhD, Stony Brook, NY (*Abstract Co-Author*) Nothing to Disclose  
Lev Bangiyev, DO, Stony Brook, NY (*Abstract Co-Author*) Nothing to Disclose  
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**PURPOSE**

Patients with generalized epilepsy undergo neuroanatomical changes along their disease course. Previous studies have shown cortical thickness changes in this disease population but with a longer disease duration. The goal of our study was to detect cortical thickness changes in newly-diagnosed pediatric generalized epilepsy patients.

**METHOD AND MATERIALS**

Generalized epilepsy patients (N=14) and controls (N=14) were studied. Our patient population included: 14 magnetic resonance (MR) negative patients diagnosed with generalized epilepsy and a mean duration of 1 year. The mean age was 16.5 years and the mean age of seizure onset was 15.5 years. EEG was collected and showed generalized pattern with clear background in most of our patient population. FreeSurfer was used to analyze cortical thickness in both patients and age-matched controls.

**RESULTS**

Pediatric generalized epilepsy patients showed decreased cortical thickness in both hemispheres in the anterior cingulate cortex and medial superior frontal regions.

**CONCLUSION**

Morphometric analysis in epileptic patients with negative MR showed thinner cortices in both hemispheres in the anterior cingulate cortex and medial superior frontal regions when compared to control group. To the best of our knowledge, this is the first study reporting that a decrease in cortical thickness decreases can be detected within about one year of seizure onset.

**CLINICAL RELEVANCE/APPLICATION**

Understanding the early changes in generalized epilepsy may prove useful in drug selection, improvement of clinical outcome and in the prediction of long-term cognitive impairments. The role of anterior cingulate cortex and medial superior frontal regions in the pathogenesis of generalized epilepsy or in resulting neurological disturbances remains to be investigated.

**SSE18-03 Comparison of the Diagnostic Accuracy of FDG-PET/MR to that of FDG-PET/CT for Epileptogenic Zone Detection**

Monday, Dec. 2 3:20PM - 3:30PM Room: S401CD

**Participants**

Kazufumi Kikuchi, MD, PhD, Fukuoka, Japan (*Presenter*) Nothing to Disclose  
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Yoshiyuki Kitamura, Fukuoka, Japan (*Abstract Co-Author*) Nothing to Disclose  
Shingo Baba, Fukuoka, Japan (*Abstract Co-Author*) Nothing to Disclose

**PURPOSE**

To compare the diagnostic accuracy of FDG-PET/MR and that of FDG-PET/CT with respect to identifying epileptogenic zone (EZ) in patients with localization-related epilepsy

**METHOD AND MATERIALS**

This prospective study was approved by our institutional review boards, and written informed consent was obtained from each participant. Between November 2014 and April 2018, thirty-one patients (17 males, 14 females; 8-58 years; median 31 years) were evaluated. All patients were firstly scanned by FDG-PET/CT system for a diagnosis of localization-related epilepsy, then followed by FDG-PET/MR system immediately after. Two series of FDG-PET images acquired using PET/CT and PET/MR were interpreted independently by five board-certified radiologists. All readers were blinded to clinical data including the laterality of seizure as well as electroencephalogram. A Likert scale scoring system was used to assess image quality. The epileptogenic zone was histopathologically proven after surgery. Diagnostic sensitivities and Likert scale scores derived from both PET/MR and PET/CT were compared using the paired t-test. A  $P < 0.05$  was considered significant.

**RESULTS**

Diagnostic sensitivity derived from PET/MR was higher than that from PET/CT ( $83.2 \pm 5.3\%$  vs.  $61.9 \pm 2.7\%$ ,  $P = 0.0006$ ). Image quality score derived from PET/MR was higher than that from PET/CT ( $2.66 \pm 1.45$  vs.  $1.66 \pm 1.49$ ,  $P < 0.0001$ ).

**CONCLUSION**

The diagnostic accuracy of FDG-PET/MR was superior to that of PET/CT for detection of EZ in patients with localization-related epilepsy.

**CLINICAL RELEVANCE/APPLICATION**

FDG-PET/MR provides the accurate information of epileptogenic zone, which improves outcome of patient with localization-related epilepsy.

**SSE18-04 Metabolic Connectivity Can Help Predict Seizure Outcomes in Temporal Lobe Epilepsy Surgery**

Monday, Dec. 2 3:30PM - 3:40PM Room: S401CD

**Participants**

Mohamed Tantawi, MBCh, Philadelphia, PA (*Presenter*) Nothing to Disclose  
Mahdi Alizadeh, Philadelphia, PA (*Abstract Co-Author*) Nothing to Disclose  
Caio Matias, Philadelphia, PA (*Abstract Co-Author*) Nothing to Disclose

## **PURPOSE**

The understanding of epilepsy as a network disorder introduced the idea of using the brain connectome as a prognostic indicator. The objective of this study is to assess the potential of metabolic connectivity as a predictive factor of outcome in epilepsy surgery by examining preoperative metabolic connectivity in patients who underwent Laser interstitial Thermal Therapy (LITT) for medically resistant temporal lobe epilepsy (TLE).

## **METHOD AND MATERIALS**

In this study, we collected positron emission tomography (PET) scans from 24 TLE patients who had unilateral mesial temporal sclerosis. At 1 year follow up after surgery 13 patients were seizure free (Engel class IA), but 11 patients had recurrent seizures and were classified as not seizure free (non-IA class). Initially, PET scans were preprocessed using SPM12. Next, connectivity matrices were constructed based on the correlation of interregional glucose metabolic values within subjects. Finally, graph theoretical analysis was performed using Brain Analysis using Graph Theory (BRAPH) software.

## **RESULTS**

Metabolic network organization in the seizure free group differed substantially compared with the not seizure-free group. Compared with seizure free patients, the temporal pole and cingulate regions had higher connectivity with the surrounding areas in the not seizure free group, while multiple regions including cingulate, precentral gyri, postcentral gyri, and superior parietal gyrus were highly clustered with surrounding nodes indicating greater functional segregation.

## **CONCLUSION**

Our study demonstrated a relationship between presurgical metabolic connectivity and post-surgical seizure outcome of the patients who had LITT surgery and the potential role as an imaging biomarker to predict surgical outcomes in this patient cohort. Extension of the disease to extratemporal networks, specifically the limbic network, plays a role in seizure recurrence after surgery. Although MTS typically involves sclerosis of the hippocampus, we can conclude that this pathology will involve other medial structures in the temporal lobes of the brain as well as neuronal connections projecting to other structures involving the limbic system, such as the temporal pole and cingulate.

## **CLINICAL RELEVANCE/APPLICATION**

Combined with the current tests used in clinical practice, metabolic connectivity may be used as an additional prognostic/diagnostic factor during pre-surgical evaluation for refractory TLE patients.

## **SSE18-05 Resting-State Functional Network Topology Correlates with Surgical Outcome in Temporal Lobe Epilepsy**

Monday, Dec. 2 3:40PM - 3:50PM Room: S401CD

### Participants

Matthew N. Desalvo, MD, Boston, MA (*Abstract Co-Author*) Nothing to Disclose  
Linda Douw, Amsterdam, Netherlands (*Abstract Co-Author*) Nothing to Disclose  
Naoro Tanaka, MD, PhD, Boston, MA (*Abstract Co-Author*) Nothing to Disclose  
Andrew J. Cole, Boston, MA (*Abstract Co-Author*) Nothing to Disclose  
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## **PURPOSE**

To correlate resting-state functional network topology and surgical outcome in patients with medically refractory temporal lobe epilepsy (TLE).

## **METHOD AND MATERIALS**

Data from forty patients with medically intractable temporal lobe epilepsy were retrospectively analyzed. All (40/40) patients underwent pre-operative resting-state functional magnetic resonance imaging (fMRI) and subsequent unilateral anterior temporal lobectomy. Postoperative seizure-free status was categorized using the Engel Epilepsy Surgery Outcome Scale. Resting-state functional connectivity networks were analyzed for each subject using a minimum spanning tree (MST) approach, and global and regional network properties were calculated and statistically compared between subjects who experienced complete postoperative seizure freedom (Engel IA) and all others (Engel IB-IV).

## **RESULTS**

Global network properties related to network integration were statistically significantly ( $p < 0.05$ ) different between subjects who had Engel IA surgical outcomes and all others, with 9% decreased leaf fraction and 10% decreased tree hierarchy in subjects with ongoing seizures. The regional properties of a cluster of anatomic regions in the contralateral temporoinsular region were statistically significantly ( $p < 0.05$ ) different between subjects in these two groups. Specifically, the group-level leaf proportion was 59% decreased in the contralateral entorhinal cortex, 73% decreased in the contralateral inferior temporal gyrus, 43% decreased in the contralateral temporal pole, and 69% decreased in the contralateral insula in subjects with ongoing seizures.

## **CONCLUSION**

Resting-state network topology correlates with surgical outcome in temporal lobe epilepsy, with decreased network integration globally and involving the contralateral temporoinsular region associated with ongoing postoperative seizures.

## **CLINICAL RELEVANCE/APPLICATION**

Resting-state fMRI may be a useful non-invasive tool to determine whether patients being evaluated for resective epilepsy surgery are more likely to experience postoperative seizure freedom.



## **SSE18-06 Evaluation of Integrity of White Matter Fibers in Patients with Anti-NMDAR Encephalitis Based on Automated Fiber Quantification**

Monday, Dec. 2 3:50PM - 4:00PM Room: S401CD

### Participants

Chun Zeng, Chongqing, China (*Presenter*) Nothing to Disclose

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Yongmei Li, MD, PhD, Chongqing, China (*Abstract Co-Author*) Nothing to Disclose

Yayun Xiang, Chongqing, China (*Abstract Co-Author*) Nothing to Disclose

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### PURPOSE

To show the changes in integrity of white matters in patients with anti-NMDAR encephalitis based on automated fiber quantification (AFQ).

### METHOD AND MATERIALS

Forty-eight patients with anti-NMDA receptor encephalitis diagnosed in our hospital and 40 matching gender, age and education level healthy controls were recruited in this study. All subjects underwent conventional head MRI, diffusion tensor imaging (DTI) scanning, mRS and mini-mental state examination (MMSE) scores. Fractional anisotropy (FA) and mean diffusivity (MD) quantitative analyses were conducted on 100 nodes of 20 white matter fibers in all subjects' brains using AFQ to compare whether there were statistical differences, and to analysis correlations between these two parameters and mRS and MMSE scores, respectively.

### RESULTS

(1) Conventional MRI showed that lesions in bilateral corticospinal tracts (CST) and hippocampi in one patients and in left frontal cortex in another patients. (2) Diffuse increase of FA values and reduction of MD values were measured on the bilateral CST, cingulum cingulate, cingulum hippocampus, and arcuat, showing significantly statistical differences from the healthy controls ( $P < 0.01$ ). Diffusion indexes of the other fibers showed segmental changes, and there was no statistical difference between the two groups ( $P > 0.05$ ). (3) FA values of the bilateral CST, cingulum cingulate, cingulum hippocampus, and arcuat were negatively correlated with mRS score ( $r = -0.81, -0.77, -0.86, -0.85$ , respectively;  $P < 0.01$ ), and positively correlated with MMSE score ( $r = 0.90, 0.83, 0.92, 0.89$ , respectively;  $P < 0.01$ ). MD values of the bilateral CST, cingulum cingulate, cingulum hippocampus, and arcuat were positively correlated with mRS score ( $r = 0.84, 0.77, 0.88, 0.77$ , respectively;  $P < 0.01$ ), and negatively correlated with MMSE score ( $r = -0.92, -0.86, -0.92, -0.89$ , respectively;  $P < 0.01$ ).

### CONCLUSION

In patients with anti-NMDA receptor encephalitis, extensive microstructural damage is found in the fibers dominated by CST, cingulum cingulate, cingulum hippocampus, and arcuat, which is closely related to the mRS scores and MMSE scores of patients and is helpful for the diagnosis of occult lesions and explanation of the clinical symptoms.

### CLINICAL RELEVANCE/APPLICATION

(Dealing with AFQ and white matter) "Automated fiber quantification can demonstrated white matter changes and this exam is recommended when the underlying cause of such a lesion is unclear"

Printed on: 10/29/20



SSE19

## Neuroradiology (Neurointerventional Techniques)

Monday, Dec. 2 3:00PM - 4:00PM Room: S504AB



AMA PRA Category 1 Credit™: 1.00  
ARRT Category A+ Credit: 1.00

### Participants

Akash P. Kansagra, MD, Saint Louis, MO (*Moderator*) Consultant, Terumo Corporation; Consultant, Penumbra, Inc; Medical Advisory Board, iSchemaView, Inc  
Jeremy J. Heit, MD, PhD, Stanford, CA (*Moderator*) Consultant, Medtronic plc; Consultant, Terumo Corporation; Scientific Advisory Board, iSchemaView, Inc; Medical Advisory Board, iSchemaView, Inc

### Sub-Events

#### SSE19-01 Functional Flow in Cranial Rotational Angiography: Optimization of Injection Rate to Preserve Cardiac Pulsation Information

Monday, Dec. 2 3:00PM - 3:10PM Room: S504AB

### Participants

Katrina L. Ruedinger, MS, Madison, WI (*Presenter*) Nothing to Disclose  
Evan Harvey, Madison, WI (*Abstract Co-Author*) Nothing to Disclose  
Sebastian Schafer, PhD, Madison, WI (*Abstract Co-Author*) Consultant, Siemens AG Employee, Siemens AG  
Michael Speidel, PhD, Madison, WI (*Abstract Co-Author*) Nothing to Disclose  
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### PURPOSE

Complex flow patterns in cranial anatomy could lead to new insight in disease staging and treatment. An injection protocol which optimizes identification of temporal information from rhythmic variations in density of the contrast bolus during systole and diastole in 4D-DSA studies has not been defined. Our purpose was to determine the injection protocol most likely to result in optimal contrast pulsatility (CP).

### METHOD AND MATERIALS

Two 3D printed patient specific cerebrovascular models consisting of the ICA, MCA, and ACA were connected to a closed-loop flow system driven by a positive displacement pulsatile pump (5.5 L/min, 60 beats/min). The system was configured to deliver 250-260 mL/min of the total flow to the model. A mixture of 60% glycerol and 40% distilled water was used as the working fluid. Contrast (Iovue 370mg I/cc, 75% dilution) was injected through a 6F catheter positioned upstream from the ICA using a power injector. 4D-DSA acquisitions (11.5 second/304 projections) were done for the following injection rates: 1.5, 2.0, 2.5, 3.0 and 3.5 cc/sec for 8 seconds. The CP present in the time concentration curves (TCCs) was analyzed using a previously described numerical metric, the side band ratio (SBR), to determine the signal strength.

### RESULTS

CP was present in the TCCs throughout the model in all of the 4D-DSAs acquired. In the inlets of both models, the strongest CP signal (highest SBR) was found with the 2.5 ml/s injection rate. At this injection rate, CP was identifiable throughout the entire vasculature in both models. As compared to previously determined ground truth (micro CT) geometrical measurements, the accuracy of a 3D reconstruction was preserved.

### CONCLUSION

An injection rate of 2.5 ml/s provided the strongest CP in a 4D-DSA reconstruction while also maintaining geometric accuracy of a 3D reconstruction. Use of this injection rate provided the best temporal data for use in 4D-DSA velocity and flow calculations.

### CLINICAL RELEVANCE/APPLICATION

Quantifying blood flow in the angiography suite would enhance decision making. This would be enabled by an injection protocol which optimizes contrast pulsatility while maintaining geometric accuracy.

#### SSE19-02 Simultaneous Acquisition of High Speed Angiography (HSA) at 1000 Frames Per Second during Digital Subtraction Angiography (DSA) and Digital Angiography (DA)

Monday, Dec. 2 3:10PM - 3:20PM Room: S504AB

### Participants

Jordan Krebs, BS, Buffalo, NY (*Presenter*) Research Grant, Canon Medical Systems Corporation  
Allison Shields, Buffalo, NY (*Abstract Co-Author*) Research Grant, Canon Medical Systems Corporation  
Daniel Bednarek, PhD, Buffalo, NY (*Abstract Co-Author*) Research Grant, Canon Medical Systems Corporation

## **PURPOSE**

DSA and DA sequences acquired during neuro-endovascular image-guided interventions provide visualization of vascular morphology to interventionalists, but detailed blood flow information is blurred due to movement of contrast during the exposure pulse times. A method is proposed for acquiring this flow information simultaneously during each x-ray pulse using a high frame-rate imager.

## **METHOD AND MATERIALS**

A new single photon-counting detector (Actaeon from XCounter) is a direct-conversion, high-resolution 100  $\mu\text{m}$  pixel, small field-of-view x-ray detector capable of imaging at frame rates of 1000 fps. The Actaeon was used with a mobile c-arm angiography unit to image blood flow details in a 3D-printed, patient-specific aneurysm phantom. The c-arm was operated at 6 pulses per second with technique parameters of 70 kVp, 100 mA, 32 ms pulse width. Ten ml iodine-based contrast was autoinjected into the vessel to enable visualization of flow dynamics in the phantom. One millisecond frames were acquired at 1000 fps during each pulse. 32 HSA frames were integrated to create single region-of-interest DSA/DA images in the sequence. Individual HSA runs of 32 frames are viewed post-acquisition.

## **RESULTS**

The integrated frames demonstrated standard low quantum noise DSA/DA images; however, the flow of the injected contrast is blurred, only showing the shape of the vessels. At no additional dose, the images acquired at 1000 fps were simultaneously recorded. These high-speed images preserve detailed flow information showing the movement of contrast throughout the vessel and pathology.

## **CONCLUSION**

It was demonstrated that the new Actaeon detector can provide DSA/DA quality images and simultaneously is capable of providing images containing detailed flow information at no additional cost in exposure. The additional flow information comes at no added risk to the patient and could become a useful tool for clinicians to use during a procedure in assessing flow dependent tasks, such as the effectiveness of interventional devices in diverting blood flow away from the aneurysm.

## **CLINICAL RELEVANCE/APPLICATION**

Simultaneous 1000 fps acquisition during DSA can provide detailed flow images for assessing treatment at no additional cost in radiation exposure to patients.

## **SSE19-03 In Vitro Testing of a Funnel-Shaped Tip for Mechanical Thrombectomy: A Novel Approach to Decrease Clot Migration**

Monday, Dec. 2 3:20PM - 3:30PM Room: S504AB

### **Participants**

Yasemin Tanyildizi, MD, Mainz, Germany (*Presenter*) Nothing to Disclose  
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Tiemo Gerber, Mainz, Germany (*Abstract Co-Author*) Nothing to Disclose  
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## **PURPOSE**

One limitation of mechanical thrombectomy (MT) is clot migration during procedure. This might be caused by abruption of the trapped thrombus at the distal access catheter (DAC) tip during stent retriever retraction, due to the cylindrical shape of the catheter tip. New DACs solving this problem needed to be developed. Therefore a cylindrical-shaped tip was modified to a funnel-shaped tip. The study at hand evaluates the proof-of-concept in an experimental in vitro setting

## **METHOD AND MATERIALS**

In order to detect the superiority of a funnel-shaped tip vs. a cylindrical-shaped tip, both models (made of modified introducer sheaths) were tested in an experimental setup. A silicon vessel model and thrombi generated from pig's blood were used for MT. MT was performed 20 times for each device using two different stent retrievers, 10 times respectively.

## **RESULTS**

For the funnel-shaped model, for both stent retrievers (Trevor XP ProVue 3/20 mm; Trevor XP ProVue 4/20 mm) MT was successful at first pass in 9 out of 10 times (90 %), respectively. For the cylindrical-shaped model, 5 out of 10 (50%) MTs were successful at first pass with the smaller stent retriever and 6 out of 10 (60 %) for the larger stent retriever

## **CONCLUSION**

Our first in vitro experiments show a better recanalization rate for the funnel-shaped tip, in comparison to the cylindrical-shaped tip. Further in vitro and in vivo studies are needed to verify the safety and the efficiency of the proposed funnel-shaped tip

## **CLINICAL RELEVANCE/APPLICATION**

Clot migration during mechanical thrombectomy can be decreased by modifying the catheter tip from cylindrical to funnel-shaped.

## **SSE19-04 Spin Echo T2 signal Intensity the Day After Flow Diverter Insertion is Associated with Early Total Regression**

#### Participants

So Yeon Won, Seoul, Korea, Republic Of (*Presenter*) Nothing to Disclose  
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#### PURPOSE

The purpose of this study was to predict early total regression of flow-diverted sac through MR finding of Spin Echo T2-weighted images the day after pipeline insertion.

#### METHOD AND MATERIALS

Thirty consecutive patients whose cerebral aneurysms were treated with pipeline embolization device between Feb 2014 and Oct 2018 were included in this study. The procedures consisted of installation of pipeline embolization device (PED; Medtronic, Minneapolis, Minnesota, USA) and any other procedures such as additional coil embolization were not performed. All the procedures were successful except one incomplete apposition due to stent kinking. Angiographic evaluation 3 month after the procedure showed total or near total regression of aneurysmal sac (n=20); and partial regression (n=10). Percent area of stagnated iodine contrast agent was measured by a neurosurgeon on anterior-to-posterior and lateral view of angiography just after installation of pipeline device. Geometric and signal intensity-based analysis was performed by a neuroradiologist using in-house software to demonstrate voxel based histogram analysis. Volume of interest (VOI) was set along the whole volume of treated aneurysmal sac. All the signal intensity was normalized by that of normal appearing white matter.

#### RESULTS

Demographic data comparison between two groups (total or near total regression vs. partial regression) showed no significant difference. Volume of treated aneurysmal sac was not different (2559.28 mm<sup>3</sup>±3021.45, 2551.76 mm<sup>3</sup>±6550.58, p=0.455). Total or near total regression group showed larger area of percent iodine stagnation than partial regression did (52.26%, 23.35%, p=0.002). Median signal intensity and 10-percentile signal intensity of VOI were higher in total or near total regression group (1.29, 0.93, p=0.025; 0.57, 0.24, p=0.005).

#### CONCLUSION

Percentage area of iodine stagnation on lateral angiography, median and 10-percentile signal intensity of VOI of treated aneurysmal sac on T2 weighted image can be used to predict total regression of aneurysmal sac.

#### CLINICAL RELEVANCE/APPLICATION

MR finding of Spin Echo T2-weighted images the day after pipeline insertion can be used to predict early total regression of flow-diverted sac and to reduce invasive angiographic procedures.

#### SSE19-05 Incidence of Post-Lumbar Puncture Headaches Requiring Epidural Blood Patch After Fluoroscopic Guided Lumbar Puncture

Monday, Dec. 2 3:40PM - 3:50PM Room: S504AB

#### Participants

Daniel W. O'Neal, MD, Norfolk, VA (*Presenter*) Nothing to Disclose  
Abhimanyu Aggarwal, MD, Leesburg, VA (*Abstract Co-Author*) Nothing to Disclose  
John C. Agola, MD, New York, NY (*Abstract Co-Author*) Nothing to Disclose

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#### PURPOSE

The aim of this study was to determine the incidence of post-lumbar puncture headaches severe enough to warrant an epidural blood patch following fluoroscopic guided lumbar puncture.

#### METHOD AND MATERIALS

Retrospective analysis was performed on 388 fluoroscopic guided lumbar punctures in adults at a tertiary care teaching hospital from 7/1/2018 to 3/31/2019. Patient inclusion criteria included age between 18 and 90 years old; male or female; and both outpatients and inpatients. All lumbar punctures were performed in the prone position utilizing fluoroscopic guidance by attending radiologists or diagnostic radiology residents under direct supervision. Lumbar punctures were performed for diagnostic, therapeutic, myelographic, and nuclear medicine purposes. Medical chart review for each patient to identify lumbar puncture related complications, specifically the need to perform an epidural blood patch, extended up to 30 days post-procedure.

#### RESULTS

Of the 388 fluoroscopic guided lumbar punctures performed during the study period, 10 also required an epidural blood patch in the post-procedure course. This calculates to a 2.6% incidence of post-lumbar puncture headaches that are severe enough to warrant the intervention of a blood patch.

#### CONCLUSION

This single center retrospective analysis shows that following fluoroscopic guided lumbar puncture performed in the prone position there is a 2.6% incidence of post-lumbar puncture headaches requiring the intervention of an epidural blood patch over a nine-

month period.

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

Knowing the incidence of post-lumbar puncture headaches requiring epidural blood patch after fluoroscopic guided lumbar puncture allows the radiologist to provide accurate informed consent.

