

**Tuesday**

**Hot Topic Session: Quantitative MR Biomarkers in the MSK System**

Tuesday, Dec. 1 7:15AM - 8:15AM Location: E350



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

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

**Participants**

Martin Torriani, MD, Boston, MA (*Moderator*) Nothing to Disclose

**LEARNING OBJECTIVES**

1) To discuss how MRI-based cartilage mapping techniques yield biomarkers of cartilage integrity, and discuss the technical requirements and current indications for clinical use of these methods. 2) To describe the emerging capabilities of high-resolution MR imaging to examine bone microarchitecture and its potential in providing biomarkers of bone strength. 3) To discuss potential applications of MR spectroscopy in musculoskeletal neoplasms and fat quantification of musculoskeletal tissues such as marrow and muscle.

**ABSTRACT**

There is strong incentive to increase the role of quantitative techniques in clinical musculoskeletal imaging, especially applications related to cartilage health, bone structure, tumor and metabolic imaging. This Hot Topic session will discuss clinical applications of biomarkers of cartilage integrity (T1rho, T2, T2\* and dGEMRIC), bone structure by high-resolution MRI, and tissue metabolism (MR spectroscopy for tumor imaging, muscle and marrow fat content).

**Sub-Events****SPSH30A T2, T2\*, T1rho and dGEMRIC as Biomarkers of Cartilage Integrity****Participants**

Thomas M. Link, MD, PhD, San Francisco, CA, (thomas.link@ucsf.edu) (*Presenter*) Research funded, General Electric Company; Research funded, InSightec Ltd; Royalties, Springer Science+Business Media Deutschland GmbH; Research Consultant, Pfizer Inc;

**LEARNING OBJECTIVES**

1) To define how T2, T2\*, T1rho and dGEMRIC quantitatively assess cartilage matrix composition. 2) To describe the requirements for applying these quantitative measurements to clinical imaging. 3) To critically assess previous clinical studies and list indications for using quantitative cartilage imaging biomarkers.

**SPSH30B Bone Microarchitecture by MRI****Participants**

Gregory Chang, MD, New York, NY (*Presenter*) Speaker, Siemens AG

**LEARNING OBJECTIVES**

1) To define bone microarchitecture and its contribution to bone strength and fracture risk. 2) To describe the technical requirements for MRI of bone microarchitecture, including hardware, pulse sequences, and image post-processing. 3) To provide an overview of clinical studies of MRI of bone microarchitecture.

**SPSH30C MR Spectroscopy of the Musculoskeletal System****Participants**

Martin Torriani, MD, Boston, MA (*Presenter*) Nothing to Disclose

**LEARNING OBJECTIVES**

1) To define how MR spectroscopy quantitatively measures tissue biochemistry. 2) To describe general guidelines for usage of MR spectroscopy in musculoskeletal clinical imaging, including technical factors, quantification/analysis and interpretation. 3) To assess the state-of-the-science in regards to the use of MR spectroscopy for musculoskeletal tissues.

**Controversy Session: Gadolinium Contrast Agents and Adverse Effects: Too Much Attention or Too Little?**

Tuesday, Dec. 1 7:15AM - 8:15AM Location: E451A

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

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**Participants**

Hero K. Hussain, MD, Ann Arbor, MI (*Moderator*) Nothing to Disclose  
Emanuel Kanal, MD, Pittsburgh, PA (*Presenter*) Consultant, Boston Scientific Corporation; Consultant, Medtronic, Inc; Consultant, St. Jude Medical, Inc; Consultant, Bayer AG; Investigator, Bracco Group; Royalties, Guerbet SA;  
Martin R. Prince, MD, PhD, New York, NY, (map2008@med.cornell.edu) (*Presenter*) Patent agreement, General Electric Company; Patent agreement, Hitachi, Ltd; Patent agreement, Siemens AG; Patent agreement, Toshiba Corporation; 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, Medtronic, Inc; Patent agreement, Topspins, Inc; Stockholder, Topspins, Inc  
Richard H. Cohan, MD, Ann Arbor, MI, (rcohan@umich.edu) (*Presenter*) Consultant, General Electric Company; ; ;  
Matthew S. Davenport, MD, Cincinnati, OH, (matdaven@med.umich.edu) (*Presenter*) Book contract, Wolters Kluwer nv; Book contract, Reed Elsevier;

**LEARNING OBJECTIVES**

1) To discuss associations of gadolinium based contrast agents (GBCA) and Nephrogenic Systemic Fibrosis (NSF). 2) To review rates and types of acute adverse reactions in patients receiving GBCA, and to place those in perspective with respect to the risk of NSF. 3) To discuss several other potential safety factors about GBCA, and to compare and contrast incidence of new potential safety factors among the various CNS-approved GBCA. 4) To explain the current thinking regarding imaging patients with renal impairment, and to define renal function thresholds that might be useful for operationalizing imaging in this patient population.

**ABSTRACT**

To review associations of gadolinium based contrast agents (GBCA) and Nephrogenic Systemic Fibrosis (NSF), and discuss current practice patterns that led to almost complete elimination of NSF. Speaker: Martin Prince. To review rates and types of acute adverse reactions in patients receiving GBCA, discuss principles of premedication and treatment, and place the acute adverse reaction rate in perspective with respect to the risk of NSF. Speaker: Richard Cohan. To list and integrate several other potential safety factors about GBCA, other than NSF and acute allergic type, into the clinical decision making process about whether or not to administer GBCA, and to compare and contrast incidence of new potential safety factors among the various CNS-approved GBCA available today. Speaker: Emanuel Kanal. To explain the current thinking regarding imaging patients with renal impairment, to highlight the differences that exist between serum creatinine-based and eGFR-based screening, and to define the ranges of renal function thresholds for which caution might be advised to avoid potential harm that might result from the administration of iodinated and gadolinium-based contrast media. Speaker: Matthew Davenport.

**URL**

## RSNA Diagnosis Live™: 'Tic Tac D'Oh' - Test Your Diagnostic Skills at the Crack of Dawn

Tuesday, Dec. 1 7:15AM - 8:15AM Location: E451B



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

### Participants

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

Christopher G. Roth, MD, Philadelphia, PA (*Presenter*) Nothing to Disclose

Sandeep P. Deshmukh, MD, Philadelphia, PA, (sandeep.deshmukh@jefferson.edu) (*Presenter*) Nothing to Disclose

### LEARNING OBJECTIVES

1) The participant will be introduced to a series of radiology case studies via an interactive team game approach designed to encourage "active" consumption of educational content. 2) The participant will be able to 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) The attendee 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. This interactive session will use RSNA Diagnosis Live™. Please bring your charged mobile wireless device (phone, tablet or laptop) to participate.

**Clinical Decision Support and Utilization Management: Preparing for the CMS 2017 Mandate**

Tuesday, Dec. 1 8:30AM - 10:00AM Location: E451A

The logo consists of the letters 'HP' in a bold, sans-serif font, enclosed within a thin black rectangular border.

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

**Participants**

Keith J. Dreyer, MD, PhD, Boston, MA (*Coordinator*) Co-Chairman, Medical Advisory Board, Merge/IBM  
Keith J. Dreyer, MD, PhD, Boston, MA (*Moderator*) Co-Chairman, Medical Advisory Board, Merge/IBM  
Jeffrey B. Weilburg, MD, Boston, MA (*Presenter*) Nothing to Disclose  
Mark D. Hiatt, MD, MBA, Salt Lake City, UT, (mark.hiatt@regence.com) (*Presenter*) Medical Director, Regence BlueCross BlueShield;  
Board Member, RadSite ; Former Officer, HealthHelp, LLC  
Joseph Hutter, Baltimore, MD (*Presenter*) Nothing to Disclose  
Jennifer K. Coleman, Traverse City, MI (*Presenter*) Nothing to Disclose

**LEARNING OBJECTIVES**

1) Explain the need for assuring the appropriateness of ordered exams. 2) Know the role of utilization management in reducing inappropriate and unnecessary tests. 3) Identify the advantages and limitations of clinical decision support. 4) Recognize how payers are considering meeting the CMS mandate for pre-order decision support.

**ABSTRACT**

This course will discuss the 2017 CMS mandate for pre-order decision support for MRI, CT, and PET, including the need for assuring the appropriateness of ordered exams, the roles of utilization management and clinical decision support in reducing inappropriate and unnecessary tests, the advantages and limitations of methods to manage utilization, and how payers are considering meeting the CMS mandate for pre-order decision support.

**URL**

[https://www.federalregister.gov/articles/search?conditions%5Bregulation\\_id\\_number%5D=0938-AS40](https://www.federalregister.gov/articles/search?conditions%5Bregulation_id_number%5D=0938-AS40)

## Smoking Related Lung Disease: Radiologic-Pathologic Correlation

Tuesday, Dec. 1 8:30AM - 10:00AM Location: E451B



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

### Participants

Jeffrey R. Galvin, MD, Baltimore, MD (*Moderator*) Nothing to Disclose

### LEARNING OBJECTIVES

1) Describe the range of lung injury resulting from the inhalation of cigarette smoke. 2) Explain the general mechanisms of cigarette smoke injury. 3) List the currently accepted diagnostic categories. 4) Identify the key imaging features of smoking related lung disease.

### ABSTRACT

Symptomatic cigarette smokers are a common source of referral for diagnostic imaging. Radiologists are regularly confronted with an array of findings on plain radiography and computed tomography that mirror varying combinations of emphysema, airway inflammation, airway fibrosis and the changes of pulmonary Langerhans' cell histiocytosis (PLCH). In addition, there is growing acceptance of a link between cigarette smoke and alveolar wall fibrosis. The radiologist is confronted with an extensive list of smoking-related diagnostic categories including: emphysema, obstructive bronchitis, respiratory bronchiolitis-interstitial lung disease (RB-ILD), desquamative interstitial pneumonia (DIP), PLCH and acute eosinophilic pneumonia. These injuries are best understood through correlation of the imaging with pathology and physiology.

**Active Handout:** Jeffrey R. Galvin

<http://abstract.rsna.org/uploads/2015/15001895/RC301.pdf>

### Sub-Events

#### RC301A Introduction

### Participants

Jeffrey R. Galvin, MD, Baltimore, MD (*Presenter*) Nothing to Disclose

### LEARNING OBJECTIVES

1. Describe the range of lung injury resulting from the inhalation of cigarette smoke. 2. Explain the general mechanisms of cigarette smoke injury. 3. List the currently accepted diagnostic categories.

### ABSTRACT

Symptomatic cigarette smokers are a common source of referral for diagnostic imaging. Radiologists are regularly confronted with an array of findings on plain radiography and computed tomography that mirror varying combinations of emphysema, airway inflammation, airway fibrosis and the changes of pulmonary Langerhans' cell histiocytosis (PLCH). In addition, there is growing acceptance of a link between cigarette smoke and alveolar wall fibrosis. The radiologist is confronted with an extensive list of smoking-related diagnostic categories including: emphysema, obstructive bronchitis, respiratory bronchiolitis-interstitial lung disease (RB-ILD), desquamative interstitial pneumonia (DIP), PLCH and acute eosinophilic pneumonia. These injuries are best understood through correlation of the imaging with pathology and physiology.

#### RC301B CT Definable Subtypes of COPD

### Participants

Alexander A. Bankier, MD, PhD, Boston, MA (*Presenter*) Author with royalties, Reed Elsevier Consultant, Olympus Corporation

### LEARNING OBJECTIVES

1) Describe the current Fleischner classification of chronic obstructive pulmonary disease (COPD). 2) Identify the different categories of emphysema and associated abnormalities on computed tomography. 3) Explain the relationship between image derived assessment of COPD and clinical assessment including pulmonary function.

### ABSTRACT

Symptomatic cigarette smokers are a common source of referral for diagnostic imaging. Radiologists are regularly confronted with an array of findings on plain radiography and computed tomography that mirror varying combinations of emphysema, airway inflammation, airway fibrosis and the changes of pulmonary Langerhans' cell histiocytosis (PLCH). In addition, there is growing acceptance of a link between cigarette smoke and alveolar wall fibrosis. The radiologist is confronted with an extensive list of smoking-related diagnostic categories including: emphysema, obstructive bronchitis, respiratory bronchiolitis-interstitial lung disease (RB-ILD), desquamative interstitial pneumonia (DIP), PLCH and acute eosinophilic pneumonia. These injuries are best understood through correlation of the imaging with pathology and physiology.

### Honored Educators

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

Alexander A. Bankier, MD, PhD - 2013 Honored Educator  
Alexander A. Bankier, MD, PhD - 2014 Honored Educator  
Alexander A. Bankier, MD, PhD - 2015 Honored Educator

### **RC301C      Inflammatory Lung Disease in Smokers**

Participants

Seth J. Kligerman, MD, Denver, CO (*Presenter*) Nothing to Disclose

#### **LEARNING OBJECTIVES**

1) Describe the categories of cigarette smoke related lung inflammation. 2) Classify the smoking-related inflammatory disorders including: respiratory bronchiolitis, desquamative interstitial pneumonia, pulmonary Langerhans cell histiocytosis and acute eosinophilic pneumonia. 3) Identify the key imaging features of smoking-related inflammatory disease on imaging. 4) Understand how pathologic changes mirror findings on imaging.

#### **ABSTRACT**

Smoking Related Lung Disease: Radiologic-Pathologic Correlation Symptomatic cigarette smokers are a common source of referral for diagnostic imaging. Radiologists are regularly confronted with an array of findings on plain radiography and computed tomography that mirror varying combinations of emphysema, airway inflammation, airway fibrosis and the changes of pulmonary Langerhans' cell histiocytosis (PLCH). In addition, there is growing acceptance of a link between cigarette smoke and alveolar wall fibrosis. The radiologist is confronted with an extensive list of smoking-related diagnostic categories including: emphysema, obstructive bronchitis, respiratory bronchiolitis-interstitial lung disease (RB-ILD), desquamative interstitial pneumonia (DIP), PLCH and acute eosinophilic pneumonia. These injuries are best understood through correlation of the imaging with pathology and physiology.

### **RC301D      Fibrotic Lung Disease in Smokers**

Participants

Jeffrey R. Galvin, MD, Baltimore, MD (*Presenter*) Nothing to Disclose

#### **LEARNING OBJECTIVES**

1) Describe the categories of cigarette smoke related lung fibrosis. 2) Identify the key imaging features that indicate the presence of lung fibrosis. 3) Explain the importance of imaging in the interpretation of pulmonary functions.

#### **ABSTRACT**

Symptomatic cigarette smokers are a common source of referral for diagnostic imaging. Radiologists are regularly confronted with an array of findings on plain radiography and computed tomography that mirror varying combinations of emphysema, airway inflammation, airway fibrosis and the changes of pulmonary Langerhans' cell histiocytosis (PLCH). In addition, there is growing acceptance of a link between cigarette smoke and alveolar wall fibrosis. The radiologist is confronted with an extensive list of smoking-related diagnostic categories including: emphysema, obstructive bronchitis, respiratory bronchiolitis-interstitial lung disease (RB-ILD), desquamative interstitial pneumonia (DIP), PLCH and acute eosinophilic pneumonia. These injuries are best understood through correlation of the imaging with pathology and physiology.

RC323

## Molecular Imaging Mini-Course: Clinical Applications of Molecular Imaging - Neuro

Tuesday, Dec. 1 8:30AM - 10:00AM Location: N226



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

### Participants

### Sub-Events

#### RC323A      Oncology Applications

#### Participants

Hyunsuk Shim, PhD, Atlanta, GA, (hshim@emory.edu) (*Presenter*) Nothing to Disclose

#### LEARNING OBJECTIVES

1) To learn about the potential of combining an advanced MR spectroscopic imaging with standard MR images to reduce the recurrence rate in glioblastomas.

#### ABSTRACT

Radiation therapy (RT) is as good as the images that guide RT planning. RT based on conventional MRIs may not fully target tumor extent in glioblastomas (GBM), which may, in part, account for high recurrence rates (60-70 percent at 6 months). Magnetic resonance spectroscopic imaging (MRSI), a molecular imaging modality that quantifies endogenous metabolite levels without relying on perfusion, leakage and diffusion of injected material, may better define extent of actively proliferating tumor. In addition, advances in this technology now permit acquisition of full-brain high-resolution 3D MRSIs in 12-14 minutes. We correlated state-of-the-art MRSI metabolite maps with tissue histopathology to validate further its use for identifying tumor that may not be fully imaged by conventional MRI sequences and provide support for its adjunctive use in tumor contouring for RT planning. Integration of histologically-verified, whole brain 3D MRSI into RT planning is feasible and may considerably modify target volumes. Thus, RT planning for GBMs may be augmented by MRSI potentially leading to reduced recurrence rates.

#### RC323B      Functional Applications

#### Participants

Satoshi Minoshima, MD, PhD, Salt Lake City, UT (*Presenter*) Royalties, General Electric Company; Consultant, Hamamatsu Photonics KK; Research Grant, Hitachi, Ltd; Research Grant, Nihon Medi-Physics Co, Ltd; Research Grant, Astellas Group; Research Grant, Seattle Genetics, Inc;



## Contemporary Thyroid and Parathyroid Imaging: The Incidental Thyroid Nodule Through 4DCT

Tuesday, Dec. 1 8:30AM - 10:00AM Location: N227



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

### Participants

### Sub-Events

#### RC306A Managing the Incidental Thyroid Nodule

### Participants

Jenny K. Hoang, MBBS, Durham, NC, (jennykh@gmail.com) (*Presenter*) Nothing to Disclose

### LEARNING OBJECTIVES

1) Describe the recommendations for workup an incidental thyroid nodule detected on imaging. 2) Examine the implications and costs of workup of incidental thyroid nodules.

### ABSTRACT

Facts about incidental thyroid nodules on imaging Majority of thyroid nodules detected incidentally do not have suspicious clinical history or imaging findings to differentiate a malignant from benign nodule. Incidental thyroid nodules are common whereas thyroid cancer is uncommon. Only 1.6% of patients with one or more thyroid nodules will actually have thyroid cancer [1]. Health care costs of workup of incidental thyroid nodules add up. Other costs to consider are patient anxiety, time lost, and potential complications of diagnostic lobectomy. Facts about incidental thyroid cancers Small thyroid cancers are typically indolent and most patients die with rather than of thyroid cancer. The observed incidence of thyroid cancer is increasing exponentially and has doubled in the last decade [2]. Mortality has not changed significantly despite this trend which raises concern that the apparent increase in incidence is due to overdiagnosis of subclinical thyroid cancers. How should we be reporting thyroid nodules on imaging? In 2015 the American College of Radiology published a white paper on the management of Incidental Thyroid Nodules [3]. References: 1. Smith-Bindman R, Lebda P, Feldstein VA, et al. Risk of thyroid cancer based on thyroid ultrasound imaging characteristics: results of a population-based study. JAMA Intern Med 2013; 173:1788-17962. Davies L, Welch HG. Current thyroid cancer trends in the United States. JAMA Otolaryngol Head Neck Surg 2014; 140:317-3223. Hoang JK, Langer JE, Middleton WD, et al. Managing Incidental Thyroid Nodules Detected on Imaging: White Paper of the ACR Incidental Thyroid Findings Committee. J Am Coll Radiol 2015; 12:143-150

#### RC306B Imaging Thyroid Cancer

### Participants

Ashley H. Aiken, MD, Atlanta, GA, (ashley.aiken@emoryhealthcare.org) (*Presenter*) Nothing to Disclose

### LEARNING OBJECTIVES

1) Discuss the American Thyroid Association (ATA) recommendations for preoperative imaging evaluation of thyroid cancer. 2) Recognize the indications for cross-sectional imaging in the pre-operative evaluation of thyroid cancer. 3) Use pre-operative cross-sectional imaging to accurately stage the primary tumor and regional lymph nodes.

### ABSTRACT

Differentiated thyroid cancer (DTC), including papillary and follicular subtypes, is the most common (90%) primary thyroid malignancy. The remaining 10% of thyroid cancers include medullary, anaplastic and lymphoma. The American Thyroid association (ATA) guidelines currently recommend ultrasound (US) as the preoperative study for uncomplicated thyroid cancer. Cross-sectional imaging adds important anatomical information and should be recommended for cases with clinical evidence of invasive disease (vocal cord palsy, fixed mass, dysphagia, or respiratory symptoms), large size or mediastinal extent not well seen on US or rapid enlargement. Cross-sectional imaging is also recommended by the ATA when there is US or clinical evidence of bulky LAD or US expertise is not available. When interpreting a CT or MRI for preoperative evaluation, the radiologist should assess the primary tumor for extrathyroidal extension. The critical structures to assess for local invasion include the infrahyoid strap muscles (T3), larynx, trachea, or esophagus (T4a), recurrent laryngeal nerve (T4a), carotid encasement (T4b) and prevertebral fascia (T4b). The second role of imaging is to assess for regional nodal disease. It is important for the radiologist to recognize that lateral neck dissections are NOT part of routine management and identification of nodal disease in the lateral neck will alter the surgical plan. Radiologists should pay close attention to the typical drainage pathways including the central neck (level VI), lateral neck (levels III, IV), superior mediastinum (VII) and retropharyngeal nodes. Nodal metastases in papillary thyroid cancer may be characteristically cystic or calcified on CT or hyperintense on T1 weighted MRI. However, metastatic nodes may also be small and reactive appearing, so that clustered nodes in the paratracheal and mediastinal locations should increase suspicion. PET/CT may play a role in dedifferentiated tumors that no longer concentrate iodine, especially for surveillance in patients with elevated thyroglobulin but negative <sup>131</sup>I WBS.

**Active Handout:** Ashley Hawk Aiken

<http://abstract.rsna.org/uploads/2015/15001959/RC306B.pdf>

#### RC306C Parathyroid Imaging

### Participants

Deborah R. Shatzkes, MD, New York, NY, (shatzkes@hotmail.com) (*Presenter*) Nothing to Disclose

### LEARNING OBJECTIVES

1) Key anatomic features of both normal and variant parathyroid anatomy. 2) The imaging modalities available for the work-up of primary hyperparathyroidism and their relative pros and cons. 3) The surgical techniques that have driven the development of contemporary parathyroid imaging.

#### **ABSTRACT**

The advent of minimally invasive parathyroid surgery (MIPS) has driven the development of improved localization techniques for parathyroid adenoma. The most successful imaging techniques are those that combine excellent anatomic detail with functional information that will help differentiate parathyroid adenoma from other nodules in the region. Ultrasound remains a very useful modality, because of its availability, cost and absent ionizing radiation. Radionuclide scanning, typically utilizing Tc99m Sestamibi, adds more specific functional information, and when combined with CT, good anatomic detail. Recently, there has been increasing interest in parathyroid CT, also known as 4DCT. This is essentially a CTA study whereby the characteristic hyperperfusion of parathyroid adenomas allows them to be differentiated from lymph nodes and exophytic thyroid nodules. There remains considerable controversy regarding technical details of 4DCT, particularly the number of phases required. The associated ionizing radiation remains a significant concern. Often, a combination of two imaging modalities is performed in order to increase reliability. The high incidence of ectopic parathyroid glands, the position of the glands at the root of the neck, the proximity to often multinodular thyroid tissue and what appears to be a rising incidence of multi glandular disease are challenges that relate to all imaging modalities.

## Emergency Radiology Series: Current Imaging of the Acute Abdomen

Tuesday, Dec. 1 8:30AM - 12:00PM Location: N228



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

### Participants

Douglas S. Katz, MD, Mineola, NY (*Moderator*) Nothing to Disclose  
Michael N. Patlas, MD, FRCPC, Hamilton, ON, (patlas@hhsc.ca) (*Moderator*) Nothing to Disclose  
Hani H. Abujudeh, MD, MBA, Boston, MA (*Moderator*) Nothing to Disclose

### Sub-Events

#### RC308-01 CT and MR of Acute Appendicitis

Tuesday, Dec. 1 8:30AM - 8:55AM Location: N228

### Participants

Perry J. Pickhardt, MD, Madison, WI (*Presenter*) Co-founder, VirtuoCTC, LLC; Stockholder, Collectar Biosciences, Inc; Research Consultant, Bracco Group; Research Consultant, KIT ; Research Grant, Koninklijke Philips NV

### LEARNING OBJECTIVES

1) Assess the relative advantages and disadvantages for CT and MR imaging in the setting of suspected appendicitis. 2) Compare the diagnostic performance of CT and MR for both appendicitis and alternative conditions. 3) Describe the increasing use of MR for abdominal imaging in the ED setting.