#### **SSE19-06 Battery-Powered Drill Biopsy Systems Demonstrate Similar Efficacy but Decreased Radiation Dose Compared to Manual Bone Biopsy Systems in CT-Guided Sampling of the Vertebral Column**

Monday, Dec. 2 3:50PM - 4:00PM Room: S504AB

#### **Participants**

Shingo Kihira, MD, New York, NY (*Presenter*) Nothing to Disclose  
Clara Koo, New York, NY (*Abstract Co-Author*) Nothing to Disclose  
Andrew Lee, MD, New York, NY (*Abstract Co-Author*) Nothing to Disclose  
Amit Aggarwal, MD, Jersey City, NJ (*Abstract Co-Author*) Nothing to Disclose  
Amish H. Doshi, MD, New York, NY (*Abstract Co-Author*) Speaker, Merit Medical Systems, Inc

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#### **PURPOSE**

To investigate differences in efficacy and radiation dose between battery powered and manual bone biopsy systems in CT-guided biopsy of lytic, mixed, sclerotic, and suspected discitis/osteomyelitis

#### **METHOD AND MATERIALS**

This was a retrospective single center IRB approved study. A total of 351 CT-guided core needle biopsies were performed at one institution from May of 2010 to February of 2019. Classification of vertebral body lesions, bone biopsy system, diagnostic yield, crush artifact, radiation dose, and procedure times were collected. The bone biopsy systems used for the procedure were OnControl (VidaCare) for the powered drill, and Bonoptx (AprioMed) and Murphy (Cook) for the manual systems. Comparison within lytic, sclerotic, mixed (both lytic and sclerotic), and suspected discitis/osteomyelitis were made by Fisher exact test. One-way ANOVA was used for subgroup analysis of the drill systems for procedure time and radiation dose.

#### **RESULTS**

Our patient cohorts consisted of a total of 351 patients with 194 lytic, 29 mixed, 74 sclerotic, and 54 infectious vertebral body lesions. The mean  $\pm$  standard deviation of age (years) was  $62 \pm 11$  with M/F of 160/191. No statistical difference was found when comparing diagnostic yields of the battery powered drill to the manual systems for lytic, mixed, sclerotic, suspected discitis/osteomyelitis, and all lesions. However, in a subgroup analysis, radiation dose was significantly lower for battery powered drill in lytic ( $p=0.003$ ) and all lesions ( $p=0.0001$ ). Procedure time was on average shorter for powered drills than manual systems, especially in sclerotic lesions, however the difference was not statistically significant ( $p=0.07$ ).

#### **CONCLUSION**

Our findings demonstrate that there was no significant difference in diagnostic yield when comparing battery-powered and manual bone biopsy systems for CT guided vertebral column bone biopsies. However, the use of a power-drill system may result in a reduction in radiation dose compared to manual bone biopsy systems.

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

The battery powered drill may be a preferable bone biopsy system compared to manual systems for vertebral body lesions regardless of lesion type given non-inferior diagnostic yield, significantly lower radiation dose, and potentially shorter procedure time.

Printed on: 10/29/20



SSE20

## Neuroradiology (Structural Imaging)

Monday, Dec. 2 3:00PM - 4:00PM Room: S504CD

MR NR

AMA PRA Category 1 Credit™: 1.00  
ARRT Category A+ Credit: 1.00

FDA Discussions may include off-label uses.

### Participants

James M. Provenzale, MD, Durham, NC (*Moderator*) Research Grant, Bayer AG; Research funded, sanofi-aventis Group; ; Elizabeth Tong, MD, Stanford, CA (*Moderator*) Nothing to Disclose

### Sub-Events

#### SSE20-01 Substantial Dose Reduction for Sinus CT with Maintenance of High Resolution: A Prospective Clinical Reader Study Utilizing Photon-Counting-Detector CT Substantial Dose Reduction for Sinus CT with Maintenance of High Resolution: A Prospective Clinic

Monday, Dec. 2 3:00PM - 3:10PM Room: S504CD

### Participants

Benjamin Voss, MD, Milwaukee, WI (*Presenter*) Nothing to Disclose  
David R. De Lone, MD, Rochester, MN (*Abstract Co-Author*) Nothing to Disclose  
Kishore Rajendran, PhD, Rochester, MN (*Abstract Co-Author*) Nothing to Disclose  
Tammy A. Drees, Rochester, MN (*Abstract Co-Author*) Nothing to Disclose  
Shuai Leng, PHD, Rochester, MN (*Abstract Co-Author*) Nothing to Disclose  
Joel G. Fletcher, MD, Rochester, MN (*Abstract Co-Author*) Grant, Siemens AG; Consultant, Medtronic plc; Consultant, Takeda Pharmaceutical Company Limited; Grant, Takeda Pharmaceutical Company Limited; ;  
Cynthia H. McCollough, PhD, Rochester, MN (*Abstract Co-Author*) Research Grant, Siemens AG

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### PURPOSE

To examine the ability of photon-counting detector (PCD) CT to improve spatial resolution and reduce radiation dose for sinus CT compared to routine energy-integrating detector (EID) CT.

### METHOD AND MATERIALS

After informed consent, twenty-eight patients underwent sinus imaging on a PCD CT system following a clinically indicated scan on the same day. EID images were reconstructed using 512 & 1024 matrices (CTDIvol = 13.5-14.5 mGy). Ultra high resolution PCD exams (Sn100kV) acquired at 10, 8, 7 & 6 CTDIvol, corresponding to 28%, 43%, 50%, and 57% dose reduction, were reconstructed using a 1024 matrix (7 patients/dose level). Images were anonymized, randomized and reviewed by a neuroradiologist. Visualization of key anatomic structures [sphenoid ostia (SO), lesser palatine foramen (LPF), nasomaxillary sutures (NS), anterior ethmoid artery canal (AEA)] was rated for each panel on a Likert scale (1=worse visualization and confidence than routine; 2=worse, no confidence change, 3=similar/routine, 4=preferred, no confidence change, 5=Improved detection & confidence). Image quality scores were provided (noise, sharpness, artifacts, overall quality). Wilcoxon signed-rank ( $p < 0.05$ ) was used to test significance.

### RESULTS

At 10 and 8 mGy, PCD was significantly superior to EID 512 for all critical anatomy (SO  $p=0.016$ , mean difference (MD) 0.56; LPF  $p=0.0007$ , MD 1.5; NS  $p=0.0002$ , MD 1.2; AEA  $p=0.0005$ , MD 1.4). At these dose levels, PCD was also significantly superior to EID 1024 for visualizing the LPF ( $p < 0.05$ ; MD 0.64), the NS ( $p=0.008$ ; MD 0.64), and the AEA ( $p=0.009$ ; MD 0.86). At 7 and 6 mGy, PCD was superior to EID 512 for LPF ( $p=0.03$ ) and AEA ( $p=0.02$ ), but not significantly different for any anatomic structure compared to EID 1024. Noise, sharpness, and overall image quality was similar between PCD and EID 1024 across dose levels.

### CONCLUSION

PCD CT imaging of the sinus demonstrates superior visualization of anatomy with no significant noise increase even at dose reductions of up to 57% when compared to routine imaging, enabling a significant dose reduction in a frequently imaged population.

### CLINICAL RELEVANCE/APPLICATION

PCD CT shows potential to improve routine imaging in a variety of clinical scenarios where spatial resolution and image fidelity improve confidence and accuracy while offering lower dose acquisition.

#### SSE20-02 Spiral T1-SE for Routine Post-Contrast Brain MRI: Multi-Center/Reader Study Results

Monday, Dec. 2 3:10PM - 3:20PM Room: S504CD

### Participants

Melvyn B. Ooi, PhD, Phoenix, AZ (*Presenter*) Employee, Koninklijke Philips NV

Zhiqiang Li, PhD, Phoenix, AZ (*Abstract Co-Author*) Research support, Koninklijke Philips NV  
Ryan Robison, PhD, Phoenix, AZ (*Abstract Co-Author*) Master Enterprise Agreement, Philips Koninklijke NV  
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Akshay Bakhru, Bangalore, India (*Abstract Co-Author*) Nothing to Disclose  
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Jalal B. Andre, MD, Seattle, WA (*Abstract Co-Author*) Research Grant, Koninklijke Philips NV Consultant, Hobbittview, Inc Research Grant, Toshiba Corporation  
Jeffrey H. Miller, MD, Phoenix, AZ (*Abstract Co-Author*) Nothing to Disclose  
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James G. Pipe, PhD, Rochester, MN (*Abstract Co-Author*) Research Grant, Koninklijke Philips NV

## PURPOSE

Spiral MRI provides several advantages over routine (Cartesian) MRI, including scan efficiency, and robustness to flow, aliasing, and geometric distortions. Nevertheless, spiral MRI has not gained widespread clinical adoption due to its greater demand on system fidelity. We present here the results of a multi-center clinical study to investigate spiral MRI as an added value alternative to routine post-contrast brain MRI.

## METHOD AND MATERIALS

A spiral consortium of 7 clinical sites acquired 88 patient cases on Philips 3.0/1.5T Ingenia scanners with standard hardware configurations. For each patient, two post-contrast scans were acquired: a spiral 2DT1SE, and a routine Cartesian 2DT1SE/fast-SE. The spiral was matched to each Cartesian for scan time, FOV/resolution, and a/TR. The spiral-out readout is fully sampled  $\sim 10/20$  ms for 3.0/1.5T. Crusher gradients around the 180°-pulse provide added flow signal suppression and black blood contrast. Online reconstruction ( $\sim 1$  sec/slice) uses a B0 prescan in a conjugate-gradient algorithm for joint off-resonance deblurring and Dixon water/fat separation. Nine neuroradiologists reviewed all 88 patient cases. For each patient, the matching pair of spiral vs. Cartesian scans were compared side-by-side, and scored on 10 image quality (IQ) metrics using a 5-point Likert scale.

## RESULTS

Summary statistics over all patient cases for the 10 metrics (Wilcoxon signed-rank test,  $p < 0.01$ ) show: Spiral performs better than Cartesian in 7/10 metrics: flow artifact reduction, SNR, GM/WM contrast, image sharpness, lesion conspicuity, preference for diagnosing abnormal enhancement, and overall intracranial IQ. Spirals perform poorer than Cartesian in 2/10 metrics related to magnetic susceptibility: susceptibility artifact, and overall extracranial IQ. Spirals are comparable to Cartesian in 1/10 metrics: motion artifact.

## CONCLUSION

Spiral 2DT1SE was superior or comparable to standard-of-care Cartesian 2DT1SE/FSE in 8 of 10 assessed metrics, and was preferred by neuroradiologists for post-contrast intracranial evaluation. Future work to improve IQ in areas of magnetic susceptibility will explore advanced B0 mapping, deblurring, and system characterization methods.

## CLINICAL RELEVANCE/APPLICATION

Spiral MRI enables increased scan efficiency (higher SNR, faster scans) and robustness to certain artifacts, providing a compelling alternative to Cartesian MRI that is the current clinical workhorse.

## SSE20-03 Neuropathologic Correlates of Enlarged Perivascular Spaces and Contribution to Cognitive Decline in a Community Cohort of Older Adults

Monday, Dec. 2 3:20PM - 3:30PM Room: S504CD

### Participants

Carles Javierre Petit, Chicago, IL (*Presenter*) Nothing to Disclose  
Julie A. Schneider, MD, Chicago, IL (*Abstract Co-Author*) Nothing to Disclose  
Nazanin Makkinejad, Chicago, IL (*Abstract Co-Author*) Nothing to Disclose  
Ashish A. Tamhane, MS, Chicago, IL (*Abstract Co-Author*) Nothing to Disclose  
David A. Bennett, MD, Chicago, IL (*Abstract Co-Author*) Nothing to Disclose  
Konstantinos Arfanakis, PhD, Chicago, IL (*Abstract Co-Author*) Nothing to Disclose

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## PURPOSE

Enlarged perivascular spaces (EPVS) have been associated with aging, increased stroke risk, decreased cognitive function and vascular dementia. However, the relationship of EPVS with age-related neuropathologies is not well understood. Therefore, the purpose of this study was two-fold: to assess the neuropathologic correlates of EPVS, and to determine the contribution of EPVS burden to cognitive decline by combining ex-vivo brain magnetic resonance images (MRI) and pathology in a community cohort of older adults.

## METHOD AND MATERIALS

Cerebral hemispheres were obtained from 662 participants of two longitudinal, epidemiologic clinical-pathologic cohort studies of aging. Experienced observers blinded to all pathologic and clinical data rated EPVS burden using a semiquantitative four-level scale (See Figure). Neuropathologic assessment was performed by a board-certified neuropathologist blinded to all clinical and imaging findings. Univariate and multivariate logistic regression was used to investigate the association of EPVS burden with the following age-related neuropathologies: gross and microscopic infarcts, atherosclerosis, arteriosclerosis, cerebral amyloid angiopathy, amyloid plaques, neurofibrillary tangles, hippocampal sclerosis, Lewy bodies, and TDP-43. Finally, mixed-effects models were used to evaluate EPVS burden contribution to cognitive decline in 6 domains: global, episodic, semantic, working, perceptual, and visuospatial.

## RESULTS

Univariate analyses showed significant association of EPVS burden with gross (OR=1.59, p-value=0.002) and microscopic infarcts (OR=1.40, p-value=0.025). Multivariate logistic regression showed a significant association of EPVS burden with gross infarcts (OR=1.60, p=0.004). EPVS burden was significantly contributing to cognitive decline for all cognitive domains except working memory; and the interaction between EPVS burden and time also showed significant for global, episodic and visuospatial cognitive domains.

## CONCLUSION

The results suggest: that EPVS and gross infarcts may share similar neurobiological pathways, which is in fair agreement with the literature and proposed etiologies driving these two processes, and that EPVS burden significantly contributes to cognitive decline independently from demographics and neuropathologies.

## CLINICAL RELEVANCE/APPLICATION

This is the biggest clinical-pathologic study up to date, and the only one to include cognitive decline in combination with EPVS.

## SSE20-04 Visualization of the Morphology and Pathology of the Peripheral Branches of the Cranial Nerves Using 3-Dimensional High Contrast Magnetic Resonance Neurography

Monday, Dec. 2 3:30PM - 3:40PM Room: S504CD

### Participants

Lixia Wang, Wuhan, China (*Abstract Co-Author*) Nothing to Disclose  
Wenjun Wu, Wuhan, China (*Abstract Co-Author*) Nothing to Disclose  
Feihong Wu, Wuhan, China (*Presenter*) Nothing to Disclose  
Dingxi Liu, Wuhan, China (*Abstract Co-Author*) Nothing to Disclose  
Chuansheng Zheng, Wuhan, China (*Abstract Co-Author*) Nothing to Disclose  
Xiangquan Kong, Wuhan, China (*Abstract Co-Author*) Nothing to Disclose

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## PURPOSE

Aims to assess the feasibility and advantages of a contrast-enhanced three-dimensional (3D) flip-angle evolution (SPACE) short-tau inversion (STIR) T2-weighted (T2W) magnetic resonance neurography (MRN) sequence (ceMRN) for visualizing the morphology and pathology of peripheral branches of the cranial nerves.

## METHOD AND MATERIALS

35 volunteers with no relevant cranial nerve symptoms and 12 patients with maxillofacial tumors were enrolled. Conventional MRN (cMRN) and ceMRN were performed with 3T MRI system. The continuity of 10 major branches of the cranial nerves on ceMRN was evaluated based on the 5-score evaluation of 3 readers and their interobserver variability was tested. The image quality was compared between cMRN and ceMRN. The relationship between maxillofacial tumors and adjacent peripheral nerves was classified and analyzed in ceMRN of these patients.

## RESULTS

The interobserver consistency of all nerves across the 3 readers was excellent, with an average  $\kappa$  value > 0.83. Visualization of the inferior alveolar nerve, hypoglossal nerve and lingual nerve were excellent, with scores of 3.95, 3.77, and 3.63 respectively. Detection of the facial nerve, infraorbital nerve, masseteric nerve, and glossopharyngeal/vagus nerve were relatively good, with scores of 3.25, 3.15, 3.04 and 3.04 respectively. Depiction of the supraorbital nerve and auriculotemporal nerve were moderate, with scores of 2.87 and 2.79 respectively. Delineation of the buccal nerve was fair, with a score of 1.88. The contrast signal-to-noise ratios of nerve to bone marrow, nerve to muscle and nerve to fat on ceMRN were significantly lower than those on cMRN, and the contrast ratios of nerve to bone marrow, nerve to muscle, and nerve to gland on ceMRN were significantly higher than those on cMRN (all  $P < 0.05$ ). The relationship between the extracranial branches of the cranial nerves and tumors were classified as isolated, compressed, embodied, invaded or spread perineurally based on the imaging features on ceMRN.

## CONCLUSION

The ceMRN demonstrates excellent visualization the peripheral branches of cranial nerves in a 3D pattern and appears to be a promising method for diagnosis and pretreatment assessment of the pathologies of cranial nerves.



## CLINICAL RELEVANCE/APPLICATION

(dealing with 3D ceMRN) 'ceMRN can be used as a preoperative method to evaluate the relationship between peripheral branches of the cranial nerves and maxillofacial tumor.'

### SSE20-05 Simultaneous Multi-Angular-Relaxometry of Tissue (SMART) MRI Identifies Myelin-Related Tissue Damage in Multiple Sclerosis

Monday, Dec. 2 3:40PM - 3:50PM Room: S504CD

#### Participants

Biao Xiang, MA, Saint Louis, MO (*Presenter*) Nothing to Disclose

Jie Wen, PhD, Saint Louis, MO (*Abstract Co-Author*) Nothing to Disclose

Anne H. Cross, Saint Louis, MO (*Abstract Co-Author*) Consultant, Biogen Idec Inc; Consultant, Celgene Corporation; Consultant, Novartis AG; Consultant, Merck KGaA; Consultant, F. Hoffmann-La Roche Ltd; Consultant, TG Therapeutics

Dmitriy A. Yablonskiy, PhD, Saint Louis, MO (*Abstract Co-Author*) Nothing to Disclose

#### PURPOSE

Rapid, pathologically specific and quantitative MRI techniques are needed to assess tissue damage in multiple sclerosis (MS), particularly in progressive MS. The purpose of this study was to demonstrate that SMART MRI metrics can distinguish non-relapsing progressive MS from relapsing-remitting MS (RRMS) and to examine correlations with clinical assessments.

#### METHOD AND MATERIALS

22 non-relapsing progressive MS and 11 RRMS subjects were scanned at 3T. SMART data with isotropic 1 mm<sup>3</sup> resolution were acquired using a three dimensional multi-gradient-echo sequence with five flip angles  $\alpha$  (5°, 10°, 20°, 40°, 60°) and three gradient echoes (TE: 2.3, 6.2, 10.1ms) for each  $\alpha$ . A phase-based technique was implemented for  $\alpha$ -mapping. MS tissue damage, assessed by SMART metrics of macromolecule proton fraction (MPF) and R1 (1/T1) in normal-appearing cortical gray matter (NAGM) and subcortical normal-appearing white matter (NAWM), were correlated with Expanded Disability Status Scale (EDSS), 25-foot timed walk, nine-hole peg test (9HPT), paced auditory serial addition test (PASAT) and Symbol Digit Modality tests. Spearman rank test was used to compute rho values.

#### RESULTS

MPF was higher in NAWM than in NAGM, consistent with the high macromolecular content in myelin (Fig. 1). MPF measurement demonstrated relatively stronger correlations with the motor related clinical assessments EDSS and 9HPT ( $p < 0.001$ ), while a higher quantitative R1 metric showed significant correlations with better cognitive related PASAT scores ( $p = 0.004$ ). Interestingly, the left hemisphere showed stronger correlations than right hemisphere when assessing correlations between MPF and motor related clinical tests. Additionally, MPF in NAWM had significantly stronger correlation with clinical assessments than MPF of cortical NAGM. Higher MPF measurements in both GM and WM readily differentiated the relapsing-remitting group from the group with non-relapsing progressive MS ( $p < 0.01$ ).

#### CONCLUSION

Results from this study suggest that SMART MRI has high potential for assessing myelin content and MS-related damage.

## CLINICAL RELEVANCE/APPLICATION

Without applying either MT or 180° radiofrequency pulses, SMART MRI generates high resolution quantitative images and is safe for high-field MRI, making it a useful outcome measure in clinical trials.

### SSE20-06 Magnetic Resonance Elastography of Brain: Tumor Adherence and Stiffness

Monday, Dec. 2 3:50PM - 4:00PM Room: S504CD

#### Participants

Sandeep Juvvadi, Hyderabad, India (*Presenter*) Nothing to Disclose

Prateek Kalra, Columbus, OH (*Abstract Co-Author*) Nothing to Disclose

Arunark Kolipaka, PhD, Columbus, OH (*Abstract Co-Author*) Benzer Pharmacy; Tenet Healthcare Corporation; Lonwin Healthcare

#### PURPOSE

To determine brain tumor adherence as well as stiffness in patients using magnetic resonance elastography (MRE) and compare to histopathology.

#### METHOD AND MATERIALS

In vivo brain MRE was performed on 7 patients using a 3T MRI scanner (Skyra, Siemens Healthcare, Germany). Mechanical waves were introduced into the brain using a pneumatic driver system with a pillow driver at 60Hz and a SE EPI-MRE sequence was used to acquire all axial slices of the brain. Imaging parameters included: TR=3333ms, TE=44ms, slice thickness=3, matrix=128x64, FOV=260cm, GRAPPA acceleration factor R=2; mechanical vibration frequency=60Hz; 4 MRE time offsets; and motion-encoding gradient of 16.67ms duration (60Hz) to encode in-plane and through-plane motion of propagating waves in the brain. Wave images were processed using an in-house local frequency estimation algorithm with curl processing to obtain stiffness as well as octahedral shear strain (OSS) to determine mechanical and adherence properties of the brain tumor respectively. Mean stiffness of the tumor and normal brain are reported along with the OSS values around the tumor boundary. Furthermore, the histopathology measurements obtained post surgery were also recorded for comparison.

#### RESULTS

Figure shows a T2- weighted magnitude image (a), snap shot of wave propagation (b) and the corresponding stiffness map (c) with a mean stiffness value of 1.2kPa in the tumor region (green contour) and 2.3kPa non-tumor (red contour); OSS map (d) also confirms soft tumor and non-adherent along with histopathology (e) confirming soft tumor glioma grade 4 and easily resectable. The stiffness measurements of other tumors ranged from 0.8 to 1.9kPa for meningioma or gliomas or metastasis. Similarly, histopathology results in other patients with varying tumors also confirmed the findings of MRE.

## **CONCLUSION**

This study has demonstrated that stiffness and adherence patterns of different brain tumors can be quantitated using MRE. This study for the first time compared material properties of the brain tumors noninvasively to histopathology observations. However, more studies are further warranted.

## **CLINICAL RELEVANCE/APPLICATION**

Brain MRE is a noninvasive technique, which can potentially differentiate benign vs malignant tumors and provide information on tumor adherence that can enable better guidance for surgical resection.

Printed on: 10/29/20



SSE21

## Pediatrics (Interventional Radiology)

Monday, Dec. 2 3:00PM - 4:00PM Room: S403B



AMA PRA Category 1 Credit™: 1.00  
ARRT Category A+ Credit: 1.00

### Participants

Anne Marie Cahill, MBBCh, Philadelphia, PA (*Moderator*) Nothing to Disclose  
Kamlesh U. Kukreja, MD, Bellaire, TX (*Moderator*) Nothing to Disclose

### Sub-Events

#### SSE21-01 Comparison of DVT Risk Factors and Indications for Pharmacomechanical Thrombolysis in Children Less than 13 Years Old versus Adolescents

Monday, Dec. 2 3:00PM - 3:10PM Room: S403B

### Participants

Aparna Annam, DO, Denver, CO (*Presenter*) Nothing to Disclose  
Dianne Thornhill, PhD, Aurora, CO (*Abstract Co-Author*) Nothing to Disclose  
Paul J. Rochon, MD, Aurora, CO (*Abstract Co-Author*) Speaker, Penumbra, Inc; Speakers Bureau, C. R. Bard, Inc; Speaker, Cook Group Incorporated; Advisory Board, Medtronic plc; Speaker, Medtronic plc  
Marilyn Manco-Johnson, Aurora, CO (*Abstract Co-Author*) Nothing to Disclose

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### PURPOSE

Pharmacomechanical thrombolysis (PMT) is often performed for iliofemoral DVT in adolescents in order to prevent or minimize the impact of post-thrombotic syndrome (PTS). This study aims to evaluate children less than 13 years old with iliofemoral DVT for their DVT risk factors, incidence of PTS and indications for PMT as compared to adolescents.

### METHOD AND MATERIALS

This is a prospective cohort observational study of patients 0-12 years of age presenting with first time, imaging documented DVT within the IVC or the iliac vessels. This was compared to a separate cohort of adolescents, age 13-20 years using chi-square and Fisher's exact tests. Outcomes included imaging-documented recurrent DVT or post thrombotic syndrome (PTS) using a modified Villalta scale. Subgroup analyses of DVT risk factors, including genetic thrombophilia, acquired thrombophilia or anatomic variant (May-Thurner or Atretic IVC) as well as initial treatment were also performed.