### ABSTRACT

N/A

### Honored Educators

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

Perry J. Pickhardt, MD - 2014 Honored Educator

#### RC308-02 T1 Bright Appendix Sign is Helpful for the Diagnosis of Acute Appendicitis in Pregnant Women

Tuesday, Dec. 1 8:55AM - 9:05AM Location: N228

### Participants

Ilah Shin, Seoul, Korea, Republic Of (*Presenter*) Nothing to Disclose  
Yong Eun Chung, MD, PhD, Seoul, Korea, Republic Of (*Abstract Co-Author*) Nothing to Disclose  
Myeong-Jin Kim, MD, PhD, Seoul, Korea, Republic Of (*Abstract Co-Author*) Nothing to Disclose

### PURPOSE

To evaluate the diagnostic value of T1 bright appendix sign for the diagnosis of acute appendicitis in pregnant women

### METHOD AND MATERIALS

This retrospective study included 125 pregnant women with suspected appendicitis who underwent MRI, including axial T2WI with/without fat saturation, coronal and sagittal T2WI, and 3D T1WI. Total of 22 patients were surgically confirmed as acute appendicitis. T1 bright appendix sign was defined as T1 high signal intensity (SI) material filling more than half length of appendix while this T1 high SI did not result from appendicolith on 3D T1WI. MR images were reviewed by two experienced radiologists in consensus and visibilities of the appendices were evaluated. The maximal diameter of visible appendix with presence or absence of T1 bright appendix sign was evaluated from MR. Sensitivity, specificity, positive predictive value (PPV) and negative predictive value (NPV) of T1 bright appendix sign were calculated

### RESULTS

In patients with acute appendicitis (n=22), appendix was visualized in all patients and the mean diameter of the appendix was  $9.4 \pm 2.7$  mm (range, 6.0-14.6 mm). In patients with a normal appendix (n=103), appendix was not visualized in 14 patients (13.6%). The mean diameter of the visualized normal appendix was  $5.0 \pm 0.7$  mm (range, 3.1-6.8 mm). Among patient without appendicitis, T1 bright appendix sign was seen in 40 patients (45%), whereas it was noted in only 1 patient with acute appendicitis (4.5%). Fourteen patients had borderline sized appendix (appendix diameter between 6 - 7 mm) and 4 out of 14 patients were diagnosed as appendicitis. Among them, T1 bright appendix sign was seen in 4 patients without appendicitis. The sensitivity, specificity, PPV and NPV of T1 bright appendix sign for the diagnosis of normal appendix were 45%, 96%, 98%, and 30% for all patients and 60%, 100%, 100%, and 50% for patients with borderline sized appendix

### CONCLUSION

T1 bright appendix sign was a specific finding for the diagnosis of normal appendix in pregnant women suspected of acute appendicitis

### CLINICAL RELEVANCE/APPLICATION

If a bright appendix sign is seen in pregnant women with suspected appendicitis, the probability of acute appendicitis might be low

### RC308-03 Optimization of MR Protocols in Pregnant Women with Suspected Acute Appendicitis

Tuesday, Dec. 1 9:05AM - 9:15AM Location: N228

#### Participants

Ilah Shin, Seoul, Korea, Republic Of (*Presenter*) Nothing to Disclose

Yong Eun Chung, MD, PhD, Seoul, Korea, Republic Of (*Abstract Co-Author*) Nothing to Disclose

Myeong-Jin Kim, MD, PhD, Seoul, Korea, Republic Of (*Abstract Co-Author*) Nothing to Disclose

#### PURPOSE

To investigate the optimal MR protocols in pregnant women who were suspected of acute appendicitis

#### METHOD AND MATERIALS

This retrospective study included 125 pregnant women (mean IUP, 21.6; range, 16-30 weeks) with suspected appendicitis. MR images were reviewed by two experienced radiologists in consensus in 3 separate sessions. On session 1, axial single shot (SSH) T2WI, respiratory gated fat saturated T2WI, 3D T1 weighted images (set 1) were reviewed. In session 2 and 3, set 1 + coronal T2WI (set 2) and set 2 + sagittal T2WI were reviewed respectively. The visibility of appendix (1: not identified - 5: entirely visualized) and probability of appendicitis (1: not appendicitis - 5: definite appendicitis) were evaluated in each session. If diseases other than appendicitis were suspected, reviewers were asked to provide specific diagnosis with a 5-point scale confidence level. Visualization score and diagnostic performance were compared by ANOVA and chi-square test. Area under the curve (Az) value was compared with DeLong methods

#### RESULTS

Visualization scores of appendix was slightly increased in both set 2 ( $4.5 \pm 1.3$ ) and set 3 ( $4.5 \pm 1.3$ ) compared to set 1 ( $4.2 \pm 1.3$ ) without statistical significance (ANOVA,  $P=0.214$ ). There was no significant differences in confidence level among three groups, in both patients with appendicitis (4.9 in all sets,  $P>0.999$ ) and without appendicitis (1.2 in all sets,  $P=0.914$ ). Eighteen patients had been diagnosed to other diseases including ureter stone (1), obstruction (3), torsion (7), acute pyelonephritis (2), hemoperitoneum (2), colon cancer (2), and terminal ileitis (1). Sensitivity and accuracy were increased in set 2 (77.8%, 96.8%) and set 3 (83.3%, 97.6%) compared to set 1 (66.7%, 95.2%) for the diagnosis of other disease. Az value was significantly higher in set 3 (Az, 0.917) compared to both set 2 (Az, 0.889) and set 1 (Az, 0.833,  $P < 0.05$ )

#### CONCLUSION

Axial T2WI with/without fat saturation and 3D T1WI were sufficient for the diagnosis of acute appendicitis. However, additional coronal and sagittal SSH T2WI were required for the accurate diagnosis of disease other than appendicitis in pregnant women

#### CLINICAL RELEVANCE/APPLICATION

Although axial T2WI and 3D T1WI is sufficient for the diagnosis of appendicitis, coronal and sagittal T2WI might be needed for the accurate diagnosis of diseases other than acute appendicitis in pregnant women who are suspected of acute appendicitis

### RC308-04 "Saving Time without Sabotaging Diagnosis"- The FAST MR Protocol for Evaluating Acute Appendicitis in the Emergency Setting

Tuesday, Dec. 1 9:15AM - 9:25AM Location: N228

#### Participants

Memoona Mian, MD, FRCR, Vancouver, BC (*Abstract Co-Author*) Nothing to Disclose

Ismail T. Ali, MBChB, MD, Vancouver, BC (*Presenter*) Nothing to Disclose

Teresa I. Liang, MD, Vancouver, BC (*Abstract Co-Author*) Nothing to Disclose

Patrick D. McLaughlin, FFRCSI, Cork, Ireland (*Abstract Co-Author*) Speaker, Siemens AG

Savvas Nicolaou, MD, Vancouver, BC (*Abstract Co-Author*) Institutional research agreement, Siemens AG

Triona M. Walshe, FFRCSI, Vancouver, BC (*Abstract Co-Author*) Nothing to Disclose

Silvia D. Chang, MD, Vancouver, BC (*Abstract Co-Author*) Nothing to Disclose

#### PURPOSE

Acute appendicitis is a major concern especially in young females presenting to ER with right iliac fossa pain. Prompt diagnosis/exclusion has major implications in the urgent care setting. Due to concerns for radiation exposure with CT scan, MR is gaining popularity as the imaging of choice given the low yield of ultrasound in such cases. In this study, we assess the diagnostic performance of FAST MR protocol comprising T2 HASTE and DW imaging for investigating such patients in the Emergency department.

#### METHOD AND MATERIALS

50 patients (49 Females; mean age  $25.4 \pm 5.2$  yrs) with MR imaging between July 2017 and March 2015 for possible acute appendicitis were reviewed. MR abdomen/pelvis performed on 1.5 T MR per departmental protocol included axial T1 gradient echo in-out of phase, transverse FSE T2 with fat sat/motion correction, axial/coronal T2 HASTE and axial DWI images. In a randomized blinded fashion, two independent radiologists with > 5 years' experience in acute imaging reviewed both protocols for presence/absence of acute appendicitis with interpretation confidence on a five point scale (5 : highly confident to 1: nondiagnostic). Mean acquisition and interpretation times for both protocols were calculated. Sensitivity, specificity and accuracy for the FAST protocol was calculated, using clinical disposition of the patient as gold standard.

#### RESULTS

Mean scan time for FAST and FULL protocol was calculated to be 21.1 min and 40.5 min respectively. Mean interpretation time for FAST protocol for reader one and two was  $4.1 \pm 1.5$  min and  $4.5 \pm 1.4$  min and for FULL protocol was  $8.1 \pm 1.8$  min and  $7.1 \pm 1.4$  min respectively. The appendix was not confidently identified in 3 scans which were considered negative for the purpose of this study given the absence of indirect signs of inflammation like fat stranding, free fluid. Sensitivity, specificity and accuracy for the FAST protocol were calculated to be 100% each for reader one and 75%, 100% and 94% respectively for reader two.

## CONCLUSION

The FAST MR protocol with high diagnostic accuracy in detecting/excluding appendicitis and significant reduction in scan/interpretation time can be a valuable tool for assessing patients with possible acute appendicitis in the ER setting.

## CLINICAL RELEVANCE/APPLICATION

FAST MR protocol significantly reduces scan/read times without sabotaging diagnostic accuracy for evaluating acute appendicitis, thus is an efficient and cost-effective technique in the ER setting.

### RC308-05 CT Angiography for Gastrointestinal Hemorrhage

Tuesday, Dec. 1 9:25AM - 9:50AM Location: N228

#### Participants

Jorge A. Soto, MD, Boston, MA (*Presenter*) Nothing to Disclose

#### LEARNING OBJECTIVES

1) To review an appropriate algorithm for the evaluation of patients presenting with overt lower intestinal bleeding, with emphasis on CT angiography. 2) To describe the proper CT angiography technique for overt gastrointestinal bleeding. 3) Illustrate with multiple examples the CT angiographic findings of active gastrointestinal bleeding, as well as potential pitfalls in interpretation.

#### ABSTRACT

Overt gastrointestinal bleeding is a common and serious condition that may threaten a patient's life depending on the severity and duration of the event. Precise identification of the location, source and cause of bleeding are the primary objectives of the diagnostic evaluation. The diagnostic algorithm implemented in these acutely ill patients include various imaging modality options, as well as upper endoscopy and colonoscopy. For patients presenting with hematochezia, implementation of colonoscopy in the emergency setting poses multiple challenges, especially the inability to adequately cleanse the colon and poor visualization owing to the presence of intraluminal blood clots. Scintigraphy with technetium 99m-labeled red blood cells is highly sensitive but also has some limitations, such as imprecise localization of the source of bleeding. CT angiography offers logistical and diagnostic advantages in the detection of active hemorrhage. A three-phase examination (non-contrast, arterial and portal venous) is typically performed. Potential technical and interpretation pitfalls should be considered and will be explained. The information derived from CT angiography helps direct therapy and select the most appropriate hemostatic intervention (when necessary): endoscopic, angiographic, or surgical. Precise anatomic localization of the bleeding point also allows a targeted endovascular embolization. The high diagnostic performance of CT angiography makes this test a good alternative for the initial emergent evaluation of patients with acute lower intestinal bleeding.

#### Honored Educators

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Jorge A. Soto, MD - 2013 Honored Educator  
Jorge A. Soto, MD - 2014 Honored Educator  
Jorge A. Soto, MD - 2015 Honored Educator

### RC308-06 The Association of the Hypovolemic Shock Complex and Patient Mortality in Patients with Acute Internal Hemorrhage of the Abdomen and Pelvis

Tuesday, Dec. 1 9:50AM - 10:00AM Location: N228

#### Awards

##### RSNA Country Presents Travel Award

#### Participants

Benjamin Fritz, MD, Freiburg, Germany (*Presenter*) Nothing to Disclose  
Jan Fritz, MD, Baltimore, MD (*Abstract Co-Author*) Research Grant, Siemens AG; Research Consultant, Siemens AG; Speaker, Siemens AG  
Philippe A. Dovi-Akue, MD, Freiburg, Germany (*Abstract Co-Author*) Nothing to Disclose  
Maximilian Russe, MD, Freiburg, Germany (*Abstract Co-Author*) Nothing to Disclose  
Mathias F. Langer, MD, PhD, Freiburg, Germany (*Abstract Co-Author*) Nothing to Disclose  
Elmar C. Kotter, MD, MSc, Freiburg, Germany (*Abstract Co-Author*) Editorial Advisory Board, Thieme Medical Publishers, Inc

#### PURPOSE

The hypovolemic shock complex (HSC) constitutes computed tomography (CT) signs that are believed to be related to hypovolemic shock; however, its association with patient prognosis is unclear. We, therefore, sought to determine the frequency of HSC signs in patients with acute internal hemorrhage of the abdomen and pelvis and their association with patient mortality.

#### METHOD AND MATERIALS

A retrospective search of our hospital database between 2012 and 2014 derived 197 patients with clear contrast-enhanced MDCT demonstration of acute internal hemorrhage of the abdomen and pelvis. Experienced observers evaluated the CT studies for 10 different radiological signs of HSC. The frequencies of HSC signs were correlated with death during hospitalization.

#### RESULTS

44/197 (22.3%) of the patients died. The mortality group showed an average of 3.0 HSC signs, whereas the survival group showed 1.1 ( $p<0.001$ ). Mortality and survival groups showed differences of the frequency of hyperenhancing adrenal glands (70.5% (31/44) vs. 19.0% (29/153),  $p<0.001$ ), halo sign (54.5% (24/44) vs. 32% (48/150),  $p=0.01$ ), splenic hypoperfusion (37.2% (16/43) vs. 4% (6/151),  $p<0.0001$ ), altered renal enhancement (15.9% (7/44) vs. 3.3% (5/153),  $p=0.033$ ), shock bowel (22.7% (10/44) vs. 3.3% (5/150),  $p=0.005$ ), liver hypoperfusion (15.9% (7/44) vs. 3.3% (5/153),  $p=0.004$ ), and hyperenhancement/edema of the gallbladder

(12.1% (4/33) vs. 0% (0/137),  $p=0.044$ ). No significant differences existed for a flat IVC (59.1% (26/44) vs. 45.1% (69/153),  $p=0.103$ ), small diameter aorta (9.5% (4/42) vs. 6.5% (10/153),  $p=0.516$ ) and pancreatic hyperenhancement/edema (6.8% (3/44) vs. 0% (0/153),  $p=0.083$ ). 10% (7/73) of patients with no signs of HSC died compared to 11% (5/44) with 1, 27% (9/33) with 2, 33% (8/24) with 3, 67% (4/6) with 4, 44% (4/9) with 5, 67% (2/3) with 6, 100% (2/2) with 7, 100% (2/2) with 8 and 100% (1/1) with 9 HSC signs.

## CONCLUSION

HSC signs are common in patients with acute internal hemorrhage. Patient mortality significantly increases if 2 or more signs are present. While several signs are associated with increased mortality, inferior vena cava, aorta and pancreas signs have the weakest association.

## CLINICAL RELEVANCE/APPLICATION

Timely MDCT diagnosis and reporting of the HSC can contribute to appropriate management of the acute patient care and prognosis.

### RC308-07 Question and Answer

Tuesday, Dec. 1 10:00AM - 10:15AM Location: N228

Participants

### RC308-08 Imaging of Bowel Ischemia

Tuesday, Dec. 1 10:15AM - 10:40AM Location: N228

Participants

Vincent M. Mellnick, MD, Saint Louis, MO, (mellnickv@mir.wustl.edu) (*Presenter*) Nothing to Disclose

## LEARNING OBJECTIVES

1) To apply protocols for CT and MRI that are best for identifying and characterizing bowel ischemia. 2) To compare the underlying causes and imaging findings of bowel ischemia, including nonocclusive ischemia, arterial and venous occlusion, vasculitis, and obstruction. 3) To differentiate the CT and MRI findings of bowel ischemia due in various stages of chronicity. 4) To use this information to better detect bowel ischemia in clinical practice and recommend appropriate management.

## ABSTRACT

N/A

### RC308-09 CT for Acute Nontraumatic Abdominal Pain - Is Oral Contrast Really Required? Initial Conclusions

Tuesday, Dec. 1 10:40AM - 10:50AM Location: N228

Participants

Rivka Kessner, Tel Aviv, Israel (*Presenter*) Nothing to Disclose  
Sophie Barnes, Tel Aviv, Israel (*Abstract Co-Author*) Nothing to Disclose  
Pinhas Halpern, Tel Aviv, Israel (*Abstract Co-Author*) Nothing to Disclose  
Vadim Makrin, Tel Aviv, Israel (*Abstract Co-Author*) Nothing to Disclose  
Arye Blachar, MD, Tel Aviv, Israel (*Abstract Co-Author*) Nothing to Disclose

## PURPOSE

To compare the diagnostic performance of abdominal CT performed with and without oral contrast, in patients presenting to the ED with acute nontraumatic abdominal pain.

## METHOD AND MATERIALS

Our prospective study was conducted on a sample of adult patients presenting with nontraumatic abdominal pain to the ED of a large tertiary medical center. 250 patients with acute abdominal pain that underwent IV contrast-enhanced abdominal CT were enrolled over a 9-month period. 125 patients were recruited for the study group using convenience sampling, and underwent CT without oral contrast. A control group of 125 patients was recruited, matching the cohort groups' gender and age and underwent abdominal CT during the same week - with oral contrast material. Exclusion criteria were: pregnancy, history of IBD, recent abdominal operation, suspected renal colic, AAA rupture or intestinal obstruction. The exams were first reviewed by the senior attending radiologist to determine if an additional scan with oral contrast was required. Two senior radiologists then performed consensus reading to determine the significance of the lack of oral contrast administration. The reviewers also determined specific technical and imaging findings, including the presence of oral contrast in the pathological area and the influence of the technique on some radiological findings.

## RESULTS

Each group consisted of 67 males and 58 females. The average age of the two groups was 46.9 years. The main diagnoses were appendicitis (20%), diverticulitis (8.4%), colitis (6.4%) and a normal CT exam (40.4%). There was no significant difference between the groups regarding the history of the patients and the technique of the studies. Among the 125 patients of the study group, no patient had to undergo additional scan in order to establish the correct diagnosis. In only 1 patient from each group (0.8%), contrast material was considered to be necessary. In 8 patients from the study group (6.4%) and 5 patients from the control group (4%) oral contrast was considered helpful.

## CONCLUSION

Our study indicates that examination of patients with acute nontraumatic abdominal pain with CT scans without oral contrast material - are diagnostic and have comparable performance to scans performed after oral contrast administration.

## CLINICAL RELEVANCE/APPLICATION

Our study indicates that patients presenting to the ED with acute nontraumatic abdominal pain, may be examined with CT without



oral contrast material.

#### **RC308-10 Assessing the Prevalence and Clinical Relevance of Positive Abdominal and Pelvic CT Findings in Senior Patients Presenting to the Emergency Department.**

Tuesday, Dec. 1 10:50AM - 11:00AM Location: N228

##### **Participants**

Abdullah Alabousi, MD, Hamilton, ON (*Abstract Co-Author*) Nothing to Disclose  
Michael N. Patlas, MD,FRCPC, Hamilton, ON (*Abstract Co-Author*) Nothing to Disclose  
Malek Meshki, MD, Hamilton, ON (*Presenter*) Nothing to Disclose  
Sandra Monteiro, PhD, Hamilton, ON (*Abstract Co-Author*) Nothing to Disclose  
Douglas S. Katz, MD, Mineola, NY (*Abstract Co-Author*) Nothing to Disclose

##### **PURPOSE**

To retrospectively evaluate the prevalence and clinical relevance of positive abdominal and pelvic CT(A/P CT) findings for patients ages 65 and older, when compared with all other Emergency Department (ED) patients undergoing A/P CT during the same time period.

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

An IRB-approved retrospective review of all adult patients who underwent an emergency 64-MDCT of the abdomen and pelvis for acute non-traumatic abdominal complaints over a two-year period at a single institution was performed. The prevalence and clinical relevance of positive CT findings was assessed for patients <65 and >65. Statistical comparisons were made with Student t-tests.

##### **RESULTS**

2102 patients between 10/1/2011 and 9/30/2013 were reviewed. 1009 patients were excluded as their CT was performed to assess for trauma, for post-operative changes, or because the patients had a known diagnosis or the CT examination was performed for cancer staging. 631 patients were included in the <65 group (298 men and 333 women; mean age 46, age range 18-64), and 462 were included in the >65 group (209 men and 253 women; mean age 78, age range 65-99). Overall, there were more positive CT findings explaining the abdominal/pelvic pain for patients <65 (388 positive cases, 61.5%), compared with the >65 group (258 positive cases, 55.8%), which was a statistically significant difference ( $p<0.03$ ). However, patients >65 were more likely to have clinically/surgically relevant findings. 50% of patients >65 presenting with appendicitis had complications evident on the initial CT, compared with 27% of those <65 ( $p<0.05$ ). In addition, bowel obstruction (41 vs 27 patients,  $p<0.05$ ), ruptured abdominal aortic aneurysm (7 vs 2 patients,  $p<0.05$ ) and malignancy (19 vs 12 patients,  $p<0.05$ ) were all more common in individuals presenting to the ED >65 years of age.

##### **CONCLUSION**

The findings of our retrospective study refute the hypothesis that there is increased prevalence of positive abdominal and pelvic CT findings in patients >65. However, older patients in our series were more likely to present with clinically/surgically relevant findings, and a lower threshold for ordering imaging examinations in this patient population should be considered.

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

64-MDCT shows more clinically/surgically relevant findings in individuals older than 65 than in younger patients presenting to the Emergency Department with acute non-traumatic abdominal complaints.

##### **Honored Educators**

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Douglas S. Katz, MD - 2013 Honored Educator  
Douglas S. Katz, MD - 2015 Honored Educator

#### **RC308-11 MR of the Acute Abdomen**

Tuesday, Dec. 1 11:00AM - 11:25AM Location: N228

##### **Participants**

Stephan W. Anderson, MD, Boston, MA (*Presenter*) Nothing to Disclose

##### **LEARNING OBJECTIVES**

1) To overview the current utilization of MR of the acute abdomen, with an emphasis on protocol optimization, and correct interpretation, using case examples. 2) To examine potential pitfalls in the interpretation of MR of the acute abdomen. 3) To review the current literature of MR of the acute abdomen.

#### **RC308-12 The "Onyx Rim" Sign in Pelvic MRI: Perifollicular Hemorrhage as a Potential Predictor of Viability in the Setting of Ovarian Torsion**

Tuesday, Dec. 1 11:25AM - 11:35AM Location: N228

##### **Participants**

Iva Petkovska, MD, Tucson, AZ (*Presenter*) Nothing to Disclose  
Zeena Irani, MD, MS, Tucson, AZ (*Abstract Co-Author*) Nothing to Disclose  
Bobby T. Kalb, MD, Tucson, AZ (*Abstract Co-Author*) Nothing to Disclose  
Christopher Geffre, MD, Tucson, AZ (*Abstract Co-Author*) Nothing to Disclose  
Janiel Cragun, MD, Tucson, AZ (*Abstract Co-Author*) Nothing to Disclose  
James R. Costello, MD, PhD, Tucson, AZ (*Abstract Co-Author*) Nothing to Disclose  
Hina Arif Tiwari, MD, Tucson, AZ (*Abstract Co-Author*) Nothing to Disclose

Ferenc Czeyda-Pommersheim, MD, Pittsburgh, PA (*Abstract Co-Author*) Nothing to Disclose  
Diego R. Martin, MD, PhD, Tucson, AZ (*Abstract Co-Author*) Nothing to Disclose

## PURPOSE

To correlate noncontrast MRI features of perfollicular hemorrhage with ovarian viability in the clinical setting of torsion.

## METHOD AND MATERIALS

This is an IRB-approved retrospective review of 8 patients with ovarian torsion on MRI confirmed with intraoperative exam. Preoperative MR exams were performed on either a 1.5T/3.0T system (Siemens Magnetom Aera/Skyra) using 18-channel anterior abdominal and pelvic surface coils. Images were acquired without breath holding using multiplanar T2-weighted Half-Fourier Single-shot Echo-train (HASTE) sequences, repeated with fat-suppression using SPECTral Adiabatic Inversion Recovery (SPAIR). All MRIs were retrospectively reviewed in a blinded fashion separately by two radiologists for the presence or absence of a T2-hypointense perfollicular rim. This finding, when present, was utilized as a predictor of nonviability of the torsed ovary. Each torsed ovary was categorized as either a) viable or b) nonviable based on presence/absence of a perfollicular T2-hypointense rim. Clinical outcomes were determined by either a) histopathologic correlation, or b) imaging follow-up and review of the patient's medical records.

## RESULTS

Of 8 patients with ovarian torsion on MRI, 5 were categorized as non-viable on MRI due to the presence of a perfollicular T2 hypointense rim, and 3 as viable due to a lack of perfollicular T2-hypointense rim. Using the reference standards of pathology (n=5) and medical chart review and imaging follow-up (n=3), MRI demonstrated a sensitivity of 100 %, and specificity of 100 % for predicting viability of a torsed ovary based on presence of a perfollicular T2-hypointense rim. Histopathological correlation demonstrated perfollicular hemorrhage separating the theca interna and externa in every patient with non-viable ovaries, corresponding to the perfollicular T2-hypointensity identified on preoperative MRI.

## CONCLUSION

Preoperative noncontrast MRI may hold promise for the prediction of ovarian viability in clinical setting of torsion.

## CLINICAL RELEVANCE/APPLICATION

Preoperative MRI for the diagnosis of ovarian torsion may provide a biomarker for prediction of ovarian viability, with potential impact on preoperative planning and management.

## RC308-13 Diagnostic Performance of Individual and Combined MR Signs of Acute Cholecystitis

Tuesday, Dec. 1 11:35AM - 11:45AM Location: N228

### Participants

Avneesh Gupta, MD, Boston, MA (*Presenter*) Nothing to Disclose  
Christina A. LeBedis, MD, Boston, MA (*Abstract Co-Author*) Nothing to Disclose  
Stephan W. Anderson, MD, Boston, MA (*Abstract Co-Author*) Nothing to Disclose  
Jorge A. Soto, MD, Boston, MA (*Abstract Co-Author*) Nothing to Disclose

## PURPOSE

To determine the performance of individual and combined MR signs of acute cholecystitis, and to propose a rapid non-contrast MR protocol for emergency diagnosis of right upper quadrant pain.

## METHOD AND MATERIALS

The institutional review board approved this HIPAA-compliant retrospective study. Informed consent was waived. 288 patients presenting to the emergency department with acute right upper quadrant pain between 10/3/2010 and 11/28/2012 undergoing MR within 48 hours of US were included. MR was performed in all included patients due to equivocal US and persistent symptoms. Individual MR signs were graded in a blinded fashion using single shot T2, diffusion (b=0, b=600) and 3D GRE post contrast sequences. Sensitivity and specificity values for individual and combined imaging signs were calculated using surgical diagnosis as the reference standard for acute cholecystitis.

## RESULTS

Of 288 patients, 128 were treated conservatively and excluded from analysis. 160 underwent cholecystectomy and 77 were diagnosed with acute cholecystitis at surgery. Sensitivities of the MR findings of gallstones, distention, wall thickening, pericholecystic fluid, gallbladder fossa restricted diffusion, wall restricted diffusion, gallbladder fossa hyper enhancement and wall hyper enhancement for the detection of acute cholecystitis were 96%, 59.7%, 72.7%, 49.4%, 47.3%, 26.7%, 55% and 11%, respectively. Corresponding specificities were 24.6%, 71%, 55.9%, 78.2%, 74.8%, 88.3%, 83.2% and 98.4%. Combining stones, distention, pericholecystic fluid and gallbladder fossa restricted diffusion yielded sensitivity of 35% and specificity of 92.7%, and these findings were identifiable using single shot T2 and diffusion sequences only. The combination of stones, distention and gallbladder fossa hyper enhancement was 43.8% sensitive and 89.6% specific for acute cholecystitis.