### RESULTS

38 children (25 males, 13 females) ages 0-12 years and 61 adolescents (20 males, 41 females) ages 13-20 were enrolled. 7 children were initially treated with PMT (2 minor bleeding complications and no major bleeding complications). 33 adolescents were first treated with PMT (4 minor bleeding complications and 3 major bleeding complications). Children vs adolescent risk factors for DVT included: infection 8 (21%) vs 5 (8%) (P=0.07), catheter related 6 (42%) vs 1 (2%) (P<0.001), trauma 9 (21%) vs 12 (20%) (P=0.64), congenital heart disease 2 (5%) vs 1 (2%) (P=0.56), chronic disease 2 (5%) vs 2 (3%) (P=0.63), acquired thrombophilia (13 (34%) vs 34 (56%) (P=0.02), anatomic variant 4 (11%) vs 21 (34%) (P=0.009). Only 2 children (6.3%) were found to have PTS and both were related to infection. 16 adolescents developed PTS which was related to obesity, estrogen use and anatomic variants.

### CONCLUSION

The greatest DVT risk factors in the 0-12 year old age group was the presence of a catheter. Vascular variants were not found to be risk factors for DVT development in younger patients. Given the overall low incidence of PTS in children 0-12 years, PMT is not indicated to prevent/decrease severity of PTS in this age group but may be beneficial to maintenance of future vascular access.

### CLINICAL RELEVANCE/APPLICATION

Understanding the risk factors affecting DVT development and the subsequent progression in different age groups can help tailor treatment and set the goals of therapy.

#### SSE21-02 A Cross-Sectional Review of Pediatric Gastrojejunostomy Use Amongst US Tertiary Children Hospital

Monday, Dec. 2 3:10PM - 3:20PM Room: S403B

### Participants

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**PURPOSE**

Gastrostomy tubes (GT) are commonly converted to gastrojejunostomy tubes (GJT) in children with gastric feeding difficulties. Conversion can be resource intensive for hospitals and interventional radiologists. The aim of this study is to describe baseline practice variation among US freestanding children's hospitals related to utilization of GJT. Furthermore, we aim to better describe the frequency GJT exchange by calculating the number of average annual exchanges (AAE) for pediatric GJT patients.

**METHOD AND MATERIALS**

Using data from 2010-2018, a retrospective analysis was performed on 49 tertiary children hospital using the Pediatric Health Information System. Patients were captured by International Classification Disease codes for GT and GJT placement. All initial encounters for patients receiving a GT were captured and conversion dates were used in this analysis. Each patient was then stratified by number of annual average exchanges (AAE).

**RESULTS**

Of 85,254 patients who received a GT during the study period, 14,732 (18%) were subsequently converted to GJT. Of those converted to GJT, 60% were white and were 5 years at conversion. No significant change was found in rate of GT to GJT conversions during the study period. However, over the study period, there was a significant decrease in mean days from GT to GJT conversion, 636 days in 2010 to 234 days in 2018 (P-value <0.001). After conversion to GJT, the median AAE for a GJT patient was found to be 4 exchanges per year (IQR 1- 19 exchanges), at an average adjusted estimated cost of \$1,168.10.

**CONCLUSION**

Approximately one-fifth of children with a GT will be later converted to a GJT. GT converted to GJT will require numerous future exchanges and hospital visits, creating a significant burden on patients, families, and providers. More work is needed to clarify the optimal approach to patients with feeding intolerance.

**CLINICAL RELEVANCE/APPLICATION**

Gastrostomy Tubes converted to Gastrojejunostomy feeds are becoming more frequent at children hospitals. Thus, creating a significant burden on patients and families with continuous need for routine changes and additional cost. Further work is needed to find optimal feeding approach for children gastric feeding intolerant.

**SSE21-03 Biodegradable Stents Placement in Biliary Strictures after Liver Transplant in Children: A Single Center Experience**

Monday, Dec. 2 3:20PM - 3:30PM Room: S403B

**Awards**

**Trainee Research Prize - Resident**

**Participants**

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**PURPOSE**

To evaluate the feasibility and safety of the use of biodegradable SX-Ella biliary stents as part of the treatment of post-liver transplant biliary strictures in pediatric patients. To compare the evolution between pediatric patients treated with and without SX-ELLA

**METHOD AND MATERIALS**

We conducted a retrospective observational study including pediatric patients with symptomatic benign biliary stricture as a complication of liver transplant diagnosed by US or MR, and treated percutaneously by our interventional team between 2008 and 2019. A descriptive comparison of the clinical evolution and stricture recurrence between patients with and without SX-ELLA placement using clinical, analytical and radiological parameters, was performed.

**RESULTS**

A total of 25 children were included in the study, divided in two groups: group A (19 children) treated with SX-ELLA biodegradable stent placement and group B (6 children) treated with bilioplasty, drainage catheters and metallic stents. Group A: average number of bilioplasties prior to SX-ELLA placement=1.2. Average time with a biliary tutor=45days. Average stricture recurrence after SX-ELLA placement=0.1 (only 2 patients, one treated with another biodegradable stent, the other patient underwent surgery). After SX-ELLA placement no bilioplasty or biliary drainage was needed. The average number of cholangitis episodes= 0.4. Current clinical and radiological resolution is 68% and 63% respectively. Group B: presented an average number of bilioplasties=2.5, average number of permanent stents= 0.5. Average time with a biliary tutor=225.2 days (7.4 months). Average stricture recurrence= 1.8. Two patients underwent surgery. Average of cholangitis episodes=2. Current clinical and radiological resolution is 50% and 33.3%

respectively.

## CONCLUSION

Biodegradable stents placement by a transhepatic approach is a feasible, safe, and effective tool providing a good alternative in the therapeutic algorithm for the treatment of biliary strictures after liver transplant in children improving clinical and radiological outcome. However, the present results should be confirmed with further randomized controlled trials.

## CLINICAL RELEVANCE/APPLICATION

The use of biodegradable stents reduces stricture recurrence, repetitive cholangitis episodes as well as the average time with a biliary tutor and its complications, improving clinical and radiological outcome.

## SSE21-04 Hemodialysis Catheter Placement in Children Under One Year - Technical Challenges and Outcomes

Monday, Dec. 2 3:30PM - 3:40PM Room: S403B

### Participants

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## PURPOSE

To evaluate the feasibility, technical aspects, challenges, and outcomes of hemodialysis (HD) central venous catheter (CVC) insertion and maintenance in patients under one year of age.

## METHOD AND MATERIALS

Single center retrospective study of all patients under one year who underwent HD-CVC insertions between January 2002 and December 2016. Demographic data, intra-procedural and post-procedural details, including catheter maintenance procedures, technical modifications, complications and long-term outcomes were evaluated.

## RESULTS

29 consecutive patients who underwent 49 HD-CVC insertions were included. Mean patient age and weight at the time of insertion was 117 days (median: 113 days; range: 2-342 days) and 4.9 kg (median: 4.6 kg; range: 2.6 - 6.9 kg), respectively. 15/49 (31%) were non-tunneled temporary HD-CVCs; 34/49 (69%) were tunneled permanent HD-CVCs. All insertions were successful. Comparing temporary to permanent catheters respectively: 0/15 (0%) vs 23/34 (68%) required modifications at insertion; 1/15 (7%) vs 25/34 (74%) required catheter maintenance procedures; 25.4 vs 0.84 catheter related blood stream infections/1000 catheter days occurred; and 25.4 vs 1.9 catheter associated thrombosis/1000 catheter days occurred. 11/29 patients (38%) died at <1 year of age from their underlying disease. The remaining 18 patients (62%) survived beyond 1 year: 9/18 (50%) underwent subsequent renal transplantation, 5/18 (27%) remained on dialysis, 1/18 (6%) transitioned to palliative care, 1/18 (6%) completely recovered and 2/18 (11%) were transferred to another institution for management.

## CONCLUSION

HD-CVC placement is feasible in children under 1 year of age. Insertion modifications and maintenance procedures are required to maintain function.

## CLINICAL RELEVANCE/APPLICATION

Hemodialysis central venous catheter placement is feasible in children under 1 year of age, however insertion modifications and maintenance procedures are often required to maintain function.

## SSE21-05 Hepatic Vein Interventions in Pediatric Liver Transplant Patients: Single Center Experience

Monday, Dec. 2 3:40PM - 3:50PM Room: S403B

### Participants

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## PURPOSE

To evaluate the results of hepatic vein related complications in pediatric liver transplantation patients in our center and related diagnostic and therapeutic interventions.

## METHOD AND MATERIALS

A total of 452 pediatric patients who underwent liver transplantation between March 2002 and April 2019 were retrospectively reviewed. Patients with hepatic vein stenosis and thrombosis were evaluated. Sedation and analgesia were used in every patient. Femoral, jugular and percutaneous routes were used. After the pressure-gradient measurements, angioplasty and/or stent implantations were performed. In cases with thrombosis thromboaspirations were done.

## RESULTS

A total of 452 pediatric patients 244 male (54%) and 208 female (46%) underwent liver transplantation during study period. The mean ages were 6.3 and 5.9 years for male and females respectively. Of the patients, 327 (72%) were transplanted from the live donor and 125 (28%) from the cadaver. Fulminant liver failure (40%) was the most common indication. A total of 43 patients (23 female and 20 male) underwent hepatic venography-cavography. Jugular vein access (n:42) was the most frequently used route. In 4 patients through and through access was used. In 33 patients a total of 65 balloon angioplasty (mean 1.97), 14 stent implantation (in 10 patients), and 2 thromboaspirations were performed. The hepatic vein complication rate was 7.3% in our pediatric patient group and the average number of hepatic venography procedure was 2,7. Twenty-four of the 33 patients (72.7%) who were intervened is still alive.

## CONCLUSION

The risk and incidence of vascular complications in pediatric patients after liver transplantation are higher than in adults. Among these complications, the incidence of hepatic venous outflow obstruction or thrombosis has been reported between 1-13% in the literature. Our 7.3% rate is consistent with the literature data. Angioplasty is the first choice in stenoses and repetitive sessions may be required. In our group, the rate of recurrent angioplasty was found to be 42%. Stent implantation should generally be the last choice in patients who do not respond to recurrent balloon angioplasties or respond poorly. Endovascular interventions for hepatic vein related problems in pediatric liver transplantation cases are safe and effective, and should be the first choice of treatment.

## CLINICAL RELEVANCE/APPLICATION

Pediatric liver transplant patients, hepatic vein problems

### SSE21-06 Intraabdominal Lymphatic Malformation in Children: Treatments and Outcomes

Monday, Dec. 2 3:50PM - 4:00PM Room: S403B

#### Participants

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## PURPOSE

Intra-abdominal lymphatic malformations (LM) pose unique challenges and risks. This study evaluates possible treatment options for intra-abdominal LM and their long-term outcomes.

## METHOD AND MATERIALS

Retrospective review of children (<18 years) with an intra-abdominal LM diagnosed on imaging between January 2001 to September 2018. Treatment options were expectant management with a course of antibiotics, sclerotherapy and/or surgical resection. All patients were followed up for at least 1 year after their initial diagnosis. Sclerotherapy consisted of doxycycline with or without 3% sodium tetradecyl sulphate. One or more drains were inserted in all sclerotherapy patients.

## RESULTS

15 patients (average age at diagnosis: 6.5 years, range: 1 day to 17 years) were included, all of which had macrocystic LM. Treatment consisted of: sclerotherapy alone (n=9), surgical resection alone (n=2), both sclerotherapy and surgical resection (n=1) and expectant management (n=2). The average number of days of sclerotherapy performed was 2.2 days (range: 1 to 6 days). None of the patients had intra- or post-operative complications related to their sclerotherapy or surgery. Of the two patients who were treated expectantly, both presented with infection of their LM. The LM decreased in size in all patients with 10/15 (66.7%) patients having no residual lesion on follow-up ultrasound. Of the 10 patients, 8 had undergone sclerotherapy, 1 had surgical excision and 1 was managed expectantly. Of the remaining 5/15 (33.3%) patients with residual LM, 3 were less than 2cm at the time of their last follow-up imaging. The two remaining patients had persistent but asymptomatic intra-abdominal LM despite sclerotherapy alone and both sclerotherapy and surgical excision. All patients had complete resolution of their symptoms on follow-up.

## CONCLUSION

Sclerotherapy is a less invasive and effective treatment option for intra-abdominal macrocystic LM. In patients presenting with infection, sclerotherapy or surgical resection may not be needed as the acute event may lead to decrease in size of the lesion and resolution of symptoms. Both sclerotherapy and expectant management of infected LM lead no recurrent symptoms for at least one year following initial diagnosis.

## CLINICAL RELEVANCE/APPLICATION

Sclerotherapy is an effective treatment for intra-abdominal macrocystic lymphatic malformations. When infected, only expectant management may be needed.

Printed on: 10/29/20



SSE22

## Physics (Ultrasound)

Monday, Dec. 2 3:00PM - 4:00PM Room: E352

PH US

AMA PRA Category 1 Credit™: 1.00  
ARRT Category A+ Credit: 1.00

FDA Discussions may include off-label uses.

### Participants

Timothy J. Hall, PhD, Madison, WI (*Moderator*) Equipment support, Siemens AG; Technical support, Siemens AG; Researcher, F.K.A. Gammex RMI; Researcher, Sun Nuclear Corporation  
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### Sub-Events

#### SSE22-01 Photoacoustic Imaging for Assessing Sonoporation of Pancreatic Cancer in a Pre-Clinical Model

Monday, Dec. 2 3:00PM - 3:10PM Room: E352

### Participants

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### PURPOSE

To evaluate the disruption of different US contrast agents (UCAs) for augmenting chemotherapy treatment (i.e., sonoporation) in a murine model of pancreatic cancer.

### METHOD AND MATERIALS

Athymic, nude mice (n=140) were injected with MIA PaCa-2 cells in the right flank and randomized into 2 control groups (untreated or chemotherapy only) and 8 treatment groups. The latter consisted of chemotherapy and one of 4 UCAs: Definity® (Lantheus Medical Imaging, N Billerica, MA), Lumason® (Bracco, Milan, Italy), Optison™ (GE Healthcare, Princeton, NJ) or Sonazoid™ (GE Healthcare, Oslo, Norway) imaged with a Logiq E9 (GE Healthcare, Waukesha, WI) in a high or low acoustic power cohort (ISPTA of 200 or 60mW/cm<sup>2</sup>). Groups were treated once a week for 3 weeks. Hemoglobin and oxygenation measurements were obtained weekly (at baseline, during treatment and 1 week post treatment) using photoacoustic imaging with a Vevo 2100 LAZR scanner (Fujifilm Visualsonics, Toronto, Canada). Mice were followed for tumor growth and survival and compared with two-way ANOVAs.

### RESULTS

All tumor volumes in the 8 treatment groups and in the chemotherapy only group were statistically smaller than those from the untreated group (p<0.02). When comparing tumor volumes from the treatment groups in the high acoustic power cohort to the group receiving chemotherapy alone, all 4 UCA treated groups had significantly smaller tumors (p<0.006) with Optison achieving the greatest reduction (p=0.001). In the low acoustic power cohort, only mice receiving Definity showed a significant tumor volume reduction (p=0.003), while all other comparison were not significant (p>0.07). Total hemoglobin and oxygenation values across tumors as well as within areas of detected blood flow were greater in the high acoustic power cohort (p<0.001), while the impact of UCAs was statistically significant for oxygenation (Definity and Sonazoid; p<0.05) and for hemoglobin within areas of detected blood flow (Optison; p=0.014).

### CONCLUSION

Preliminary results indicate that chemotherapy treatment of pancreatic xenografts can be augmented with high acoustic power sonoporation, and optimal acoustic parameters may be UCA-dependent.

## CLINICAL RELEVANCE/APPLICATION

Sonoporation of pancreatic cancer was successful in a pre-clinical model and the best imaging parameters studied will form the basis for a Phase II clinical trial.

### SSE22-02 **Ultrasound Monitoring of Myofascial Pain Syndrome Treatment and Response: Assessing Botulinum Toxin Propagation without Contrast Media with a Novel B-Flow Sequence and Bite Force Stiffness with Shear-Wave Elastography**

Monday, Dec. 2 3:10PM - 3:20PM Room: E352

#### Participants

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#### PURPOSE

Idiopathic masticatory myalgia (IMM) is related to multifocal tissue stiffening. Botulinum Toxin (BT) can alleviate symptoms, yet the procedure (number, amount) is empirical. Our goal is to use ultrasound imaging (US) to quantify both IMM treatment and response.

#### METHOD AND MATERIALS

Porcine ex-vivo masseter was used to compare US BT imaging with optic assessment of excised tissue specimens (dyed with Indigocarmine). A novel B-flow sequence based on 2D-digital image correlation (2D-DIC) was used to compensate for tissue deformation during injection, allowing high sensitive detection of B-mode changes due to BT propagation without contrast medium. Then 50 units of BT toxin type A dissolved in 1 ml normal saline (0.9% NaCl) were injected in both left and right masseters of a female IMM patient. A 3D printed setup was used to co-register BT injection with US imaging. Shear wave velocity (SWV) values of the left masseter muscle were prospectively assessed in a volunteer with alternating relaxed states and biting states of varying force using a Logiq E9 (GE Healthcare) US. Bite force was measured of the right and left second molar teeth, respectively, using the Occlusal Force-Meter GM10 (Nagano Keiko).

#### RESULTS

2D-DIC allowed visualization of the injected fluid without a contrast medium. In ex-vivo tests,  $r_s = 0.95$  with optic tissue area, and Dice Coefficient = 0.85. In vivo, BT propagated along the fiber structure of the muscle, with threefold larger axial compared to lateral expansion. A compressive strain was observed both above and below the needle. SWV ranged between 1.52 and 3.98 m/s for bite force between 0 and 450 N. For bite force and SWV, we found a correlation of  $r_s = 0.908$  with the force-meter placed on the contralateral (right) side.

#### CONCLUSION

Due to greater axial compared to lateral propagation, multiple injections of smaller amounts of BT in masseter instead of a single injection with larger amount are recommended. SWE provides imaging modality of bite force through correlating activation of the masseter muscle when the force-meter is placed on the contralateral side with respect to the ultrasound probe.

## CLINICAL RELEVANCE/APPLICATION

The presented B-flow method is promising for a wide range of applications, where Contrast-Enhanced US is not feasible. SWE could have diagnostic properties for differentiating idiopathic masticatory myalgia from other diseases affecting the masticatory muscles.

### SSE22-03 **US-Triggered Bulk Antibiotic Release from Novel Hardware in a Rabbit Spinal Infection Model**

Monday, Dec. 2 3:20PM - 3:30PM Room: E352

#### Participants

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## PURPOSE

This study evaluated the efficacy of ultrasound (US)-triggered drug delivery devices to combat bacterial infection in an *ex vivo* cadaveric rabbit spine model.

## METHOD AND MATERIALS

Poly(lactic acid) (PLA)-coated, vancomycin (VAN)-loaded poly(ether ether ketone) (PEEK) devices (1 cm<sup>3</sup>) with a drug-loading reservoir (0.785 cm<sup>3</sup>) were 3D printed. Two device designs were evaluated: 1 large hole for drug release vs 2 smaller holes. Clips were implanted medial to the spinal midline in mature (~6 months, 3 kg) female White New Zealand cadaveric rabbits (n = 4) under an IACUC-approved protocol. To simulate infection, 10<sup>4</sup> cfu of *Staphylococcus aureus* were added to 2 of the 4 sites; the other 2 sites were left clean. Two of the 4 sites (1 inoculated, 1 clean) were insonated for 20 minutes with a Logiq E9 ultrasound scanner (GE Healthcare, Waukesha, WI) equipped with a C1-6 curvilinear probe, using power Doppler imaging (1.7 MHz frequency, 6.4 kHz PRF, 100% acoustic output power) to induce rupture of the PLA coating for VAN release. In parallel, positive and negative bacterial controls were evaluated. All implanted devices were incubated for 2 hours post-insonation, then retrieved for analysis. Results were collected in duplicate (n = 16 total) and compared with a two-way ANOVA.

## RESULTS

Infected sites showed marked reduction in bacterial colonization following US-triggered VAN release, while uninsonated sites exhibited little reduction in bacterial colonization. At 48 hours, there was significantly greater VAN release from the insonated clips compared to the uninsonated clips (p < 0.04). There was significantly greater US-triggered total VAN release from the 1-hole device design than from the 2-hole design (7420 ± 2992 µg vs. 3500 ± 954 µg, p < 0.0001). These levels are sufficient to prevent adhesion of *S. aureus* to implant materials.

## CONCLUSION

This study demonstrated the feasibility of an US-mediated antibiotic delivery device, which could become a potent weapon against spinal surgical site infections.

## CLINICAL RELEVANCE/APPLICATION

This system will aggressively combat post-surgical bacterial infection with great versatility in applications for wide clinical impact.

## SSE22-04 Development of Dedicated Anatomical Breast Ultrasound Phantoms for Ultrasound System Performance Evaluation and Image Optimization Training Tools

Monday, Dec. 2 3:30PM - 3:40PM Room: E352

### Participants

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## PURPOSE

In this study, a range of novel anatomical breast ultrasound phantoms were developed for ultrasound system performance evaluation and image optimization tools. The anatomical phantoms had moderate technical complexity associated with them and simulated the sonographic characteristics of the different breast tissues and contained a range of lesion pathology such as cysts, Mondor's disease, fibroadenoma and angular, spiculated lesions representing malignant findings. Both a system performance evaluation plan and a pedagogical plan were developed for use with these novel phantoms.

## METHOD AND MATERIALS

Design specifications for the anatomical breast phantom were developed through consultation between Radiologists, breast US sonographers as well as taking into consideration the typical profile of patients presenting to a large Radiology Department. The phantoms were scanned using General Electric Logiq 9, Logiq e and Philips Epic ultrasound systems using the breast pre-set; the individual lesions were scanned using a focused optimization approach. The images were evaluated by breast radiologists and sonographers to determine the performance of each ultrasound system. The image images were scored using a 5-point Likert scale (1=poor to 5=excellent). A pedagogical plan was developed to augment the function of these phantoms as training tools; it included the elements outlined in Fig1b.

## RESULTS

No one system consistently performed the best at imaging all types of lesions; however system 3 had the overall best performance (Fig 1c). In particular, it had excellent performance for imaging cystic structures. It was found that the cystic structures provided information about the systems noise level, lesion detectability performance and spatial resolution of the different systems. While, the fibroadenoma and malignant lesions provided information about the system's dynamic range, contrast and spatial resolution performance.

## CONCLUSION

The anatomical breast phantoms were able to effectively demonstrate differences between ultrasound systems identifying differences between individual lesion features, such as reduction of haze and noise in cystic structures as well as demonstrate the impact of different image optimization controls.

## CLINICAL RELEVANCE/APPLICATION

This study demonstrates the utility of "life-like" ultrasound breast phantoms in the performance evaluation of systems as well as the demonstration of different image optimization controls.

## **SSE22-05 Photoacoustic Lymphangiography: The Promising Imaging Modality for Lymphatic Vessels**

Monday, Dec. 2 3:40PM - 3:50PM Room: E352

### **Participants**

Hiroki Kajita, Tokyo, Japan (*Presenter*) Nothing to Disclose  
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### **PURPOSE**

Photoacoustic lymphangiography (PAL) is a new optical imaging technique based on photoacoustic technology, which visualizes small blood vessels and lymphatic vessels in the extremities by high-resolution three-dimensional images. In this report, we introduce the still images and videos obtained with PAL in healthy subjects and lymphedema patients.

### **METHOD AND MATERIALS**

We used the PAI-05 system with semi-spherical ultrasonic detector array. Twenty healthy volunteers and 30 lymphedema patients were recruited. To image the lymphatic structures of the limbs, 0.5 mL of indocyanine green (5 mg/mL) was administered subcutaneously to the dorsal aspect of each foot or hand. PA images were acquired by irradiating the tissue using a laser at wavelengths of near-infrared region. We first obtained the lower leg or forearm of the subjects with a wide-field still images, and then recorded the videos of the targeted vessels with the scope of 20 mm in diameter.

### **RESULTS**

In the still images, the lymphatic vessels up to the diameter of 0.2 millimeters could be observed three-dimensionally with the venules around them in the still images. We could distinguish between blood vessels and lymphatic vessels by colors using the difference of molar extinction coefficient. PAL also revealed the depth of each vessel from the skin surface. In the patient-group, dermal backflow patterns were often observed as dense interconnecting three-dimensional structures of lymphatic vessels. Extended or twisting collecting vessels passing below the fine complex network of dermal lymphatics were also observed. In the videos, lymphatic pump was observed intermittently with various intervals. It was difficult to detect the lymphatic flow in the patients because the lymphatic fluids in the channels are stagnated.