## CONCLUSION

Individual and combined MR features show high specificity for acute cholecystitis. Most signs can be detected by diffusion and single shot T2 weighted sequences only. Gallbladder fossa restricted diffusion is a novel imaging sign, and when combined with the presence of gallstones, pericholecystic fluid and distention yields a specificity of 92.7% for acute cholecystitis.

## CLINICAL RELEVANCE/APPLICATION

A highly specific, rapid non-contrast MR protocol consisting of diffusion and single shot T2 weighted sequences can be effective for the diagnosis of acute cholecystitis when US findings are equivocal.

## Honored Educators

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Jorge A. Soto, MD - 2013 Honored Educator

Jorge A. Soto, MD - 2014 Honored Educator

Jorge A. Soto, MD - 2015 Honored Educator

**RC308-14 Question and Answer**

Tuesday, Dec. 1 11:45AM - 12:00PM Location: N228

Participants

RC321

## Medical Physics 2.0: Computed Tomography

Tuesday, Dec. 1 8:30AM - 10:00AM Location: N229



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

### Participants

Ehsan Samei, PhD, Durham, NC (*Director*) Nothing to Disclose  
Douglas E. Pfeiffer, MS, Boulder, CO (*Director*) Nothing to Disclose

### LEARNING OBJECTIVES

1) To understand the current recommendations for computed tomography testing and quality control. 2) To understand impact of accreditation and regulation on CT quality assurance. 3) To understand current dosimetry and dose-reporting considerations.

### ABSTRACT

Many organizations have contributed to the methodology for testing computed tomography scanners. These have included state regulatory agencies, the Food and Drug Administration, the American Association of Physicists in Medicine, and the American College of Radiology, among many other groups and individuals. These contributions have included many good ideas, but also much confusion as to what is required. Further, the complexity of modern CT scanners has rendered some tests obsolete or difficult to implement. This presentation focuses mainly on the testing delineated by the 2012 American College of Radiology Computed Tomography Quality Control Manual and that required under the Intersocietal Accreditation Commission. Recommended and required tests will be identified but not described in detail.

### Sub-Events

#### RC321A Computed Tomography Perspective

### Participants

Mahadevappa Mahesh, MS, PhD, Baltimore, MD (*Presenter*) Author with royalties, Wolters Kluwer nv

### LEARNING OBJECTIVES

1) To reflect on MDCT technology enabling volumetric data acquisition. 2) To evaluate new innovations enabling dose reductions in CT.

### ABSTRACT

This talk will provide brief overview on the innovations that has led to the development of CT technology (single slice (SDCT) to multiple slices (MDCT)). Past decade saw the rapid evolution in the capability to obtain multiple slices per gantry rotation (4-320 slices). Having achieved the capability to acquire volumetric data (covering entire cardiac anatomy in half of gantry rotation), the race is currently towards acquiring CT images at optimal radiation dose. Volume CT, dual energy CT, Iterative reconstruction, quantitation are some of the new challenges that will be discussed in this talk. 1. CT Technology 1a. MDCT detector configuration 1b. Volume CT - Wide detector and dual source CT 2. New Challenges 2a. Iterative reconstruction 2b. Dual energy 2c. Dose check

#### RC321B Computed Tomography 1.0

### Participants

Douglas E. Pfeiffer, MS, Boulder, CO (*Presenter*) Nothing to Disclose

### LEARNING OBJECTIVES

1) To understand the current recommendations for computed tomography testing and quality control. 2) To understand impact of accreditation and regulation on CT quality assurance. 3) To understand current dosimetry and dose-reporting considerations.

### ABSTRACT

Many organizations have contributed to the methodology for testing computed tomography scanners. These have included state regulatory agencies, the Food and Drug Administration, the American Association of Physicists in Medicine, and the American College of Radiology, among many other groups and individuals. These contributions have included many good ideas, but also much confusion as to what is required. Further, the complexity of modern CT scanners has rendered some tests obsolete or difficult to implement. This presentation focuses mainly on the testing delineated by the 2012 American College of Radiology Computed Tomography Quality Control Manual and that required under the Intersocietal Accreditation Commission. Recommended and required tests will be identified but not described in detail.

#### RC321C Computed Tomography 2.0

### Participants

Ehsan Samei, PhD, Durham, NC (*Presenter*) Nothing to Disclose

### LEARNING OBJECTIVES

1) To become familiar with the major new developments of physics support for clinical CT operations. 2) To understand the need and the definitions of the new CT performance metrics for dose and quality. 3) To understand the testing implications of new CT technologies. 4) To understand the need for operational optimization of CT systems.

### ABSTRACT

**Neuroradiology Series: Stroke**

Tuesday, Dec. 1 8:30AM - 12:00PM Location: N230



AMA PRA Category 1 Credits™: 3.25  
ARRT Category A+ Credits: 3.50



Discussions may include off-label uses.

**Participants**

Howard A. Rowley, MD, Madison, WI, (hrowley@uwhealth.org) (*Moderator*) Research Consultant, Bracco Group; Research Consultant, Guerbet SA; Research Consultant, General Electric Company; Consultant, F. Hoffmann-La Roche Ltd; Consultant, W.L. Gore & Associates, Inc; Consultant, Lundbeck Group; ; ; ; ;  
Albert J. Yoo, MD, Newton, MA (*Moderator*) Research Grant, Penumbra, Inc; Research Grant, Terumo Corporation; Research Consultant, Medtronic, Inc;

**Sub-Events****RC305-01 Imaging for Stroke Triage: Where Do We Stand?**

Tuesday, Dec. 1 8:30AM - 8:55AM Location: N230

**Participants**

Max Wintermark, MD, Lausanne, Switzerland, (max.wintermark@gmail.com) (*Presenter*) Advisory Board, General Electric Company;

**LEARNING OBJECTIVES**

1) We will review the most common neuroimaging modalities and treatment algorithms used in the evaluation of acute stroke patients.

**ABSTRACT**

Neuroimaging has become essential in the evaluation of the acute stroke patient. CT and MRI are used to confirm the diagnosis of acute stroke, exclude stroke mimics, and triage patients for intravenous t-PA and endovascular revascularization therapies. Advanced neuroimaging techniques, including CT-angiography, MR-angiography, CT-perfusion and MR-perfusion further inform acute stroke treatment decisions and are increasingly used in the acute setting. We will review the most common neuroimaging modalities and treatment algorithms used in the evaluation of acute stroke patients.

**RC305-02 Feasibility Of Improving Detection Of Early Ischemic Infarction on Head CT Using Continuity-Based Correlative Enhancement.**

Tuesday, Dec. 1 8:55AM - 9:05AM Location: N230

**Participants**

Aseem Sharma, MBBS, Saint Louis, MO (*Presenter*) Stockholder, General Electric Company; Consultant, BioMedical Systems; Co-Founder, Correlative Enhancement, LLC  
Manu S. Goyal, MD, MSc, Saint Louis, MO (*Abstract Co-Author*) Nothing to Disclose  
Michelle M. Miller-Thomas, MD, Saint Louis, MO (*Abstract Co-Author*) Nothing to Disclose  
Rashmi Jain, MD, Saint Louis, MO (*Abstract Co-Author*) Nothing to Disclose  
James D. McEachern, MD, Saskatoon, SK (*Abstract Co-Author*) Nothing to Disclose  
Charles F. Hildebolt, DDS, PhD, Saint Louis, MO (*Abstract Co-Author*) Nothing to Disclose

**PURPOSE**

Recognition of early signs of brain infarction may influence patient management, but can be difficult on head CT. Using custom software (patent pending) that manipulates images based on correlation between intensities of continuous pixels, we aimed to assess the feasibility of improving the detection of brain infarction with head CT images.

**METHOD AND MATERIALS**

35 head CT images through the region of proven infarction and 20 control images across brain tissue without infarction were post-processed using a custom software (patent pending). Three readers, evaluated the baseline and enhanced images in a masked manner, and marked the location of infarction whenever suspected, while using a 5-point scale to rate their confidence for the presence of infarction. In a separate session, readers rated the comparative ease-of-recognition of signs of infarction for baseline and enhanced images on a 7-point scale, while evaluating these images simultaneously along with the follow-up imaging indicating the infarct distribution. Infarct identification data were analyzed with jackknife, alternative, free-response receiver operating characteristic (JAFROC) weighted software. Comparative ease-of-recognition was assessed using the one-sided Wilcoxon signed rank test for differences > a value of 4.

**RESULTS**

For infarct localization, JAFROC analysis revealed figure-of-merit values of 0.56 and 0.67 for baseline and enhance images respectively ( $p=0.03$ ). Corresponding values for infarct localization within 6 hours of symptom onset were 0.49 and 0.63 ( $p = 0.04$ ). Comparative ease-of-recognition was significantly higher than the equivalent value of 4 for all three readers ( $p < 0.01$ , 0.03,  $< 0.01$ ), tilted favorably towards the enhanced images.

**CONCLUSION**

Continuity-based correlative enhancement improves conspicuity and accurate detection of early changes of brain infarction on non-contrasted head CT.

## CLINICAL RELEVANCE/APPLICATION

By improving diagnostic accuracy for detection of ischemic infarction on head CT, continuity-based correlative enhancement may help in making more informed decisions for management of stroke patients.

### RC305-03 Diagnostic Accuracy of Whole-brain CT Perfusion in MRI-confirmed Infratentorial Infarctions

Tuesday, Dec. 1 9:05AM - 9:15AM Location: N230

#### Participants

Kolja M. Thierfelder, MD,MSc, Munich, Germany (*Abstract Co-Author*) Nothing to Disclose  
Christine Bollwein, Munich, Germany (*Abstract Co-Author*) Nothing to Disclose  
Birgit B. Ertl-Wagner, MD, Munich, Germany (*Abstract Co-Author*) Nothing to Disclose  
Louisa von Baumgarten, Munich, Germany (*Abstract Co-Author*) Nothing to Disclose  
Maximilian F. Reiser, MD, Munich, Germany (*Abstract Co-Author*) Nothing to Disclose  
Wieland H. Sommer, MD, Munich, Germany (*Presenter*) Founder, QMedify GmbH  
Andreas Straube, MD, Munich, Germany (*Abstract Co-Author*) Nothing to Disclose

#### PURPOSE

Recently introduced whole-brain CT perfusion (WB-CTP) allows for an evaluation of the posterior fossa, but data on WB-CTP in this region is limited. Our aim was to determine the diagnostic accuracy of WB-CTP for infratentorial infarctions and to identify factors influencing the detection rate.

#### METHOD AND MATERIALS

Out of a retrospective cohort of 1361 consecutive patients who underwent WB-CTP due to suspected stroke, we selected all patients with an MRI-confirmed infratentorial ischemic infarction. The study was designed as a case-control study with a ratio of cases to controls without infratentorial infarction of 1:3. Two blinded and experienced readers independently evaluated 4 different perfusion maps - Cerebral Blood Flow (CBF), Cerebral Blood Volume (CBV), Mean Transit Time (MTT), and Time to Drain (TTD) - for the presence and location of an infratentorial perfusion deficit.

#### RESULTS

Seventy subjects met the inclusion criteria for the patient group. The control group consisted of 210 patients. Overall, WB-CTP reached a sensitivity of 45.4% and a specificity of 93.1%. Infarctions of the cerebellum were detected in 20/38 (53%), while infarctions of the brain stem were detected in only 9/32 (28%) of the cases,  $p < 0.05$ . Among the different perfusion maps, TTD was the most sensitive (47.2%), followed by MTT (41.0%), CBF (39.2), and CBV (9.1%). With respect to specificity, CBV (98.1%) reached the highest value, followed by CBF (93.8%), TTD (92.9%), and MTT (89.2%). Mean final infarction volume (15.2ml) and diameter (27.1mm) of infarctions that were detected in WB-CTP were significantly larger than volume (5.4ml) and diameter (17.8mm) of infarctions that were not detected (each with  $p < 0.001$ ).

#### CONCLUSION

Depending on infarction size and localization, whole-brain CT perfusion is able to detect around 45% of infratentorial infarctions with a specificity of around 90%.

## CLINICAL RELEVANCE/APPLICATION

Whole-brain CT perfusion is able to detect around 45% of infratentorial infarctions and may be an important alternative in the case of suspected posterior circulation ischemia when MRI is not available.

### RC305-04 Intracranial Vessel Imaging at 1.5 Tesla versus 3 Tesla versus 7 Tesla:A Comparison Trial

Tuesday, Dec. 1 9:15AM - 9:25AM Location: N230

#### Participants

Lale Umutlu, MD, Essen, Germany (*Presenter*) Consultant, Bayer AG  
Oliver Kraff, MSc, Essen, Germany (*Abstract Co-Author*) Nothing to Disclose  
Anja Fischer, MD, Essen, Germany (*Abstract Co-Author*) Nothing to Disclose  
Stefan Maderwald, PhD, MSc, Essen, Germany (*Abstract Co-Author*) Nothing to Disclose  
Mark E. Ladd, PhD, Heidelberg, Germany (*Abstract Co-Author*) Nothing to Disclose  
Thomas C. Lauenstein, MD, Essen, Germany (*Abstract Co-Author*) Nothing to Disclose  
Michael Forsting, MD, Essen, Germany (*Abstract Co-Author*) Nothing to Disclose  
Marc U. Schlamann, Essen, Germany (*Abstract Co-Author*) Nothing to Disclose

#### PURPOSE

The increase of the magnetic field strength is associated to an increase in SNR that can be transitioned into imaging at higher spatiotemporal resolution. With the successful implementation of 7T neuro MRI, the aim of this study was to investigate and intraindividually compare non-enhanced MR imaging of intracranial arteries and veins at 1.5 Tesla, 3 Tesla and 7 Tesla utilizing TOF-MRA and susceptibility-weighted imaging.

#### METHOD AND MATERIALS

10 healthy volunteers were each examined on a 1.5 T (Magnetom Aera, Siemens), a 3T (Magnetom Skyra, Siemens) and a 7T MR system (Magnetom 7T, Siemens) utilizing 32-channel head coils. TOF-MRA and SWI were optimized to achieve best spatial resolution for each field strength while preserving comparable acquisition times. All datasets were read by two radiologists utilizing a 5-point scale (5= excellent vessel delineation to 1= non-diagnostic). All TOF-MRA datasets were assessed for delineation of the intracranial arteries, subdivided into 8 segments (ICA, A1/2, M1,M2,M3,PCA, P1/2, basilar artery). SWI datasets were read for delineation of 14 different smaller and larger veins. Additionally, overall image quality, vessel sharpness, vessel to background contrast and image impairment due to artifacts was assessed. For statistical analysis, a Wilcoxon Rank Test was used.

#### RESULTS

With increasing magnetic field strength, all sequences could be obtained at higher spatial resolution at comparable acquisition

times, enabling improved vessel delineation. TOF-MRA at 7T enabled a significantly better delineation particularly of small peripheral vessel segments compared to 3T and 1.5T (mean M3 TOF7T=4.3; TOF3T=3.8; TOF1.5T=2.9). 7 Tesla SWI imaging demonstrated its superiority in the highly-detailed delineation of larger and smaller veins with statistical significance to lower field strengths ( $p=0.03$ ) (e.g. average mean value larger veins: SWI7T =4.5, SWI3T =3.3, SWI1.5T =2.7). Overall image quality was rated comparably high for all three field strengths (7T=4.6; 3T=4.7; 1.5T=4.7).

## CONCLUSION

Our results demonstrate the benefits of an increase of magnetic field strength from 1.5T to 7T, offering improved and highly-detailed delineation of the intracranial arterial and venous vasculature.

## CLINICAL RELEVANCE/APPLICATION

The excellent delineation of non-enhanced vascular structures in 7T neuro MRI may lead to a more accurate diagnosis of vascular disease, such as aneurysms or cavernomas using 7T MRI.

### RC305-05 High Resolution Intracranial Vessel Wall Imaging of Atherosclerotic Plaque Characteristics: Correlation with Patient Symptoms

Tuesday, Dec. 1 9:25AM - 9:35AM Location: N230

#### Participants

Aaron M. Rutman, MD, Seattle, WA (*Presenter*) Nothing to Disclose  
Chun Yuan, PhD, Seattle, WA (*Abstract Co-Author*) Research Grant, Koninklijke Philips NV; Consultant, Koninklijke Philips NV; ;  
William D. Hwang, MD, Seattle, WA (*Abstract Co-Author*) Nothing to Disclose  
Daniel S. Hippe, MS, Seattle, WA (*Abstract Co-Author*) Research Grant, Koninklijke Philips NV; Research Grant, General Electric Company  
Niranjan Balu, PhD, Seattle, WA (*Abstract Co-Author*) Nothing to Disclose  
Thomas S. Hatsukami, MD, Seattle, WA (*Abstract Co-Author*) Research Grant, Koninklijke Philips NV  
David Tirschwell, MD, MSc, Seattle, WA (*Abstract Co-Author*) Nothing to Disclose  
Adam de Havenon, MD, Seattle, WA (*Abstract Co-Author*) Nothing to Disclose  
Mahmud Mossa-Basha, MD, Seattle, WA (*Abstract Co-Author*) Research support, General Electric Company

## PURPOSE

High resolution intracranial vessel wall imaging (VWI) has recently gained attention for its ability to evaluate and differentiate various intracranial arteriopathies, including atherosclerosis (ICAD), inflammatory vasculopathy, arterial dissection, and reversible cerebral vasoconstriction syndrome. VWI also allows for atherosclerotic plaque characterization, depicting potential vulnerable plaque features. The aim was to compare the VWI plaque characteristics between symptomatic and asymptomatic intracranial atherosclerotic lesions using a multi-contrast VWI protocol.

## METHOD AND MATERIALS

Cases of ICAD imaged with VWI were collected and retrospectively analyzed from our database between the dates 12/20/12-12/5/13. The imaging protocol included T2, T1 pre and post contrast, 3D T2 SPACE VWI and TOF MRA sequences. Symptomatic plaques were those upstream from an infarct within 6 months of VWI. Lesions with symptoms greater than 6 months prior were excluded. Each plaque was assessed for presence/absence of a fibrous cap, presence of fibrous cap thinning/disruption, cap:necrotic core ratio, and remodeling ratio (total vessel area of diseased segment)/(total vessel area of reference segment). Characteristics were compared by Fisher's exact test (fibrous cap presence, thinning/disruption) and unpaired t-test (cap:necrotic core ratio, remodeling ratio).

## RESULTS

48 intracranial atherosclerotic plaques were included from 22 patients. Assessment for fibrous capsule was possible in 18/21 symptomatic and 25/27 asymptomatic plaques. 18/18 symptomatic and 11/25 asymptomatic lesions either did not have a visible fibrous cap, or had apparent disrupted luminal surface or thinning of a visible fibrous cap ( $p<<0.01$ ). There was no significant difference in the cap:lipid core ratio or the remodeling ratio between symptomatic and asymptomatic lesions.

## CONCLUSION

VWI allows for evaluation of ICAD characteristics which may indicate plaque vulnerability, and be associated with symptoms. These features might serve as biomarkers for assessing risk, as well as indicate culprit lesions. Our study shows a significantly increased likelihood of absent fibrous cap or fibrous cap rupture/thinning in the setting of symptoms.

## CLINICAL RELEVANCE/APPLICATION

VWI of intracranial atherosclerotic plaque can demonstrate characteristics of vulnerable, symptom-associated plaque.

### RC305-06 Potential Applications for Intracranial Vessel Wall Imaging

Tuesday, Dec. 1 9:35AM - 10:00AM Location: N230

#### Participants

David J. Mikulis, MD, Toronto, ON (*Presenter*) Stockholder, Thornhill Research Inc; Research Grant, General Electric Company;

## LEARNING OBJECTIVES

1) Understand the issues concerning clinical implementation of intra-cranial vessel wall imaging. 2) Understand how vessel wall imaging can aid in differentiating vasculopathies that have similar angiographic appearances. 3) Understand pitfalls related to arterial wall image interpretation.

## ABSTRACT

Modern high field MRI systems with increased multi-element coil design have enabled higher resolution by providing greater overall signal. This in turn has paved the way for imaging smaller parts including the walls of smaller and smaller vascular structures. For example, current technology is capable of generating 3D images with 0.4 x 0.4 x 0.4 mm isotropic voxels using 3T MRI. This has

enabled characterization of circle of Willis vessels out to secondary branches (A2,M2, and P2). Not only has analysis of vasculopathies with identical angiographic appearances been made possible thereby increasing specificity of diagnosis, it has also provided insight into disease pathophysiology. An example of this is the strong relationship found between ischemic stroke and gadolinium enhancing intra-cranial atherosclerotic plaques. The purpose of this presentation therefore is to summarize the current status of arterial wall imaging in clinical neuroradiology.

### RC305-07 Update on Acute Stroke Intervention

Tuesday, Dec. 1 10:20AM - 10:45AM Location: N230

#### Participants

Colin P. Derdeyn, MD, Saint Louis, MO, (colin-derdeyn@uiowa.edu) (*Presenter*) Consultant, Terumo Corporation; Consultant, Penumbra, Inc; Consultant, Silk Road Medical; Stock options, Pulse Therapeutics, Inc; ;

#### LEARNING OBJECTIVES

1) Describe the current indications for endovascular stroke intervention. 2) Describe the available mechanical devices currently used in these cases.

#### ABSTRACT

The past 12 months have seen the publication of more positive pivotal clinical trials ( $n = 4$ ) for the treatment of acute ischemic stroke than the last 20 years combined ( $n = 6$ ). Endovascular stroke treatment (EVT) is now proven effective for a large subgroup of patients presenting with acute ischemic stroke. We will carefully review the data from the four recently published trials of endovascular treatment (EVT) for acute ischemic stroke: MR CLEAN (Multicenter Randomized Clinical Trial of Endovascular Treatment for Acute Ischemic Stroke in the Netherlands), ESCAPE (Endovascular Treatment for Small Core and Anterior Circulation Proximal Occlusion with Emphasis on Minimizing CT to Recanalization Times), and EXTEND-IA (Extending the Time for Thrombolysis on Emergency Neurological Deficits) and SWIFT PRIME (Solitaire With the Intention For Thrombectomy as Primary Endovascular Treatment for Acute Ischemic Stroke). We will examine the implications of these trials for current practice and future studies. In particular, we will focus on procedural details such as patient selection, devices, adjunctive therapies, treatment time windows and performance metrics.

**Active Handout:** Colin P. Derdeyn

<http://abstract.rsna.org/uploads/2015/15000010/RC305-07 Stroke-2015-Powers-3020-35.pdf>

### RC305-08 Carotid Intraplaque Hemorrhage is Associated with Accelerated Progression in Patients with Acute Ischemic Stroke: A Prospective Multicenter-Study on Carotid Plaque Imaging in Patients with Acute Stroke

Tuesday, Dec. 1 10:45AM - 10:55AM Location: N230

#### Participants

Andreas Schindler, MD, Munich, Germany (*Presenter*) Nothing to Disclose  
Anna Bayer-Karpinska, Munich, Germany (*Abstract Co-Author*) Nothing to Disclose  
Tilman Obenhuber, Munich, Germany (*Abstract Co-Author*) Nothing to Disclose  
Florian Schwarz, MD, Munich, Germany (*Abstract Co-Author*) Nothing to Disclose  
Clemens C. Cyran, MD, Munich, Germany (*Abstract Co-Author*) Research Grant, Bayer AG Research Grant, Novartis AG Speakers Bureau, Bayer AG  
Tobias Saam, MD, Munich, Germany (*Abstract Co-Author*) Research Grant, Diamed Medizintechnik GmbH; Research Grant, Pfizer Inc  
Andreas D. Helck, MD, Munich, Germany (*Abstract Co-Author*) Nothing to Disclose  
Andreas Harloff, Freiburg, Germany (*Abstract Co-Author*) Speaker, Boehringer Ingelheim GmbH Speaker, Bayer AG  
Holger Poppert, Munich, Germany (*Abstract Co-Author*) Nothing to Disclose  
Martin Dichgans, MD, Munich, Germany (*Abstract Co-Author*) Nothing to Disclose

#### PURPOSE

To prospectively evaluate whether carotid plaque hemorrhage - as detected by high-resolution carotid plaque MRI - is associated with an accelerated progression rate of atherosclerosis.

#### METHOD AND MATERIALS

58 consecutive patients ( $76.3 \pm 9.8$  years; 45 male) with acute ischemic stroke in the anterior circulation and non-stenosing carotid plaque in any carotid artery were included in the ongoing multi-center trial (which is also registered on ClinicalTrials.gov). Patients underwent MRI of both carotid arteries at baseline and at 12 months. Carotid plaques were characterized by the American Heart Association (AHA) classification system and plaque burden as well as components such as the lipid-rich/necrotic core, calcifications, and hemorrhage were identified and quantified. Annualized changes for each item were analyzed for both arteries combined on a patient basis for the whole cohort, as well as depending on the status of intra plaque hemorrhage (IPH) at baseline (IPH+ vs. IPH-). Unpaired t-test and one-sample t-test vs. 0 were performed.

#### RESULTS

A total of 14 patients had complicated AHA-LT6 plaques with IPH at baseline; no new IPH was detected at follow-up. During follow-up a total of four re-events occurred (all IPH+ at baseline). For all patients no significant changes in plaque burden or component size were measurable after one year, with a non-significant increase of mean wall area of 2.3%/year. IPH+ vs. IPH- subjects had a significantly higher progression of the normalized wall index (3.5% vs. 0.5%;  $p < 0.05$ ), and an accelerated progression of mean wall area (7.3% vs. 0.8%;  $P = n.s.$  for IPH+ vs. IPH-;  $P = 0.037$  for IPH+ vs. 0). No significant quantitative changes for all plaque components were measurable, although mean necrotic core area increased from 6.2 to 7.1 mm<sup>2</sup> in IPH+ patients (+16%) and remained unchanged in IPH- patients.