### **CONCLUSION**

In this study, three-dimensional high spatial and temporal resolution images were obtained using the PAI-05 system, allowing the visualization of fine lymphatic vasculature and its pumping movement. The morphologic and dynamic characteristics of the vessels were significantly different in the volunteers and patients.

### **CLINICAL RELEVANCE/APPLICATION**

The actual anatomical course of each lymphatic vessel and venul visualized by PAL is useful in both planning of lymphatico-venous bypassing surgery for lymphedema and locating them during the surgery.

## **SSE22-06 Tissue Viscoelastic Estimates Using a Reverberant Shear Wave Field in Tissues Exhibiting a Power Law Behavior: Generation of 2-D Shear Wave Dispersion Images**

Monday, Dec. 2 3:50PM - 4:00PM Room: E352

### **Participants**

Juvenal Ormachea, Rochester, NY (*Presenter*) IP disclosures, Reverberant shear wave elastography; Commercial agreement, Elastance Imaging LLC  
Kevin J. Parker, PhD, Rochester, NY (*Abstract Co-Author*) Nothing to Disclose  
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### **CONCLUSION**

Dispersion images are shown to have contrast between tissue types and with quantitative values that align with previous studies. Further study is required to define the practical upper limits of SW frequencies, and the range of normal dispersions expected within a healthy population.

### **Background**

We analyze the case of shear waves (SW) established as a fully reverberant field, in which the waves propagate in all directions. The application of reverberant shear wave (R-SW) fields can be accomplished by applying external sources that can be excited by multiple frequencies within a bandwidth. This enables the analysis of the dispersion of shear wave speed (SWS) as it increases with frequency, indicating the viscoelastic nature of the tissue under study. Furthermore, dispersion images can be created alongside the SWS images. We report preliminary studies on breast and liver tissues using the multi-frequency R-SW technique.

### **Evaluation**

A custom-made portable trifold futon with multiple embedded vibration sources was mounted to a clinical bed to generate the R-SW field. Vibration frequency ranges between 40-400 Hz were used for both CIRS phantoms and liver experiments and 117-702 Hz was used for breast experiments. A Verasonics ultrasound system (Vantage-128TM, WA, USA), was used to track the induced displacements. The wavenumber was estimated by evaluating the autocorrelation function of the R-SW signal. The relationship between SWS and frequency was evaluated over the vibration frequency range. Our multi-frequency data was analyzed for both the traditional linear dispersion slope (LDS) and for power law coefficient (PLC) dispersion.

### **Discussion**

In liver, mean LDS of  $0.35 \pm 0.06$ ,  $0.52 \pm 0.11$  (m/s/100Hz) and PLC of  $0.25 \pm 0.04$ ,  $0.40 \pm 0.10$  were obtained for a thin and an obese patient, respectively. In breast, LDS of  $0.13 \pm 0.06$ ,  $0.49 \pm 0.09$  (m/s/100Hz) and PLC of  $0.24 \pm 0.11$ ,  $0.69 \pm 0.10$  were obtained for a fibroadenoma and dense tissue, respectively. This work shows that R-SW fields can be produced in deep tissues using external sources, up to 400 Hz in obese patients' livers and over 700 Hz in breast tissue. The dispersion can be analyzed as LDS or as a PLC consistent with a more advanced framework of tissue rheology.

Printed on: 10/29/20



SSE23

## Physics (Nuclear Medicine)

Monday, Dec. 2 3:00PM - 4:00PM Room: E351



AMA PRA Category 1 Credit™: 1.00  
ARRT Category A+ Credit: 1.00

### Participants

Chin-Tu Chen, PhD, Chicago, IL (*Moderator*) Board Member, BioMed Global Board Member, EVO Worldwide, Inc Board Member, AEPX Board Member, EnDepth Vision Systems, LLC Research Grant, DxRay, Inc Advisor, Reflexion Medical Inc Shareholder, EDDA Technology, Inc

Srinivas C. Kappadath, PhD, Houston, TX (*Moderator*) Research Grant, General Electric Company; Research Grant, BTG International Ltd; Consultant, BTG International Ltd; Consultant, ABK Biomedical Inc; Consultant, Terumo Corporation

### Sub-Events

#### SSE23-01 Comparison of Post-Therapy Y-90 PET/CT Dosimetry Methods in Liver Therapy with Y-90 Microspheres

Monday, Dec. 2 3:00PM - 3:10PM Room: E351

#### Participants

Karin Knesaurek, PhD, New York, NY (*Presenter*) Nothing to Disclose

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Renata Pyzik, New York, NY (*Abstract Co-Author*) Nothing to Disclose

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### CONCLUSION

The MIM and Planet Dose DPK dosimetry values were practically interchangeable. Y-90 dosimetry values obtained by all methods were similar, but LDMwS tended to produce slightly higher values.

### Background

The aim of our study was to compare dosimetry methods for Y-90 PET/CT, using commercially available software packages.

### Evaluation

As a part of continuing study, 25 patients were taken to a PET/CT suite (mCT, Siemens Medical) following therapy with Y-90 microspheres. The low mA, non-diagnostic CT images were used for attenuation correction and localization of the Y-90 microspheres in PET/CT studies. The acquisition time was 15 min, the reconstruction matrix size was 200x200x75 mm and voxel size 4.07x4.07x3.00 mm. Two commercially available software packages, MIM 6.8 (MIM software Inc., Cleveland, Ohio) and Planet Dose (DOSIsoft SA, Cachan, France) were utilized to calculate Y-90 dosimetry from PET images. Three methods were used for voxel-based dosimetry calculations; the Local Deposition Method (LDM), LDM with scaling (LDMwS) for known injected activity, and a Dose Point Kernel (DPK) method using the MIRD kernel. Only the DPK approach was applied to the Planet Dose software and these values were compared with MIM DPK dosimetry values. LDM and LDMwS were only applied to the MIM software. The average total liver dosimetry values (mean±SD) were 53.59±23.47 Gy, 60.93±28.62 Gy, 55.33±24.80 Gy and 54.25±23.70 Gy, for LDM, LDMwS, DPK with MIM and DPK with Planet Dose (DOSI), respectively. In most cases the LDMwS method produced slightly higher values than the other methods. The MIM and Planet Dose DPK dosimetry values (i.e., DPK vs. DOSI) were highly comparable. Bland-Altman analysis calculated a mean difference of 1.1 ± 1.6 Gy. The repeatability coefficient was 3.1 ( 5.7% of the mean).

### Discussion

The slightly higher values produced by LDMwS compared to the other methods is due to the difference between dose calibrator scaling, and the quantitative accuracy of the Y-90 PET imaging. Although, the differences are not great, they should be diminished by better quantifiable Y-90 PET imaging and improved dose calibrator quality control.

#### SSE23-02 Accuracy Dose Evaluation in Radioembolization Procedures Using 99mTc-SPECT/CT and 90Y-PET/CT

Monday, Dec. 2 3:10PM - 3:20PM Room: E351

#### Participants

Luca Indovina, PhD, Roma, Italy (*Presenter*) Nothing to Disclose

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Luca Zagaria, Roma , Italy (*Abstract Co-Author*) Nothing to Disclose  
Marco De Spirito, Rome , Italy (*Abstract Co-Author*) Nothing to Disclose

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## CONCLUSION

In this paper it is emphasized that, in radioembolization procedures,  $^{99m}\text{Tc}$ -SPECT/CT images can be used to predict directly the final dose distribution for  $^{90}\text{Y}$  microspheres with accuracy. In particular, pixel's intensity uniformity, noise and sensitivity in  $^{99m}\text{Tc}$ -SPECT/CT images are obviously much better than those observed in  $^{90}\text{Y}$ -PET/CT scans. The  $^{90}\text{Y}$ -PET/CT dosimetric accuracy, in comparison to  $^{99m}\text{Tc}$ -SPECT/CT dosimetric accuracy, is still acceptable for dosimetric purpose and it remains a necessary tool for theranostic analysis with therapeutic and diagnostic capabilities.

## Background

Radioembolization with  $^{90}\text{Y}$ -microspheres is increasingly used in HCC treatment. In terms of the impact of tumoral dose, many studies confirmed a tumor dose response relationship. For pre-therapeutic dosimetry,  $^{99m}\text{Tc}$ -MAA is used as a surrogate of microsphere distribution to assess tumoral targeting and dosimetry. In the same way,  $^{90}\text{Y}$ -PET/CT following radioembolization has been established as a viable diagnostic tool for tumoral targeting and dosimetry. The aim of this study is to evaluate dosimetry accuracy both in  $^{99m}\text{Tc}$ -SPECT/CT and in  $^{90}\text{Y}$ -PET/CT.

## Evaluation

iDVH and dDVH obtained from  $^{99m}\text{Tc}$  SPECT-CT and  $^{90}\text{Y}$  PET-CT were evaluated to analyze mean and voxel dose accuracy in tumor and liver dose evaluation, as implemented in MIM software vs. 6.8, with three different dosimetric approach both in a torso phantom and patients. Images were acquired in a Siemens Biograph mCT PET/CT and in a Siemens Intevo 2 SPECT/CT. Figure 1 shows dose distribution in the phantom liver compartment for  $^{99m}\text{Tc}$  SPECT-CT and  $^{90}\text{Y}$  PET-CT. iDVH and dDVH for all the dose calculation methods, both for  $^{99m}\text{Tc}$  and  $^{90}\text{Y}$ , are reported in Figure 2 and 3, respectively. Figure 4, 5 and 6 show same results in patient study with  $^{99m}\text{Tc}$  SPECT-CT.

## Discussion

Mean doses, standard deviation and coefficient of variation obtained from iDVH, for  $^{99m}\text{Tc}$  SPECT-CT and  $^{90}\text{Y}$  PET-CT, shows deviations from MIRD dose between -9% and -4% while deviations between -27% and -9% are reported for  $^{90}\text{Y}$  PET-CT. Finally, the CoV dispersion index 1 confirm the better dose distribution estimation obtained in the 3D dosimetry for  $^{99m}\text{Tc}$  SPECT-CT with respect to those obtained for  $^{90}\text{Y}$  PET-CT.

## SSE23-03 Development of Wearable Technology to Enable Therapy Personalization of $^{177}\text{Lu}$ DOTATATE for Neuroendocrine Tumors

Monday, Dec. 2 3:20PM - 3:30PM Room: E351

### Participants

Robert Miyaoka, Seattle, WA (*Presenter*) Co-founder, Precision Sensing, LLC; Research Consultant, MIM Software Inc; Research Grant, General Electric Company;  
Larry Pierce, PhD, Seattle, WA (*Abstract Co-Author*) Co-founder, Precision Sensing LLC  
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## PURPOSE

The goal of this work is to enable patient specific  $^{177}\text{Lu}$ -DOTATATE organ dosimetry without requiring serial imaging sessions at a medical facility. This will be accomplished by developing wearable monitoring technology to allow quantitative measurements to be made through at home usage. This will support accurate estimation of the washout from individual organs at risk (OAR) enabling physicians to tailor the number of treatments based upon personalized organ dosimetry information .

## METHOD AND MATERIALS

The enabling technologies are the development of a precision sensing belt (PSB) and software methods that can determine the optimal placement of a sparse set (e.g., 8-15) of small radiation detectors around the mid-section of the patient. A CT image will be used to register the PSB with a patient's internal organs. Based upon the patient specific CT image, Monte Carlo simulations and optimization methods are used to select the optimum positioning of a small set of detectors around the patient. Measurements from the PSB are then correlated with a quantitative SPECT/CT image acquired 24 hours after dose administration. After being sent home, the patient will wear the PSB for 2 minutes per day for 7-21 days. The basic methodology was tested using Monte Carlo simulation. The testing phantom consisted of anthropomorphic objects representing the liver, spleen, right and left kidneys and two tumors. Activity ratios for the liver, spleen, right and left kidneys, 2.5 cm and 1.5 cm tumors to background were 2, 10, 10, 8, 48 and 60. The washout half-lives were 74, 66, 40, 46, 92, 96, and 95 hours, respectively. One hundred simulations were run and the root mean squared error (RSME) was determined for the estimated and actual decay constants for the OAR, background and tumors .

## RESULTS

**Using only 4 PSB measurements at 4 hrs and 1, 3 and 7 days, the RSME between the estimated and actual washout constants for the OAR and background were all <5%. The 2.5 cm tumor had the worst RMSE of ~12%. However, when 21 daily PSB measurements were made all OAR, background and tumors had a RSME of <4% .**

## CONCLUSION

**The initial results based upon simulation studies indicate that the precision sensing belt is able to estimate washout from OAR and tumors to within  $\pm 5\%$ . Use of the PSB could significantly lower the cost of any clinical trial to investigate personalized  $^{177}\text{Lu}$  DOTATATE therapy and lead to FDA approval for personalized therapy.**

## CLINICAL RELEVANCE/APPLICATION

The goal of the precision sensing belt is to enable low cost, patient friendly methods for the personalization of 177Lu DOTATATE therapy.

### SSE23-04 Quantitative Impact of Iterative Reconstruction Settings for Next-Generation Digital Photon Counting PET/CT

Monday, Dec. 2 3:30PM - 3:40PM Room: E351

#### Participants

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#### PURPOSE

The introduction of next generation, digital PET/CT enables high definition reconstruction with decreased voxel volumes, improving image quality, lesion detectability, and quantitative accuracy. However, using a larger reconstruction matrix without changing reconstruction parameters leads to increases in image noise. We assessed the impact of iterative reconstruction settings on PET quantification in order to overcome the perceived limitations of image noise.

#### METHOD AND MATERIALS

80 patients injected with 13 mCi 18F-FDG were imaged 90sec/bed on a digital photon counting PET/CT system (Philips Vereos, dPET). PET listmode data were reconstructed with 4 and 2mm<sup>3</sup> isometric voxel volumes, initially using 3 iterations with 29 subsets. Secondary reconstructions then completed using 13, 15, and 17 subsets for the 4mm standard definition (SD) images, and 11, 13, and 15 for the 2mm high definition (HD) images. We evaluated visual quality and quantitative precision in target tumors and background tissues, using the 29 subset images as a reference.

#### RESULTS

Visual review revealed that the lower subset images were more preferable than the reference 29 subset images, particularly for the HD reconstructions where image noise is more apparent. Quantitative evaluation was revealed to be quite stable over a range of reconstruction settings. On average, quantification of physiologic uptake varied less than 2% and 3% for SD and HD reconstructions. In target lesions, the SUV<sub>max</sub> decreased on average 4.4%, 4.1%, and 4.2% for SD images with 13, 15, and 17 subsets. In the HD images, the average decrease was 8.7%, 7.2%, and 6.4% for 11, 13, and 15 subsets.

#### CONCLUSION

The improved sensitivity and time of flight timing resolution of the dPET system allow for more accurate lesion detection and quantification, enhanced by the use of HD reconstructions. Here we have shown that when modifying the reconstruction settings to optimize visual quality of the images, quantitative parameters remain stable. Thus the optimization can be tailored to chosen voxel volumes and expected count densities in order to best leverage the capabilities of new digital photon counting PET.

## CLINICAL RELEVANCE/APPLICATION

Higher definition PET imaging is readily achieved after optimization of iterative reconstruction parameters to account for increased noise in the now more count sparse voxels.

### SSE23-05 A Study of Pseudo CT Generation for PET/MR Attenuation Correction Using Deep Learning

Monday, Dec. 2 3:40PM - 3:50PM Room: E351

#### Participants

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Hongcheng Shi, Shanghai, China (*Abstract Co-Author*) Nothing to Disclose

#### PURPOSE

Accurate attenuation correction (AC) remains a challenging problem in today's PET/MR systems. Specialized UTE MR images have been used for generating AC map in conventional scanners. However, the UTE acquisitions are time-consuming and provide little information for clinical diagnostic purpose. In this study, we investigated the feasibility of a deep learning approach using conditional generative adversarial network (cGAN) (Isola et. al., arXiv:1611.07004) to synthesize pseudo CT images from T1-weighted MR images for AC map generation in brain PET/MRI imaging.

#### METHOD AND MATERIALS

The cGAN network was trained to provide continuously valued CT images. The network structure was adopted from the original paper, which consists of a U-Net generator and a PatchGAN discriminator. Both MR and CT images were acquired at the head position for 100 patients. The T1-GRE-FSP-ISO images, which were included in the clinical scanning protocol, were chosen as the input MR images. The MR and CT images were registered and transformed into 2D axial images with 1mm\*1mm pixel size and 2mm slice thickness. Images of 80 patients were used in the training procedure and those of

the other 20 patients were used for validation. The performance of the trained model was evaluated by comparing the generated pseudo-CT to the acquired CT images using structural similarity index (SSIM). Dice coefficients were also calculated via segmenting the images into air (<-500 HU), bone (>500 HU), and soft tissue regions.

## RESULTS

For the validation image set of 20 patients, the SSIM between the pseudo-CT images generated by the trained model and acquired CT images is  $0.894 \pm 0.049$ . The Dice coefficients are  $0.987 \pm 0.008$  for air,  $0.736 \pm 0.094$  for bone, and  $0.938 \pm 0.028$  for soft tissues.

## CONCLUSION

The initial results show that this deep learning approach based on cGAN technique has the potential to synthesize continuously-valued pseudo-CT images from T1-weighted MR brain images, which can then be further used to generate AC map for PET/MR imaging. Future work may include training of 2.5D or fully 3D models as well as employing additional MR sequences as the model input.

## CLINICAL RELEVANCE/APPLICATION

This study provides an alternative approach for attenuation correction in PET/MR systems, which may potentially improve the current PER/MR imaging procedure and quality.

## SSE23-06 Total-body Parametric Imaging on EXPLORER

Monday, Dec. 2 3:50PM - 4:00PM Room: E351

### Participants

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## PURPOSE

Dynamic PET can estimate physiologically relevant parameters. Current PET scanners offer whole-body dynamic imaging but require a multi-pass scan protocol, which results in low signal-to-noise and misses temporal information at each bed position. To overcome these limitations, a 2-meter long PET/CT (EXPLORER) has been developed. In this work, we perform total-body parametric imaging and demonstrate its potential benefit for clinical imaging.

## METHOD AND MATERIALS

We conducted the first human dynamic total-body PET study using the EXPLORER scanner in a healthy female subject. A 60min dynamic scan was performed immediately after an intravenous injection of 256 MBq of  $^{18}\text{F}$ -FDG. We divided the one-hour dynamic dataset into 187 frames and reconstructed it using a 3D TOF list-mode OSEM algorithm with all quantitative corrections (normalization, attenuation, scatter and random corrections) incorporated in the forward model. The linear Patlak model was implemented to analyze total-body FDG metabolism. The Patlak slope Ki image was estimated from the reconstructed 30-60min frames and was compared with the standard uptake value of the static scans at different times post-injection. The input function was obtained from the aorta time activity curve.

## RESULTS

First, the reconstructed dynamic images show good image quality with low noise and demonstrate the high sensitivity of the EXPLORER and the benefit of total-body coverage. Second, the Patlak Ki image show good contrast and high signal-to-noise ratio for detecting abnormally high FDG uptake which may potentially increase lesion detectability using FDG PET. In this volunteer study, a hot spot in the right collarbone, possibly representing bone healing processes, can be clearly seen in the Patlak Ki image using the 30-60min data. The hot spot is confirmed in the delayed scan acquired at 4-hr post injection. This result suggests that we may be able to use dynamic scans to obtain improved lesion conspicuity without the inconvenience of late time-point scanning.

## CONCLUSION

In this study we performed a total-body parametric imaging study using the EXPLORER and demonstrated its high image quality for clinical imaging.

## CLINICAL RELEVANCE/APPLICATION

**FDG PET images glucose metabolism and has been widely used in cancer detection and staging. Total-body parametric imaging can potentially improve lesion detection over existing static scans.**

**Printed on: 10/29/20**





SSE24

## Physics (Deep Learning - X-Ray Scatter Correction and Denoising)

Monday, Dec. 2 3:00PM - 4:00PM Room: S104A

AI CT PH

AMA PRA Category 1 Credit™: 1.00  
ARRT Category A+ Credit: 1.00

FDA Discussions may include off-label uses.

### Participants

Ioannis Sechopoulos, PhD, Atlanta, GA (*Moderator*) Research Grant, Siemens AG; Research Grant, Canon Medical Systems Corporation; Speakers Bureau, Siemens AG; Scientific Advisory Board, Fischer Medical  
Timothy P. Szczykutowicz, PhD, Madison, WI (*Moderator*) Equipment support, General Electric Company; License agreement, General Electric Company; Founder, Protocolshare.org LLC; Medical Advisory Board, medInt Holdings, LLC; Consultant, General Electric Company; Consultant, Takeda Pharmaceutical Company Limited

### Sub-Events

#### SSE24-01 Low-Contrast Detectability of Image-Based Denoising Algorithm using Deep Learning in CT: A 12-Reader Study Comparing with Advanced Modeled Iterative Reconstruction and Filtered Back Projection

Monday, Dec. 2 3:00PM - 3:10PM Room: S104A

### Participants

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Jungheum Cho, MD, Seongnam, Korea, Republic Of (*Abstract Co-Author*) Nothing to Disclose  
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### PURPOSE

To compare the low-contrast detectability of deep learning-based denoising algorithm (DLA) with those of advanced modeled iterative reconstruction (ADMIRE) and filtered back projection (FBP).

### METHOD AND MATERIALS

Using abdomen and pelvis CT images of 100 patients reconstructed with both ADMIRE and FBP, we trained DLA while feeding FBP images as input and ADMIRE images as the ground truth. To compare the low-contrast detectability of the DLA with those of ADMIRE and FBP, randomized repeat scans of Catphan® low-contrast phantom module (CTP 515) were performed under various conditions of radiation exposures (100 kVp; 200, 100, 50, 25 mAs). All images were reconstructed or denoised using each algorithm. We used 9 mm and 5 mm supra-slice targets with +10 HU difference to the background in measuring the low-contrast detectability. Twelve radiologists reviewed 960 images and evaluated target presence on a five-point confidence scale. Task transfer function (TTF) and noise power spectrum (NPS) of each algorithm were evaluated using American College of Radiology CT accreditation phantom module 1 under the condition of 100 kVp and 200 mAs. To compare the low contrast detectability, multireader multicase area under the receiver operating characteristic curve (AUC) was calculated and noninferiority tests were performed. To compare the TTF and NPS across the algorithms, TTF50, area under the NPS (AUNPS), and NPS peak frequency were compared using paired t-test.

### RESULTS

AUC of DLA in detecting low contrast targets was noninferior to that of ADMIRE (AUC difference [95% confidence interval], -0.013 [-0.038-0.012];  $P < 0.001$ ) and superior to that of FBP (0.039 [0.017-0.060],  $P < 0.001$ ). TTF50 of DLA was significantly higher than those of FBP and ADMIRE ( $P < 0.001$ ), except comparing with that of ADMIRE in the disc simulating hypothetical bone. AUNPS of DLA was significantly lower than those of ADMIRE and FBP ( $P < 0.001$ , respectively). The NPS peak frequency of DLA was not different from that of ADMIRE ( $P > 0.99$ ) and was significantly lower than that of FBP ( $P < 0.001$ ).

### CONCLUSION

The low-contrast detectability of the deep learning-based denoising algorithm was noninferior to that of ADMIRE and was superior to that of FBP.

### CLINICAL RELEVANCE/APPLICATION

The deep learning-based denoising algorithm can potentially imitate and substitute the advanced modeled iterative reconstruction, as the image quality of the deep learning-based denoising algorithm was comparable to that of ADMIRE and was superior to that of FBP.

#### SSE24-02 Patient-Specific Noise Reduction Using a Deep Convolutional Neural Network

Monday, Dec. 2 3:10PM - 3:20PM Room: S104A

#### Participants

Andrew Missert, PHD, Rochester, MN (*Presenter*) Nothing to Disclose  
Shuai Leng, PHD, Rochester, MN (*Abstract Co-Author*) Nothing to Disclose  
Lifeng Yu, PhD, Rochester, MN (*Abstract Co-Author*) Nothing to Disclose  
Joel G. Fletcher, MD, Rochester, MN (*Abstract Co-Author*) Grant, Siemens AG; Consultant, Medtronic plc; Consultant, Takeda Pharmaceutical Company Limited; Grant, Takeda Pharmaceutical Company Limited; ;  
Cynthia H. McCollough, PhD, Rochester, MN (*Abstract Co-Author*) Research Grant, Siemens AG

#### PURPOSE

To develop and evaluate patient-specific training to improve performance for convolutional neural network (CNN)-based CT denoising.