#### CONCLUSION

Intraplaque hemorrhage is associated with an accelerated atherosclerotic plaque progression rate in patients with acute ischemic stroke.

#### CLINICAL RELEVANCE/APPLICATION



This multi-center study provides further evidence that IPH is a good marker of plaque vulnerability; further studies are needed to test if patients with IPH could profit from more intensive therapy.

### **RC305-09 Dual-Energy Head CT Can Accurately Distinguish Intraparenchymal Hemorrhage from Calcification in Emergency Department Patients**

Tuesday, Dec. 1 10:55AM - 11:05AM Location: N230

#### **Participants**

Laleh Daftarbesheli, MD, Boston, MA (*Presenter*) Nothing to Disclose  
Ranliang Hu, MD, Boston, MA (*Abstract Co-Author*) Nothing to Disclose  
Joseph Y. Young, MD, Boston, MA (*Abstract Co-Author*) Nothing to Disclose  
Markus Y. Wu, MD, Boston, MA (*Abstract Co-Author*) Nothing to Disclose  
Michael H. Lev, MD, Boston, MA (*Abstract Co-Author*) Research support, General Electric Company Stockholder, General Electric Company  
Rajiv Gupta, PhD, MD, Boston, MA (*Abstract Co-Author*) Nothing to Disclose  
Stuart R. Pomerantz, MD, Boston, MA (*Abstract Co-Author*) Research Grant, General Electric Company

#### **PURPOSE**

Conventional head CT and MRI with gradient-echo susceptibility scanning are limited in their ability to distinguish hemorrhage from calcification, a critical distinction in the selection of stroke patients for IV-thrombolytic and endovascular therapies. Dual energy CT (DECT) scanning, however, may be able to better discriminate calcium from hemorrhage based on the differing proportions of X-ray attenuation of these materials at different scanning energies. The purpose of this study is to evaluate the ability of DECT for differentiation of calcification from acute hemorrhage.

#### **METHOD AND MATERIALS**

In this IRB approved study, all unenhanced DECT head exams performed in our emergency department in November and December 2014 were retrospectively reviewed. Patients with at least one focus of intra-parenchymal hyperdensity were included and material decomposition images were post-processed. Virtual non-calcium and calcium overlay images were reviewed for the presence of calcification versus hemorrhage. Relevant prior and follow-up imaging and clinical data were used to determine the reference standard.

#### **RESULTS**

Of 399 DECT head exams, 83 (21%) contained at least one intraparenchymal hyperdensity on the corresponding simulated single energy CT (SECT) image; 64/83 (77%) with reference standard proof of diagnosis were included. Mean age was 67 years; 39/64 (61%) were male. 68 distinct intraparenchymal hyperdense lesions were identified, of which 41/68 (60%) were calcification and 27/68 (40%) were hemorrhage. Sensitivity, specificity and accuracy of DECT for the detection of hemorrhage were 96% (CI 81-99%), 100% (CI 91-100%) and 99% (CI 90-100%), respectively. Seven of 27 (26%) of hemorrhages were incorrectly classified by SECT alone, compared to 1/27 (4%) for DECT.

#### **CONCLUSION**

DECT post-processed images can distinguish intraparenchymal hemorrhage from calcification rapidly and with very high accuracy in emergency department patients. Conventional gradient-echo MRI and CT scanning are unable to make this distinction accurately. This may have important implications for patient care, most notably in excluding stroke patients with intracranial hemorrhage from IV-thrombolytic and endovascular stroke therapies.

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

Ability of DECT for differentiation of calcification from hemorrhage has important implications for patient care, most notably in excluding stroke patients with hemorrhage from IV-thrombolytic.

### **RC305-10 Favorable Outcomes Following Endovascular Treatment in Anterior Circulation Stroke Patients Defined Prospectively Using MRI and Clinical Criteria**

Tuesday, Dec. 1 11:05AM - 11:15AM Location: N230

#### **Participants**

Ramon G. Gonzalez, MD, PhD, Boston, MA (*Presenter*) Nothing to Disclose  
Thabele M. Leslie-Mazwi, MD, Boston, MA (*Abstract Co-Author*) Nothing to Disclose  
Pamela W. Schaefer, MD, Boston, MA (*Abstract Co-Author*) Nothing to Disclose  
Michael H. Lev, MD, Boston, MA (*Abstract Co-Author*) Research support, General Electric Company Stockholder, General Electric Company  
Natalia Rost, Boston, MA (*Abstract Co-Author*) Nothing to Disclose  
Lee Schwamm, MD, Boston, MA (*Abstract Co-Author*) Nothing to Disclose  
Joshua A. Hirsch, MD, Boston, MA (*Abstract Co-Author*) Shareholder, Intratech Medical Ltd

#### **PURPOSE**

To evaluate the clinical efficacy of major anterior circulation stroke thrombectomy in patients prospectively classified by specific MRI and clinical criteria.

#### **METHOD AND MATERIALS**

72 patients with MCA or terminal ICA occlusion by CTA, followed by core infarct volume determination by MRI, underwent thrombectomy after meeting institutional criteria. 40 patients were prospectively classified as Likely to Benefit (LTB) using the following institutional criteria: DWI lesion volume <70ml, age < 80, stroke onset to procedure initiation < 6 hours and baseline mRS ≤1. Thirty two were prospectively classified as Uncertain to Benefit (UTB) if one or more of the clinical criteria were not met or if the DWI lesion was 70-100 ml. Outcomes were based on 90-day modified Rankin score (mRS). Favorable outcomes were defined as 90 day mRS of 0, 1 or 2.

#### **RESULTS**

Reperfusion (mTICI 2b or 3) and prospective categorization as LTB were strongly associated with favorable outcomes ( $p < 0.001$  and  $p < 0.005$ , respectively). Successful reperfusion had a significant positive impact on the distribution of mRS scores of the LTB cohort ( $p < 0.0001$ ). Intervention resulted in successful reperfusion in 68% of the LTB patients and 75% of UTB patients (not significant). Favorable outcomes were obtained in 53% and 25% of LTB and UTB patients that were treated, respectively ( $p = 0.016$ ; Fisher exact test). In considering the effect of successful intervention, favorable outcomes were observed in 74% of LTB patients that had successful reperfusion compared to 33% of successfully reperfused UTB patients ( $p = 0.004$ ; Fisher exact test).

## CONCLUSION

Patients prospectively classified as Likely to Benefit based on MRI and clinical criteria have a high likelihood of favorable outcome after thrombectomy, particularly if reperfusion is successful.

## CLINICAL RELEVANCE/APPLICATION

This work demonstrates how to achieve high levels of favorable outcomes in severe ischemic stroke patients by using imaging for selection of appropriate patients for endovascular therapy.

### RC305-11 Body Temperature Fluctuations Modulate Infarct Expansion, Penumbral Rescue, and Clinical Outcome in Acute Ischemic Stroke Following Successful Endovascular Reperfusion: Impact of Subclinical Temperature Changes on Ischemic Progression

Tuesday, Dec. 1 11:15AM - 11:25AM Location: N230

#### Participants

Seena Dehkharghani, MD, Atlanta, GA (*Abstract Co-Author*) Nothing to Disclose  
Meredith Bowen, BA, Atlanta, GA (*Presenter*) Nothing to Disclose  
Diogo C. Haussen, MD, Atlanta, GA (*Abstract Co-Author*) Nothing to Disclose  
Michael Frankel, MD, Atlanta, GA (*Abstract Co-Author*) Nothing to Disclose  
Adam B. Prater, MD, Atlanta, GA (*Abstract Co-Author*) Nothing to Disclose  
Andrey Lima, MD, Atlanta, GA (*Abstract Co-Author*) Nothing to Disclose  
Tyler Gleason, Atlanta, GA (*Abstract Co-Author*) Nothing to Disclose  
Raul G. Nogueira, MD, Boston, MA (*Abstract Co-Author*) Consultant, Stryker Corporation Consultant, Medtronic, Inc Consultant, CoAxia, Inc

## PURPOSE

The exquisite temperature sensitivity of neuronal substrate has been thoroughly expounded in past studies. The effect of systemic temperature changes on stroke progression, and its impact upon the fate of at-risk tissues remains unknown. We undertook the analysis of temperature fluctuations and their interaction with rescue of penumbral tissues in a cohort of successfully revascularized acute stroke patients, hypothesizing greater relative infarct expansion as a function of sub-clinical systemic temperature changes.

## METHOD AND MATERIALS

129 patients with acute stroke presenting within 12 hours were culled from our prospective registry. CT perfusion was obtained, with perfusion analysis undertaken in a user- and vendor-independent processing environment (RAPID). Automated lesion segmentation and thresholding of CTP data produced core, penumbral, and mismatch volumes. Final infarct volumes (FIV) were measured from DWI, and relative infarct growth (FIV-core/mismatch) computed. Systemic temperatures were recovered from medical records for the duration of hospitalization (up to q15 minutes), with minima, maxima, and ranges collected. All patients underwent successful endovascular reperfusion (mTICI IIb/III). Kendall's tau correlation was prescribed to assess the association between temperature change from baseline and both relative infarct growth (RIG) and favorable clinical outcome (FCO) as 90d mRS  $\leq 2$ .

## RESULTS

59 men and 70 women (age  $63 \pm 14$  yrs) with acute stroke (NIHSS median[IQR]=19[9]; time to groin puncture median[IQR]=330[301]) were examined. All patients exhibited an occlusive lesion of the anterior circulation (ICA/MCA) with successful reperfusion (mTICIIb/III). Median core (rCBF), penumbral (Tmax), and FIV (median[IQR]) were 9.6cc[25], 131cc[125], and 21cc[37], respectively. Mean temperature minima=35.1°C and maxima=37.9°C. Correlational analysis demonstrated significant associations between temperature fluctuation from baseline and both RIG ( $P=0.01$ ) and FCO ( $P < 0.001$ ).

## CONCLUSION

The impact of sub-clinical temperature changes had not previously been reported as a driving factor in penumbral rescue, however the present findings suggest that neuronal fate may be affected by even minor temperature changes

## CLINICAL RELEVANCE/APPLICATION

Sub-clinical temperature dysregulation may potentiate neuronal injury following acute ischemic stroke, compelling further investigation into the mechanistic relationship.

### RC305-12 Impact of the Implementation of Thrombectomy with Stent Retrievers on the Frequency of Hemispherectomy in Patients with Acute Ischemic Stroke

Tuesday, Dec. 1 11:25AM - 11:35AM Location: N230

#### Participants

Peter Sporns, MD, Munster, Germany (*Presenter*) Nothing to Disclose  
Jens Minnerup, Munster, Germany (*Abstract Co-Author*) Nothing to Disclose  
Tarek Zoubi, Muenster, Germany (*Abstract Co-Author*) Nothing to Disclose  
Uta Hanning, MD, Muenster, Germany (*Abstract Co-Author*) Nothing to Disclose  
Walter L. Heindel, MD, Muenster, Germany (*Abstract Co-Author*) Nothing to Disclose  
Wolfram Schwindt, MD, Muenster, Germany (*Abstract Co-Author*) Nothing to Disclose  
Thomas Niederstadt, MD, Munster, Germany (*Abstract Co-Author*) Nothing to Disclose

## PURPOSE



The increasing use of endovascular treatments has led to higher recanalization rates and better clinical outcomes compared to intravenous thrombolysis alone. Stent retrievers represent the latest development for recanalization of large vessel occlusions. Decompressive hemicraniectomy has proved beneficial in patients suffering from rising intracranial pressure after malignant stroke. We investigated the effect of the implementation of stent retriever treatment on the frequency of hemicraniectomy as a surrogate marker for infarct size and thus for poor neurological outcome.

#### **METHOD AND MATERIALS**

Patients with acute ischemic stroke were retrospectively studied. We compared the frequency of hemicraniectomy following proximal artery occlusion of the internal carotid artery and middle cerebral artery main stem in the years before (2009 and 2010) and after (2012 and 2013) introducing stent retrievers.

#### **RESULTS**

Overall, 497 patients with proximal arterial occlusion were included in the study. Of 253 patients admitted in the years 2009 and 2010 44 (17.4 %) and of 244 patients admitted in 2012 and 2013 20 (8.2 %) received a hemicraniectomy. This decrease in the proportion of hemicraniectomies was statistically significant ( $p < 0.01$ ).

#### **CONCLUSION**

The findings in this study illustrate a significantly reduced rate of hemicraniectomies in patients with proximal artery occlusions after implementation of thrombectomy with stent retriever. Hereby we could show a significant reduction of malignant infarctions after thrombectomy with stent retriever.

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

Stent retriever is a safe and effective device and improves clinical outcome.

#### **RC305-13    Hallmarks of Pediatric Ischemic Stroke**

Tuesday, Dec. 1 11:35AM - 12:00PM Location: N230

##### **Participants**

Arastoo Vossough, MD, PhD, Philadelphia, PA (*Presenter*) Nothing to Disclose

#### **LEARNING OBJECTIVES**

1) Define the epidemiological features and risk profiles of stroke in different pediatric patient populations. 2) Classify the types of pediatric stroke and features of vasculopathies leading to stroke. 3) Identify major mimickers of pediatric arterial ischemic stroke. 4) Specify current approved treatment options available for pediatric stroke 5) Identify recent and ongoing clinical trials in pediatric stroke.

**First Trimester Ultrasound (An Interactive Session)**

Tuesday, Dec. 1 8:30AM - 10:00AM Location: S402AB



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

**Participants****Active Handout:** Carol Beer Benson<http://abstract.rsna.org/uploads/2015/15001996/Active RC310.pdf>**Sub-Events****RC310A Ectopic Pregnancy****Participants**Anne M. Kennedy, MD, Salt Lake City, UT (*Presenter*) Nothing to Disclose**LEARNING OBJECTIVES**

1) Diagnose tubal ectopic. 2) Differentiate Cesarean scar implantation from a normal, low-lying pregnancy. 3) Recognize the more unusual sites of ectopic pregnancy (cervical, interstitial, abdominal). 4) Understand the indications for expectant vs. medical vs. surgical management.

**ABSTRACT**

Ectopic pregnancy can be a life-threatening condition for young, healthy women. The availability of sensitive urine pregnancy tests means that we are seeing patients at a time when it may be very difficult to see any sonographic findings of pregnancy. The session will review and illustrate examples of the recommended descriptive terms 'pregnancy of unknown location', 'probable ectopic' and 'definite ectopic' both of which refer to tubal ectopics. We will also review the appearance of heterotopic pregnancy and non-tubal ectopics including Cesarean scar implantation, interstitial and cervical implantation, and abdominal and ovarian ectopic with demonstration of the role of color Doppler, 3D ultrasound and other imaging modalities. Modern management of ectopic pregnancy has become much less aggressive, in part because the diagnosis is made so much earlier. The indications for the various treatment options will be outlined with illustrative case of local injection as well as intraoperative photos during laparoscopy.

**Active Handout:** Anne M. Kennedy<http://abstract.rsna.org/uploads/2015/15001997/RC310A.pdf>**RC310B Diagnosis of Miscarriage****Participants**Peter M. Doubilet, MD, PhD, Boston, MA, ([pdoubilet@partners.org](mailto:pdoubilet@partners.org)) (*Presenter*) Nothing to Disclose**LEARNING OBJECTIVES**

1) Know the sonographic criteria for definite miscarriage and probable miscarriage in the early first trimester. 2) Understand that any sac-like intrauterine structure (rounded edges, no yolk sac or embryo) in a woman with a positive pregnancy test is highly likely to be a gestational sac. 3) Understand that nonvisualization of an intrauterine gestational sac in a woman with hCG above the 'discriminatory' level (2000 mIU/ml) does not exclude the possibility of a normal pregnancy.

**ABSTRACT**

This lecture will cover the diagnosis of early first trimester miscarriage in two settings: (i) ultrasound demonstrates no intrauterine gestational sac ('pregnancy of unknown location'); (ii) ultrasound demonstrates an intrauterine gestational sac but no embryo or heartbeat. In the first of these settings, the role of the quantitative hCG level will be discussed, including whether a single measurement can be used to rule out a normal intrauterine pregnancy. In the second setting, the currently accepted criteria for definite miscarriage and for probable miscarriage will be presented. The lecture will also address findings that indicate a high likelihood of impending pregnancy failure when an embryo with heartbeat is seen on ultrasound.

**Active Handout:** Peter Michael Doubilet<http://abstract.rsna.org/uploads/2015/15001998/RC310B Early1stTriMiscarriage--RSNA2015.pdf>**RC310C Mid-late First Trimester****Participants**Carol B. Benson, MD, Boston, MA (*Presenter*) Nothing to Disclose**LEARNING OBJECTIVES**

1) Recognize the importance of evaluating the developing fetal head during the late first trimester for early detection of large neural tube defects. 2) Incorporate measurement of the nuchal translucency into their assessment of the fetuses of gestational age 11-14 weeks. 3) Recognize sonographic abnormalities of the ventral wall to distinguish normal physiologic bowel herniation from defects including omphalocele and gastroschisis.

**ABSTRACT**

This lecture will discuss the sonographic appearance of fetal anatomy in the latter part of the third trimester in order to help participants recognize abnormalities of the fetus at this early gestational age. While many anomalies cannot be detected until later in pregnancy, the discussion will focus on those anomalies that can be detected in the first trimester. Specific topics covered will be central nervous system anomalies, including anencephaly, encephalocele and holoprosencephaly, ventral wall defects including omphalocele and gastroschisis, bladder outlet obstruction, and skeletal anomalies including skeletal dysplasias. Detection of anomalies early in gestation, before the second trimester, permits time to assess the fetus for other anomalies, syndromes, and aneuploidy.

## Tools and Use Cases for Text Information Extraction in Radiology

Tuesday, Dec. 1 8:30AM - 10:00AM Location: S403B



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

### Participants

Paras Lakhani, MD, Philadelphia, PA, (Paras.lakhani@jefferson.edu) (*Moderator*) Nothing to Disclose

### LEARNING OBJECTIVES

1) Place natural language processing (NLP) in context of the history of radiology reporting. 2) Review how NLP is used in disciplines outside of radiology. 3) Understand basic NLP methods. 4) Assess the applicability of NLP to radiology reports.

### ABSTRACT

Natural Language Processing (NLP) refers to the automated extraction of meaningful information from narrative text. Some NLP systems use simple rules to categorize text according to whether a particular concept may be present. More sophisticated systems use part-of-speech tagging and grammatical parsing to extract concepts and relationships from text. Some NLP systems use statistical approaches that can learn to categorize text automatically based on a test set of positive and negative examples. When applied to radiology reports, NLP systems are most frequently used to identify and retrieve reports of interest, such as reports containing a critical result, an incidental finding, or a recommendation for follow up. NLP systems are simpler to construct and more accurate when the structure of the analyzed text is constrained in some manner. Several real-world examples of both simple and sophisticated NLP systems in radiology will illustrate the spectrum of applicable techniques and the potential benefit to radiology practice.

### Sub-Events

#### RC353A Natural Language Processing to Solve Problems in Clinical Practice

### Participants

Michael E. Zalis, MD, Boston, MA (*Presenter*) Co-founder, QPID Health Inc; Chief Medical Officer, QPID Health Inc; Stockholder, QPID Health Inc

### LEARNING OBJECTIVES

View learning objectives under main course title. In greater detail: 1) demonstrate gaps of function that exist with current EHR and PACS approaches to handling unstructured data 2) describe general approaches to NLP and assisted reasoning in addressing these gaps, 3) provide some specific examples of novel solutions that address these gaps and improve clinical efficiency.

#### RC353B The Good, The Bad, and The Ugly: Using Natural Language Processing to Understand Information Content in Radiology Reports

### Participants

Brian E. Chapman, PhD, Salt Lake City, UT (*Presenter*) Nothing to Disclose

### LEARNING OBJECTIVES

1) Become familiar with programming tools that can be used to build simple NLP applications. 2) Understand how the similarities and differences between medical and natural language affect natural language processing applications. 3) Understand how these tools can be used to estimate information content and clarity in radiology reports.

#### RC353C Use Cases in Radiology: Extracting Critical Results and Structured Reporting Using Natural Language

### Participants

Paras Lakhani, MD, Philadelphia, PA, (Paras.lakhani@jefferson.edu) (*Presenter*) Nothing to Disclose

### LEARNING OBJECTIVES

1) See a real-world example of an NLP solution used to identify critical radiology results and documentation of communication. 2) Understand logic of text-mining algorithms designed to identify critical test results, and how they can be applied to large databases. 3) Demonstrate results of an NLP system used to identify critical radiology results. 4) Demonstrate how NLP can be used to make structured radiology reports.

### ABSTRACT

The Joint Commission requires timely communication of critical results to an appropriate healthcare provider, and the American College of Radiology's Practice Guideline for Communication recommends documentation of critical results in the radiology report. NLP techniques can be used identify radiology reports containing critical results and documentation of communication with high accuracy. Such algorithms may be used for Joint Commission compliance, performance monitoring, and quality assurance initiatives. Examples of specific text-mining algorithms that identify critical results will be provided. Also, the process of validating and determining the effectiveness of such algorithms using precision and recall will be discussed. Structured reporting is felt to have many advantages over free-text reporting, including that it is preferred by clinicians, facilitates data-mining, business analytics, retrospective research, and quantitative imaging. However, traditional SR reporting applications are found to be time-consuming by some radiologists, resulting in decreased productivity. Thus, an NLP solution to automatically create standardized reports from free-text radiology dictations will be demonstrated. Such a solution may provide the benefits of structured reporting with without loss in productivity.

Participants

Wendy Chapman, PhD, Salt Lake City, UT (*Presenter*) Nothing to Disclose

**LEARNING OBJECTIVES**

1) Review information extraction methods for building rule-based, grammar-based, and machine-learning NLP systems with examples of when to use each. 2) Demonstrate the creation of manually created reference standards against which to measure NLP systems. 3) Present a survey of open-source tools for NLP and manual chart review and how these can be built upon.

**ABSTRACT**

Natural language processing (NLP) is a term that describes a range of techniques for identifying, understanding, and analyzing information from text. Some of the earliest applications of NLP in medicine were on imaging reports. Attendees will be walked through both simple and complex NLP methods with examples of how and when they are best used in imaging. Several open-source tools will be demonstrated with information provided on how these tools can easily be built upon for customized needs.

RC304

## Musculoskeletal Series: Ultrasound

Tuesday, Dec. 1 8:30AM - 12:00PM Location: E450A



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

### Participants

Marnix T. van Holsbeeck, MD, Detroit, MI, (marnix@rad.hfh.edu) (*Moderator*) Consultant, General Electric Company Consultant, Koninklijke Philips NV Stockholder, Koninklijke Philips NV Stockholder, General Electric Company Grant, Siemens AG Grant, General Electric Company  
Jon A. Jacobson, MD, Ann Arbor, MI, (jjacobsn@umich.edu) (*Moderator*) Consultant, BioClinica, Inc; Royalties, Reed Elsevier; ; ;

### LEARNING OBJECTIVES

1) The 'Ultrasound' Series Course will review musculoskeletal sonography through live instruction by expert refresher course instructors, interspersed with scientific presentations.

### Sub-Events

#### RC304-01 Elbow Ultrasound (Demonstration)

Tuesday, Dec. 1 8:30AM - 9:00AM Location: E450A

### Participants

Jon A. Jacobson, MD, Ann Arbor, MI (*Presenter*) Consultant, BioClinica, Inc; Royalties, Reed Elsevier; ; ;

### LEARNING OBJECTIVES

View learning objectives under main course title.

### Honored Educators

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

Jon A. Jacobson, MD - 2012 Honored Educator

#### RC304-02 Ultrasound of the Distal Biceps Brachii Tendon Using Four Approaches: Reproducibility and Reader Preference

Tuesday, Dec. 1 9:00AM - 9:10AM Location: E450A

### Participants

Shefali P. Kothary, MD, New York, NY (*Presenter*) Nothing to Disclose  
Theodore T. Miller, MD, New York, NY (*Abstract Co-Author*) Nothing to Disclose  
Gabrielle P. Konin, MD, Philadelphia, PA (*Abstract Co-Author*) Nothing to Disclose  
Ogonna K. Nwawka, MD, New York, NY (*Abstract Co-Author*) Nothing to Disclose  
Yoshimi Endo, MD, New York, NY (*Abstract Co-Author*) Nothing to Disclose  
Gregory R. Saboeiro, MD, New York, NY (*Abstract Co-Author*) Research funded, Terumo Corporation Speakers Bureau, Bioventus LLC

### PURPOSE

To determine which sonographic appearance of the distal biceps tendon is preferred by readers and if images obtained by two different operators are reproducible.

### METHOD AND MATERIALS

An IRB approved, HIPAA compliant prospective study was performed evaluating the distal biceps brachii tendon in 40 elbows in 20 volunteers. The subjects had no history of biceps injury or abnormality, and were without antecubital pain. There were 8 males and 12 females, ages 24 to 67 years (mean age of 37) with a body mass index (BMI) of 18.3 to 31.1 (mean BMI of 24.7). Distal biceps brachii tendons of each subject were scanned in long axis using a 6-15 MHz linear transducer on a GE Logic 9 by two experienced musculoskeletal radiologists independently (operator A and B) using four different approaches: anterior, lateral, medial, and posterior. Five musculoskeletal radiologists independently reviewed the static images, and ranked the 4 approaches based on overall combination of echogenicity of the tendon, visualized length, and visualization of the insertion.

### RESULTS

The appearance of the distal tendon obtained via the medial approach was preferred by readers in 78.5% (314/400) of cases (74.5% performed by operator A and 82.5% performed by operator B). The anterior approach was preferred by readers in 19.25% (77/400) of cases (24.0% by operator A and 14.5% by operator B). The lateral approach was preferred in 2.25% (9/400) of cases (1.5% by operator A and 3% by operator B), and the posterior approach was never preferred.

### CONCLUSION

The appearance of the distal biceps brachii tendon using the medial approach is preferred by readers and is reproducible between different operators.