#### METHOD AND MATERIALS

Two training methods were investigated for CNN-based denoising of CT images: one using abdominal CT data from multiple patient cases to perform generic CNN training, and the other using patient-specific data to fine-tune the generic CNN for use with images from that same patient. A deep residual CNN was trained with routine dose (RD) abdominal CT images from 10 patients, and the corresponding low-dose (LD) images, which use noise insertion into the projection data to simulate data acquired at 25% of RD. The mean squared error (MSE) between LD and RD images was used as the loss function. After training for 300 epochs, the model was referred to as CNN-General. The model was then fine-tuned for 300 epochs using RD images from a new patient (Patient A) and 19 additional LD image realizations achieved through repeated insertion of random noise. After fine-tuning, the model was referred to as CNN-A, since it was tuned to the anatomy of Patient A. Simulated LD (25, 50, and 75%) data from 3 patients (A,B,C) not included in the original 10-patient training cohort were used for validation data; the LD data for Patient A that was used for validation was a different LD realization than the 19 simulated exams used for Patient-A-specific training. Performance was assessed by comparing the minimum MSE values achieved during training and various anatomic features in the original RD images of Patient A after denoising with both methods.

#### RESULTS

After the first 50 epochs of fine-tuning, CNN-A converged to a lower MSE than CNN-General when applied to Patient A for 25%, 50%, and 75% of RD by factors of 12%, 22%, and 22% respectively. When applied to the original RD images for Patient A, we found that CNN-A improves the visibility of subtle anatomic features compared to CNN-General.

#### CONCLUSION

A CNN-based denoising algorithm trained using a random patient cohort can be fine-tuned for a specific patient to improve denoising performance using a single CT exam with multiple random noise realizations.

#### CLINICAL RELEVANCE/APPLICATION

Patient-specific fine-tuning of a CNN-based denoising algorithm can improve performance compared to one that was only trained on a general patient cohort.

#### SSE24-03 Deep Learning Based Adaptive Filtering for Projection Data Noise Reduction in X-Ray Computed Tomography

Monday, Dec. 2 3:20PM - 3:30PM Room: S104A

#### Participants

Tzu-Cheng E. Lee, PhD, Vernon Hills, IL (*Presenter*) Nothing to Disclose  
Jian Zhou, PhD, Vernon Hills, IL (*Abstract Co-Author*) Principal Scientist, Canon Medical Systems Corporation  
Zhou Yu, Waukesha, IL (*Abstract Co-Author*) Employee, Canon Medical Systems Corporation

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#### PURPOSE

Raw data noise reduction is often applied in CT before reconstruction in order to improve the quality of reconstructed images. Adaptive data filtering methods have been widely used for this purpose. However, most of adaptive filtering methods choose the kernel parameter based on empirical knowledge which may lack robustness depending on data conditions. In this research, we leverage the deep learning technique to mitigate this limitation. We propose a parametric kernel prediction network (PKPN) which can automatically generate kernel parameters that are adaptive to various data statistics.

#### METHOD AND MATERIALS

We develop a deep neural network, PKPN, which can automatically predict the spatially variant kernel parameter based on various input data statistics. PKPN includes two major components: a linear sequence network and a spatial variant filtering module (see figure 1). The network is to generate parameters for every data pixel required by the filtering module. Note that when training the network, we still compute the loss between the predicted projection and the reference projection. This ensures that the data after adaptive filtering can still be optimal in terms of training criteria.

#### RESULTS

We calculated the RMSE and the SSIM with the high-dose reference. For low-dose abdominal (120 kVp, simulated 35 mAs) and thoracic (120 kVp, simulated 45 mAs) projection data, PKPN shows both better RMSE and SSIM on the reconstructed images compared to conventional filtering method (Relative Noise Level) processed data (see figure 2). Anatomical detail is also clearer at the PKPN set compares to the RNL set.

#### CONCLUSION

PKPN can learned through the training process with a relatively simple three-layer neural network. For both simulated and clinical

low-dose cases, PKPN shows very competitive performance in terms of both image accuracy and resolution compared to the conventional approach. Moreover, the proposed method can be readily extended to kernel functions other than the simple 2-D isotropic Gaussian function.

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

PKPN for sinogram/projection denoising improves the overall reconstructed CT image quality compared to the conventional approach especially for the low-dose acquisitions.

#### **SSE24-04 Deep Learning based Material Image Denoising for Dual Energy CT with Only Noisy Training Images**

Monday, Dec. 2 3:30PM - 3:40PM Room: S104A

##### **Participants**

Dufan Wu, PhD, Boston, MA (*Presenter*) Research Grant, General Electric Company  
Kyungsang Kim, PhD, Boston, MA (*Abstract Co-Author*) Nothing to Disclose  
Kuang Gong, PhD, Boston, MA (*Abstract Co-Author*) Nothing to Disclose  
Ramandeep Singh, MBBS, Boston, MA (*Abstract Co-Author*) Nothing to Disclose  
Mannudeep K. Kalra, MD, Lexington, MA (*Abstract Co-Author*) Research Grant, Siemens AG; Research Grant, Riverain Technologies, LLC;  
Quanzheng Li, PhD, Boston, MA (*Abstract Co-Author*) Research Grant, General Electric Company

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

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##### **PURPOSE**

Basis material images such as iodine map are noisy in dual energy computed tomography (DECT) due to ill-posed decomposition matrix. This study aimed to reduce noise level of basis material images with deep neural networks which could be trained without noiseless data.

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

Most existing deep learning methods for image denoising require noiseless images as ground truth during training, which are not available for real basis material images in DECT. In this work we proposed a novel deep learning based denoising method for DECT which required only noisy data for training. The projections were split to odd and even sets and each set was reconstructed by filtered backprojection (FBP) separately to acquire  $\xi_1$  and  $\xi_2$  with nearly independent noise from each other. Two networks (UNet) were trained to map  $\xi_1$  to material decomposition of  $\xi_2$  and vice versa. The final denoised material images were the averaged results from the two networks. The method was validated on chest DECT scans from 45 patients for iodine map denoising. 30 patients were randomly selected as training images and the rest 15 were used for testing.

##### **RESULTS**

The method was compared against direct inversion and non-local mean based guided filtering (HYPR-NLM) on the 15 testing subjects. 5 ROIs were drawn on aortas for each subject to study bias and noise level of the basis material images. Bias was calculated by subtracting mean of direct inversion's ROIs from mean of the other two methods' ROIs. The proposed method achieved bias of  $-0.0015 \pm 0.0055$ , which was small enough to be considered unbiased. The proposed method achieved standard deviation of  $0.026 \pm 0.009$  on ROIs and was consistently reduced compared to direct inversion ( $0.123 \pm 0.019$ ) and HYPR-NLM ( $0.030 \pm 0.010$ ), both with  $p < 0.01$  under dependent t-test. The images of iodine maps decomposed by the proposed method demonstrated significantly reduced noise level compared to direct inversion. It also showed less structural bias and block / spiky artifacts compared to HYPR-NLM.

##### **CONCLUSION**

The proposed deep learning method which required only noisy images to train could significantly reduce noise in basis material images of DECT without introducing bias.

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

The proposed method could greatly reduce the noise in material decomposition images of DECT and improve image quality in relevant applications such as pulmonary embolism, renal mass, gout, etc.

#### **SSE24-05 Scatter Correction for Contrast-Enhanced Digital Breast Tomosynthesis (CEDBT) Using Deep Learning Approach**

Monday, Dec. 2 3:40PM - 3:50PM Room: S104A

##### **Participants**

Xiaoyu Duan, Stony Brook, NY (*Presenter*) Nothing to Disclose  
Hailiang Huang, MS, Stony Brook, NY (*Abstract Co-Author*) Nothing to Disclose  
Pranjal Sahu, Stony Brook, NY (*Abstract Co-Author*) Nothing to Disclose  
Wei Zhao, PhD, Stony Brook, NY (*Abstract Co-Author*) Research support, Siemens AG

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

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##### **PURPOSE**

Contrast enhanced digital breast tomosynthesis (CEDBT) utilizes weighted subtraction of high energy (HE) and low energy (LE) DBT to generate a 3D iodinated contrast enhancement map of the breast, and potentially improve breast lesion detection and characterization. However, the increased scattered radiation at HE exacerbates the cupping artifact. Monte Carlo (MC) based scatter correction (SC) method suffers from long computation time, and kernel-based method is less accurate, especially near the breast edge due to thickness roll-off. This work is aimed at developing fast and accurate SC using Convolutional Neural Network (CNN).

## METHOD AND MATERIALS

The FDA open-source VICTRE tool was used to create digital breast phantoms with various shapes, sizes, and breast densities. HE DBT projection images with and without scatter were generated from MC simulation based on the acquisition geometry of Siemens Mammomat Inspiration DBT system. A U-Net CNN was trained to obtain scattered radiation map from projection images with scatter. To minimize the effect of quantum noise on scatter estimate, a gaussian filter was applied to smooth the scatter maps in the training dataset. The segmented breast region, compressed breast thickness, and projection angle were provided to the CNN as separate channels. Mean absolute percentage error (MAPE) was used as the loss function. The number of projections used for training, validation, and testing was 526, 125, and 150 respectively. The accuracy of the CNN-based SC was compared with the accuracy of kernel-based SC using projection images without scatter from MC simulation as ground truth. The proposed SC method was tested on the HE projection images and DBT volume acquired from an IRB-approved clinical study investigating CEDBT.

## RESULTS

After training, the CNN performed SC in real-time. CNN-based SC shows higher accuracy in scatter estimate for HE projections compared to kernel-based SC in the breast peripheral region. The cupping artifact in HE DBT is suppressed post SC.

## CONCLUSION

The proposed CNN-based SC provides a fast and accurate scatter correction for CEDBT.

## CLINICAL RELEVANCE/APPLICATION

The scatter removal in HE DBT improves the image quality of CEDBT, which can potentially make high clinical impact on breast cancer detection and 3D assessment of contrast-enhanced lesions.

## SSE24-06 Monte-Carlo-Free Deep Scatter Estimation (DSE) for X-Ray CT and CBCT

Monday, Dec. 2 3:50PM - 4:00PM Room: S104A

### Participants

Julien Erath, MSc, Forchheim, Germany (*Presenter*) Employee, Siemens AG  
Joscha Maier, Heidelberg, Germany (*Abstract Co-Author*) Nothing to Disclose  
Eric Fournie, Forchheim, Germany (*Abstract Co-Author*) Siemens AG  
Karl Stierstorfer, PhD, Forchheim, Germany (*Abstract Co-Author*) Employee, Siemens AG  
Marc Kachelriess, PhD, Heidelberg, Germany (*Abstract Co-Author*) Nothing to Disclose

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## PURPOSE

To provide an accurate real-time scatter correction algorithm that uses CT measurements of a few simple-to-manufacture phantoms for calibration.

## METHOD AND MATERIALS

DSE is a neural network that maps measured CT data onto scatter-free data. To train DSE a Monte Carlo (MC) simulation of scatter had been used [J. Nondest. Eval. 37:57, 2018] [Med. Phys. 46(1):238-249, 2019]. While being very accurate, this simulation-based approach (sbDSE) highly relies on the quality of the MC simulation which needs to be tailored to the CT scanner. To avoid the need for MC we define a limited set of geometric phantoms in several arrangements to provide a training set for the DSE. The advantage of geometric phantoms is that on the one hand they can be measured in a physical setup, providing the sum of primary and scattered radiation. On the other hand the primary radiation can accurately be determined in a polychromatic simulation of the objects. Thus, the scatter intensity can be estimated by subtracting the simulated primary intensity from the measured intensity. The DSE network is trained to map the measured intensity onto the difference of the measured intensity minus the forward projected intensity. This measurement-based DSE (mbDSE) is evaluated using simulations of the calibration procedure (Siemens Somatom Force system, without anti scatter grid). We apply mbDSE to simulations of semi-anthropomorphic phantoms of different sizes.

## RESULTS

The mean absolute relative error of the mbDSE scatter estimate is between 2 and 3%. Without scatter correction the CT values of the thorax phantom deviated from the scatter-free ground truth by 102 HU (mean of heart ROI), 140 HU (mean of soft tissue ROI close to vertebra), and 15 HU (mean of lung ROI). DSE is able to correct these values to 2 HU, 1 HU, and 0 HU. An MC-based scatter correction did not perform better. Visually the artifacts introduced due to the scatter are completely removed.

## CONCLUSION

The proposed mbDSE may outperform sbDSE and the conventional MC-based scatter estimation since it does not require modeling the scanner's x-ray and scattering properties in detail. Instead it can extract the features relevant for scatter from a set of phantom measurements.

## CLINICAL RELEVANCE/APPLICATION

Accurate scatter estimation allows for accurate correction of scatter artifacts and is thus crucial for providing good image quality.

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SSE25

## Science Session with Keynote: Radiation Oncology (Gynecologic Cancers)

Monday, Dec. 2 3:00PM - 4:00PM Room: E263



AMA PRA Category 1 Credit™: 1.00  
ARRT Category A+ Credit: .50

### Participants

Eric Leung, MD, FRCPC, Toronto, ON (*Moderator*) Nothing to Disclose  
Tracy M. Sherertz, MD, Seattle, WA (*Moderator*) Nothing to Disclose

### Sub-Events

#### SSE25-01 Optimization and Evaluation the Random Forest Model in Prediction the Efficacy of Chemoradiotherapy for Advanced Cervical Cancer Based on Radiomics Signature Coming from High-Resolution T2WI Images

Monday, Dec. 2 3:00PM - 3:10PM Room: E263

### Participants

Defeng Liu, BA, Qinhuangdao, China (*Presenter*) Nothing to Disclose  
Xiaohang Zhang, MS, Beijing, China (*Abstract Co-Author*) Nothing to Disclose  
Qinglei Shi, Beijing, China (*Abstract Co-Author*) Nothing to Disclose  
Juan Du, Qinhuangdao, China (*Abstract Co-Author*) Nothing to Disclose  
Yongji Wang, Beijing, China (*Abstract Co-Author*) Nothing to Disclose  
Lanxiang Liu, Qinhuangdao, China (*Abstract Co-Author*) Nothing to Disclose

### PURPOSE

To establish and optimize a random forest model, and to evaluate the predictive ability of it in prediction the treatment effect of advanced cervical cancer (>IIb) treated with neoadjuvant chemotherapy-radiation therapy based on radiomics signatures coming from high resolution T2WI images.

### METHOD AND MATERIALS

This retrospective study included 82 patients with locally ACC (squamous carcinoma 74, adenocarcinoma 8; pathological stage: IIB 40, IIIa 23, IIIb 10, Iva 4, IVb 5) scanned from March 2013 to May 2018. All these patients received concurrent chemoradiotherapy, and all MR examinations were performed before treatment within one month at a 1.5 T scanner (MAGNETOM Avanto, Siemens Healthcare, Erlangen, Germany). According to curative effect, patients were divided into complete remission and partial remission group. Radiomics signatures were extracted using an open source tool named Pyradiomics (<https://pyradiomics.readthedocs.io/en/latest/index.html>). The model of RF was established and optimized based on the open source toolkit scikit-learn (<https://scikit-learn.org/stable/>). Through optimization the number of decision trees, the criteria for selecting final partition index, the minimum number of samples partitioned by each node, the performance of RF was evaluated.

### RESULTS

The number of decision trees in random forests demonstrated important impact on the performance of the model. When the number of decision trees was set to 10, 25, 40, 55, 70, 85 and 100 respectively, the performance of random forest model shows a trend of rising firstly and then declining. Criteria in selecting final partition index have significant effects on the generation of decision tree. In this study, Gini index demonstrated a better effect compared with information gain index. After optimization, when the number of decision tree is set to 55 and the selection criterion of optimal partition index is set to Gini, the AUC value can reach 0.917.

### CONCLUSION

After optimization, the random forest model seems can provide valuable information and showed potential in prediction treatment effect for advanced cervical cancer (>IIb) treated with neoadjuvant chemotherapy-radiation therapy based on a high resolution T2WI images.

### CLINICAL RELEVANCE/APPLICATION

The optimized RF model seems can provide valuable information and showed potential in prediction treatment effect for advanced cervical cancer (>IIb) treated with neoadjuvant chemotherapy-radiation therapy.

#### SSE25-02 Survival Outcomes in Cervical Cancer Patients Who Undergo Radiotherapy Followed by Hysterectomy or Exenteration

Monday, Dec. 2 3:10PM - 3:20PM Room: E263

### Participants

Andrew Huang, MD, Madison, WI (*Presenter*) Nothing to Disclose  
Karen E. Huang, MS, San Francisco, CA (*Abstract Co-Author*) Nothing to Disclose  
John K. Chan, San Francisco, CA (*Abstract Co-Author*) Speaker, F. Hoffmann-La Roche Ltd

For information about this presentation, contact:

## PURPOSE

While definitive radiotherapy regimens have been shown to be an excellent upfront alternative to surgery for cervical cancer, a small proportion of women still undergo a hysterectomy or exenteration either as an adjuvant or salvage therapy. We wished to determine the outcomes of these women compared to other women in the same cancer stage.

## METHOD AND MATERIALS

We queried a custom Surveillance, Epidemiology, and End Results Program (SEER) database that included chemotherapy and radiotherapy treatment variables. Patients staged between 2004-2010 were included in the analysis and stratified by AJCC 6th edition stage. The primary endpoint was 5-year overall survival. We selected for patients who first underwent both external radiotherapy and brachytherapy who then later underwent hysterectomy or pelvic exenteration. We then compared these patients against all-comers within each stage using the Fisher-Exact test. We excluded patients with stage IA, IIIA, and IV disease as there were <20 patients who met our selection criteria in each of these cohorts.

## RESULTS

There were 32,028 patients that met our initial selection criteria of having cervical cancer, a specific AJCC stage, and 5-year survival data available. Of these, 311 received both external beam radiotherapy and brachytherapy, followed by either a hysterectomy or pelvic exenteration. Five-year survival stratified by initial stage was 69% (IB1, n=24), 90% (IB2, n=95), 68% (IIA, n=30), 69% (IIB, n=66), and 63% (IIIB, n=62). Compared to all-comers, patients with IB1 disease who underwent surgery had a lower 5-year survival (69 vs 90%, p=0.006) while patients with IB2 disease who underwent surgery had a higher 5-year survival (90 vs 74%, p<0.001, Table 1). No statistical differences in survival were seen in IIA (68 vs 62%, p=.705), IIB (69 vs 64%, p=.366), and IIIB (63 vs 51%, p=.056) patients.

## CONCLUSION

Surgical resection after both external beam radiotherapy and brachytherapy in the treatment of cervical cancer is associated with decreased overall survival in Stage IB1 patients but increased overall survival in IB2 patients.

## CLINICAL RELEVANCE/APPLICATION

There is still controversy whether adjuvant hysterectomy after definitive radiotherapy for cervical cancer improves outcomes in cervical cancer; our study hopes to contribute to the body of evidence related to this question.

## SSE25-03 Bone Fragility After Pelvic Chemoradiotherapy for Cervix Cancer

Monday, Dec. 2 3:20PM - 3:30PM Room: E263

### Participants

Alina D. Dragan, MRCS,FRCR, Watford, United Kingdom (*Presenter*) Nothing to Disclose  
Anwar R. Padhani, MD,FRCR, Northwood, United Kingdom (*Abstract Co-Author*) Advisory Board, Siemens AG; Speakers Bureau, Siemens AG; Speakers Bureau, sanofi-aventis Group; Speakers Bureau, Johnson & Johnson; Speakers Bureau, Astellas Group  
Romaana Mir, MRCP,FRCR, Northwood, United Kingdom (*Abstract Co-Author*) Nothing to Disclose  
Peter J. Hoskin, Middlesex, United Kingdom (*Abstract Co-Author*) Nothing to Disclose

## PURPOSE

Bone insufficiency fractures after pelvic radiotherapy are reported to have a low incidence and delayed onset when assessed on CT scans. Our aim was to determine the prevalence of pelvic insufficiency fractures (PIFs) after chemoradiotherapy (CRT) for cervical cancer (CxCa) on MRI follow-up, noting time of onset, symptoms, interval to healing and ADC values on diffusion MRI scans.

## METHOD AND MATERIALS

In our institution, locally advanced CxCa patients undergo external beam RT (45-50Gy, 25#) including the sacral alar, cervix brachytherapy (24-28Gy, 4#) and weekly Cisplatin. They are followed up with serial MRI pelvis at 3, 12 and 24 months post-treatment. 20 consecutive women were retrospectively reviewed by an oncologic radiologist for the presence of PIFs, defined by linear low T1W and high STIR signal intensity. Features were graded for severity according to displacement, multiplicity, extent of bone oedema. ADC values were measured at the sites of fracture; when no fracture was seen, ADC was measured in the sacral alar. Correlations with symptoms was performed.

## RESULTS

15 patients had 55 MRI scans (7 pre- and 48 post-treatment), average follow-up 22 months. 12/15 patients were aged over 50. 13/15 were staged as 2B. 9/15 patients had PIFs, majority diagnosed at 3 months (8/9 patients), 1 at 12 months. PIFs were graded as mild-1, moderate-5 or severe-3. 25 fracture sites were identified (18 sacral, 3 pubic, 1 iliac, 1 acetabular, 2 L4-5). Mean ADC values were 731  $\mu\text{m}^2/\text{s}$  (204-1482) for all visible sacral fractures and 177  $\mu\text{m}^2/\text{s}$  (33-499) for non-fractured sites (MW Test: p<0.001). Healing occurred at 5/25 fracture sites (in 6-23 months), with only 1 patient showing healing of all affected sites. 2 patients had related bone pain. 2 patients with PIFs sustained displaced pelvic fractures after falls. Only 1 patient had pelvic tumour recurrence at 12 months (no PIF).

## CONCLUSION

PIFs on MRI are common after CRT for locally advanced CxCa, with an early onset post-treatment. Majority of patients are asymptomatic, but might have increased risk of displacement after trauma. Further research will be done into radiation dose distribution/techniques and any correlation with bone changes.

## CLINICAL RELEVANCE/APPLICATION

PIFs are common on MRI follow-up after CRT for CxCa. Although mostly asymptomatic, only 20% healed during follow-up, with 2/15 patients suffering displaced pelvic fractures after minor trauma.

## SSE25-04 Vaginal Recurrence of Endometrial Cancer Treated with Image-Guided Brachytherapy: Prognostic Value of MRI Characteristics

#### Participants

Aida K. Kiviniemi, MD, Brookline, MA (*Presenter*) Nothing to Disclose  
Gabriela Alban, Boston, MA (*Abstract Co-Author*) Nothing to Disclose  
Teresa Cheng, Boston, MA (*Abstract Co-Author*) Nothing to Disclose  
Pierre McLaughlin, Boston, MA (*Abstract Co-Author*) Nothing to Disclose  
Tina Kapur, PhD, MSc, Boston, MA (*Abstract Co-Author*) Research Grant, Siemens AG Consultant, Varian Medical Systems, Inc  
Martin T. King, MD, PhD, Boston, MA (*Abstract Co-Author*) Nothing to Disclose  
Clare M. Tempany-Afdhal, MD, Charlestown, MA (*Abstract Co-Author*) Research Grant, InSightec Ltd; Research Grant, Gilead Sciences, Inc; Advisory Board, Profound Medical Inc; Spouse, Employee, Spring Bank Pharmaceuticals, Inc; Spouse, Director, Trio Healthcare; Spouse, Consultant, Gilead Sciences, Inc; Spouse, Consultant, Merck & Co, Inc; Spouse, Consultant, Echosens SA; Spouse, Consultant, Shinogi; Spouse, Consultant, Ligand Pharmaceuticals, Inc; Spouse, Stock options, Spring Bank Pharmaceuticals, Inc; Spouse, Stock options, Allurion; Spouse, Stock options, Trio Healthcare; ;  
Larissa J. Lee, Boston, MA (*Abstract Co-Author*) Nothing to Disclose

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#### PURPOSE

Imaging characteristics and related prognostic determinants for vaginal recurrence of endometrial cancer (EC) are poorly understood. This study evaluates the prognostic significance of MRI appearance, tumor location, and volume in patients treated with salvage radiotherapy.

#### METHOD AND MATERIALS

Patients with available pelvic MRI at vaginal recurrence of EC treated from 2004-2017 with external beam radiotherapy (EBRT) and image-guided brachytherapy (BT) were retrospectively identified. Extracted qualitative MRI features included tumor location, morphology, T2 signal intensity, enhancement, necrosis, and diffusion appearance. Recurrent tumor volumes were segmented at baseline and pre-BT MRI when available. The association of recurrence location and primary EC characteristics was evaluated by Fisher's exact test. Rates of recurrence-free survival (RFS) and overall survival (OS) were compared by logrank or univariate Cox regression.