### CLINICAL RELEVANCE/APPLICATION

When sonographically evaluating the elbow for suspected pathology of the distal biceps tendon, the medial approach should be the primary method of visualization, supplemented by the other approaches if necessary.

### **RC304-03 Shear Wave Elastography (SWE) Improves Treatment Monitoring of Patients with Tendinopathies**

Tuesday, Dec. 1 9:10AM - 9:20AM Location: E450A

#### **Participants**

Timm Dirrichs, Aachen, Germany (*Presenter*) Nothing to Disclose  
Christiane K. Kuhl, MD, Bonn, Germany (*Abstract Co-Author*) Nothing to Disclose  
Valentin Quack, Aachen, Germany (*Abstract Co-Author*) Nothing to Disclose  
Simone Schradung, MD, Aachen, Germany (*Abstract Co-Author*) Nothing to Disclose

#### **PURPOSE**

It has been shown that SWE is useful for the evaluation of tendoninopathies. Purpose of this prospective clinical study was to analyze the correlation between clinical symptoms and tendon stiffness in patients undergoing treatment of tendinopathies. Aim is to establish SWE as tool for monitoring tendon healing under therapy.

#### **METHOD AND MATERIALS**

Prospective study in 35 patients with 47 symptomatic tendons (17 achilles, 15 patellar tendons and 15 humeral epicondylitis) who underwent a standardized multi-modality US protocol consisting of B-mode US, power Doppler (PD-US), and SWE, using a high-resolution linear 15 MHz probe (Aixplorer, Supersonic). All patients underwent this multi-modality US protocol three times: prior to any therapy, after 4 week of therapy and after 6 months of therapy. At each visit, patients were seen by an orthopedic surgeon who ranked the patients' clinical symptoms by standardized orthopedic scores (VISA-A, VISA-P, DASH). Clinical scores of symptom severity were correlated with ultrasound findings by using the Spearman correlation.

#### **RESULTS**

Clinical scores revealed symptom relief in 46.8% (22/47) of patients after 4 weeks and in 68.0% (32/47) after 6 months. A change of structural tendon abnormalities as observable by B-mode US was detectable in one single patient after 4 weeks (1/22; 4.5%), as well as after 6 months (1/32; 3.1%). A decrease in neovascularization as observed by PD-US was detectable in 9 patients after 4 weeks (9/22; 40.9%) and in 13 patients after 6 months (13/32; 39.4%). An increase in tendon stiffness as determined by SWE was found in 18 patients after 4 weeks (18/22; 81.8%) and in 28 patients after 6 months (28/32; 90.6%). At quantitative analysis, the 32 patients whose clinical symptoms improved exhibited an increase of mean SWE values by 23 kPa (from 41.7 to 64.2 kPa) after 4 weeks and by 64 kPa (from 41.7 to 105.5 kPa) after 6 months. Clinical scores correlated poorly with findings at B-mode ( $r = 0.24$ ), moderately with findings at PD-US ( $r = 0.59$ ), and perfectly with findings made at SWE ( $r = 0.80$ ).

#### **CONCLUSION**

Shear wave elastography correlates better with clinical symptoms and seems to display tendon healing better and earlier than B-mode and Power Doppler.

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

Shear wave elastography appears to be useful to guide treatment and to develop new treatment approaches in patients with tendinopathies.

### **RC304-04 Delayed Onset Muscle Soreness (DOMS) after Eccentric Resistance Training of the Elbow Flexor Muscles: Temporal Evolution of MRI, Diffusion Tensor Imaging and Ultrasound Shear-Wave Elastography Findings**

Tuesday, Dec. 1 9:20AM - 9:30AM Location: E450A

#### **Participants**

Christoph A. Agten, MD, Zurich, Switzerland (*Abstract Co-Author*) Nothing to Disclose  
Florian M. Buck, MD, Langnau am Albis, Switzerland (*Abstract Co-Author*) Nothing to Disclose  
Linda Dyer, Zurich, Switzerland (*Abstract Co-Author*) Nothing to Disclose  
Christian W. Pfirrmann, MD, MBA, Forch, Switzerland (*Abstract Co-Author*) Advisory Board, Siemens AG; Consultant, Medtronic, Inc  
Andrea Roskopf, MD, Zurich, Switzerland (*Presenter*) Nothing to Disclose

#### **PURPOSE**

To evaluate the appearance of DOMS over time using fluid-sensitive and diffusion-weighted MRI sequences, diffusion-tensor imaging(DTI) and ultrasound(US) shear-wave elastography in healthy volunteers.

#### **METHOD AND MATERIALS**

Five men (m;mean age 39.6 $\pm$ 4.6 years) and 5 women (w;30.6 $\pm$ 13.5 years) underwent unilateral eccentric resistance training of the elbow flexor muscles consisting of 3 sets (12 repetitions each) of individually adapted maximal weights. 1.5T-MRI was done before and after (15 min;1,3, and 7 days) the training, including fluid-sensitive sequences, diffusion-weighted-sequences, and DTI of the distal upper arm. Evaluated MRI parameters were: visible muscle edema (vME; mild, moderate, severe), cross-sectional muscle area (CSMA), muscle diffusion restriction (ADC:10-6mm<sup>2</sup>/sec), fractional anisotropy(FA). US shear-wave elastography of the brachial muscle was performed before and after(15min; 0.5,1,2,3 and 7 days) the training. Subjective DOMS-evaluation parameters were assessed:pain (scale 0-10), tension feeling, extension deficit.

#### **RESULTS**

In men mean vME was moderate and peaked 3 days post training, for women mean vME was mild and peaked 2 days post training. CSMA was highest 3 days post-training in men(+9%) and women(+11%). Maximum mean ADC value was found after 3 days in men(1809; before training:1530) and women(1742; before:1476). Mean FA dropped from 361(m) and 389(w) to a minimum of 252 and 321 respectively after 3 days.US-elastography revealed an increase of mean shear wave velocity values(MSWV) after training in men(before training:3.0 m/s $\pm$ 0.3; peak 15min post:4.0 m/s $\pm$ 0.9) and in women(before:2.8 $\pm$  0.4;peak 1 day post:3.2 m/s $\pm$ 0.4). In men a significant positive correlation was found between ADC of M. brachialis and MSWV( $r=0.92$ , $p=0.028$ ) and a significant negative correlation between maximal FA of flexor muscles and pain ( $r=-0.99$ ; $p<0.001$ ) was seen. Maximal pain level(m:3 $\pm$ 1,w:4 $\pm$ 3)

and maximal extension deficit was achieved after 2 days. Tension feeling started 15min post-training and normalized after 7 days.

## CONCLUSION

Muscles changes can be detected 15 minutes after eccentric resistance training using diffusion-MRI and US shear-wave elastography. FA correlates negatively with subjective pain symptoms in men. ADC shows changes earlier than fluid-sensitive-MR sequences.

## CLINICAL RELEVANCE/APPLICATION

ADC and US-elastography are recommended when looking for very early muscle changes after eccentric muscle exercise.

### RC304-05 Ultrasound of the Post-arthroplastic Hip

Tuesday, Dec. 1 9:30AM - 9:40AM Location: E450A

#### Participants

David Robinson, BSC, Hampton East, Australia (*Presenter*) Nothing to Disclose  
Steven Lee, FRANZCR, Windsor, Australia (*Abstract Co-Author*) Nothing to Disclose  
Paul Marks, FRANZCR, Box Hill, Australia (*Abstract Co-Author*) Nothing to Disclose  
Michal Schneider, PhD, Clayton, Australia (*Abstract Co-Author*) Nothing to Disclose

## PURPOSE

Ultrasound has been recommended as an imaging modality in the follow-up of hip replacement surgery. However, no descriptions of typical ultrasound appearances of the major pathologies that may afflict the hip replacement have been published to date. We set out to characterize ultrasound findings of the post-arthroplastic hip.

## METHOD AND MATERIALS

Patients presenting to the department for routine follow-up imaging of their hip prosthesis were consecutively recruited. Ultrasound imaging was performed of the anterior and posterior prosthesis and of the iliopsoas bursa and tendon.

## RESULTS

Fifty two patients were prospectively recruited with a mean ( $\pm$ SD) age of 60.4 ( $\pm$ 12) years. Twelve patients had bilateral hip prostheses, giving 64 hips for analysis. There were 45 Birmingham hip resurfacings (BHR), ten MITCH, five Articular Surface Replacement (ASR), three Total Hip Replacements (THR) and one ADEPT hip resurfacing. Mean age of the prosthesis in situ was 8.2 years. Ultrasound was able to reliably image the soft tissues of all hips. The average ( $\pm$ SD) maximal antero-posterior (AP) synovial thickness was 6.5 ( $\pm$  7) millimeters and the AP Iliopsoas tendon measurement was 4.8 ( $\pm$  0.94) millimeters. Forty four hips presented with normal ultrasonic appearances. There were 15 iliopsoas bursal effusions ranging from mild (a trace of fluid surrounding the iliopsoas tendon), to very large (fluid-filled masses anterosuperior to the prosthesis). Four hips showed enlargement of the prosthesis-to-bone "step" possibly indicating the process of osteolytic femoral neck thinning. One hip demonstrated mild synovial thickening at the anterior recess.

## CONCLUSION

Ultrasound is able to detect and evaluate a range of soft tissue pathologies about the post-prosthetic hip, such as fluid or effusion of the iliopsoas bursa, iliopsoas tendon thickening and heterogeneity, synovial thickening of the anterior and posterior hip joint recesses. Ultrasound imaging has an important role to play in the follow-up of the post-prosthetic hip

## CLINICAL RELEVANCE/APPLICATION

Ultrasound of the post-prosthetic hip can demonstrate abnormalities during follow up and may serve as a useful tool in the management of patients with hip replacements.

### RC304-06 Hip Ultrasound (Demonstration)

Tuesday, Dec. 1 9:40AM - 10:10AM Location: E450A

#### Participants

Marnix T. van Holsbeeck, MD, Detroit, MI, (marnix@rad.hfh.edu) (*Presenter*) Consultant, General Electric Company Consultant, Koninklijke Philips NV Stockholder, Koninklijke Philips NV Stockholder, General Electric Company Grant, Siemens AG Grant, General Electric Company  
Kathy Quenneville, BS, RT, Commerce Township, MI, (kathyq@rad.hfh.edu) (*Presenter*) Nothing to Disclose

## LEARNING OBJECTIVES

1) Demonstrate the osseous landmarks that guide the diagnostic work up of an adult hip. 2) Practice a step by step approach in the evaluation of anterior hip pain. 3) Rationalize the individual steps for the hip dynamic examination.

### RC304-07 Ankle and Foot Ultrasound (Demonstration)

Tuesday, Dec. 1 10:20AM - 10:50AM Location: E450A

#### Participants

Andrew J. Grainger, MRCP, FRCR, Leeds, United Kingdom (*Presenter*) Speaker, General Electric Company; Equipment support, Siemens AG;

## LEARNING OBJECTIVES

View learning objectives under main course title.

### RC304-08 Semi-Quantitative Sonoelastography of Inflammatory Myopathies: Comparison with Clinical Examination, Magnetic Resonance (MR) Imaging, and Pathologic Finding

Tuesday, Dec. 1 10:50AM - 11:00AM Location: E450A



#### Participants

Yoonah Song, MD, Seoul, Korea, Republic Of (*Presenter*) Nothing to Disclose  
Seunghun Lee, MD, Seoul, Korea, Republic Of (*Abstract Co-Author*) Nothing to Disclose  
Dae Hyun Yoo, Seoul, Korea, Republic Of (*Abstract Co-Author*) Nothing to Disclose  
Sung Guk Kim, Seoul, Korea, Republic Of (*Abstract Co-Author*) Nothing to Disclose

#### PURPOSE

To evaluate real-time sonoelastography (SEL) in patients with inflammatory myopathies compared to clinical examination, MR imaging, and pathologic finding.

#### METHOD AND MATERIALS

The study was approved by the institutional review board, and informed consent was waived. Seventeen lesions of 16 consecutive patients with inflammatory myopathies (5 men, 11 women; mean age, 41 years; range, 11-67 years) were assessed with real-time SEL using Hitachi EUB-7500 ultrasound (US) system and software for elastography. Elastogram was obtained using freehand manipulation, compressing areas which were correlated with active inflammation on MR imaging. Using dedicated software for color information from the elastographic images, the relative strains for target muscle and reference muscle were measured. All lesions were underwent an US-guided percutaneous biopsy. The US and MR images were analyzed in conjunction with clinical symptom and biochemical data.

#### RESULTS

The strain ratio of target muscle was higher than adjacent muscle (mean 3.14; range, 0.95-5.93). There was no significant agreement between the strain ratios of the color parameters and the biochemical data. Sixteen of 17 specimens (94.1%) were confirmed by inflammatory myopathies. One lesion (5.9%) shows well preserved muscle fiber with few lymphocytes infiltration.

#### CONCLUSION

Muscle hardness as semi-quantitative measured by SEL, was increased in cases of inflammatory myopathies. The correlation between strain ratio from the elastographic images and the pathologic data suggest that SEL could be an important tool not only in the diagnosis but also in the management of the patients with inflammatory myopathies.

#### CLINICAL RELEVANCE/APPLICATION

High strain ratio could add knowledge regarding early development of inflammatory myopathy, which might have an impact on guidance before US-guided procedure to improve success rate for biopsy.

#### RC304-09 Real-time Sonoelastography Evaluation of the Achilles Tendon Following Ultrasound-guided Platelet-rich Plasma Injection for Refractory Achilles Tendinopathy

Tuesday, Dec. 1 11:00AM - 11:10AM Location: E450A

#### Participants

Chin Chin Ooi, MMedSc,BSc, Singapore, Singapore (*Presenter*) Nothing to Disclose  
Michal Schneider, PhD, Clayton, Australia (*Abstract Co-Author*) Nothing to Disclose  
Peter Malliaras, Melbourne, Australia (*Abstract Co-Author*) Nothing to Disclose  
David Connell, Melbourne, Australia (*Abstract Co-Author*) Nothing to Disclose

#### PURPOSE

To investigate the clinical feasibility of sonoelastography (SE) in depicting changes in Achilles tendon stiffness following platelet-rich plasma (PRP) injection for Achilles tendinopathy, and to correlate SE findings with clinical outcome at 12 months post-injection.

#### METHOD AND MATERIALS

Between January 2013 and January 2014, consecutive patients with unilateral refractory Achilles tendinopathy were enrolled. B-mode ultrasound (US), color Doppler (CD) and SE were performed at baseline, 4-6 weeks, 6 months and 12 months post treatment. The strain ratio (strain value between Achilles tendon and Kager's fat) during SE, and the proportion of tendons with intratendinous hypoechogenicities and neovascularities were documented. Clinical outcomes were assessed by the Victorian Institute of Sport Assessment-Achilles (VISA-A) questionnaire at all time points and correlated with the sonographic findings.

#### RESULTS

Forty-five Achilles tendons from 45 patients (33 males, 12 females, mean age 51, mean symptom duration 15.3 months) were examined. The clinical VISA-A improved significantly from 38.4 ( $\pm 14.1$ ) at baseline, 77.2 ( $\pm 12.5$ ) at 6 months ( $p < 0.001$ ) to 81.2 ( $\pm 10.8$ ) at 12 months ( $p < 0.001$ ). The mean strain ratio values were 2.16 ( $\pm 1.42$ ) at baseline, 2.03 ( $\pm 0.67$ ) at 4-6 weeks, 1.81 ( $\pm 0.62$ ) at 6 months and 1.19 ( $\pm 0.34$ ) at 12 months with a significant reduction observed at 6 months ( $p = 0.006$ ) and 12 months ( $p < 0.001$ ). The proportion of tendons with neovascularities were significantly reduced at 6 months ( $p < 0.001$ ) and 12 months ( $p < 0.001$ ) whereas a significant change in the distribution of tendons with hypoechogenicities was only observed at 12 months in comparison to baseline ( $p < 0.001$ ). At 12 months evaluation, none of the tendons regained a normal echotexture despite improvement in VISA-A. Strain ratio demonstrated a significant moderate correlation with VISA-A ( $r = -0.610$ ,  $p < 0.001$ ) while B-mode and CD US did not show a significant correlation ( $r = -0.041$ ,  $p = 0.817$ , and  $r = -0.116$ ,  $p = 0.514$ ).

#### CONCLUSION

The treated Achilles tendons showed progressive stiffening, along with improvement in clinical findings up to one year follow-up. SE using strain ratio could be a promising supplementary tool for monitoring the progress of Achilles tendon healing after treatment.

#### CLINICAL RELEVANCE/APPLICATION

The supplementation of SE to conventional US may improve the specificity in routine monitoring of Achilles tendon healing and provide more objective data for safer return to activities.

#### RC304-10 Comparison of Ultrasound Guided Collagenase Clostridium Histolyticum Injections and Blinded Injections for the Treatment of Dupuytren's Contracture

#### Participants

Eva Llopis, MD, Valencia, Spain (*Presenter*) Nothing to Disclose  
Luis Aguilera, MD, Alzira, Spain (*Abstract Co-Author*) Nothing to Disclose  
Rosana Perez, MD, Alzira, Spain (*Abstract Co-Author*) Nothing to Disclose  
Victoria Higuera, MD, Alzira, Spain (*Abstract Co-Author*) Nothing to Disclose  
Elena Belloch, Alzira, Spain (*Abstract Co-Author*) Nothing to Disclose

#### PURPOSE

Collagenase clostridium histolyticum (collagenase) injections have been proven an effective, safe treatment for Dupuytren disease, an alternative to fasciectomy. Our objective was to analyze the additional value of US guided injections and to study the correlation of US and MR for the diagnosis of Dupuytren disease

#### RESULTS

All patients were male but 2; average age 66,5yo; 5th finger was the most frequently affected, (group A 50% and B 60.41%) pretendinous cord was the most frequent 71% and 52% (group A/B) followed by lateral cord 13% and 28.6% (group A/B). US appearance is variable (combined 45%, hyperechogenic 36%, hypoechogenic 18%), mean distance from skin 1,8mm, average size of the cord 3,9mm (1,6-5,5mm). On T1WI MR is mainly low SI (36%) or combined 45%. Complete extension (<5% contraction) was achieved in 36.97% and 57,14% (group A/B), the percentage of correction was 70% and 76 (group A /B),  $p=0.095$ , being statistically significant for PIP, 54%/76% (group A/B),  $p=0.020$ . VAS in 68% and 76% (group A/B), failure in 32% and 23% (group A/B). No nerve damage or tendon rupture occurred. Skin complications 32% and 23,8% (group A/B).

#### CONCLUSION

US guidance offers better results and slightly decrease of skin complications than blind collagenase injection being a good alternative to fasciectomy, although not statistically significant. More significant results are seen on lateral cords on PIP contractions, where US is recommended. MR and US can identify collagenous and cellular components, thus potentially improving effectiveness, however US is more variable.

#### CLINICAL RELEVANCE/APPLICATION

US has added value in targeting Dupuytren cords for injection of collagenase with better outcome and lower rate of complications especially for lateral cords on PIP contractions

#### RC304-11 Ultrasound-Guided Treatment of Refractory Chronic Plantar Fasciopathy: A Randomized Controlled Pilot Study of Platelet-Rich Plasma versus Corticosteroid Injection

Tuesday, Dec. 1 11:20AM - 11:30AM Location: E450A

#### Participants

Kenneth S. Lee, MD, Madison, WI (*Presenter*) Research Consultant, SuperSonic Imagine; Consultant, Echometrix, LLC; Royalties, Reed Elsevier  
John J. Wilson, MD, MS, Madison, WI (*Abstract Co-Author*) Nothing to Disclose  
Sarah Kohn, Madison, WI (*Abstract Co-Author*) Nothing to Disclose  
Elizabeth Plovnick, Madison, WI (*Abstract Co-Author*) Nothing to Disclose  
Jeffrey Swick, MD, Madison, WI (*Abstract Co-Author*) Nothing to Disclose  
Ray Vanderby, PhD, Madison, WI (*Abstract Co-Author*) Nothing to Disclose

#### PURPOSE

To investigate if ultrasound(US)-guided platelet-rich plasma(PRP) injection is effective for treating moderate to severe refractory chronic plantar fasciopathy(PF) compared to standard of care corticosteroid(SOC) injection.

#### METHOD AND MATERIALS

Inclusion criteria were met, which required unilateral PF, failed conservative therapy, and VAS pain level of at least 5 of 10 for at least 6 months duration. 44 consecutive subjects were randomized into two groups, PRP and SOC. Subjects received either a single injection of autologous PRP or a single injection of triamcinolone 40 mg at week 0. VAS pain levels, validated clinical surveys (FAAM/SANE), and US changes of PF thickness, hypoechogenicity (grade 0 -3), and hyperemia (grade 0-3) were obtained at week 0 (pre-injection), week 16 and 32. Analysis of covariance was used for statistical analysis. Statistical significance was determined at  $p$ -value < 0.05.

#### RESULTS

21 PRP subjects (mean age 47.8 yrs; range 30-64), M:F(4:17) and 23 SOC subjects (mean age 49.2 yrs; range 30-64), M:F(7:16) completed the 32-week study from March 2011-July 2014. No loss to follow-up. Baseline VAS pain levels were not significant (6.93 in PRP vs 6.63 in SOC;  $p=0.4$ ). At week 16 and 32, both groups showed improvement in VAS pain levels compared to baseline, but PRP showed greater improvement than SOC over time (6.93 to 2.64 to 1.7;  $p=0.00$ ). SOC pain level improved initially at week 16 but rebounded by week 32 (3.28 to 4.77;  $p=0.002$ ). FAAM scores improved for both groups ( $p<0.001$ ) but the PRP group improved by 12.6 more points by week 32 ( $p=0.02$ ). SANE scores showed improving trend over time consistently favoring PRP ( $p=0.006$ ). 132 US exams performed. Baseline US changes were not significant except for hypoechogenicity (2.80 in PRP vs 1.79 in SOC;  $p<0.002$ ). PF thickness decreased (mean of 0.33 mm;  $p<0.001$ ) in both groups but no difference between groups ( $p=0.74$ ). PRP showed greater echotexture improvement than SOC over time (decrease of 0.42/visit, SD 0.13 in PRP vs 0.004/visit in SOC;  $p=0.003$ ). Hyperemia did not change over time (0.86 for PRP vs 0.81 for SOC,  $p=0.80$ ). There were no complications.

#### CONCLUSION

US-guided PRP injection may be an effective treatment option for refractory chronic PF compared to corticosteroid injection. Larger multi-armed studies are now needed to establish a new standard of care treatment algorithm.

#### CLINICAL RELEVANCE/APPLICATION

PRP is more effective than corticosteroid injection for the long-term treatment of refractory chronic plantar fasciopathy

PA is more effective than corticosteroid injection for the long-term treatment of refractory chronic plantar fasciopathy.

**RC304-12    Ultrasound-guided Interventions**

Tuesday, Dec. 1 11:30AM - 12:00PM Location: E450A

**Participants**

Kenneth S. Lee, MD, Madison, WI (*Presenter*) Research Consultant, SuperSonic Imagine; Consultant, Echometrix, LLC; Royalties, Reed Elsevier

**LEARNING OBJECTIVES**

View learning objectives under main course title.

## GU Incidental Findings 2015 - What Is New and Helpful in Managing Them? (An Interactive Session)

Tuesday, Dec. 1 8:30AM - 10:00AM Location: E450B



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

### Participants

Lincoln L. Berland, MD, Birmingham, AL, (lberland@uabmc.edu) (*Coordinator*) Consultant, Nuance Communications, Inc; Stockholder, Nuance Communications, Inc;  
Stuart G. Silverman, MD, Brookline, MA, (sgsilverman@partners.org) (*Presenter*) Author, Wolters Kluwer nv  
Elaine M. Caoili, MD, MS, Ann Arbor, MI (*Presenter*) Nothing to Disclose  
Susan M. Ascher, MD, Washington, DC (*Presenter*) Nothing to Disclose

### LEARNING OBJECTIVES

1) Appreciate the need for and value of recommendations for managing incidental findings. The participants should also be able to choose from a variety of methods to bring these recommendations to the point of interpretation. 2) Identify incidental adnexal cystic lesions that require further evaluation to include the type and timing of follow up examinations. 3) Apply appropriate imaging criteria and thresholds to better distinguish benign adrenal adenomas from more clinically important lesions. 4) Manage incidental renal masses, even when they are incompletely characterized, such as when they are too small to characterize or detected on an examination that is not designed to evaluate them fully. Please bring your charged mobile wireless device (phone, tablet or laptop) to participate.

RC309

## Pitfalls in Abdominal Imaging

Tuesday, Dec. 1 8:30AM - 10:00AM Location: E353C



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

### Participants

### Sub-Events

#### RC309A Pitfalls in Bowel Imaging

### Participants

David H. Kim, MD, Madison, WI (*Presenter*) Consultant, Viatronix, Inc; Co-founder, VirtuoCTC, LLC; Medical Advisory Board, Digital ArtForms, Inc; Stockholder, Collectar Biosciences, Inc

### LEARNING OBJECTIVES

1) List the advantages/disadvantages of positive and negative oral contrast 2) Recognize common pitfalls that mimic disease 3) Devise practical approaches to manage common bowel imaging scenarios

#### RC309B Atypical Liver Lesions

### Participants

Rendon C. Nelson, MD, Durham, NC, (rendon.nelson@duke.edu) (*Presenter*) Consultant, General Electric Company Consultant, Nemoto Kyorindo Co, Ltd Consultant, VoxelMetrix, LLC Research support, Bracco Group Research support, Becton, Dickinson and Company Speakers Bureau, Siemens AG Royalties, Wolters Kluwer nv

### LEARNING OBJECTIVES

1) To understand the typical imaging appearance of various focal liver lesions on CT and MR and how they can present in an atypical fashion (i.e. the imaging spectrum).