#### RESULTS

In total, 36 patients with baseline pelvic MRI (1.5T or 3T) were included. Pre-BT MRI was available in 67% (24/36). Vaginal recurrence of EC was most commonly located in the vaginal cuff (72%) and showed nodular irregular morphology (82%), restricted diffusion (100%), hypoenhancement (88%), and an enhancing peripheral rim (73%). Tumor involvement of the lower third vagina was associated with lymphovascular invasion (17% without LVI, 63% with LVI) in the hysterectomy specimen ( $p < 0.05$ ) and prior adjuvant RT ( $p < 0.05$ ). The median tumor volumes at baseline and pre-BT MRI were 9.1 cm<sup>3</sup> and 2.5 cm<sup>3</sup>, respectively, with a median tumor shrinkage of 69% after EBRT. Tumor volume both at baseline and pre-BT predicted OS (HR 1.04, 95% CI 1.01-1.06,  $p < 0.05$  and HR 1.06, 95% CI 1.00-1.12,  $p < 0.05$ ) whereas % shrinkage and BT dose were not prognostic. Diffuse growth pattern along the vaginal wall and the lack of an enhancing rim were associated with worse RFS ( $p < 0.001$  and  $p < 0.05$ ). Tumor T2 heterogeneity and necrosis were not prognostic.

#### CONCLUSION

Tumor volume at baseline and pre-BT MRI, and the absence of rim enhancement were prognostic for survival. This study represents the first systematic evaluation and prognostication of MRI features in vaginal recurrence of EC treated with salvage BT.

#### CLINICAL RELEVANCE/APPLICATION

The study provides valuable diagnostic and clinical information for salvage radiation treatment of vaginal recurrence of EC.

#### SSE25-05 Radiation Oncology Keynote Speaker: Gynecology

Monday, Dec. 2 3:40PM - 4:00PM Room: E263

#### Participants

Bryan J. Traughber, MD, Cleveland, OH (*Presenter*) Research Grant, Koninklijke Philips NV; Research Grant, Elekta AB

Printed on: 10/29/20



SSE26

## Vascular/Interventional (Education and Safety)

Monday, Dec. 2 3:00PM - 4:00PM Room: E260

IR SQ VA

AMA PRA Category 1 Credit™: 1.00  
ARRT Category A+ Credit: 1.00

### Participants

Lisa H. Kang, MD, Sacramento, CA (*Moderator*) Nothing to Disclose  
Gloria M. Salazar, MD, Boston, MA (*Moderator*) Consultant, Medtronic plc

### Sub-Events

#### SSE26-01 Endovascular Simulation Training: A Tool to Increase Enthusiasm for Interventional Radiology Among Medical Students

Monday, Dec. 2 3:00PM - 3:10PM Room: E260

### Participants

Roman Kloeckner, MD, Mainz, Germany (*Presenter*) Advisory Board, Guerbet SA; Advisory Board, Bristol-Myers Squibb Company; Advisory Board, Sirtex Medical Ltd; Speaker, Guerbet SA; Speaker, Sirtex Medical Ltd; Speaker, BTG International Ltd  
Fabian D. Stohr, Mainz, Germany (*Abstract Co-Author*) Nothing to Disclose  
Sebastian Schotten, MD, Mainz, Germany (*Abstract Co-Author*) Nothing to Disclose  
Christoph Dueber, MD, Mainz, Germany (*Abstract Co-Author*) Nothing to Disclose  
Michael B. Pitton, MD, Mainz, Germany (*Abstract Co-Author*) Nothing to Disclose  
Franziska Schmidt, Mainz, Germany (*Abstract Co-Author*) Nothing to Disclose  
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### PURPOSE

Interventional radiology (IR) is a growing field. However, in most medical schools it is underrepresented in the curriculum. Therefore, we aimed to test whether endovascular simulator training improves the attitude towards IR among medical students.

### METHOD AND MATERIALS

This prospective study is conducted at two university medical centers. In both, a dedicated 90-minute course on IR is given to 4th year medical students; in center A in two weeks in February 2019 on a daily basis, in center B once per week between March and May 2019. The course is split into two halves: One theoretical 45-minute part about IR and one practical 45-minute part using endovascular simulators. Questionnaires are completed before the course, after the theoretical part, and after the practical part using smartphones/tablets. Students are asked to rate their knowledge of IR, their interest in IR, the attractiveness of IR, and their willingness to potentially work in IR in the future on a 7-point Likert scale. To prevent position effect-bias, the study was conducted in a crossover design, i.e. 50% of the students heard the theoretical part first followed by the practical training, the other 50% vice versa.

### RESULTS

As of the abstract deadline, 211 students completed all three questionnaires. Seminar and simulator led to an increase in knowledge about IR (pretest: 2.7 vs. post-seminar/post-simulator: 5.11/5.36), interest in IR (5.16 vs. 5.54/5.69), attractiveness of IR (4.55 vs. 4.76/4.85), and the likelihood to choose IR in the future (3.33 vs. 3.75/3.9) (all  $p < 0.05$ ). Although both parts led a significant improvement, the effect was significantly stronger for the simulator part compared to the theoretical part regarding all items (all  $p < 0.05$ ).

### CONCLUSION

Endovascular simulator training in medical school significantly increases the knowledge about IR and the willingness to potentially choose IR in the future. In May 2019 the second part will be completed in center B, hopefully confirming these initially positive results.

### CLINICAL RELEVANCE/APPLICATION

Implementing dedicated IR-courses in medical school can help to fight recruitment problems in IR; a practical simulator training further increases students' motivation.

#### SSE26-02 Burnout and Moral Injury Among Interventional Radiologists

Monday, Dec. 2 3:10PM - 3:20PM Room: E260

### Participants

Jacob J. Bundy, MD, MPH, Ann Arbor, MI (*Presenter*) Nothing to Disclose  
Anthony N. Hage, MD, Ada, MI (*Abstract Co-Author*) Nothing to Disclose  
Ravi N. Srinivasa, MD, Agoura Hills, CA (*Abstract Co-Author*) Nothing to Disclose



Joseph J. Gemmete, MD, Northville, MI (*Abstract Co-Author*) Consultant, Terumo Corporation; Stockholder, Ablative Solutions, Inc; Stockholder, Innovative Cardiovascular Solutions; Stockholder, InNeuro; Stockholder, FlexDex, Inc; Stockholder, Kalypso LP  
Eunjee Lee, Ann Arbor, MI (*Abstract Co-Author*) Nothing to Disclose  
Jonathan Gross, MD, New York, NY (*Abstract Co-Author*) Nothing to Disclose  
Travis L. Healey, MD, Indianapolis, IN (*Abstract Co-Author*) Nothing to Disclose  
Agnieszka O. Solberg, MD, Bismarck, ND (*Abstract Co-Author*) Owner, SunMountain Medical Consulting LLC; Spouse, Owner, SunMountain Medical Consulting LLC  
Jeffrey F. Chick, MD, MPH, Ann Arbor, MI (*Abstract Co-Author*) Nothing to Disclose

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**PURPOSE**

To characterize burnout among Interventional Radiologists.

**METHOD AND MATERIALS**

An anonymous, Institutional Review Board-exempt, 34-question online survey was distributed to practicing Interventional Radiologists through the Society of Interventional Radiology Open Forum, Twitter, Facebook, and LinkedIn. The survey consisted of demographic and practice environment questions, and the 22-item Maslach Burnout Inventory (MBI). Interventional radiologists with high scores on EE ( $\geq 27$ ) or DP ( $\geq 10$ ) MBI subscales were considered to have at least one manifestation of physician burnout. STROBE reporting guidelines were followed.

**RESULTS**

339 surveys were completed over ten days starting on January 7, 2019. 263 (77.6%) respondents identified as men, 75 (22.1%) as women, and 1 (0.3%) as trans-male. The respondents were Interventional Radiologists practicing at academic (136; 40.1%), private (145; 42.8%), and hybrid (58; 17.1%) centers. Respondents worked an estimated  $>40$  hours (15; 4.4%), 40-60 hours (225; 66.4%), 60-80 hours (81; 23.9%), and  $>80$  hours (18; 5.3%) per week. 307 (90.6%) reported taking call, with most respondents taking 1-5 (116; 34.2%) or 6-10 (158; 46.6%) calls per month. Mean MBI scores for EE, DP, and personal achievement were  $29.7 \pm 12.9$ ,  $10.7 \pm 7.0$ , and  $39.7 \pm 6.8$ . Burnout among respondents was 72.0% (244 Interventional Radiologists). Identifying as a woman was significantly associated with burnout (odds ratio 2.4;  $P=0.009$ ). Compared to respondents who worked  $<80$  hours per week, working  $>80$  hours per week was significantly associated with burnout (odd ratio 7.0;  $P=0.030$ ). Practice level ( $P=0.553$ ), practice setting ( $P=0.557$ ), diagnostic radiology duties ( $P=0.588$ ), practice size ( $P=0.232$ ), years' post-graduate ( $P=0.373$ ), age ( $P=0.856$ ), and amount of call taken ( $P=0.110$ ) were not significantly associated with burnout.

**CONCLUSION**

Burnout is prevalent among Interventional Radiologists. Identifying as a woman and working more than 80 hours per week were strongly associated with burnout. Strategies to reduce burnout within interventional radiology should consider improving gender equity and work hours among Interventional Radiologists.

**CLINICAL RELEVANCE/APPLICATION**

Strategies to reduce burnout within interventional radiology should consider improving gender equity and work hours among Interventional Radiologists.

**SSE26-03 Hand Motion Analysis of Radiologists Performing Simulated Radial Arterial Access: Discerning Differences in Operator Experience Using Kinematic Analysis**

Monday, Dec. 2 3:20PM - 3:30PM Room: E260

**Participants**

Jeffrey Weinstein, MD, Wellesley, MA (*Presenter*) Nothing to Disclose  
Fady El-Gabalawy, MD, Boston, MA (*Abstract Co-Author*) Nothing to Disclose  
Ammar Sarwar, MD, Boston, MA (*Abstract Co-Author*) Stockholder, Agile Devices, Inc; Scientific Advisory Board, Agile Devices, Inc; Grant Support, Sirtex Medical Inc  
Olga R. Brook, MD, Boston, MA (*Abstract Co-Author*) Nothing to Disclose  
Salomao Faintuch, MD, Boston, MA (*Abstract Co-Author*) Nothing to Disclose  
Michael Hsu, MD, Boston, MA (*Abstract Co-Author*) Nothing to Disclose  
Seth J. Berkowitz, MD, Boston, MA (*Abstract Co-Author*) Nothing to Disclose  
Matthew R. Palmer, PhD, Boston, MA (*Abstract Co-Author*) Nothing to Disclose  
Muneeb Ahmed, MD, Boston, MA (*Abstract Co-Author*) Research Grant, General Electric Company Stockholder, Agile Devices, Inc Scientific Advisory Board, Agile Devices, Inc

**PURPOSE**

To perform a pilot evaluation of the ability of electromagnetic hand motion sensor technology to determine differences in the kinematic profile of operators based on their practice experience with radial artery access.

**METHOD AND MATERIALS**

Six fellowship-trained, right-handed attending interventional radiologists with 1-13 years of experience performed simulated arterial access on a commercial phantom. Two of the attendings reported limited radial arterial access experience ( $<50$  cases), two reported significant experience obtaining palpatory radial artery access ( $>100$  cases), and two had experience with radial artery access under ultrasound (US) guidance ( $>100$  cases). The task involved placing a 21-gauge needle into the phantom radial artery and threading a wire into the artery. The phantom had tubing with red fluid and a squeeze-bulb to simulate a radial artery with blood and arterial pulsations. Each operator performed the task 5 times with an electromagnetic sensor affixed to the dorsum of each hand between the second and third metacarpals. Total time and total distance the sensors traveled (path length) were measured. Statistical analysis was performed using paired T-tests.

**RESULTS**

The radiologists with significant palpatory radial artery access experience had both a shorter time to complete the task and path

length compared to those who had limited radial artery experience ( $91 \pm 13$ s vs.  $143 \pm 32$ s,  $p < 0.01$  and  $141 \pm 18$  cm vs.  $239 \pm 100$  cm,  $p = 0.012$ ). Those with ultrasound experience had a shorter time to complete the task than those with limited radial access experience ( $105 \pm 11$ s vs.  $143 \pm 32$ s,  $p = 0.012$ ) but their path length was not significantly shorter ( $168 \pm 35$ cm vs.  $239 \pm 100$ cm,  $p = 0.063$ ). When comparing only the palpatory and US groups, the time to complete the task was not significantly different ( $91 \pm 13$ s vs.  $105 \pm 11$ s,  $p = 0.079$ ) but the path length was shorter for the palpatory group ( $141 \pm 18$  cm vs  $168 \pm 35$ cm,  $p = 0.042$ ).

## CONCLUSION

Kinematic analysis of hand motion using electromagnetic motion tracking was successful in distinguishing variability of operator experience with radial artery access. Further exploration of this technology may determine if the kinematic profile correlates with proficiency in completing a procedural task.

## CLINICAL RELEVANCE/APPLICATION

Electromagnetic motion sensor technology can determine subtle differences in experience between trained operators for a given manual task and help determine areas for further development.

### SSE26-04 Comparison of a New Material-Specific Contrast-to-Noise Ratio-Based Exposure Control with a Regular-Dose Dependent Exposure Control in a Clinical Angiographic System

Monday, Dec. 2 3:30PM - 3:40PM Room: E260

#### Participants

Thomas Werncke, MD, DIPLPHYS, Hannover, Germany (*Abstract Co-Author*) Nothing to Disclose  
Sabine Maschke, Hannover, Germany (*Abstract Co-Author*) Nothing to Disclose  
Jan Hinrichs, MD, Hannover, Germany (*Abstract Co-Author*) Nothing to Disclose  
Frank K. Wacker, MD, Hannover, Germany (*Abstract Co-Author*) Nothing to Disclose  
Bernhard C. Meyer, MD, Hannover, Germany (*Presenter*) Research Consultant, Pro Medicus Limited

## PURPOSE

The purpose of this phantom study was to evaluate the skin-dose reduction potential of a material specific contrast-to-noise ratio based exposure control (CEC) in comparison to a regular detector based exposure control (DEC) in a clinical angiographic system.

## METHOD AND MATERIALS

A standardized 3D-printed phantom with an iron, tantalum and platinum foil and cavities for contrast material (iodine, barium, carbon dioxide) was developed in order to investigate the dependency of a spatial frequency dependent CNR on image acquisition settings. This phantom was placed into a stack of polymethylmethacrylate and aluminum plates, simulating a patient equivalent thickness (PET) of 2.5cm-40cm. Fluoroscopic (FL) and diagnostic radiograph (DR) images were acquired using a clinical angiographic system with material-specific CEC (iron, tantalum, platinum, carbon dioxide, iodine barium) and regular DEC protocols implemented. The CNR of the CEC protocols were adjusted to the CNR of the DEC protocols in order to allow for a comparison. The possible skin radiation dose reduction for material specific CEC protocols compared to DEC protocols was estimated while the CNR was maintained.

## RESULTS

Material specific CEC demonstrated a substantial skin dose reduction potential compared to DEC protocols. For platinum and tantalum the possible mean skin radiation dose reduction while maintaining CNR was  $59 \pm 21\%$  (max. 91% at 30cm) and  $65 \pm 18\%$  (max. 92% at 30cm) for DR and  $58 \pm 23\%$  (max. 84% at 30cm) and  $58 \pm 23\%$  (max. 87% at 27.5cm) for FL, respectively. For carbon dioxide imaging the possible mean skin radiation dose reduction was  $52 \pm 19\%$  (max. 87% at 30cm). For barium, iodine and iron the mean skin radiation dose reduction while maintaining CNR was  $32 \pm 19\%$ ,  $33 \pm 17\%$ ,  $34 \pm 17\%$  for DR and  $18 \pm 12\%$ ,  $19 \pm 18\%$  and  $18 \pm 11\%$  for FL. For these materials highest skin dose reduction of approx. 40% for FL and 50% for DR at 27.5-30cm.

## CONCLUSION

The use of a material specific contrast-to-noise ratio based exposure control bears a substantial skin dose reduction potential compared to the regular detector dose dependent exposure control.

## CLINICAL RELEVANCE/APPLICATION

Material specific CEC allows for a substantial radiation dose reduction without loss of image quality as compared to DEC. In particular, the dedicated imaging of tantalum and platinum might help to considerably reduce the radiation exposure of the patient and staff.

### SSE26-05 Demonstration of a Real-Time Scattered Radiation Display for Staff Dose Management during Fluoroscopic Interventional Procedures

Monday, Dec. 2 3:40PM - 3:50PM Room: E260

#### Participants

Jonathan L. Troville, MS,BS, Buffalo, NY (*Presenter*) Research support, Canon Medical Systems Corporation  
Chao Guo, MS, Amherst, NY (*Abstract Co-Author*) Research support, Canon Medical Systems Corporation  
Stephen Rudin, PhD, Buffalo, NY (*Abstract Co-Author*) Research Grant, Canon Medical Systems Corporation  
Daniel Bednarek, PhD, Buffalo, NY (*Abstract Co-Author*) Research Grant, Canon Medical Systems Corporation

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## PURPOSE

To facilitate staff dose management during long fluoroscopic interventional procedures, our group has developed a real-time, virtual reality (VR) scattered radiation display system (SDS). A demonstration of how the SDS works using data from clinical procedures is presented.

## METHOD AND MATERIALS

The SDS provides a VR representation of a patient graphic, the c-arm gantry, patient table, and a color-coded overlay that displays the spatial distribution of scattered radiation in the room as well as the scatter dose rate at a staff member's location using a circular indicator. Update of the staff indicator position occurs in real-time via body tracking using a Microsoft Kinect V2 depth camera. To demonstrate its use, cardiovascular interventional cases were retrospectively analyzed under IRB approval using log files of all exposure events obtained from Canon's Dose Tracking System (DTS). The log file data for each clinical case was read into the SDS for selection of the appropriate pre-calculated scatter distributions during playback for each procedure. The real-time SDS has been developed in Matlab using the Python controller area network (CAN) interface module to facilitate inflow of geometric and exposure messages from a Canon Biplane Angiography system. A virtual CAN bus using the Python interface was utilized to play back the clinical log files for this demonstration.

## RESULTS

For each cardiovascular case, VR scatter distribution displays were generated showing variations with changes in each of the geometric and exposure parameters read in from the system. A staff member indicator was placed on-screen to display the changing dose-rates during the intervention. The magnitude of the change in scatter is shown as the procedures progressed. Simultaneously, patient skin dose distributions and entrance dose rates were displayed with the DTS.

## CONCLUSION

A real-time scattered radiation display can enable staff members to make informed decisions throughout the procedure on where to stand in the room and thus maintain staff dose as low as reasonably achievable. The SDS can be implemented in the procedure room with the DTS for a comprehensive approach to radiation safety and dose reduction.

## CLINICAL RELEVANCE/APPLICATION

A real-time scattered radiation display system can facilitate staff dose management and with Canon's real-time patient skin dose mapping system would offer a comprehensive approach to dose reduction.

## SSE26-06 A Systematic Review of 639 Patients with Biopsy-Confirmed Nephrogenic Systemic Fibrosis

Monday, Dec. 2 3:50PM - 4:00PM Room: E260

### Participants

Hanieh Attari, MD, New York, NY (*Presenter*) Nothing to Disclose

Yan Cao, CMD, Warren, MI (*Abstract Co-Author*) Nothing to Disclose

Sadjad Riyahi, MD, Sunnyside, NY (*Abstract Co-Author*) Nothing to Disclose

Martin R. Prince, MD, PhD, New York, NY (*Abstract Co-Author*) Patent agreement, General Electric Company; Patent agreement, Hitachi, Ltd; Patent agreement, Siemens AG; Patent agreement, Koninklijke Philips NV; Patent agreement, Nemoto Kyorindo Co, Ltd; Patent agreement, Bayer AG; Patent agreement, Lantheus Medical Imaging, Inc; Patent agreement, Bracco Group; Patent agreement, Mallinckrodt plc; Patent agreement, Guerbet SA; Patent agreement, Toshiba Corporation

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## PURPOSE

To perform a systematic review of nephrogenic systemic fibrosis (NSF).

## METHOD AND MATERIALS

PubMed database was searched using 'nephrogenic systemic fibrosis' from January 2000 to February 2019 for studies in which patients with biopsy-confirmed NSF were reported. Data were pooled and authors were contacted for clarification. We used GraphPad software for statistical analysis of the data.

## RESULTS

639 biopsy-confirmed patients with NSF from 173 articles are included. Among 542 with data 292 were female and 250 were male. Age at symptom onset was available for 174 patients [mean=49, (range=6-87)] with no reports in neonates or toddlers and few reports (n=7) in the very old (>80 years). 532 patients had documented exposure to GBCA including Group I (gadodiamide=315, gadopentetate dimeglumine=49, gadoversetamide=6), Group II (gadobutrol=1, gadobenate dimeglumine=1), multiple (n=49) and unknown (n=111). All but 3 patients with GBCA exposure, received gadolinium prior to 2008. 14 patients had no prior GBCA exposure in spite of searching. For 413 patients with clinical severity data, different degrees of motion limitation were present in 291/413(70%) indicating a more severe form of the disease in contrast to 122/413(30%) with only dermatological manifestations. Having a more severe debilitating disease was significantly correlated with being on dialysis at the time of GBCA exposure (P=0.005), chronic renal failure (P=0.04), and receiving a higher cumulative GBCA dose (P=0.0004). NSF was also associated with pro-inflammatory conditions, hyperphosphatemia, beta blockers and epoetin. 48%(70/146) of patients with autoimmune data, had autoimmune disease. Face was always spared except for 3 patients. For 341 patients with follow-up, 12 were cured and 72 partially improved including one during pregnancy. In 34 of these patients, improvement of symptoms occurred following renal function restoration. 4 deaths were attributed to NSF.

## CONCLUSION

Although 639 patients with biopsy-confirmed NSF were reported, only 3 followed GBCA exposure after 2008 indicating that regulatory actions and practice changes have been effective preventive measures. Improvement and sometimes cure with renal function restoration is now possible.

## CLINICAL RELEVANCE/APPLICATION

This systematic review shows that NSF has been nearly eliminated, is no longer incurable and supports the preference for group II GBCAs in at risk patients.

Printed on: 10/29/20



VSI022

## Interventional Oncology Series: Primary Liver Cancer-Update on Therapeutic Options and Future Outlook

Monday, Dec. 2 3:15PM - 5:15PM Room: E450B

**GI** **IR** **OI** **RO**

AMA PRA Category 1 Credits™: 2.00  
ARRT Category A+ Credits: 2.25

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

### Participants

Anne M. Covey, MD, New York, NY (*Moderator*) Stockholder, Amgen Inc; Advisory Board, Accurate Medical  
Nadine Abi-Jaoudeh, MD, Orange, CA (*Moderator*) Research collaboration, Koninklijke Philips NV; Research collaboration, Teclison  
Cherry Pharma Inc; Research support, SillaJen, Inc; Intellectual property and Owner, Bruin Biosciences Inc

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### LEARNING OBJECTIVES

1) Learn which patients are most likely to benefit from locoregional treatment of hepatocellular carcinoma. 2) Understand how locoregional therapies fit into the overall treatment plan of patients with hepatocellular carcinoma and how systemic treatments may affect patient selection. 3) Describe the rational and potential therapeutic combinations of locoregional and systemic therapy for patients with hepatocellular carcinoma.

### Sub-Events

#### VSI022-01 Transplant/Resection for HCC

Monday, Dec. 2 3:15PM - 3:30PM Room: E450B

#### Participants

Parissa Tabrizian, New York, NY (*Presenter*) Nothing to Disclose

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### LEARNING OBJECTIVES

1) Review the role of liver resection and transplantation for patients with HCC. 2) Discuss outcomes in patients with HCC undergoing liver resection or transplantation. 3) Describe the impact of locoregional therapy on a surgical practice.

#### VSI022-02 Ablation for HCC

Monday, Dec. 2 3:30PM - 3:45PM Room: E450B

#### Participants

Bernhard Gebauer, MD, Berlin, Germany (*Presenter*) Speaker, PAREXEL International Corporation; Speaker, ICON plc; Speaker, BAYER AG; Speaker, F. Hoffmann-La Roche Ltd; Speaker, Pfizer Inc; Speaker, Guerbet SA; Speaker, Sirtex Medical Ltd

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### LEARNING OBJECTIVES

1) Compare different techniques of ablation in HCC. 2) Identify patients profit from ablation. 3) Describe complications of ablation. 4) Identify complete ablation and local recurrence in follow-up.

#### VSI022-03 Microwave Ablation versus Radiation Segmentectomy for Treatment-Naïve Early-Stage Hepatocellular Carcinoma

Monday, Dec. 2 3:45PM - 3:55PM Room: E450B

#### Participants

Mohamed Soliman, New York City, NY (*Presenter*) Nothing to Disclose  
Madhu R. Joshi, Brooklyn, NY (*Abstract Co-Author*) Nothing to Disclose  
Maria Mitry, MD, New York, NY (*Abstract Co-Author*) Nothing to Disclose  
Caroline C. Chung, NYC, NY (*Abstract Co-Author*) Nothing to Disclose  
Russell Rosenblatt, MD, NYC, NY (*Abstract Co-Author*) Nothing to Disclose  
Resmi Charalel, MD, New York, NY (*Abstract Co-Author*) Nothing to Disclose

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## PURPOSE

To compare treatment efficacy of microwave ablation (MWA) and radiation segmentectomy (RS) in treatment of solitary hepatocellular carcinoma (HCC) less than 3 cm.