### ABSTRACT

**Active Handout:**Rendon C. Nelson

[http://abstract.rsna.org/uploads/2015/14000560/Active\\_RC309B.pdf](http://abstract.rsna.org/uploads/2015/14000560/Active_RC309B.pdf)

#### RC309C Pitfalls in Hepatic Doppler Sonography

### Participants

Jonathan B. Kruskal, MD, PhD, Boston, MA, (jkruskal@bidmc.harvard.edu) (*Presenter*) Author, UpToDate, Inc

### LEARNING OBJECTIVES

1) Discuss the common technical pitfalls that occur when performing the liver Doppler examination, and how these can be mitigated. 2) Discuss the perceptual and interpretive errors that occur when performing the liver Doppler examination, and how these can be minimized. 3) Describe the clinical impact of technical and interpretive errors.

### ABSTRACT

### Honored Educators

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

Jonathan B. Kruskal, MD, PhD - 2012 Honored Educator

#### RC309D Pearls and Pitfalls in Pancreatic Diseases

### Participants

Khaled M. Elsayes, MD, Ann Arbor, MI (*Presenter*) Nothing to Disclose

### LEARNING OBJECTIVES

1) Describe most commonly encountered imaging pitfalls of the pancreas. 2) Describe relevant technical background, pathophysiology and hemodynamics of these pitfalls. 3) Discuss tips to avoid erroneous diagnosis and pearls to reach correct diagnosis.

### ABSTRACT

There is a wide range of common pitfalls in pancreas imaging, which can lead to frequent incorrect diagnoses mainly because many radiologists are not completely familiar with anatomical, morphological, physiological, hemodynamic and biological principles as well as deficiency of modern clinical and radiological knowledge. This leads to common misinterpretations which would further results in

wrong management with potentially negative outcome. In this course, we will review important typical features of common pancreatic pathologies and mimics of these pathologies that may require different treatment and improved prognosis.

#### **Honored Educators**

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

Khaled M. Elsayes, MD - 2014 Honored Educator

RC351

## Pelvic MRI in Oncology: Pearls for Practice

Tuesday, Dec. 1 8:30AM - 10:00AM Location: E350



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

### Participants

### Sub-Events

#### RC351A Practical Approach to Understanding Gene Mutations with Interpretation of Imaging in Gynecologic Malignancy

### Participants

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

### LEARNING OBJECTIVES

1) To learn the genetic mutations present in Endometrial and Ovarian Cancer. 2) Pathogenesis of Ovarian Cancer. 3) Implications on image interpretation.

### ABSTRACT

Endometrial cancer is the most common female gynecologic malignancy. Epithelial ovarian cancer is the most common cause of gynecological cancer death in the United States. More recently epithelial ovarian tumors have been broadly classified into two distinct groups. The type I tumors have low grade serous, clear cell, endometrioid, and mucinous histological features. Typically, these tumors are slow growing and confined to the ovary, and are less sensitive to standard chemotherapy. BRAF and KRAS somatic mutations are relatively common in these tumors, which may have important therapeutic implications. Type II tumors are high grade serous cancers of the ovary, peritoneum, and fallopian tube. These tumors are clinically aggressive and are often widely metastatic at the time of presentation. We will discuss the gene mutations associated with different endometrial and epithelial ovarian cancer, pathogenesis, implications on therapy and imaging.

### Honored Educators

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

Priya R. Bhosale, MD - 2012 Honored Educator

#### RC351B Pearls and Pitfalls in Prostate MRI

### Participants

Aradhana M. Venkatesan, MD, Houston, TX, ([avenkatesan@mdanderson.org](mailto:avenkatesan@mdanderson.org)) (*Presenter*) Institutional research agreement, Koninklijke Philips NV

### LEARNING OBJECTIVES

1) List the elements of common prostate MRI acquisition protocols, defining the roles for each pulse sequence in prostate cancer detection. 2) List imaging findings critical to accurate prostate cancer detection and staging. 3) Identify imaging pitfalls in the detection and staging of prostate cancer. 4) Describe common MRI findings of treated prostate cancer. 4) List the elements of the Prostate Imaging-Reporting and Data System (PI-RADS) structured reporting scheme. 5) List the updated changes reflected in the most recent PI-RADSv2 structured reporting scheme.

### ABSTRACT

Prostate cancer is one of the most frequently diagnosed cancers in the male population. It is the second most common type of cancer detected in American men and their second leading cause of cancer death. The proposed refresher course will provide an overview of MRI for prostate cancer imaging, including a discussion of salient imaging findings on multi-parametric MRI, pitfalls in imaging interpretation, and an overview of existing standardized reporting templates for prostate MR interpretation.

#### RC351C How to Perform and Interpret MRI of the Bladder and Urethra: Anatomy, Technique, and Applications

### Participants

Mukesh G. Harisinghani, MD, Boston, MA (*Presenter*) Nothing to Disclose

### LEARNING OBJECTIVES

1) MR techniques to image the bladder and urethra will be discussed. 2) Pointers for optimal MR evaluation will be discussed. 3) Pointers for accurate diagnosis on MRI will be discussed.

### ABSTRACT

The proposed course will provide an overview of applying MR for imaging the bladder and urethral region

## Breast Series: Emerging Technologies in Breast Imaging

Tuesday, Dec. 1 8:30AM - 12:00PM Location: Arie Crown Theater



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

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

### Participants

Emily F. Conant, MD, Philadelphia, PA (*Moderator*) Speaker, Hologic, Inc; Scientific Advisory Board, Hologic, Inc; Consultant, Siemens AG  
Margarita L. Zuley, MD, Pittsburgh, PA (*Moderator*) Research Grant, Hologic, Inc;  
Bonnie N. Joe, MD, PhD, San Francisco, CA (*Moderator*) Nothing to Disclose

### Sub-Events

#### RC315-01 MRI Acquisition and DWI

Tuesday, Dec. 1 8:30AM - 8:50AM Location: Arie Crown Theater

### Participants

Savannah C. Partridge, PhD, Seattle, WA (*Presenter*) Nothing to Disclose

### LEARNING OBJECTIVES

1) Review the basics of clinical breast MRI acquisition. 2) Identify factors that may impact image quality and interpretation. 3) Describe advanced MRI approaches with potential value for breast imaging.

### ABSTRACT

#### RC315-02 Correlation of R2\* Value Using Iterative Decomposition of Water and Fat with Echo Asymmetry and Least-squares Emission (IDEAL) with Histologic Prognostic Factor and Hypoxic Biomarker

Tuesday, Dec. 1 8:50AM - 9:00AM Location: Arie Crown Theater

### Participants

Mari Miyata, MD, Kitakyushu, Japan (*Presenter*) Nothing to Disclose  
Takatoshi Aoki, MD, PhD, Kitakyushu, Japan (*Abstract Co-Author*) Nothing to Disclose  
Atsuji Matsuyama, MD, Kitakyushu, Japan (*Abstract Co-Author*) Nothing to Disclose  
Shohei Shimajiri, MD, Kitakyushu, Japan (*Abstract Co-Author*) Nothing to Disclose  
Shunsuke Kinoshita, Kitakyushu, Japan (*Abstract Co-Author*) Nothing to Disclose  
Yukunori Korogi, MD, PhD, Kitakyushu, Japan (*Abstract Co-Author*) Nothing to Disclose  
Yoshiko Hayashida, MD, Fukuoka, Japan (*Abstract Co-Author*) Nothing to Disclose

### PURPOSE

Hypoxic breast cancers are difficult to treat by radiation and chemotherapy, and a fibrotic focus (FF) induced by hypoxia is an important predictor of early tumor recurrence. The purpose of this study is to correlate R2\* value using iterative decomposition of water and fat with echo asymmetry and least-squares emission (IDEAL) with FF and hypoxic biomarker (HIF-1α) in breast carcinoma.

### METHOD AND MATERIALS

This study consisted of 30 patients who were diagnosed with invasive carcinoma of breast and underwent breast MRI including IDEAL before surgery. The scan time of IDEAL R2\* map imaging was 23 sec. Entire region of interest (ROI) was delineated on the R2\* map carefully, and average tumor R2\* value was calculated for each ROI. Histological specimens were evaluated for the presence of FF (a scar-like lesion near the center of a carcinoma) and the grading of HIF-1α (0, no staining; 1, weakly positive and/or positive cells in less than 10 %; 2, moderately positive and/or positive cells in 10-50 %; 3, strongly positive and/or positive cells in more than 50 %) by 2 pathologists and final decision was reached by consensus.

### RESULTS

Fibrotic focus was identified in 43.3% (13/30) breast carcinomas. Average R2\* value for breast carcinoma with FF (45.1±18.9) was significantly higher than that without FF (29.8±13.9) (p<0.05). Spearman rank correlation suggested that average R2\* value correlated with the grade of HIF-1α (p<0.05), and the grade of HIF-1α with FF was significantly higher than that without FF (p < 0.01).

### CONCLUSION

Quantification of tumor R2\* using IDEAL is associated with the presence of FF and the overexpression of HIF-1α, and may therefore be a useful prognostic and hypoxic biomarker for breast carcinoma.

### CLINICAL RELEVANCE/APPLICATION

In vivo IDEAL-R2\* imaging is simple to perform without extrinsic contrast agent and the R2\* value may be useful for therapeutic strategy for breast carcinoma.

#### RC315-03 Apparent Diffusion Coefficient Values of Breast Cancer and Normal Breast Tissue in Diffusion-weighted Imaging: Effects of the Menstrual Cycle and Menopausal Status



#### Participants

Jin You Kim, MD, Busan, Korea, Republic Of (*Presenter*) Nothing to Disclose  
Shinyoung Park, MD, Busan, Korea, Republic Of (*Abstract Co-Author*) Nothing to Disclose  
Jin Il Moon, MD, Busan, Korea, Republic Of (*Abstract Co-Author*) Nothing to Disclose  
Ji Won Lee, MD, Busan, Korea, Republic Of (*Abstract Co-Author*) Nothing to Disclose  
Suk Kim, MD, Pusan, Korea, Republic Of (*Abstract Co-Author*) Nothing to Disclose

#### PURPOSE

To investigate whether the apparent diffusion coefficient (ADC) values of breast tumor and normal fibroglandular tissue vary with the menstrual cycle and menopausal status.

#### METHOD AND MATERIALS

The institutional review board approved this prospective study, and informed consent was obtained from each participant. Forty-six patients (20 premenopausal and 26 postmenopausal) with newly diagnosed breast cancer underwent diffusion-weighted (DW) imaging with b values of 0 and 1,000 s/mm<sup>2</sup> twice (interval 12-21 days) before surgery. Two radiologists independently measured the ADC values of the breast tumor and normal fibroglandular breast tissue of the contralateral breast and the differences according to the phases of the menstrual cycle and postmenopausal breast were evaluated. The reproducibility of the ADC measurement was analyzed using the intraclass correlation coefficient (ICC).

#### RESULTS

The ADC values of normal fibroglandular tissue were significantly higher in premenopausal women than in postmenopausal women ( $1.77 \pm 0.25 \times 10^{-3}$  vs.  $1.53 \pm 0.12 \times 10^{-3}$  mm<sup>2</sup>/s;  $P = 0.007$ ). In premenopausal women, the ADC values of the breast tumor did not differ significantly between the proliferative and secretory phases of the menstrual cycle ( $0.92 \pm 0.128 \times 10^{-3}$  vs.  $0.93 \pm 0.150 \times 10^{-3}$  mm<sup>2</sup>/s;  $P = 0.421$ ). No significant differences were observed in the ADC values of normal breast tissue in relation to the menstrual cycle phase ( $1.74 \pm 0.22 \times 10^{-3}$  vs.  $1.77 \pm 0.25 \times 10^{-3}$  mm<sup>2</sup>/s;  $P = 0.202$ ). In postmenopausal women, there were no significant differences in the ADC values of either breast tumors or normal fibroglandular tissue between the two time intervals ( $P = 0.983$  and  $P = 0.363$ , respectively); the magnitude of the ADC differences was similar in women who were taking estrogen-replacement therapy and those who were not ( $P = 0.368$  and  $P = 0.418$ , respectively). The intra- and interobserver agreement was excellent for all of the ADC measurements, with ICCs ranging from 0.84 to 0.94.

#### CONCLUSION

The ADC values of breast cancer and normal fibroglandular tissue are not affected by the change in the menstrual cycle and the ADC measurements are highly reproducible within and across observers.

#### CLINICAL RELEVANCE/APPLICATION

Since ADC values are not influenced by the change in the menstrual cycle, it is not necessary to restrict the timing of performing diffusion-weighted imaging of the breast to a certain phase of the menstrual cycle.

#### RC315-04 Unenhanced Breast MRI (STIR, T2-weighted TSE, DWIBS): An Accurate and Alternative Strategy for Detecting and Differentiating Breast Lesions

Tuesday, Dec. 1 9:10AM - 9:20AM Location: Arie Crown Theater

#### Participants

Marco Moschetta, MD, Bari, Italy (*Presenter*) Nothing to Disclose  
Michele Telegrafo, MD, Bari, Italy (*Abstract Co-Author*) Nothing to Disclose  
Leonarda Rella, Bari, Italy (*Abstract Co-Author*) Nothing to Disclose  
Amato Antonio Stabile Ianora, Bari, Italy (*Abstract Co-Author*) Nothing to Disclose  
Giuseppe Angelelli, Bari, Italy (*Abstract Co-Author*) Nothing to Disclose

#### PURPOSE

To assess the role of STIR, T2-weighted TSE and DWIBS sequences for detecting and characterizing breast lesions and to compare unenhanced (UE)-MRI results with contrast enhanced (CE)-MRI and histological findings, having the latter as the reference standard.

#### METHOD AND MATERIALS

280 consecutive patients (age range, 27-73 years; mean age  $\pm$  standard deviation (SD),  $48.8 \pm 9.8$  years) underwent MR examination with a diagnostic protocol including STIR, T2-weighted TSE, THRIVE and DWIBS sequences. Two radiologists blinded to both dynamic sequences and histological findings evaluated in consensus STIR, T2-weighted TSE and DWIBS sequences and after two weeks CE-MRI images searching for breast lesions. Sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), and diagnostic accuracy for UE-MRI and CE-MRI were calculated. UE-MRI results were also compared with CE-MRI.

#### RESULTS

UE-MRI sequences obtained sensitivity, specificity, diagnostic accuracy, PPV and NPV values of 94%, 79%, 86%, 79% and 94 %, respectively. CE-MRI sequences obtained sensitivity, specificity, diagnostic accuracy, PPV and NPV values of 98%, 83%, 90%, 84% and 98%, respectively. No statistically significant difference between UE-MRI and CE-MRI was found.

#### CONCLUSION

Breast UE-MRI could represent an accurate diagnostic tool and a valid alternative to CE-MRI for evaluating breast lesions. STIR and DWIBS sequences allow to detect breast lesions while T2-weighted TSE sequences and ADC values could be useful for lesion characterization.

#### CLINICAL RELEVANCE/APPLICATION

Unenhanced MR imaging of the breast including STIR, T2-weighted TSE and DWIBS sequences could characterize breast lesions, although not yet able to avoid histological characterization.

**RC315-05 Breast Cancer: Feasibility and Preliminary Experience of Diffusion Kurtosis Imaging for Detection and Assessment of Invasive Ductal Carcinoma Comparing with Intravoxel Incoherent Motion and Conventional Diffusion-weighted Imaging**

Tuesday, Dec. 1 9:20AM - 9:30AM Location: Arie Crown Theater

**Participants**

Kun Sun, Shanghai, China (*Presenter*) Nothing to Disclose

Fuhua Yan, MS, Shanghai, China (*Abstract Co-Author*) Nothing to Disclose

**PURPOSE**

To assess the feasibility of diffusion-kurtosis imaging (DKI) for distinguishing benign from malignant breast lesions in comparison with IVIM and conventional DWI

**METHOD AND MATERIALS**

The institutional review board approved this retrospective HIPAA-compliant study and waived informed consent. Twenty-five breast disease patients who underwent surgery from January 2014 and April 2014 were retrospectively analyzed. Multi-b-value diffusion images with five b values (range:0-2800s/mm<sup>2</sup>) were acquired and processed using the DKI model, yielded kurtosis (K),and corrected diffusion(D) coefficient, similarly, IVIM model was also acquired with 5 b values(range:0-200s/mm<sup>2</sup>), yielded D\*,D,f,ADC, The apparent diffusion coefficient (ADC) was also calculated using the conventional mono-exponential diffusion weighted imaging (DWI) model with 2 b values(50,1000) .Two radiologists reviewed these maps and measured the all these parameters. Two independent sample t test was employed and receiver operating characteristic curves were plotted for data analysis.

**RESULTS**

Among the 25 patients, 15(60%) were invasive ductal carcinoma and 10 (40%) were fibroadenoma. The area under the curve for all these parameters as following: DKI model: 0.973 for K, 0.967 for D;IVIM model::0.74 for D\*,:0.793 for D, 0.673 for f, 0.947 for ADC; Conventional DWI: 0.90 for ADC. Then we chosen K represent DWI model, IVIM-ADC represent IVIM model, ADC represent Conventional DWI model to compare the diagnostic accuracy. Although the area under the curve of K was relatively higher than IVIM-ADC and Conventional ADC, there's no significant difference (P>0.05).K was significantly higher in the malignant lesions than in the benign lesions (0.91±0.13vs.0.68±0.10,P<0.0001). IVIM- ADC and Conventional ADC were significantly lower in the malignant lesions than in the benign lesions (0.93±0.14 vs.1.05±0.20 and 1.53±0.35 vs.1.60±0.43, respectively, P<0.0001).

**CONCLUSION**

DKI model had a similar diagnostic ability with IVIM and DWI model in assessing benign and malignant breast lesions. Performing DKI model with quantification K values reduces the overlap between benign and malignant lesion than ADC values from IVIM and DWI model.

**CLINICAL RELEVANCE/APPLICATION**

DKI model had a similar diagnostic ability with IVIM and DWI model in assessing benign and malignant breast lesions.

**RC315-06 DBT Technology**

Tuesday, Dec. 1 9:30AM - 9:50AM Location: Arie Crown Theater

**Participants**

Martin J. Yaffe, PhD, Toronto, ON (*Presenter*) Research collaboration, General Electric Company Founder, Matakina International Ltd Shareholder, Matakina International Ltd Co-founder, Mammographic Physics Inc

**LEARNING OBJECTIVES**

1) To review the basic principles of digital breast tomosynthesis (DBT). 2) Identify factors that may impact image quality and interpretation.

**RC315-07 Detection and Classification of Calcifications on Two-dimensional Mammography: Comparison of Synthetic Mammography Reconstructed from Digital Breast Tomosynthesis and Full-field Digital Mammography**

Tuesday, Dec. 1 9:50AM - 10:00AM Location: Arie Crown Theater

**Participants**

Ji Soo Choi, MD, PhD, Seoul, Korea, Republic Of (*Abstract Co-Author*) Nothing to Disclose

Eun Young Ko, MD, PhD, Seoul, Korea, Republic Of (*Presenter*) Nothing to Disclose

Ga Ram Kim, MD, Seoul, Korea, Republic Of (*Abstract Co-Author*) Nothing to Disclose

Boo-Kyung Han, MD, PhD, Seoul, Korea, Republic Of (*Abstract Co-Author*) Nothing to Disclose

Eun Sook Ko, MD, Seoul, Korea, Republic Of (*Abstract Co-Author*) Nothing to Disclose

Soo Yeon Hahn, MD, Seoul, Korea, Republic Of (*Abstract Co-Author*) Nothing to Disclose

**PURPOSE**

To evaluate the interpretative performance of two-dimensional (2D) synthetic mammography (SM) reconstructed from digital breast tomosynthesis (DBT) in the detection and classification of calcifications, compared to 2D full-field digital mammography (FFDM).

**METHOD AND MATERIALS**

The institutional review board approved this study, and the patients' informed consent was waived. Between January and October 2013, 73 patients with 81 calcifications (40 biopsy proven malignant calcifications, 24 biopsy-proven benign calcifications, 17 typical benign calcifications) were consecutively enrolled. For each patient, FFDM and DBT were performed, and SM was reconstructed from each set of DBT slices. Three breast radiologists, blinded to the histology, interpreted SM and FFDM images and recorded the conspicuity (three-point scale; 1 low conspicuity, 2 medium conspicuity, 3 high conspicuity) and the presence of calcifications, and corresponding BI-RADS categories. Diagnostic performance of SM was compared with that of FFDM in terms of percentage of detected calcifications (detection sensitivity) and the percentage of times each detected calcifications was

correctly classified as benign or malignant. BI-RADS category 2 was assigned as negative and BI-RADS category greater than or equal to 3 was assigned as positive.

## RESULTS

There was no significant difference in detection sensitivity of calcifications between SM (range 91.4-95.1%) and FFDM (range 85.2-90.1%) for all readers ( $P>0.05$ ). The conspicuity scores of SM and FFDM were also not significantly different for each observer (range of mean scores 1.9-2.8 for SM, 1.9-2.8 for FFDM;  $P > 0.05$ ). For correct classification of calcifications, there was no significant difference between SM (68.9-74.0%) and FFDM (62.1-69.6%) for all readers ( $P>0.05$ ). Of discordant cases between SM and FFDM, correct classifications were more frequent with SM, compared to FFDM for all readers.

## CONCLUSION

Diagnostic performance of SM and FFDM are comparable for detection and classification of calcifications. Therefore, our results indicate that SM may overcome the limitation that DBT may underestimate the calcifications during DBT-based screening.

## CLINICAL RELEVANCE/APPLICATION

SM may overcome the limitation that DBT may underestimate the calcifications. DBT with SM may be sufficient in the detection and classification of calcifications during DBT-based screening, without addition of FFDM

### RC315-08 Comparison of Low Dose Tomosynthesis Plus Synthesized Mammography and Digital Mammography Alone for Breast Cancer Screening

Tuesday, Dec. 1 10:00AM - 10:10AM Location: Arie Crown Theater

#### Participants

Tokiko Endo, MD, Nagoya, Japan (*Presenter*) Institutional research support, FUJIFILM Holdings Corporation  
Takako Morita, MD, Nagoya, Japan (*Abstract Co-Author*) Nothing to Disclose  
Mikinao Ooiwa, Nagaya, Japan (*Abstract Co-Author*) Nothing to Disclose  
Namiko Suda, Nagoya, Japan (*Abstract Co-Author*) Nothing to Disclose  
Misaki Shiraiwa, MD, Nagoya, Japan (*Abstract Co-Author*) Nothing to Disclose  
Kazuaki Yoshikawa, MD, Hamada, Japan (*Abstract Co-Author*) Nothing to Disclose  
Yukie Hayashi, Nagoya, Japan (*Abstract Co-Author*) Nothing to Disclose  
Hirotooshi Ogawa, Nagoya, Japan (*Abstract Co-Author*) Nothing to Disclose  
Takao Horiba, Kagamihara, Japan (*Abstract Co-Author*) Nothing to Disclose  
Yasuyuki Satoh, Nagoya, Japan (*Abstract Co-Author*) Nothing to Disclose  
Shu Ichihara, Nagoya, Japan (*Abstract Co-Author*) Nothing to Disclose  
Naokazu Kamiya, Ashigarakami-gun, Japan (*Abstract Co-Author*) Employee, FUJIFILM Holdings Corporation  
Takahisa Arai, Ashigarakami-gun, Japan (*Abstract Co-Author*) Employee, FUJIFILM Holdings Corporation  
Tomonari Sendai, Ashigarakami-Gun, Japan (*Abstract Co-Author*) Employee, FUJIFILM Holdings Corporation

## PURPOSE

To compare the diagnostic performance (sensitivity, specificity and AUC) of breast tomosynthesis (DBT) plus synthesized mammography (S2D) with several-levels of dose reduction versus conventional digital mammography (FFDM) alone in breast cancer screening.

## METHOD AND MATERIALS

An institutional review board approved this study and informed consent was provided by all patients. Images of 200 breasts were acquired from 100 subjects aged 27-86 years (mean, 53 years) who underwent FFDM and DBT with the same positioning and included both mediolateral oblique and craniocaudal views. All FFDM images were acquired at normal dose (AGD 0.65 ~ 4.16mGy). For DBT, half the patients were imaged at the same dose level (AGD 0.95 ~ 3.19mGy) of FFDM and the remainder at about 75% (AGD 0.87 ~ 2.7mGy). In addition, DBT + S2D images with 60% dose were generated virtually using approximately half the normal 15 projection images. The DBT + S2D images with dose reduction were processed by improved reconstruction algorithms. Eight radiologists specialized in breast imaging were divided equally into two groups and each group reviewed images of 100 breasts retrospectively. The FFDM and DBT + S2D images were interpreted independently with an interval of minimum 4 weeks for memory washout. Diagnostic performance was assessed by comparing sensitivity, specificity and area under the receiver operating characteristic (ROC) curve.

## RESULTS

We found no significance difference in sensitivity and specificity between FFDM and DBT + S2D acquired with normal dose. Furthermore, FFDM and DBT + S2D acquired with 75% dose showed a significant difference in sensitivity ( $P = .043$ ) keeping specificity and AUC because spiculated or lobulated masses were more precisely identified by the improved DBT images.

## CONCLUSION

Dose reduction is possible with DBT + S2D in screening with the same sensitivity and specificity as FFDM. In addition, the improvement of reconstruction algorithm has the potential to provide higher sensitivity, even when the dose is reduced more than 25% compared to FFDM.

## CLINICAL RELEVANCE/APPLICATION

Screening by DBT + S2D with the improved reconstruction algorithm contributes to not only dose reduction, but also improved sensitivity keeping specificity.

### RC315-09 Impact on Recall Rates Following Implementation of Synthesized 2D Mammography in Digital Breast Tomosynthesis Screening

Tuesday, Dec. 1 10:10AM - 10:20AM Location: Arie Crown Theater

#### Awards

**Trainee Research Prize - Resident**

#### Participants

Samantha P. Zuckerman, MD, Philadelphia, PA (*Presenter*) Nothing to Disclose

Emily F. Conant, MD, Philadelphia, PA (*Abstract Co-Author*) Speaker, Hologic, Inc; Scientific Advisory Board, Hologic, Inc; Consultant, Siemens AG

Susan Weinstein, MD, Philadelphia, PA (*Abstract Co-Author*) Consultant, Siemens AG

Marie Synnestvedt, Philadelphia, PA (*Abstract Co-Author*) Nothing to Disclose

Katrina Korhonen, MD, Philadelphia, PA (*Abstract Co-Author*) Nothing to Disclose

Elizabeth McDonald, MD, PhD, Philadelphia, PA (*Abstract Co-Author*) Nothing to Disclose

#### PURPOSE

The combination of digital breast tomosynthesis (DBT) with full field digital mammography (DM) decreases recall rates and improves cancer detection in breast cancer screening compared to using DM alone. Synthesized 2D images (s2D) are being used to replace conventional DM as a method to reduce dose. However, the reconstructed s2D images frequently have a different appearance varying by breast density and lesion type, particularly "calcification-only" lesions. We have evaluated the early implementation of s2D in a population screened entirely with s2D/DBT and compared recall rates and recall finding types to similar historic outcomes from DM/DBT screening. Comparison of cancer detection rate is on-going.

#### METHOD AND MATERIALS

Recall rates and lesion type were compared for 15,571 women screened with DM/DBT from October 1, 2011-February 28, 2013 and 2,090 women screened with s2D/DBT from January 7th, 2015 to March 20th, 2015. Data collection is on-going. Differences between groups were compared using Wilcoxon rank sum test.

#### RESULTS

Overall recall rate for s2D/DBT was 8.3% compared to 8.8% for DM/DBT ( $p=0.45$ ). In addition, s2D/DBT screening was not associated with a significant change in the distribution of recalled lesion type. The percentage of screened patients recalled for calcifications, masses, asymmetries, architectural distortion and technical reasons was 1.6, 2.4, 3.8, 1.1 and 0.05 for s2D/DBT compared to 1.6, 2.7, 4.5, 1.0 and 0.2 for DM/DBT ( $p=ns$ ). Specifically, there was no change in the rate of recall for calcific lesions.

#### CONCLUSION

Preliminary data demonstrates stable recall rates and lesion types with the replacement of DM with s2D in combination with DBT. Ongoing data collection will allow comparison of cancer detection rates and PPVs.

#### CLINICAL RELEVANCE/APPLICATION

The replacement of DM with s2D in combination with DBT will lead to decreased radiation dose in screening with DBT with maintenance of recall reduction.

#### RC315-10 Synthesized 2D Mammography+Tomosynthesis: Can We See Clearly?

Tuesday, Dec. 1 10:20AM - 10:30AM Location: Arie Crown Theater

#### Participants

Melissa A. Durand, MD, New Haven, CT (*Presenter*) Research Grant, Hologic, Inc

Madhavi Raghu, MD, New Haven, CT (*Abstract Co-Author*) Nothing to Disclose

Jaime L. Geisel, MD, New Haven, CT (*Abstract Co-Author*) Consultant, QView Medical, Inc; Consultant, Siemens AG

Regina J. Hooley, MD, New Haven, CT (*Abstract Co-Author*) Nothing to Disclose

Xiaopan Yao, PhD, New Haven, CT (*Abstract Co-Author*) Nothing to Disclose

Liane E. Philpotts, MD, New Haven, CT (*Abstract Co-Author*) Nothing to Disclose

#### PURPOSE

Compare synthesized 2D mammography+tomosynthesis (C-view+Tomo) to 2D mammography+tomosynthesis (2D+Tomo) in a clinical setting.

#### METHOD AND MATERIALS

Screening mammograms were performed with C-view+Tomo and 2D+Tomo from 8/1/2014-1/9/2015. A hanging protocol showed C-view+Tomo first, followed by 2D+Tomo. Findings (calcifications, asymmetries, masses, architectural distortions) on C-view+Tomo were prospectively assessed as better, equally, or less well seen compared to 2D+Tomo. Separate BIRADS final assessments were recorded and Kappa statistics assessed agreement. Recall and cancer detection rates were compared with Fisher's exact test. Multivariate logistic regression analysis determined effect of breast density or age on visualization of C-view+Tomo findings.

#### RESULTS

201 C-view+Tomo and 2D+Tomo mammograms were performed. 4 types of findings were recorded (calcifications 50.8%, 102/201; asymmetries 28.9%, 58/201; masses 14.4%, 29/201; architectural distortions 6.0%, 12/201). 53.7% (108/201) were not dense and 46.3% (93/201) were dense; average age 56 years. 82.1% (165/201) of findings were equally/better seen with C-view+Tomo, 17.9% (36/201) less well seen. This was most evident for architectural distortions and calcifications (architectural distortions 100%, 12/12; calcifications 96.1%, 98/102; asymmetries 63.8%, 37/58; masses 62.1%, 18/29). Logistic regression models showed neither density nor age had a significant effect on visibility of findings ( $p$  0.8358 density;  $p$  0.3336 age). Kappa statistics showed perfect agreement in BIRADS assessment for architectural distortions ( $K$  1.0000), strong agreement for asymmetries ( $K$  0.9695) and masses ( $K$  0.9247), moderate agreement for calcifications ( $K$  0.7850). Recall rates were not significantly different (C view: 10.9%, 22/201; 2D: 9.45%, 19/201);  $p$  0.7421). All recalled patients returned for diagnostic imaging. 6 biopsies were performed and 2 malignancies found (PPV1:10.5%; PPV3:33.3%). Cancer detection rate was the same as both cancers were identified on both modalities.

#### CONCLUSION

C-view+Tomo shows the majority of mammographic findings equally well/better than 2D+Tomo, regardless of breast density or age, with equitable recall rates and cancer detection.

## CLINICAL RELEVANCE/APPLICATION

Visibility of findings on C-view+Tomosynthesis is at least equal to 2D, with no significant difference in recall rates or cancer detection, and suggests potential as a screening modality.

### RC315-11 Synthetized Digital Mammography Compared to Conventional Digital Mammography in a Diagnostic Setting

Tuesday, Dec. 1 10:30AM - 10:40AM Location: Arie Crown Theater

#### Participants

Giovanna Mariscotti, Turin, Italy (*Abstract Co-Author*) Nothing to Disclose  
Manuela Durando, Turin, Italy (*Presenter*) Nothing to Disclose  
Camilla Bogetti, MD, Torino, Italy (*Abstract Co-Author*) Nothing to Disclose  
Pier Paolo Campanino, Turin, Italy (*Abstract Co-Author*) Nothing to Disclose  
Elisa Regini, Torino, Italy (*Abstract Co-Author*) Nothing to Disclose  
Mirella Fasciano, Turin, Italy (*Abstract Co-Author*) Nothing to Disclose  
Giulia Schivazappa, Turin, Italy (*Abstract Co-Author*) Nothing to Disclose  
Enrica Caramia, Turin, Italy (*Abstract Co-Author*) Nothing to Disclose  
Alessia Milan, Torino, Italy (*Abstract Co-Author*) Nothing to Disclose  
Paolo Fonio, Vercelli, Italy (*Abstract Co-Author*) Nothing to Disclose  
Giovanni Gandini, MD, Torino, Italy (*Abstract Co-Author*) Nothing to Disclose

#### PURPOSE

To compare the diagnostic performances of conventional Digital Mammography (DM) versus Synthetized Digital Mammography (SDM) used alone (without combination with Digital Breast Tomosynthesis (DBT) images) in the identification and characterization of breast malignant and benign lesions in a diagnostic setting.

#### METHOD AND MATERIALS

A retrospective observer performance study was performed using anonymized images acquired between August 2014 and January 2015 (compliant to protocols approved by the Institutional Ethic Committee). The sample included 120 consecutive patients with 73 biopsy-proven cancer (confirmed histologically) and 64 biopsy-proven benign lesions. All patients (after signing an informed consent) had undergone DM combined to DBT; SDM images were obtained in both standard views. Two dedicated breast radiologists, blinded to the clinical information and histological diagnosis, retrospectively reviewed all the studies. The readers reviewed separately DM images and then SDM studies, in a different order. BIRADS category was used for the classification of the findings in both techniques. Mammographic features (mass, architectural distortion, microcalcification, asymmetry) were also indicated. A statistical analysis was performed on the data, by evaluating the differences in sensitivity (SE), specificity (SP), negative and positive predictive value (NPV and PPV) between DM and SDM. Accuracy was calculated by using areas under the receiver operating characteristic curve (AUC) for both techniques.

#### RESULTS

The SE and SP were respectively 78.6% and 67.9% for DM and 87.1% and 63.5% for SDM. No significant differences were found regarding SE and SP between DM and SDM ( $p=0.14$  and  $0.63$ ). The AUC was 0.75 for DM and 0.81 for SDM. There were not significant differences between both AUC's ( $p=0.27$ ). By stratifying the results according to mammographic features, SDM better identified and classified (according to BIRADS category) architectural distortions than DM.

#### CONCLUSION

In our study, SDM alone is comparable in performance to DM, demonstrating a similar SE, SP and AUC values; SDM could be used instead of DM in addition to DBT images as part of routine clinical study.

## CLINICAL RELEVANCE/APPLICATION

Preliminary studies suggest that SDM alone is comparable in performance to DM, so it could be used instead of DM in addition to DBT images as part of routine clinical study.

### RC315-12 Clinical Evidence of DBT Utility

Tuesday, Dec. 1 10:50AM - 11:10AM Location: Arie Crown Theater

#### Participants

Sarah M. Friedewald, MD, Chicago, IL (*Presenter*) Consultant, Hologic, Inc; Research Grant, Hologic, Inc

#### LEARNING OBJECTIVES

1) Acquire brief knowledge of the basics of tomosynthesis acquisition, interpretation and implementation. 2) Learn the clinical evidence that supported FDA approval for tomosynthesis. 3) Describe the European Clinical Evidence. 4) Describe the American Clinical Evidence. 5) Be aware of the additional studies needed for further research.

### RC315-13 Tomosynthesis in Diagnostic Mammography - Continued Change after Three Years of Experience

Tuesday, Dec. 1 11:10AM - 11:20AM Location: Arie Crown Theater

#### Participants

Reni S. Butler, MD, New Haven, CT (*Presenter*) Nothing to Disclose  
Vivek B. Kalra, MD, New Haven, CT (*Abstract Co-Author*) Nothing to Disclose  
Jaime L. Geisel, MD, New Haven, CT (*Abstract Co-Author*) Consultant, QView Medical, Inc; Consultant, Siemens AG  
Jacquelyn Crenshaw, RT, New Haven, CT (*Abstract Co-Author*) Nothing to Disclose  
Liane E. Philpotts, MD, New Haven, CT (*Abstract Co-Author*) Nothing to Disclose

#### PURPOSE

To assess how the initial impact of tomosynthesis on the diagnostic work-up changes with increasing experience over a 3 ½ year



time interval.

## METHOD AND MATERIALS

After IRB approval, a HIPAA-compliant retrospective review of diagnostic mammography examinations was performed before and at three time points over a 3 ½ year period after tomosynthesis implementation. Diagnostic exams were performed on 2D digital mammography units (Selenia, Hologic, Bedford, MA) prior to tomosynthesis implementation and on both 2D and 3D digital breast tomosynthesis units (Dimensions, Hologic, Bedford, MA) in the 3 ½ years after implementation. Total number of additional views (AV), spot compression views (SCV) and magnification views (MV), were recorded during a one month period immediately prior to tomosynthesis (2D) and compared to one month periods during the second (3D1), third (3D2), and fourth year (3D3) after tomosynthesis utilization. The number of "routine" diagnostic studies, consisting only of MLO and CC views, was recorded for each time point. Statistical analysis was performed using the two-tailed student t-test with unequal variance.

## RESULTS

The study population consisted of 497 2D diagnostic mammograms (2D) and 350 (3D1), 410 (3D2), and 314 (3D3) tomosynthesis diagnostic exams. AV, SCV and MV per exam decreased each year from 2.07, 0.84 and 0.85 (2D) to 1.42, 0.59 and 0.73 (3D1), 1.11, 0.33 and 0.41 (3D2), and 0.53, 0.23 and 0.20 (3D3), respectively. Significant differences were observed in all categories between 2D and 3D1, 3D1 and 3D2, and 3D2 and 3D3 ( $p < 0.01$ ). Concordantly, the number of routine diagnostic exams increased from 29.9% (2D) to 41.4% (3D1), 44.9% (3D2), and 73.3% (3D3), ( $p < 0.01$ ).

## CONCLUSION

In the first 3½ years after tomosynthesis implementation, there has been a continual shortening of the diagnostic work-up from year to year. This data suggests a learning curve exists in developing comfort with utilizing tomosynthesis in the diagnostic setting and that, with time, fewer additional views are seen to be necessary. The majority of diagnostic cases require only the routine views, making the difference between screening and diagnostic mammography start to blend.

## CLINICAL RELEVANCE/APPLICATION

Reported experience from a diagnostic center where tomosynthesis was adopted early may aid in shortening the learning curve at centers implementing tomosynthesis presently or in the future.

### RC315-14 Biopsy Outcomes Following Diagnostic Work-up with Digital Breast Tomosynthesis

Tuesday, Dec. 1 11:20AM - 11:30AM Location: Arie Crown Theater

#### Participants

Madhavi Raghu, MD, New Haven, CT (*Presenter*) Nothing to Disclose  
Melissa A. Durand, MD, New Haven, CT (*Abstract Co-Author*) Research Grant, Hologic, Inc  
Liva Andrejeva-Wright, MD, Wallingford, CT (*Abstract Co-Author*) Nothing to Disclose  
Regina J. Hooley, MD, New Haven, CT (*Abstract Co-Author*) Nothing to Disclose  
Jaime L. Geisel, MD, New Haven, CT (*Abstract Co-Author*) Consultant, QView Medical, Inc; Consultant, Siemens AG  
Liane E. Philpotts, MD, New Haven, CT (*Abstract Co-Author*) Nothing to Disclose

## PURPOSE

To compare the positive predictive value of biopsies performed (PPV3) before and after the implementation of tomosynthesis.

## METHOD AND MATERIALS

A retrospective review of all biopsies performed following diagnostic work-up with mammography before (2D: June 2010-June 2011) and three consecutive years (3D1:1/1/2012-12/31/2012; 3D2:1/1/2013-12/31/2014; 3D3:1/1/2014-12/31/2014) following the implementation of tomosynthesis was conducted. The recorded mammographic features of lesions recommended for biopsy (masses, architectural distortions (AD), calcifications (Ca++) and asymmetries) and subsequent pathology were evaluated. The PPV3 was compared and trends from year to year were evaluated.

## RESULTS

A total of 3567(2D), 3385(3D1), 4542(3D2) and 4507 (3D3) diagnostic mammograms were performed. There was a nonsignificant slight decrease in the proportion of BI-RADS 4,5 studies: 2D 8.5% (304/3567), 3D1 7.9% (269/3385), 3D2 8.4% (384/4542), 3D3 7.7% (345/4507)) as well as biopsies performed over time: 2D 94% (287/304); 3D1 96% (257/269); 3D2 93% (358/384); 3D3 93% (321/345)). With tomosynthesis, there was a 40% increase in the PPV3 over time, from 29% in 2D (85/287) to 41.2% (3D1;106/257;p=.005), 45% (3D2;162/358;p<.0001) and 51.1% (3D3;164/321;p<.0001). Of the total malignancies in the 2D group, 69% were masses, 2.3% AD, 28% Ca++ and 0% asymmetries. With tomosynthesis there was an increase in the proportion of malignancies manifesting as noncalcified lesions, particularly masses (66%(3D1), 78%(3D2), 80%(3D3)) and AD (4.7%(3D1), 3.0% (3D2), 5.5%(3D3)), with a small proportion of cancers manifesting as asymmetries (3.8% (3D1), 1.9% (3D2) and 0%(3D3)). Over time, calcifications made up a smaller proportion of the malignancies (24.5%(3D1), 16.7%(3D2), 15.2%(3D3)).

## CONCLUSION

Utilization of tomosynthesis resulted in a significant increase of 40% in the PPV3 for BIRADS 4, 5 lesions, demonstrating increased diagnostic acumen in characterizing lesions requiring biopsy.

## CLINICAL RELEVANCE/APPLICATION

Diagnostic work up with tomosynthesis resulted in a significant and steady increase in the PPV.

### RC315-15 Clinical and Imaging Features of Tomosynthesis Occult Breast Cancer and Reasons for Non-Detection

Tuesday, Dec. 1 11:30AM - 11:40AM Location: Arie Crown Theater

#### Participants

Liva Andrejeva-Wright, MD, Wallingford, CT (*Abstract Co-Author*) Nothing to Disclose  
Regina J. Hooley, MD, New Haven, CT (*Presenter*) Nothing to Disclose  
Kaitlin Eng, MD, New Haven, CT (*Abstract Co-Author*) Nothing to Disclose

Jonathan R. Weisiger, MD, New Haven, CT (*Abstract Co-Author*) Nothing to Disclose  
Madhavi Raghu, MD, New Haven, CT (*Abstract Co-Author*) Nothing to Disclose  
Reni S. Butler, MD, New Haven, CT (*Abstract Co-Author*) Nothing to Disclose  
Liane E. Philpotts, MD, New Haven, CT (*Abstract Co-Author*) Nothing to Disclose  
Laura S. Sheiman, MD, New Haven, CT (*Abstract Co-Author*) Nothing to Disclose

## PURPOSE

To investigate the clinical and imaging features of tomosynthesis (DBT) occult cancers and determine reasons for non-detection of these cancers.

## METHOD AND MATERIALS

This is a HIPPA compliant study with IRB approval. Between August 2011 and December 2014, a retrospective database review identified 32 cancers in 32 women diagnosed by breast ultrasound (US) or MR within one year of a normal combined DBT + 2D mammogram. Patient breast cancer risk, mammographic density, and tumor histology were assessed. Three radiologists blinded to clinical outcomes and study purpose reviewed each mammogram to determine if the cancers were truly mammographically occult. Two radiologists unblinded to clinical outcomes also reviewed each case in order to determine reasons why cancers were undetected.

## RESULTS

The average patient age was 57 years (range 41-82). Breast cancer risk was average in 44% (14/32), intermediate in 22% (7/32), and increased in 34% (11/32). Breast density was scattered fibroglandular in 13% (4/32), heterogeneously dense in 69% (22/32), and extremely dense in 19% (6/32). Cancer detection was made by US in 75% (24/32) and by MR in 25% (8/32), with 4/9 MR detected cancers also identified on MR-directed US. Four cancers were DCIS and 28 were invasive, including 20 ductal and 8 lobular tumors. Of the invasive cancers 12 were grade 1, 13 were grade 2, and 3 were grade 3. 63% (20/32) of the cancers were diagnosed more than two years since implementation of DBT. Upon case review, 72% (23/32) cases were truly occult on DBT and 28% (9/32) were seen retrospectively, including subtle findings in 16% (5/32) and interpretative errors in 13% (4/32). Of 4 cancers missed due to interpretive error, three were spiculated masses and one was a subtle architectural distortion (avg. tumor size 30 mm, range 13 - 66 mm).

## CONCLUSION

The majority of DBT occult cancers were invasive, detected in women with dense breast tissue, and identified on US. These cancers may be seen in women across all risk groups and may occur despite more than two years of reader experience. Subtle masses and architectural distortions were the common findings in tumors identified retrospectively. Cancers missed due to interpretive error tended to be large.

## CLINICAL RELEVANCE/APPLICATION

Despite the increased sensitivity of tomosynthesis combined with 2D mammography, some cancers may still be occult and radiologists should be aware of the limitations of tomosynthesis.

## RC315-16 Comparing the Performance of Full-Field Digital Mammography (FFDM), Digital Breast Tomosynthesis (DBT) and Whole Breast Ultrasound (WBUS) in the Initial Staging Evaluation of Breast Cancer: Interim Results of a Prospective Study

Tuesday, Dec. 1 11:40AM - 11:50AM Location: Arie Crown Theater

### Participants

Rosalind P. Candelaria, MD, Houston, TX (*Presenter*) Nothing to Disclose  
Monica L. Huang, MD, Houston, TX (*Abstract Co-Author*) Nothing to Disclose  
Beatriz E. Adrada, MD, Houston, TX (*Abstract Co-Author*) Nothing to Disclose  
Elsa M. Arribas, MD, Houston, TX (*Abstract Co-Author*) Nothing to Disclose  
Marion E. Scoggins, MD, Houston, TX (*Abstract Co-Author*) Nothing to Disclose  
Wei T. Yang, MD, Houston, TX (*Abstract Co-Author*) Researcher, Hologic, Inc  
Jennifer G. Schopp, MD, Houston, TX (*Abstract Co-Author*) Nothing to Disclose  
Mark J. Dryden, MD, Houston, TX (*Abstract Co-Author*) Nothing to Disclose  
H. Carisa Le-Petross, MD, Houston, TX (*Abstract Co-Author*) Nothing to Disclose  
Tanya W. Moseley, MD, Houston, TX (*Abstract Co-Author*) Nothing to Disclose  
Gary J. Whitman, MD, Houston, TX (*Abstract Co-Author*) Book contract, Cambridge University Press  
Gaiane M. Rauch, MD, PhD, Houston, TX (*Abstract Co-Author*) Nothing to Disclose  
Lumarie Santiago, MD, Houston, TX (*Abstract Co-Author*) Nothing to Disclose

## PURPOSE

To determine the incremental cancer detection rate (ICDR) of FFDM+DBT and FFDM+DBT+WBUS when compared to FFDM alone in the local staging of patients with recently diagnosed invasive breast cancer (BI-RADS 6) and patients with mammograms and/or ultrasound highly suspicious for invasive breast carcinoma (BI-RADS 5).

## METHOD AND MATERIALS

This IRB-approved, prospective study was performed in a single, large tertiary cancer center. Informed written consent was obtained. We enrolled the first 100 women who were referred to our center from 12/2014-3/2015, met inclusion criteria and agreed to participate. All women had FFDM with DBT followed by WBUS; FFDM interpretation occurred blinded to DBT images. WBUS was performed with knowledge of FFDM/DBT results. Suspicious lesions on FFDM, DBT or WBUS farthest apart in the breast were biopsied to determine disease extent and to establish multifocality and/or multicentricity. Gold standard for diagnosis of malignancy was histopathology from needle biopsy and/or surgery. A separate surgical plan was recorded for each patient based on findings from FFDM alone, FFDM+DBT and FFDM+DBT+WBUS. In patients who did not have mastectomy, true negatives were defined by negative clinical and imaging assessment at 12-month follow-up (pending).

## RESULTS

Median patient age was 54 years, range 26-82. Mean index tumor size was 2.1 cm, range 0.4-15. Mean satellite tumor size was 1.2



cm, range 0.4-4.2. Breast tissue density among the study group was predominantly fatty (1%), scattered fibroglandular (26%), heterogeneously dense (70%) and extremely dense (3%). ICDR of FFDM+DBT when compared to FFDM alone was 1% (exact 95% CI:0.02%-5.4%) in the ipsilateral and 0% (exact 95% CI:0%-5.7%) in the contralateral breast. ICDR of FFDM+DBT+WBUS when compared to FFDM alone was 20% (exact 95% CI:12.7%-29.2%) in the ipsilateral and 1.6% (exact 95% CI:0.04%-8.7%) in the contralateral breast. FFDM+DBT findings changed the surgical plan in 1% while FFDM+DBT+US findings changed the surgical plan in 20%.

## CONCLUSION

Our interim analysis indicates that there is a greater increase in cancer detection in the ipsilateral and contralateral breasts when adding WBUS to FFDM, compared to adding DBT to FFDM.

## CLINICAL RELEVANCE/APPLICATION

In large tertiary cancer centers, use of FFDM+DBT provides no significant advantage over FFDM when staging breast cancer; more studies are needed to establish proper indications for DBT in the diagnostic setting.

## RC315-17 Analysis of False Negative Exams in 2D and Tomosynthesis Screening Mammography: Comparison by Breast Density

Tuesday, Dec. 1 11:50AM - 12:00PM Location: Arie Crown Theater

### Participants

Liane E. Philpotts, MD, New Haven, CT (*Presenter*) Nothing to Disclose  
Cameron Thomson, Montreal, QC (*Abstract Co-Author*) Nothing to Disclose  
Melissa A. Durand, MD, New Haven, CT (*Abstract Co-Author*) Research Grant, Hologic, Inc  
Madhavi Raghu, MD, New Haven, CT (*Abstract Co-Author*) Nothing to Disclose  
Regina J. Hooley, MD, New Haven, CT (*Abstract Co-Author*) Nothing to Disclose

## PURPOSE

While digital breast tomosynthesis (DBT) has been shown to increase specificity in screening mammography, the sensitivity of this new modality has not yet been determined. The purpose of this study was to assess the false negative cases in patients undergoing screening with different technologies - 2D FFDM, DBT, +/- supplemental screening ultrasound.

## METHOD AND MATERIALS

An IRB-approved, retrospective search of the breast imaging database (PenRad, MN) was performed to identify all screening mammograms over a two year period (8/1/11 - 7/31/13) when both DBT and 2D machines were utilized (Hologic Dimensions or Selenia) yielding 14,295 DBT (8,291 not dense, 6,004 dense) and 10,132 2D (6,943 not dense, 3,189 dense) exams. Thirty percent of women with dense tissue underwent supplemental screening ultrasound (US). All false negative exams were identified through PenRad and reviewed for method of diagnosis, breast density, and cancer type and size.

## RESULTS

The 2D cancer detection rate (per 1000) was significantly different for dense and non dense (7.3 versus 3.4,  $p=0.02$ ) however, it was similar in the DBT group (not dense 5.3, dense 5.4). Eleven cancers were identified as false negatives (10 Invasive, 1 DCIS): 6 in the 2D group (6/10,132, 0.6 per 1000) and 5 in the DBT group (5/14,295, 0.3 per 1000) ( $p=0.56$ , NS). Five were palpable interval cancers (4 in the 2D group and 1 in the DBT group). Missed cancers in the DBT group were smaller (mean 10mm, range 5-15mm) and more likely to be diagnosed by MRI (3/5, 60%) compared to those in the 2D group, which were larger (mean 20mm, range 10-45mm) and palpable (4/6, 67%). The missed cancer rate in the dense patients (6/9,193, 0.7 per 1000) was not significantly different to not dense patients (5/15,234, 0.3 per 1000) ( $p=0.39$ , NS). Of 3000 patients undergoing screening US, only two interval cancers were identified; one as a palpable mass 8 months after screening US, and the other as a new 8mm mass found on 6 months follow up of a different BIRADS 3 lesion.