## METHOD AND MATERIALS

Following IRB approval, all patients with cirrhosis who underwent locoregional treatment (LRT) for HCC at a single academic institution between 2005-2018 were reviewed. Patients who had prior HCC treatment, multifocal HCC or HCC larger than 3cm in maximum axial diameter were excluded. A total of 26 treatment-naïve patients were identified and reviewed. The primary endpoint is median overall survival (OS), analyzed via Kaplan-Meier method. Patients were censored at time of surgery, transplantation, or last known follow-up. The secondary endpoint is progression-free survival (PFS) following LRT. Baseline patient demographics and characteristics were compared between the two groups using a non-paired t-test. Treatment toxicities were assessed by measuring changes in liver function tests pre- and 1-month post LRT, from which MELD-Na scores were calculated and compared.

## RESULTS

A total of 17/26 (65%) patients received MWA, while 9/26 (35%) received RS. There was no statistically significant differences between the groups in age (71 vs. 73,  $p=0.53$ ), gender (64% vs. 72% male,  $p=0.492$ ), cirrhosis etiology, presence of major medical comorbidities (DM, CAD, COPD), or tumor size (1.7cm vs. 2.4cm,  $p=0.5$ ). In terms of treatment safety, RS was associated with higher 1-month post-treatment elevation in AST and ALT ( $p=0.034$ ) compared to MWA. There was no statistically significant difference ( $p=0.50$ ) in median PFS between the two groups (1289 days (95% CI = 828-NA) for the MWA group and 1029 days (95% CI = 620-NA) for the RS group). The median OS in the RS group was 1879 days, while median OS in the MWA group could not be estimated because only 2 mortality events were recorded over 20 months median follow-up period.

## CONCLUSION

There was no significant difference in median PFS between RS and MWA for early-stage HCC; however, RS is associated with higher rates of hepatotoxicity at 1 month. Larger, prospective studies are needed to further assess differences in treatment efficacy and toxicity.

## CLINICAL RELEVANCE/APPLICATION

RS is a safe and efficacious treatment option for treatment-naïve patients with early-stage HCC, with similar local tumor control rate as MWA. Clinical judgement is imperative in choosing the therapeutic intervention.

## VSIO22-04 Update on Transarterial Therapies for HCC

Monday, Dec. 2 3:55PM - 4:10PM Room: E450B

### Participants

Gregory J. Nadolski II, MD, Philadelphia, PA (*Presenter*) Nothing to Disclose

## LEARNING OBJECTIVES

1) Review BCLC Tx recommendations for HCC. 2) Examine some issues with BCLC recommendations as compared to clinical practice and experience. 3) Discuss data on response to different embolization treatments.

## ABSTRACT

N/A

## VSIO22-05 Preoperative Transcatheter Arterial Chemoembolization for Surgical Resection of Huge Hepatocellular Carcinoma ( $\geq 10$ cm): A Multicenter Propensity Matching Analysis

Monday, Dec. 2 4:10PM - 4:20PM Room: E450B

### Participants

Yang Tian, Shanghai, China (*Abstract Co-Author*) Nothing to Disclose  
Chao Li, Shanghai, China (*Abstract Co-Author*) Nothing to Disclose  
Wang Xinrong, Shanghai, China (*Presenter*) Nothing to Disclose  
Mingda Wang, Shanghai, China (*Abstract Co-Author*) Nothing to Disclose  
Han Wu, Shanghai, China (*Abstract Co-Author*) Nothing to Disclose  
Jiongjie Yu, Shanghai, China (*Abstract Co-Author*) Nothing to Disclose  
Timothy M. Pawlik, Columbus, OH (*Abstract Co-Author*) Nothing to Disclose  
Jun Han, Shanghai, China (*Abstract Co-Author*) Nothing to Disclose  
Hao Xing, Shanghai, China (*Abstract Co-Author*) Nothing to Disclose  
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Wanyee Lau, Shanghai, China (*Abstract Co-Author*) Nothing to Disclose  
Mengchao Wu, Shanghai, China (*Abstract Co-Author*) Nothing to Disclose  
Feng Shen, Shanghai, China (*Abstract Co-Author*) Nothing to Disclose  
Yahao Zhou, Yunnan, China (*Abstract Co-Author*) Nothing to Disclose  
Tinghao Chen, Sichuan, China (*Abstract Co-Author*) Nothing to Disclose  
Hong Wang, Hunan, China (*Abstract Co-Author*) Nothing to Disclose  
Weimin Gu, Heilongjiang, China (*Abstract Co-Author*) Nothing to Disclose  
Yaoming Zhang, Meizhou, China (*Abstract Co-Author*) Nothing to Disclose  
Wanguang Zhang, Wuhan, China (*Abstract Co-Author*) Nothing to Disclose

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## PURPOSE

Surgical resection for hepatocellular carcinoma (HCC) is potentially curative, but long-term survival remains unsatisfactory. There is currently no effective neoadjuvant or adjuvant therapy for HCC. We sought to evaluate the impact of preoperative transcatheter

arterial chemoembolization (TACE) on long-term prognosis after surgical resection of huge HCCs ( $\geq 10$  cm).

## METHOD AND MATERIALS

Using a multicenter database, consecutive patients who underwent curative-intent resection for huge HCC without macrovascular invasion between 2004 and 2014 were identified. The association between preoperative TACE with perioperative outcomes, long-term overall survival (OS) and recurrence-free survival (RFS) was assessed before and after propensity score matching (PSM).

## RESULTS

Among the 377 enrolled patients, 88 patients (23.3%) received preoperative TACE. The incidence of perioperative mortality and morbidity was comparable among patients who did and did not undergo preoperative TACE (3.4% vs. 2.4%,  $P=0.704$ , and 33.0% vs. 31.1%,  $P=0.749$ , respectively). PSM analysis created 84 matched pairs of patients. In examining the entire cohort as well as the PSM cohort, median OS (overall cohort: 32.8 vs. 22.3 months,  $P=0.035$ , and PSM only: 32.8 vs. 18.1 months,  $P=0.023$ , respectively) and RFS (12.9 vs. 6.4 months,  $P=0.016$ , and 12.9 vs. 4.1 months,  $P=0.009$ , respectively) were better among patients who underwent preoperative TACE versus patients who did not. After adjustment for other confounding factors on multivariable analyses, preoperative TACE remained independently associated with a favorable OS and RFS after resection of huge HCC.

## CONCLUSION

Preoperative TACE did not increase perioperative morbidity or mortality, yet was associated with an improved OS and RFS after liver resection of huge HCC.

## CLINICAL RELEVANCE/APPLICATION

Preoperative TACE did not increase perioperative morbidity or mortality, yet was associated with an improved OS and RFS and is recommended before liver resection of huge HCC.

## VSI022-06 New Systemic Therapies for HCC and Combination Locoregional and Systemic Therapies

Monday, Dec. 2 4:20PM - 4:35PM Room: E450B

### Participants

Farshid Dayyani, MD, Orange, CA (*Presenter*) Speakers Bureau, Amgen Inc; Speakers Bureau, F. Hoffmann-La Roche Ltd; Speakers Bureau, Ipsen SA; Speakers Bureau, Sirtex Medical Ltd; Speakers Bureau, Exelixis, Inc; Speakers Bureau, Eisai Co, Ltd; Consultant, F. Hoffmann-La Roche Ltd; Consultant, Exelixis, Inc; Consultant, Eisai Co, Ltd; Research support, F. Hoffmann-La Roche Ltd; Research support, Bristol-Myers Squibb Company; Spouse, Employee, F. Hoffmann-La Roche Ltd

### LEARNING OBJECTIVES

1) Describe available systemic treatment options for advanced hepatocellular carcinoma. 2) Differentiate available systemic treatment options for advanced hepatocellular carcinoma based on mechanism of action. 3) Recommend appropriate treatment for advanced unresectable hepatocellular carcinoma based on level 1 evidence.

## VSI022-07 Debate: Transarterial Therapy versus Systemic Therapy for BCLC C

Monday, Dec. 2 4:35PM - 4:45PM Room: E450B

### Participants

Farshid Dayyani, MD, Orange, CA (*Presenter*) Speakers Bureau, Amgen Inc; Speakers Bureau, F. Hoffmann-La Roche Ltd; Speakers Bureau, Ipsen SA; Speakers Bureau, Sirtex Medical Ltd; Speakers Bureau, Exelixis, Inc; Speakers Bureau, Eisai Co, Ltd; Consultant, F. Hoffmann-La Roche Ltd; Consultant, Exelixis, Inc; Consultant, Eisai Co, Ltd; Research support, F. Hoffmann-La Roche Ltd; Research support, Bristol-Myers Squibb Company; Spouse, Employee, F. Hoffmann-La Roche Ltd  
Gregory J. Nadolski II, MD, Philadelphia, PA (*Presenter*) Nothing to Disclose

### LEARNING OBJECTIVES

1) Describe available systemic treatment options for advanced hepatocellular carcinoma. 2) Differentiate treatment options based on mechanism of action. 3) Recommend appropriate treatments based on Level 1 evidence.

## VSI022-08 Cholangiocarcinoma: Classification and Treatment

Monday, Dec. 2 4:45PM - 5:00PM Room: E450B

### Participants

William S. Rilling, MD, Milwaukee, WI (*Presenter*) Consultant, BTG International Ltd; Consultant, Terumo Corporation; Consultant, C. R. Bard, Inc; Research support, Guerbet SA

## VSI022-09 New Kids on the Block: SBRT and Other Options for Primary Liver Cancer

Monday, Dec. 2 5:00PM - 5:15PM Room: E450B

### Participants

Alexander H. Lam, MD, Orange, CA (*Presenter*) Nothing to Disclose

### LEARNING OBJECTIVES

1. Discuss loco-regional modalities separate from traditional ablative or transarterial therapies 2. Understand the potential benefits and drawbacks associated with each modality 3. Recognize how these new techniques may fit into the current treatment paradigm

Printed on: 10/29/20



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MSAS24

### You Get What You Measure: Fixing How We Assess Radiologist Productivity (Sponsored by the Associated Sciences Consortium) (Interactive Session)

Monday, Dec. 2 3:30PM - 5:00PM Room: S105AB

**PR**

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

#### Participants

Patricia Kroken, Albuquerque, NM (*Moderator*) Nothing to Disclose  
Corbin Wilson, Fort Worth, TX (*Presenter*) Nothing to Disclose  
Kurt A. Schoppe, MD, Grapevine, TX (*Presenter*) Nothing to Disclose

#### LEARNING OBJECTIVES

1) Understand the various reasons to measure radiologist productivity and how those reasons evolve as a group grows in size and/or geography. 2) Develop a process to communicate the need to measure productivity and how to solicit input from the all parties regarding concerns and objectives. 3) Contrast pros and cons of various productivity policies. 4) Develop a workplan for creation of a productivity policy to meet the needs of your group. 5) Examine the different factors to consider when creating the policy. 6) Communicate the plan and address concerns in such a way to create buy-in from the entire group. 7) Evaluate a productivity equity formula used by large group to allow measurement across multiple subspecialties. 8) Assess the remediation features of a large group productivity policy and evaluate the utility to their circumstances.

Printed on: 10/29/20



MSCA22

### Case-based Review of the Abdomen (Interactive Session)

Monday, Dec. 2 3:30PM - 5:00PM Room: S100AB

**GI** **OB**

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

#### Participants

Julie H. Song, MD, Sharon, MA (*Director*) Nothing to Disclose

#### Sub-Events

##### MSCA22A Women's Imaging

#### Participants

Christine O. Menias, MD, Chicago, IL (*Presenter*) Royalties, Reed Elsevier

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

menias.christine@mayo.edu

#### LEARNING OBJECTIVES

1) Review typical MR imaging of Gynecologic Entities encountered in clinical practice using case-based examples. 2) Highlight Imaging Pearls and Pitfalls that may impact diagnosis and treatment. 3) Discuss potential differential diagnosis and mimics.

##### MSCA22B Pitfalls in Post-op Abdomen and Pelvis

#### Participants

Kumaresan Sandrasegaran, MD, Phoenix, AZ (*Presenter*) Nothing to Disclose

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

Sandrasegaran.kumaresan@mayo.edu

#### LEARNING OBJECTIVES

1) To understand postoperative anatomy after complex gastric and pancreatic surgery. 2) To differentiate between expected postoperative anatomy, postoperative complications and tumor recurrence after abdominal surgery. 3) To learn pitfalls in reporting postoperative CT scans.

#### ABSTRACT

Reading postoperative CT scans is one of the most challenging tasks in abdominal radiology. The radiologist needs to understand the postoperative anatomy to distinguish what is expected and what would constitute a complication. For patients who had surgery for cancer, it is important not to call expected postoperative findings as cancer recurrence. This presentation delves into pitfalls in postoperative CT and MR for gastric, pancreatic, bowel and oncologic surgery.

##### MSCA22C Abdominopelvic Trauma Imaging

#### Participants

Christina A. LeBedis, MD, Boston, MA (*Presenter*) Nothing to Disclose

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

Christina.LeBedis@bmc.org

#### LEARNING OBJECTIVES

1) Review Imaging of abdominal trauma in a case-based format. 2) Discuss common pitfalls and clinically relevant differential diagnosis in abdominal trauma. 3) Discuss protocol considerations to optimize diagnostic yield in abdominal trauma.

##### MSCA22D Abdominopelvic Emergency Imaging

#### Participants

Douglas S. Katz, MD, Mineola, NY (*Presenter*) Nothing to Disclose

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

douglasscottkatzmd@gmail.com

#### LEARNING OBJECTIVES

1) To review a series of cases of CT of the acute abdomen and pelvis, some of which are challenging. 2) To review the differential diagnosis, if any, for these patients, and to discuss prospective patient management based on the clinical and CT findings. 3) To briefly review the imaging and clinical literature on these entities.







MSMC24

### Cardiac CT Mentored Case Review: Part IV (In Conjunction with the North American Society for Cardiovascular Imaging) (Interactive Session)

Monday, Dec. 2 3:30PM - 5:30PM Room: S406A



AMA PRA Category 1 Credits™: 2.00  
ARRT Category A+ Credits: 2.25

#### Participants

Phillip M. Young, MD, Rochester, MN (*Moderator*) Consultant, Arterys Inc

#### LEARNING OBJECTIVES

1) Understand the clinical indications for retrospective ECG gated cardiac CT. 2) Illustrate methods to assess myocardial function from cine cardiac CT images. 3) Illustrate methods to assess normal and abnormal valvular function from cine cardiac CT images.

#### Sub-Events

#### MSMC24A Coronary Atherosclerosis and Bypass Grafts

Participants

Gregory Kicska, MD, PhD, Seattle, WA (*Presenter*) Nothing to Disclose

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

kicskag@uw.edu

#### LEARNING OBJECTIVES

1) Recognizing anatomic subsets coronary artery bypass. 2) Technical considerations when imaging a bypass graft. 3) Stenosis and aneurysms in vein grafts. 4) Patterns of stenosis in internal mammary grafts. 5) Evaluating a bypass patient before reoperation.

#### ABSTRACT

Cardiac CT is often used to evaluate coronary bypass graft function. To accurately interpret these images, the Imager needs to be familiar with the patterns of stenosis, aneurysms or other complications associated with different bypass types. In addition to assessing function and need for intervention, CT can identify patients with unique risks associated with reoperation.

#### MSMC24B Congenital Heart Disease

Participants

Linda B. Haramati, MD, MS, New Rochelle, NY (*Presenter*) Spouse, Board Member, Kryon Systems Ltd

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

lharamati@gmail.com

#### LEARNING OBJECTIVES

1) To recognize complex congenital heart disease on chest CT scans performed for other indications. 2) To tailor cardiac CT protocols and reconstructions to answer specific clinical questions for patients with treated congenital heart disease. 3) To provide information that guides therapy related to longstanding complications of congenital heart disease and its treatment.

#### ABSTRACT

Adults with congenital heart disease (CHD) now outnumber children with CHD two to one. This phenomenon is due to the success of surgical palliation and medical management of patients with even the most severe forms of CHD. Surgical intervention is often performed at the time of diagnosis and in patients with residual hemodynamic lesions is often required throughout life. Though echocardiography is typically the initial imaging modality of choice, diagnosis and imaging surveillance of complex hemodynamic and anatomic CHD lesions is now most often accomplished with CT and MR. CT and CTA imaging techniques may be used to show detailed anatomic and functional images of the heart, postoperative changes and long term consequences of CHD. An organized, reproducible approach to identify cardiac anatomy of CHD lesions and surgical palliations should be adopted in order to accurately and thoroughly describe findings.

#### MSMC24C Coronary Artery Disease and Incidental Non-cardiac Findings

Participants

Diana Litmanovich, MD, Haifa, Israel (*Presenter*) Nothing to Disclose

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

dlitmano@bidmc.harvard.edu

#### LEARNING OBJECTIVES

1) Recognizing non-cardiac and non-coronary anatomic structures that can be seen on cardiac CT. 2) Become familiar with possible

non-cardiac and non-coronary pathological findings that could be seen on cardiac CT. 3) Review the suggested work-up for patients with incidentally found non-cardiac and non-coronary pathologies on cardiac CTA.

#### **ABSTRACT**

ABSTRACT Cardiac CT often includes information about surrounding structures such as lungs, mediastinum, airways, pleura, liver and bones. To accurately interpret the scan and not to overlook the possible non-cardiac pathologies, familiarity with potential incidental findings is required. Clinical importance and severity of incidental findings varies, thus currently existing algorithms for incidental findings on cardiac CT are helpful for further work-up.

Printed on: 10/29/20



MSMI24

## Molecular Imaging Symposium: MI Theranostics

Monday, Dec. 2 3:30PM - 5:00PM Room: S405AB

MI

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

FDA

Discussions may include off-label uses.

### Participants

Munir Ghesani, MD, West Windsor, NJ (*Moderator*) Author, Siemens AG; Speaker, Siemens AG  
Daniel Pryma, MD, Philadelphia, PA (*Moderator*) Research Grant, Siemens AG; Research Grant, 511 Pharma; Research Grant, Progenics Pharmaceuticals, Inc; Research Consultant, Progenics Pharmaceuticals, Inc; Research Consultant, 511 Pharma; Research Consultant, Actinium Pharmaceuticals, Inc; Research Consultant, Nordic Nanovector ASA

### Sub-Events

#### MSMI24A What is 'Theranostics'?

##### Participants

Munir Ghesani, MD, West Windsor, NJ (*Presenter*) Author, Siemens AG; Speaker, Siemens AG

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

munir.ghesani@nyulangone.org

### LEARNING OBJECTIVES

1) Understand the basic principle of theranostics. While the theranostic concept is decades old, applied in clinical practice first in form of radioiodine in diagnosis and treatment of thyroid cancer, recent FDA approval of a theranostic pair and its successful integration in clinical practice has made it very clear that this it will be widely applied in the clinical management of various malignancies in the future. 2) This course will provide information about the basic principle, current practice and future promise of theranostics.

### ABSTRACT

Understand the basic principle of theranostics. While the theranostic concept is decades old, applied in clinical practice first in form of radioiodine in diagnosis and treatment of thyroid cancer, recent FDA approval of a theranostic pair and its successful integration in clinical practice has made it very clear that this it will be widely applied in the clinical management of various malignancies in the future. This course will provide information about the basic principle, current practice and future promise of theranostics.

#### MSMI24B Practical Aspects of Theranostics Implementation

##### Participants

Daniel Pryma, MD, Philadelphia, PA (*Presenter*) Research Grant, Siemens AG; Research Grant, 511 Pharma; Research Grant, Progenics Pharmaceuticals, Inc; Research Consultant, Progenics Pharmaceuticals, Inc; Research Consultant, 511 Pharma; Research Consultant, Actinium Pharmaceuticals, Inc; Research Consultant, Nordic Nanovector ASA

### LEARNING OBJECTIVES

1) To understand the regulatory requirements for the implementation of new diagnostic and therapeutic radiopharmaceuticals. 2) To appreciate the physical space needed to safely administer such radiopharmaceuticals. 3) To review the resources needed to assess and follow patients considered for treatment with radiopharmaceuticals.

### ABSTRACT

There is a great deal of growth in therapeutic radiopharmaceuticals and associated companion diagnostics. Administering these agents requires specific training, regulatory approvals, medical and financial considerations as well as appropriate physical space. We will review these aspects to help the attendee understand the steps needed to permit optimal inclusion of these new agents into one's practice.

Printed on: 10/29/20



MSRO29

## BOOST: Head and Neck-eContouring

Monday, Dec. 2 4:30PM - 5:30PM Room: S104B



AMA PRA Category 1 Credit™: 1.00  
ARRT Category A+ Credit: 1.00

### Participants

Sung Kim, MD, New Brunswick, NJ (*Presenter*) Consultant, Nanobiotix  
Suresh K. Mukherji, MD, Carmel, IN (*Presenter*) Nothing to Disclose

### Special Information

The e-contouring sessions may be used by participating radiation oncologists to fulfill a PQI (practice quality improvement) requirement for ABR (American Board of Radiology) MOC (Maintenance of Certification). Interested radiation oncologist can download a e-contouring PQI template here: <https://academy.astro.org/content/econtouring-pqi-template> and handouts directing users to the same website will be available at the actual session.

### LEARNING OBJECTIVES

1) Expose the audience to head and neck radiation therapy contouring. 2) Describe the concepts of CTV, GTV and PTV. 3) Demonstrate the complementary nature of different imaging techniques for tumor contouring.

### ABSTRACT

The goal of this session is to expose the audience to head and neck radiation therapy contouring. The session will introduce the audience to concepts such as CTV, GTV and PTV. We will also demonstrate the important complementary nature of different imaging techniques for tumor contouring. This activity may also fulfill the ABR's Part 4: Practice Quality Improvement (PQI) requirement for Maintenance of Certification (MOC). Please refer to the ABR website for details.

Printed on: 10/29/20



RCC25

## Augmented and Virtual Reality

Monday, Dec. 2 4:30PM - 6:00PM Room: E451A

IN

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

### Participants

Justin Sutherland, PhD, Ottawa, ON (*Moderator*) Co-founder, Realize Medical Inc  
Eliot L. Siegel, MD, Severna Park, MD (*Moderator*) Board of Directors, Carestream Health, Inc; Board of Directors, Mach7 Technologies Ltd; Founder, Parto; Founder, Chios; Founder, Topoderm; Founder, VisualTrauma; Founder, ACREW; Founder, DACREW; Founder, i-Nucs; Committee member, RadSite

### Sub-Events

#### RCC25A Overview of Technologies

Participants

Justin Sutherland, PhD, Ottawa, ON (*Presenter*) Co-founder, Realize Medical Inc

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

jussutherland@toh.ca

#### RCC25B Augmented and Virtual Reality in Diagnostic Imaging

Participants

Eliot L. Siegel, MD, Severna Park, MD (*Presenter*) Board of Directors, Carestream Health, Inc; Board of Directors, Mach7 Technologies Ltd; Founder, Parto; Founder, Chios; Founder, Topoderm; Founder, VisualTrauma; Founder, ACREW; Founder, DACREW; Founder, i-Nucs; Committee member, RadSite

#### RCC25C Augmented and Virtual Reality Neuro and Interventional Models

Participants

Edward P. Quigley III, MD, PhD, Salt Lake City, UT (*Presenter*) Nothing to Disclose

### LEARNING OBJECTIVES

1) Distinguish between Augmented Reality/ Virtual Reality/ and Mixed Reality environments. 2) Describe applications of AR/VR/MR to radiology education. 3) Explore AR/VR/MR applications to neuroradiology anatomy and pathology. 4) Demonstrate applications of interventional radiology simulators in AR/VR/MR.

#### RCC25D Augmented and Virtual Reality Urologic Models

Participants

Nicole Wake, PhD, Bronx, NY (*Presenter*) In-kind support, Stratasys, Ltd; Consultant, General Electric Company

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

nwake@montefiore.org

### LEARNING OBJECTIVES

1) Explain use of VR and AR urologic cancer models to depict the cancerous lesion and its relationship to key anatomic structures. 2) Review the imaging requirements for creating AR and VR urologic cancer models. 3) Describe the segmentation workflows used to generate 3D urologic cancer models. 4) Evaluate the pros and cons of AR and VR in the context of urologic cancer.

#### RCC25E Augmented and Virtual Reality Cardiac Models

Participants

Dmitry Levin, Seattle, WA (*Presenter*) Nothing to Disclose

Printed on: 10/29/20



SPDL21

## Chest and Abdomen (Case-based Competition)

Monday, Dec. 2 4:30PM - 6:00PM Room: E451B



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

### Participants

Paul J. Chang, MD, Chicago, IL (*Presenter*) Co-founder, Koninklijke Philips NV; Researcher, Koninklijke Philips NV; Researcher, Bayer AG; Advisory Board, Bayer AG; Advisory Board, Aidoc Ltd; Advisory Board, EnvoyAI; Advisory Board, Inference Analytics; Advisory Board, Subtle Medical

Neety Panu, MD, FRCPC, Ottawa, ON (*Presenter*) Nothing to Disclose

Carla B. Harmath, MD, Chicago, IL (*Presenter*) Nothing to Disclose

### For information about this presentation, contact:

charmth@radiology.bsd.uchicago.edu

pchang@radiology.bsd.uchicago.edu

### Special Information

*This interactive session will use RSNA Diagnosis Live™. Please bring your charged mobile wireless device (phone, tablet or laptop) to participate.*

### LEARNING OBJECTIVES

1) Be introduced to a series of radiology case studies via an interactive team game approach designed to encourage 'active' consumption of educational content. 2) Use their mobile wireless device (tablet, phone, laptop) to electronically respond to various imaging case challenges; participants will be able to monitor their individual and team performance in real time. 3) Receive a personalized self-assessment report via email that will review the case material presented during the session, along with individual and team performance.

### ABSTRACT

The extremely popular audience participation educational experience, Diagnosis Live!, is an expert-moderated session featuring a series of interactive case studies that will challenge radiologists' diagnostic skills and knowledge. The session features a lively, fast-paced game format: participants will be automatically assigned to teams who will then use their personal mobile devices to test their knowledge in a fast-paced session that will be both educational and entertaining. After the session, attendees will receive a personalized self-assessment report via email that will review the case material presented during the session, along with individual and team performance.

Printed on: 10/29/20



SPSI21

## Special Interest Session: The Best of Radiology in 2019-The Editors of Radiology Keep You Up to Date

Monday, Dec. 2 4:30PM - 6:00PM Room: N227B

**BR** **GI** **NR** **RS**

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

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

### Participants

David A. Bluemke, MD, PhD, Bethesda, MD (*Moderator*) Nothing to Disclose

### For information about this presentation, contact:

dbluemke@rsna.org

### LEARNING OBJECTIVES

1) Identify key publications over the past year that may affect your clinical practice. 2) Evaluate new research developments in the field of radiological imaging. 3) Describe new developments in radiology that may affect the management of your patients.

### ABSTRACT

RADIOLOGY is the leading journal for publications leading to new, important and translatable discoveries in imaging research. In the past year, there continue to be basic developments in radiology, as well as new guidelines and clinical trials in imaging that affect your practice. Overall trends for new scientific studies reflect an increasing number of clinical trials being submitted from around the world in addition to those of North America. Publications from Europe have been prominent in recent years, but new research programs from countries such as Japan, South Korea and China are developing quickly. Large numbers of study subjects in clinical trials are now common, and tends to result in more robust demonstration of the efficacy of imaging interventions. Artificial intelligence applications are becoming commonplace in our publications, as are radiomics studies with increasing large numbers of study subjects. This seminar will highlight the results of key publications in the past year that are most likely to affect your practice in the near future, as well as presenting novel topics that are likely to be important to the field over the next 5 years.

### Sub-Events

#### SPSI21A Review of 2019: New Research that Should Impact your Practice

Participants

David A. Bluemke, MD, PhD, Bethesda, MD (*Presenter*) Nothing to Disclose

### For information about this presentation, contact:

DBLUEME@RSNA.ORG

#### SPSI21B Innovations in Abdominal Imaging in 2019

Participants

Kathryn J. Fowler, MD, San Diego, CA (*Presenter*) Consultant, 12 Sigma Technologies; Researcher, Nuance Communications, Inc; Contractor, Midamerica Transplant Services; ;

#### SPSI21C Research and Innovations in Breast Imaging in 2019

Participants

Linda Moy, MD, New York, NY (*Presenter*) Grant, Siemens AG; Support, Lunit Inc ; Support, iCad, Inc; Support, FAIR Facebook; Advisory Board, Lunit Inc; Advisory Board, iCad, Inc

#### SPSI21D New Developments in Neuroimaging in 2019

Participants

Christopher P. Hess, MD, PhD, San Francisco, CA (*Presenter*) Research, Siemens AG; Consultant, General Electric Company;

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SPSI22

## Special Interest Session: Translating Evidence-based Health Interventions into Routine Clinical Practice-Implementation Science

Monday, Dec. 2 4:30PM - 6:00PM Room: S406B

RS

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

### Participants

Ruth C. Carlos, MD, MS, Ann Arbor, MI (*Moderator*) Editor, Journal of the American College of Radiology; Support, Harvey L. Neiman Health Policy Institute; In-kind support, Reed Elsevier;  
Jeffrey G. Jarvik, MD, MPH, Seattle, WA (*Moderator*) Author with royalties, Wolters Kluwer nv; Co-editor, Springer Nature; Royalties, Springer Nature

### Sub-Events

#### SPSI22A Introduction to Dissemination and Implementation

##### Participants

Wynne E. Norton, PhD, Rockville, MD (*Presenter*) Nothing to Disclose

##### LEARNING OBJECTIVES

1) Define dissemination and implementation research. 2) Describe key study designs and frameworks used in dissemination and implementation research. 3) Identify outcomes of dissemination and implementation research. 4) Specify emerging areas of inquiry in dissemination and implementation research.

#### SPSI22B Current Implementation Research

##### Participants

Stella Kang, MD, MSc, New York, NY (*Presenter*) Royalties, Wolters Kluwer nv  
Hanna M. Zafar, MD, Philadelphia, PA (*Presenter*) Nothing to Disclose  
Jean L. Wright, MD, Baltimore, MD (*Presenter*) Nothing to Disclose

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

stella.kang@nyulangone.org

jwrigh71@jhmi.edu

##### LEARNING OBJECTIVES

1) Understand a problem analysis for improving the management of common incidental findings. 2) Identify interventions that address key problems in management of incidental findings. 3) Analyze the development of core measures of success for problems related to follow up.

##### ABSTRACT

As an AHRQ Patient Safety Learning Laboratory project, our team took a multidisciplinary approach to improving the management of incidental findings. A problem analysis, approach to process improvement, and collaborative development of project goals and measures will be described. This project incorporated the experience and expertise of clinicians, hospital informatics teams, a design firm, and patients.

#### SPSI22C Future Directions

##### Participants

Lane F. Donnelly, MD, Palo Alto, CA (*Presenter*) Nothing to Disclose  
Ruth C. Carlos, MD, MS, Ann Arbor, MI (*Presenter*) Editor, Journal of the American College of Radiology; Support, Harvey L. Neiman Health Policy Institute; In-kind support, Reed Elsevier;

##### LEARNING OBJECTIVES

1) To evaluate potential future directions in the field of implementation science. 2) To discuss the relationship and differences between implementation science and quality improvement.

##### ABSTRACT

The presenters will discuss implementation science, its relationship with quality improvement and research in radiology in general. Potential future directions in implementation science in radiology will be discussed.

#### SPSI22D Q&A

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SPSI23

## Special Interest Session: Value MR Imaging-Paradigm Shift from Generic to Targeted-Why and How

Monday, Dec. 2 4:30PM - 6:00PM Room: E353C

MR

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

### Participants

Clare M. Tempany-Afdhal, MD, Charlestown, MA (*Moderator*) Research Grant, InSightec Ltd; Research Grant, Gilead Sciences, Inc; Advisory Board, Profound Medical Inc; Spouse, Employee, Spring Bank Pharmaceuticals, Inc; Spouse, Director, Trio Healthcare; Spouse, Consultant, Gilead Sciences, Inc; Spouse, Consultant, Merck & Co, Inc; Spouse, Consultant, Echosens SA; Spouse, Consultant, Shinogi; Spouse, Consultant, Ligand Pharmaceuticals, Inc; Spouse, Stock options, Spring Bank Pharmaceuticals, Inc; Spouse, Stock options, Allurion; Spouse, Stock options, Trio Healthcare; ;

### LEARNING OBJECTIVES

1) To understand innovative approaches to improving MR efficiency. 2) To understand a novel framework for focused MR interpretations.

### Sub-Events

#### SPSI23A Why We Need to Challenge Status Quo

##### Participants

Yoshimi Anzai, MD, Salt Lake City, UT (*Presenter*) Nothing to Disclose

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

yoshimi.anzai@hsc.utah.edu

#### SPSI23B Designing Technology for Optimized MRI

##### Participants

James G. Pipe, PhD, Rochester, MN (*Presenter*) Research Grant, Koninklijke Philips NV

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

pipe.james@mayo.edu

### LEARNING OBJECTIVES

1) List technologies appropriate for increasing MR Value. 2) Describe examples of high-value exams. 3) Debate the metrics involved in optimizing MR use.

#### SPSI23C 'Fit for Purpose' Approach to MRI

##### Participants

Mitchell D. Schnall, MD, PhD, Philadelphia, PA (*Presenter*) Research Grant, Siemens AG

#### SPSI23D MRgFUS is there Value in Disruption?

##### Participants

Clare M. Tempany-Afdhal, MD, Charlestown, MA (*Presenter*) Research Grant, InSightec Ltd; Research Grant, Gilead Sciences, Inc; Advisory Board, Profound Medical Inc; Spouse, Employee, Spring Bank Pharmaceuticals, Inc; Spouse, Director, Trio Healthcare; Spouse, Consultant, Gilead Sciences, Inc; Spouse, Consultant, Merck & Co, Inc; Spouse, Consultant, Echosens SA; Spouse, Consultant, Shinogi; Spouse, Consultant, Ligand Pharmaceuticals, Inc; Spouse, Stock options, Spring Bank Pharmaceuticals, Inc; Spouse, Stock options, Allurion; Spouse, Stock options, Trio Healthcare; ;

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SPSI24

## Special Interest Session: The Role of AI in Radiology in the Developing World?

Monday, Dec. 2 4:30PM - 6:00PM Room: E450A

AI

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

### Participants

George L. Shih, MD, New York, NY (*Moderator*) Consultant, MD.ai, Inc; Stockholder, MD.ai, Inc;

### Sub-Events

#### SPSI24A Potential for AI in RAD-AID Sites

##### Participants

Daniel J. Mollura, MD, Chevy Chase, MD (*Presenter*) Nothing to Disclose

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

dmollura@rad-aid.org

### LEARNING OBJECTIVES

1) To review methods for analyzing radiology informatics infrastructure and describe potential applications of artificial intelligence in poor and low-resource regions of the world. 2) To present how international outreach programs for global health can effectively implement artificial intelligence and IT services to help radiology in low-resource hospitals of developing (low and middle-income) countries, as well as underserved areas of high-income countries. 3) To describe how radiology global health outreach can integrate clinical training of medical imaging personnel with informatics training of IT specialists so that AI will be cohesively implemented to advance emerging health care models and workflows.

### ABSTRACT

Half the world lacks radiology access, and two-thirds of the world lacks access to health informatics and IT. The arrival of artificial intelligence (AI) brings opportunities to advance radiology quality and efficiency, however, most hospitals in low and middle-income countries still do not have basic IT platforms such as PACS, RIS, and EMR. This means that the AI-revolution occurring in high-income countries threatens to widen the divide between poor and wealthy regions of the world. RAD-AID brings radiology to low-resource regions of the world by delivering training, equipment, and clinical support for low-resource facilities as a means to achieve sustainable local radiology capacity-building. A key part of that strategy is to deliver IT infrastructure such as PACS, RIS, Cloud, etc., which RAD-AID has achieved in 15 hospitals in 9 countries in the last 3 years. As RAD-AID builds these IT architectures internationally, AI-accessibility is an emerging central component of these strategies so that low-resource regions can leap frog older technologies to integrate digital imaging with AI in the future. These efforts must integrate clinical radiology education with IT infrastructure-building so that newer health care models can be implemented.

#### SPSI24B Results from Stanford TB AI Trial

##### Participants

Matthew P. Lungren, MD, Palo Alto, CA (*Presenter*) Advisor, Nines AI; Shareholder, Nines AI; Advisor, SegMed; Shareholder, SegMed; Advisor, Bunker Hill ; Shareholder, Bunker Hill

#### SPSI24C Increasing Capacity for Women's Imaging in LMICs

##### Participants

John R. Scheel, MD, PhD, Seattle, WA (*Presenter*) Research support, General Electric Company

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

jrs4yg@uw.edu

### LEARNING OBJECTIVES

1) Define the different methods for increasing radiology capacity in a resource-limited country. 2) Understand the benefits and potential disadvantages of each method, as they apply to resource-limited countries.

#### SPSI24D Potential for AI Women's Imaging

##### Participants

Susan C. Harvey, MD, Lutherville, MD (*Presenter*) Consultant, Hologic, Inc; Consultant, IBM Corporation

#### SPSI24E AI for Diabetic Retinopathy Screening

##### Participants

Lily Peng, MD, PhD, Mountain View, CA (*Presenter*) Employee, Alphabet Inc



SPSI25

## Special Interest Session: Paths to Recovery: What Can Neuroimaging Teach Us about Depression and Its Treatment

Monday, Dec. 2 4:30PM - 6:00PM Room: N226

NR

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

### Participants

David B. Hackney, MD, Newton, MA (*Moderator*) Nothing to Disclose

### ABSTRACT

Critical to the development of deep brain stimulation (DBS) as a novel therapy for patients with treatment resistant depression has been the characterization of brain systems mediating normal and abnormal mood states as well as those mediating successful and unsuccessful response to various antidepressant interventions using neuroimaging. The theoretical and data-driven foundation for DBS and its optimization as well as strategies for brain-based phenotyping for treatment selection at all stages of illness will be presented.

### Sub-Events

#### SPSI25A Depression 101: Current Approaches to Diagnosis and Treatment

##### Participants

Helen S. Mayberg, MD, New York, NY (*Presenter*) Consultant, Abbott Laboratories; License agreement, Abbott Laboratories

### LEARNING OBJECTIVES

1) Describe neuroimaging findings in patients with depression. 2) Distinguish brain change patterns associated with different antidepressant treatments. 3) Evaluate the utility of imaging-based biomarkers to guide optimal treatment selection. 4) Understand the role and challenges posed by imaging studies of deep brain stimulation for treatment resistant depression.

#### SPSI25B Current Psychoradiology for Depression

##### Participants

Qiyong Gong, MD, Chengdu, China (*Presenter*) Nothing to Disclose

### For information about this presentation, contact:

qiyonggong@hmrrc.org.cn

### LEARNING OBJECTIVES

1. Explain the history and need for the psychoradiology of depression 2. Evaluate emerging imaging techniques that could impact clinical applications to depression; 3. Describe the current state of knowledge and imaging approaches for investigating and diagnosing depression; 4. Recognize the key imaging findings in depression and how they can be examined by radiological techniques.

### ABSTRACT

In the past two decades, radiological imaging techniques have rapidly evolved to become powerful tools in studying the human brain in both healthy and diseased conditions. For psychiatry, this is particularly true with the advances of magnetic resonance imaging (MRI), where the development of the multi-modal MRI has allowed quantification of brain tissue at the structural, functional and molecular levels. While early experience using brain scans in psychiatry with traditional visual image inspection failed to establish meaningful benefit to patient care, improved and novel image acquisition strategies and semi-automated quantitative image analysis approaches have established the clinical relevance of brain imaging studies of psychiatric patients. Using these advances, the field of Psychoradiology has developed to utilize neuroimaging approaches to advance differential diagnosis and individualized patient care for common psychiatric illnesses. Given the high prevalence of major depressive disorder, the aim of this talk will be to summarize these developments, describe future challenges, and spur involvement of radiologists in optimally advancing psychoradiology for depression, and therefore expedite the translation of psychoradiological discoveries into patient care.

#### SPSI25C Strategies to Develop Imaging Biomarkers for Treatment Selection

##### Participants

Helen S. Mayberg, MD, New York, NY (*Presenter*) Consultant, Abbott Laboratories; License agreement, Abbott Laboratories

### LEARNING OBJECTIVES

1) Describe neuroimaging findings in patients with depression. 2) Distinguish brain change patterns associated with different antidepressant treatments. 3) Evaluate the utility of imaging-based biomarkers to guide optimal treatment selection. 4) Understand the role and challenges posed by imaging studies of deep brain stimulation for treatment resistant depression.

**SPSI25D Theory to Practice: Targeted Modulation of Depression Circuits using Deep Brain Stimulation**

Participants

Helen S. Mayberg, MD, New York, NY (*Presenter*) Consultant, Abbott Laboratories; License agreement, Abbott Laboratories

**LEARNING OBJECTIVES**

1) Describe neuroimaging findings in patients with depression. 2) Distinguish brain change patterns associated with different antidepressant treatments. 3) Evaluate the utility of imaging-based biomarkers to guide optimal treatment selection. 4) Understand the role and challenges posed by imaging studies of deep brain stimulation for treatment resistant depression.

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SPSI26

## Special Interest Session: Corporatization of Radiology

Monday, Dec. 2 4:30PM - 6:00PM Room: S401CD

OT

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

### Participants

Howard B. Fleishon, MD, Norcross, GA (*Moderator*) Nothing to Disclose

### LEARNING OBJECTIVES

1) Presentation of current trends in Corporatization in Radiology. 2) Provide varying perspectives of Corporatization in Radiology for the participants to compare and contrast. 3) Open discussion of the implications and challenges of Corporatization in Radiology.

### Sub-Events

#### SPSI26A Overall Market Perspective

Participants

Howard B. Fleishon, MD, Norcross, GA (*Presenter*) Nothing to Disclose

#### SPSI26B Australian Experience

Participants

Lance J. Lawler, MBBCh, FRANZCR, Wellington, New Zealand (*Presenter*) Nothing to Disclose

#### SPSI26C Practice That Elected to Sell

Participants

Catherine J. Everett, MD, New Bern, NC (*Presenter*) Shareholder, Radiology Partners; President, Eidetico Radiology Solutions

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

catherine.everett@radpartners.com

### LEARNING OBJECTIVES

understand the reasons a radiology practice should sell

#### SPSI26D Practice that Elected Not to Sell

Participants

Gregory N. Nicola, MD, River Edge, NJ (*Presenter*) Founder, N2 Health Insights; Consultant, CMO Neutigers

### LEARNING OBJECTIVES

1) Discuss broad and local reasons a practice may elect not to sell to private equity.

Printed on: 10/29/20



SPSI27

## Special Interest Session: E-cigarette/Vaping-associated Lung Injury (EVALI)

Monday, Dec. 2 4:30PM - 5:30PM Room: N228



AMA PRA Category 1 Credit™: 1.00  
ARRT Category A+ Credit: 1.00

### Participants

Mark L. Schiebler, MD, Madison, WI (*Moderator*) Stockholder, Stemina Biomarker Discovery, Inc; Stockholder, HealthMyne, Inc;  
Jeffrey S. Klein, MD, Burlington, VT (*Moderator*) Editor with royalties, Wolters Kluwer nv

### LEARNING OBJECTIVES

1) Define the public health significance of e-cigarette/vaping related associated lung disease injury (EVALI) in the USA. 2) Learn the common CT and CXR findings of Vaping Related Lung Disease. 3) Learn how the pathology helps to define the possible causes of this disorder. 4) Learn how vaping affects the vascular system.

### Sub-Events

#### SPSI27A Introduction

##### Participants

Travis S. Henry, MD, San Francisco, CA (*Presenter*) Nothing to Disclose

#### SPSI27B Scope of the Problem

##### Participants

Mark L. Schiebler, MD, Madison, WI (*Presenter*) Stockholder, Stemina Biomarker Discovery, Inc; Stockholder, HealthMyne, Inc;

#### SPSI27C CXR and CT Findings of Vaping Lung Disease

##### Participants

Seth J. Kligerman, MD, Denver, CO (*Presenter*) Speakers Bureau, Boehringer Ingelheim GmbH; Author, Reed Elsevier; Consultant, IBM Corporation

#### SPSI27D Histopathology of Vaping Lung Disease

##### Participants

Brandon T. Larsen, MD, PhD, Scottsdale, AZ (*Presenter*) Research Consultant, PAREXEL International Corporation

#### SPSI27E Physiological Changes with Vaping

##### Participants

Alessandra Caporale, PhD, Philadelphia, PA (*Presenter*) Nothing to Disclose

### For information about this presentation, contact:

ascapor@pennmedicine.upenn.edu

### LEARNING OBJECTIVES

1) Learn the 'cause' and 'effect' relation between e-cigarette aerosol inhalation and vascular outcomes. 2) Learn the physiological response to e-cigarette vaping in terms of inflammation and oxidative stress. 3) Learn how acute exposure to e-cigarette aerosol transiently affects endothelial function.

### ABSTRACT

Electronic cigarette (e-cig) aerosol contains substances potentially deleterious to the vascular endothelium. We tested the hypothesis that inhalation of nicotine-free e-cig aerosol causes acute endothelial dysfunction, and that these effects can be quantified by MRI, along with serum markers of oxidative stress and inflammation. Thirty healthy nonsmokers (mean age  $\pm$  SD=24.3  $\pm$  4.3 years), were subjected to a vaping paradigm using a nicotine-free e-cig. Two blood draws and two MRI examinations (3T, Siemens Prisma) were performed, one each pre- and post-vaping. The concentration of nitric oxide metabolites (NOx), resulting from transient changes in nitric oxide, and C-reactive protein (CRP), a marker of inflammation, were assayed. The MRI protocol assessed vascular reactivity to cuff-induced ischemia in the thigh, quantifying luminal flow mediated dilation (FMD) and hyperemic blood flow velocity in the femoral artery (fa), and hemoglobin O<sub>2</sub> saturation (HbO<sub>2</sub>) in the femoral vein. The study group showed after vaping a 33% reduction in FMD, consistent with a lower bioavailability of vasodilatory factors, suggested by the decrease in NOx (-20%, from 35.3 to 28.2  $\mu$ mol/L). Moreover, there was a 2-fold increase in CRP (+95%, from 428.6 to 835.6 ng/ml). These biochemical changes were paralleled by impaired reactive hyperemia in fa, represented by reduced peak velocity (-17%, from 56.6 to 46.7 cm/s) and slope (-26%, from 15.1 to 11.2 cm/s<sup>2</sup>), and altered microvascular reactivity, indicated by reduced pre-cuff HbO<sub>2</sub> (-20%, from 65 to 52%). These results suggest that e-cig inhalation elicits transient endothelial dysfunction and activation of an inflammatory response, and that the effect is unrelated to nicotine.

#### SPSI27F Q&A







SPSI28

## Special Interest Session: The Academy Imaging Shark Tank: Preparing Imaging Investigators to Dive into the Shark Tank

Monday, Dec. 2 4:30PM - 6:00PM Room: S502AB

RS

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

### LEARNING OBJECTIVES

Three 'Pitch Teams' will present to the audience a five minute pitch about their idea/product. A panel of professionals with backgrounds in venture capital, industry and intellectual property will provide expert feedback and facilitate questions from the audience. This session is meant to engage the early career investigator interested in learning how to talk about and market their ideas/products in a way that will attract outside investment sources, as well as provide some helpful expertise and give feedback in an interactive education forum"

### Sub-Events

#### SPSI28A Welcome

##### Participants

Ronald L. Arenson, MD, Mill Valley, CA (*Presenter*) Scientific Advisory Board, Imagion Biosystems; Consultant, Arterys Inc; Consultant, Ziteo Medical

#### SPSI28B The Pitch Teams

##### Participants

Hari Trivedi, MD, Atlanta, GA (*Presenter*) Consultant, Arterys Inc; Founder, Lightbox AI; Founder, BioData Consortium

Paul E. Bunting, Atlanta, GA (*Presenter*) Nothing to Disclose

Sebastian Obrzut, MD, San Diego, CA (*Presenter*) Nothing to Disclose

Peter D. Caravan, PhD, Charlestown, MA (*Presenter*) Research Grant, Bruker Corporation; Research Grant, Indalo Therapeutics; Research Grant, Pliant Therapeutics; Spouse, CEO, Reveal Pharmaceuticals; Stockholder, Reveal Pharmaceuticals; Stockholder, Collagen Medical; Consultant, Collagen Medical; ;

#### SPSI28C Shark Tank Panel

##### Participants

Ronald L. Arenson, MD, Mill Valley, CA (*Presenter*) Scientific Advisory Board, Imagion Biosystems; Consultant, Arterys Inc; Consultant, Ziteo Medical

Emir S. Sandhu, MD, Stanford, CA (*Presenter*) Nothing to Disclose

Scott A. Penner, JD, San Diego, CA (*Presenter*) Spouse, Consultant, Human Longevity Institute; Spouse, Research Grant, General Electric Company

Susan Harris, Wauwatosa, WI (*Presenter*) Nothing to Disclose

### For information about this presentation, contact:

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#### SPSI28D Discussion

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