## CONCLUSION

In our current practice, missed cancers were infrequent and occurred at a similar rate in dense as in non dense women. Cancers in false negative DBT exams were smaller and more likely to be found by MRI.

## CLINICAL RELEVANCE/APPLICATION

Current screening modalities including DBT and screening US are proving to result in a very low rate of missed and interval cancers.

**Interventional Series: Embolotherapy**

Tuesday, Dec. 1 8:30AM - 12:00PM Location: E351



AMA PRA Category 1 Credits™: 3.25  
ARRT Category A+ Credits: 3.50

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

**Participants**

Brian S. Funaki, MD, Riverside, IL (*Moderator*) Data Safety Monitoring Board, Novate Medical  
Rakesh C. Navuluri, MD, Chicago, IL (*Moderator*) Nothing to Disclose

**LEARNING OBJECTIVES**

1) Describe rationale of bariatric embolization. 2) Explain the rationale and 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 III endoleaks. 6) Describe approach to treatment of visceral aneurysms.

**Sub-Events****RC314-01 Using Glue-How I Do It**

Tuesday, Dec. 1 8:30AM - 8:45AM Location: E351

**Participants**

Yasuaki Arai, Tokyo, Japan (*Presenter*) Nothing to Disclose

**LEARNING OBJECTIVES**

View learning objectives under main course title.

**RC314-02 Empiric Embolization in Endoscopically Confirmed Non-variceal Acute Upper Gastrointestinal Hemorrhage is Expensive and Fails to Improve Clinical Outcome**

Tuesday, Dec. 1 8:45AM - 8:55AM Location: E351

**Participants**

Karunakaravel Karuppasamy, MBBS, FRCR, Westlake, OH (*Presenter*) Nothing to Disclose  
Bradley Martin, Cleveland, OH (*Abstract Co-Author*) Nothing to Disclose  
Gordon McLennan, MD, Chagrin Falls, OH (*Abstract Co-Author*) Research Grant, Siemens AG; Research Grant, C. R. Bard, Inc; Research Consultant, C. R. Bard, Inc; Research Consultant, Medtronic, Inc; Research Consultant, Siemens AG; Research Consultant, Surefire Medical, Inc; Research Consultant, Rene Medical; Advisory Board, Siemens AG; Advisory Board, Surefire Medical, Inc; Advisory Board, Medtronic, Inc;  
Abraham Levitin, MD, Cleveland, OH (*Abstract Co-Author*) Nothing to Disclose  
Baljendra S. Kapoor, MBBS, Cleveland, OH (*Abstract Co-Author*) Advisory Board, BTG International Ltd; Speaker, F. Hoffmann-La Roche Ltd  
Mark J. Sands, MD, Cleveland, OH (*Abstract Co-Author*) Nothing to Disclose  
Ram Kishore R. Gurajala, MBBS, FRCR, Beachwood, NJ (*Abstract Co-Author*) Nothing to Disclose

**PURPOSE**

To compare clinical outcomes, radiation exposure and costs of empiric embolization to no embolization after a negative angiogram in patients with esophagogastroduodenoscopically (EGD) confirmed non-variceal acute upper gastrointestinal source of bleeding (GIB).

**METHOD AND MATERIALS**

A retrospective review was performed of patients who had angiogram after EGD confirmed upper GIB between May 2011 and April 2013. 64 patients (43 male, 21 female) had no contrast extravasation. They were divided into two groups. Group 1 (n=30) had no embolization. Group 2 (n=34) had empiric embolization of gastroduodenal artery (n=23) or left gastric artery (n=11). Logistic and linear regression analyses were used to compare the groups. After adjusting for age and Rockall score, following clinical outcomes were measured: 30-day mortality, hospital stay, repeat procedures and transfusion requirements. Radiation exposure (fluoroscopy time and reference point air kerma) in both groups and cost of embolization in group 2 were collected.

**RESULTS**

Patients in groups 1 and 2 were similar in age and had similar Rockall scores (68.3 vs. 67.5 years, p=0.80, and 7.1 vs. 7.3, p=0.53, respectively). The 30-day mortality (30.0% vs. 23.5% (p=0.58)) and the mean hospitalization after angiogram (25.2 vs. 23.0 days (p=0.67)) were similar. Patients who had at least one repeat procedure (angiogram or endoscopy) after the initial angiogram was similar (50% vs. 50%, p=1.0). Among the available transfusion records (group 1=15; group 2=14), there was no difference in the units of packed red blood cells transfused after the initial angiogram (4.6 vs. 5.4, p=0.80). Reference point air kerma was similar (2147 vs. 2773 mGy, p= 0.19) but the fluoroscopy time was significantly higher in group 2 (17.7 vs 24.7 min, p=0.03). A total of 183 coils and 34 coil pushers were used during 32 angiograms in group 2. The mean combined cost of coils and coil pushers was \$1747 (SD 1573, range 30 to 6213).

**CONCLUSION**

In the absence of contrast extravasation, empiric embolization in acute non-variceal upper GIB fails to improve clinical outcomes compared to no embolization and is associated with higher fluoroscopy time and embolization costs.

**CLINICAL RELEVANCE/APPLICATION**

Small retrospective reviews have supported empiric embolization in acute upper GIB. However, with one of the largest series, our review fails to support the same which is associated with higher fluoroscopy time and costs.

### RC314-03 Endovascular Management of Delayed Postpancreatectomy Hemorrhage

Tuesday, Dec. 1 8:55AM - 9:05AM Location: E351

#### Participants

Maxime Ronot, MD, Clichy, France (*Abstract Co-Author*) Nothing to Disclose  
Edwige Pottier, Villejuif, France (*Abstract Co-Author*) Nothing to Disclose  
Sebastien Gaujoux, Clichy, France (*Abstract Co-Author*) Nothing to Disclose  
Alain Sauvanet, MD, Clichy, France (*Abstract Co-Author*) Nothing to Disclose  
Valerie Vilgrain, MD, Clichy, France (*Presenter*) Nothing to Disclose

#### PURPOSE

To assess the efficacy of endovascular management of delayed postpancreatectomy hemorrhage (PPH) as first line treatment.

#### METHOD AND MATERIALS

Between January 2005 and November 2013, all consecutive patients referred for endovascular treatment of PPH were included. Presence of active bleeding, pseudoaneurysm, arterial stenosis, collection, and culprit artery were recorded on pretreatment CT scans. Endovascular procedures were classified as technical success if bleeding origin was identified and treated, technical failure if identified bleeding was incompletely treated; and radiologic abstention if no abnormality was depicted and no treatment performed. Factors associated with postprocedural rebleeding were analyzed, together with second line treatments.

#### RESULTS

69 patients (53 men) were included with a mean age of 59 years (32-75). Pretreatment CT showed 27 (39%) active bleeding, 25 (36%) pseudoaneurysms, 2 (3%) arterial stenosis, and 44 (64%) postoperative collections. In 22 (32%) cases, no obvious culprit artery was found. Technical success, technical failure, or radiologic abstention were observed in 48 (70%), 9 (13%), and 12 patients (17%), respectively. 30 patients (44%) experienced rebleeding after a median delay of 2 days (range 0-46). Rebleeding rates were 29%, 58%, and 100% in case of success, abstention or failure at the first endovascular procedure, respectively ( $p < 0.001$ ). Treatment efficacy was the only factor associated with rebleeding (success vs failure  $p < 0.001$ ; success vs. abstention  $p = 0.09$ , abstention vs. failure  $p = 0.04$ , overall  $p < 0.001$ ). Rebleeding was treated by endovascular treatment, surgery, or both, in 12 (40%), 11 (37%) and 7 (23%) patients, respectively. Overall, 72% of the patients were successfully treated by endovascular procedures alone.

#### CONCLUSION

After a first endovascular procedure for PPH, almost half of patients rebleed. Rebleeding risk depends on the initial success of the procedure. Most patients are successfully treated by endovascular approach alone.

#### CLINICAL RELEVANCE/APPLICATION

Despite a high rebleeding rate, embolization should be proposed as first line treatment of post pancreatectomy hemorrhage because the majority of patients can be successfully treated by endovascular approach alone.

### RC314-04 Preoperative Embolization to Enhance Collateral Blood Flow via the Gastroduodenal Artery in Patients Undergoing Distal Pancreatectomy with Resection of the Celiac Axis

Tuesday, Dec. 1 9:05AM - 9:15AM Location: E351

#### Participants

Markus Zimmermann, MD, Aachen, Germany (*Presenter*) Nothing to Disclose  
Martin Liebl, MD, Aachen, Germany (*Abstract Co-Author*) Nothing to Disclose  
Maximilian F. Schulze-Hagen, MD, Aachen, Germany (*Abstract Co-Author*) Nothing to Disclose  
Federico Pedersoli, Aachen, Germany (*Abstract Co-Author*) Nothing to Disclose  
Maximilian Schmeding, Aachen, Germany (*Abstract Co-Author*) Nothing to Disclose  
Peter Isfort, MD, Aachen, Germany (*Abstract Co-Author*) Nothing to Disclose  
Christiane K. Kuhl, MD, Bonn, Germany (*Abstract Co-Author*) Nothing to Disclose  
Philipp Bruners, MD, Aachen, Germany (*Abstract Co-Author*) Nothing to Disclose

#### PURPOSE

Locally advanced pancreatic cancer with infiltration of the celiac axis carries a grave prognosis and has previously widely been considered as irresectable. Nevertheless, selected patients may benefit from distal pancreatectomy with resection of the celiac axis (DP-CAR). However, resection of the celiac axis may result in postoperative hepatic or gastric ischemia if collateral blood flow from the superior mesenteric artery (SMA) via the gastroduodenal artery (GA) is insufficient. We present a technique for preoperative angiographic evaluation and possibly enhancement of blood flow in this collateral by embolization of the celiac axis (CA) or the common hepatic artery (CHA).

#### METHOD AND MATERIALS

Between 2010 and 2015 six patients with locally advanced pancreatic cancer with invasion of the celiac axis underwent preoperative angiography and embolization of the celiac axis (4) or the common hepatic artery (2) before DP-CAR. 5F sheaths were placed in both common femoral arteries and through one sheath a catheter was introduced and placed in the SMA. Through the other sheath another catheter was simultaneously placed in the CA/CHA and an Amplatzer™ vascular plug was deployed - without releasing it - for temporary occlusion of the CA/CHA. Subsequently, an angiography of the SMA was performed to evaluate retrograde blood flow from the SMA via the GA to the proper hepatic artery. If sufficient retrograde flow via the GA was present, the Amplatzer™ plug was permanently released in order to further increase the flow rate in this collateral.

#### RESULTS

All six patients demonstrated sufficient collateral blood flow via the GA and consecutively underwent successful embolization of

either the CA or the CHA. No peri-interventional complications were noted. Eventually, five patients were treated with DP-CAR, of which four histologically demonstrated clear surgical margins (R0). One patient did not undergo DP-CAR because of intraoperatively discovered peritoneal metastases.

## CONCLUSION

The presented technique allows safe preoperative angiographic evaluation and possibly enhancement of collateral bloodflow from the SMA via the GA in patients undergoing DP-CAR, in order to reduce the risk of postoperative morbidity from hepatic or gastric ischemia.

## CLINICAL RELEVANCE/APPLICATION

Our technique allows preoperative evaluation and possibly enhancement of collateral blood flow from the SMA via the gastroduodenal artery in patients undergoing DP-CAR.

### RC314-05 Embolotherapy-My Worst Cases

Tuesday, Dec. 1 9:15AM - 9:30AM Location: E351

#### Participants

Robert A. Morgan, MD, London, United Kingdom, (robert.morgan@stgeorges.nhs.uk) (*Presenter*) Proctor, Medtronic, Inc

## LEARNING OBJECTIVES

View learning objectives under main course title.

## ABSTRACT

### RC314-06 The Type III Endoleak-The Great Pretender

Tuesday, Dec. 1 9:30AM - 9:45AM Location: E351

#### Participants

Brian S. Funaki, MD, Riverside, IL (*Presenter*) Data Safety Monitoring Board, Novate Medical

## LEARNING OBJECTIVES

View learning objectives under main course title.

### RC314-07 Case of the Session-Splenic Artery Embolization (or Lack Thereof)

Tuesday, Dec. 1 10:05AM - 10:20AM Location: E351

#### Participants

Brian S. Funaki, MD, Riverside, IL (*Presenter*) Data Safety Monitoring Board, Novate Medical

## LEARNING OBJECTIVES

View learning objectives under main course title.

### RC314-08 High Flow Malformations-How I Treat Them

Tuesday, Dec. 1 10:20AM - 10:35AM Location: E351

#### Participants

James E. Jackson, MD, London, United Kingdom (*Presenter*) Nothing to Disclose

## LEARNING OBJECTIVES

1) To understand the indications for treatment of high-flow vascular malformations. 2) To understand the differing vascular anatomy of arteriovenous malformations and how this affects treatment approach and outcome. 3) To understand those methods of embolization of arteriovenous malformations that are likely to improve results and reduce complications.

## ABSTRACT

The most important aspect of embolization of high-flow vascular malformations is an understanding of the anatomy of the vascular communications within them as this has a bearing both upon the method of vascular occlusion and on the final result. Whatever the anatomy, however, the general principle is that occlusion is performed at the site of the abnormal arteriovenous shunts and not in the vessel proximal to this point. The embolization of arterial feeding vessels, which was performed for many years with metallic coils or particulate matter such as polyvinyl alcohol, is akin to proximal surgical ligation and must be avoided. It has little effect upon symptoms in most individuals and renders subsequent treatment more difficult because the arterial inflow vessels have been occluded. If, however, the embolization is directed at the AV communications themselves, from an arterial approach, via a direct percutaneous puncture or retrogradely from the venous side, and these are totally obliterated - often with a liquid embolic agent - then a long-term improvement in symptoms can be achieved. This presentation will concentrate on the radiological management of these high-flow lesions. The cure of a high flow vascular anomaly is uncommon although there is no doubt that radiological and clinical obliteration of more malformations has come with a better understanding of their radiological anatomy and the use of agents that are directed at the AV shunts themselves rather than at the proximal feeding vessels.

### RC314-09 Value of Embolization in the Management of Pelvic Venous Incompetence

Tuesday, Dec. 1 10:35AM - 10:45AM Location: E351

#### Participants

Marc Antoine Jegonday, Caen, France (*Presenter*) Nothing to Disclose

Vincent Le Pennec Sr, MD, Caen, France (*Abstract Co-Author*) Educator, Cook Group Incorporated

Audrey Fohlen, Caen, France (*Abstract Co-Author*) Nothing to Disclose

Bertrand Lamy, Caen, France (*Abstract Co-Author*) Nothing to Disclose

Jean-Pierre J. Pelage, MD, PhD, Caen, France (*Abstract Co-Author*) Research Grant, Merit Medical Systems, Inc; Consultant, Merit Medical Systems, Inc; Research Grant, Cook Group Incorporated; Consultant, Cook Group Incorporated; Research Grant, Keocyt; Medical Board, Keocyt; Research Grant, Terumo Corporation; Consultant, Terumo Corporation; Research Grant, ALN; Consultant, ALN; Consultant, Boston Scientific Corporation; Research Grant, BTG International Ltd

## PURPOSE

To assess the efficacy of embolotherapy to treat symptomatic pelvic venous incompetence (PVI).

## METHOD AND MATERIALS

Retrospective evaluation of women with symptomatic PVI treated with embolization. Primary clinical success defined as decrease in pelvic and lower limb pain using a visual analogue scale (VAS). Associated symptoms including dyspareunia, vulvar pain or lower limb venous insufficiency as well as complications were also assessed.

## RESULTS

A total of 114 women (mean age  $40.9 \pm 10.3$  years) including 74% with pelvic pain (VAS of  $6.5 \pm 1.8$ ) and 64% with lower limb pain (VAS of  $5.6 \pm 2.1$ ) were treated. The most common incompetent veins were the left ovarian (82%), internal pudendal (right 49%; left 39%), inferior gluteal (right 32%; left 31%) and uterine (right 19%; left 23%) veins. Technical success was 89%. Follow-up included consultation organized after  $3.5 \pm 4.0$  months and consultation or telephone interview after  $50 \pm 34.6$  months, respectively. Pelvic pain VAS decreased to  $1.6 \pm 2.4$  ( $p < 0.0001$ ) and  $1.0 \pm 2.2$  ( $p < 0.0001$ ) at the first and second visits, respectively, with a long term success of 94%. Mean lower limb pain VAS decreased to  $3.6 \pm 2.7$  ( $p < 0.0001$ ) and  $2.5 \pm 2.6$  ( $p < 0.0001$ ) at the 2 time-points, with a long term success of 88%. VAS decreased significantly between short and long term evaluations. Clinical improvement of associated symptoms was also observed. Major complication rate was low (9%).

## CONCLUSION

Embolization of symptomatic PVI is a safe and effective treatment in well-selected patients, with a progressive and long-lasting clinical success.

## CLINICAL RELEVANCE/APPLICATION

Embolization is safe and effective to treat symptomatic PVI and is recommended when a pelvic venous origin of symptoms is established.

### RC314-10 Endovascular Management of Hemoptysis Including Coil and/or Particle Embolization: 6 Year Single Institution Comparative Experience

Tuesday, Dec. 1 10:45AM - 10:55AM Location: E351

#### Participants

Orrie N. Close, MD, Pittsburgh, PA (*Presenter*) Nothing to Disclose  
Kevin M. McCluskey, MD, Pittsburgh, PA (*Abstract Co-Author*) Nothing to Disclose  
Donghoon Shin, MS, Pittsburgh, PA (*Abstract Co-Author*) Nothing to Disclose  
Kevin Ching, MD, Pittsburgh, PA (*Abstract Co-Author*) Nothing to Disclose  
Robert F. Short, MD, PhD, Charlottesville, VA (*Abstract Co-Author*) Nothing to Disclose

## PURPOSE

To evaluate clinical outcomes for endovascular treatment of hemoptysis with microcoils and/or microparticles for bronchial and non-bronchial systemic artery embolization

## METHOD AND MATERIALS

A single institution IRB-approved review included all patients who underwent embolization for hemoptysis from 12/2008 to 12/2014. Patient demographics, technical details, angiographic findings, complications, rate of recurrence, and need for repeat intervention were reviewed. Person-years were calculated to evaluate the incidence of recurrence by endovascular treatment method. Statistical analyses were performed using Fisher's exact and chi-square tests.

## RESULTS

114 embolizations were performed in 97 patients for hemoptysis. 56 embolization procedures performed in 48 patients (mean: 58 y; range 20-91y) employed microcoils ( $< 0.18$  inch). (Of these, 10 patients received microcoil embolization only.) 58 microparticle embolizations were performed in 49 patients (52 y; range 24-84y). Rebleeding occurred following 23 (41.1%) coil embolizations and 24 (42.1%) microparticle embolizations ( $p = 1.00$ ). Incidence of rebleeding in the coil and particle embolization groups were 50.6 and 64.6 per 100 person-years respectively ( $p = .5$ ). The incidence ratio between the groups was 1.28 (95% CI: 0.69, 2.37). Complication rate was 7.1% in the coiling group (bronchial arterial dissections:  $n = 4$ ) vs. 10.3% in the particle embolization only group (arterial dissections:  $n = 4$ , spinal cord infarction:  $n = 1$ , and access site retroperitoneal hemorrhage:  $n = 1$ ). ( $p = 1.0$ ). One procedure for recurrent hemorrhage was impeded by previously placed embolization coils.

## CONCLUSION

Transcatheter embolization for hemoptysis is safe and effective using microcoils and/or microparticles. The incidence rate of recurrent hemoptysis following microcoil vs. microparticle embolization is not significantly different.

## CLINICAL RELEVANCE/APPLICATION

Use of microcoils for transcatheter embolization in the treatment of hemoptysis can be safely performed with similar clinical efficacy and complication rates as that of microparticles.

### RC314-11 Amplatzer Plugs versus Coils for Pulmonary Arteriovenous Malformations Embolization in HHT Patients - Long Term Results

Tuesday, Dec. 1 10:55AM - 11:05AM Location: E351

#### Participants

Noam Tau, MD, Petah Tikva, Israel (*Presenter*) Nothing to Disclose  
Eli Atar, MD, Petah Tikva, Israel (*Abstract Co-Author*) Nothing to Disclose  
Meir Mei-Zahav, MD, Petah Tikva, Israel (*Abstract Co-Author*) Nothing to Disclose  
Tamir Dagan, MD, Petah Tikva, Israel (*Abstract Co-Author*) Nothing to Disclose  
Einat Birk, MD, Petah Tikva, Israel (*Abstract Co-Author*) Nothing to Disclose  
Elchanan Bruckheimer, MBBS, Petah Tikva, Israel (*Abstract Co-Author*) Medical Director, RealView Imaging Ltd; Employee, RealView Imaging Ltd; Shareholder, RealView Imaging Ltd; Consultant, Getinge AB; Consultant, Valtec Cardio Ltd; Consultant, Enopace Biomedical Ltd; Medical Director, Vascular Platforms Ltd; Shareholder, Vascular Platforms Ltd; Medical Director, Restore Medical, Inc; Shareholder, Restore Medical, Inc

## PURPOSE

Evaluation of safety and efficacy of Amplatzer vascular plugs in percutaneous embolization of PAVMs in HHT patients, and comparison to the use of coils.

## METHOD AND MATERIALS

Retrospective analysis of all percutaneous PAVMs embolization performed between 2004 and 2014 in our institution. Data from patient files was collected regarding method of embolization (Amplatzer plugs, coils or both) and regarding all complications. Data regarding rates of re-canalization in treated PAVMs was assessed from follow-up imaging (following percutaneous procedure or CT Angiography).

## RESULTS

36 patients [19M, 17F], median age 32.5 years [1.9-72.7 years] underwent 51 percutaneous trans-catheter procedures at our institution and 8 procedures in outside institutions, with embolization of a total of 142 simple or complex PAVMs [72 coils, 56 Amplatzer plugs and 14 plugs and coils]. Two patients had self-resolving mild hemoptysis following embolization. No other major procedure-related complications occurred. Of this group, 16 patients with 63 PAVMs that were occluded [37 with coils, 21 with Amplatzer plugs and 5 with both plugs and coils] underwent follow-up imaging [13 angiographies, 1 CT Angiography]. 7 PAVMs showed re-canalization of occluded vessels, at a median follow-up of 8.6 years [1.5-18.11 years]. All re-canalizations occurred in coiled vessels. No re-canalizations occurred through Amplatzer plugs [7/37 vs. 0/21], p-value = 0.0413 (Fisher's exact test).

## CONCLUSION

The use of Amplatzer plugs for PAVMs embolization in HHT patients appears to be safe and effective, and has a lower re-canalization rate of feeding vessels compared to coils.

## CLINICAL RELEVANCE/APPLICATION

The use of coils as the standard of care for PAVMs embolization should be re-evaluated, since the use of Amplatzer vascular plugs is shown to have better long term results, without additional risks.

## RC314-12 Bariatric Embolization for Morbid Obesity, First Western Hemisphere Experience: Gastric Artery Embolization Trial for Lessening Appetite Nonsurgically (GET LEAN)

Tuesday, Dec. 1 11:05AM - 11:15AM Location: E351

### Participants

Mubin I. Syed, MD, Dayton, OH (*Presenter*) Consultant, CareFusion Corporation;  
Kamal Morar, MD, Dayton, OH (*Abstract Co-Author*) Nothing to Disclose  
Azim Shaikh, MD, MBA, Dayton, OH (*Abstract Co-Author*) Nothing to Disclose  
Paul Craig, MD, MA, Minneapolis, MN (*Abstract Co-Author*) Nothing to Disclose  
Talal Akhter, MD, Philadelphia, PA (*Abstract Co-Author*) Nothing to Disclose  
Hooman Khabiri, MD, Columbus, OH (*Abstract Co-Author*) Nothing to Disclose  
Omar Khan, Dayton, OH (*Abstract Co-Author*) Nothing to Disclose

## PURPOSE

The purpose of this pilot study is to achieve the collection of safety and efficacy data in patients undergoing left gastric artery embolization for morbid obesity in the Western Hemisphere.

## METHOD AND MATERIALS

This is an FDA-IDE pilot study. 5 patients have been approved to undergo the left gastric artery embolization procedure for the purpose of weight loss using Beadblock 300-500 micron particles. All patients will undergo EGD follow up pre and post procedure. Ghrelin, Leptin and CCK levels will also be measured at baseline and post procedure per follow up protocol. Inclusion Criteria Morbid obesity with a BMI  $\geq 40$  Age  $\geq 22$  years Ability to lay supine on an angiographic table  $<400$  lbs due to table weight limits Appropriate anesthesia risk as determined by certified anesthesia provider evaluation preprocedure Subjects who have failed previous attempts at weight loss through diet, exercise, and behavior modification (as it is recommended that conservative options, such as supervised low-calorie diets combined with behavior therapy and exercise, should be attempted prior to enrolling in this study).

## RESULTS

The first patient has lost 30lbs at 3 months. Second patient has lost 12lbs at 1 month. Third patient has lost 6lbs in 1 week. There have been no major adverse events. The final 2 patients in this study are still being selected.

## CONCLUSION

This is the first experience in the United States of performing left gastric artery embolization for the purpose of treating morbid obesity. Early results are promising and show no major adverse events thus far. The radial artery has also proven to be a feasible approach to performing this procedure with implications for a safer access site.

## CLINICAL RELEVANCE/APPLICATION

Morbid obesity is a prevalent and deadly public health problem. Obesity affects about 30% of the United States population. It is responsible for numerous comorbidities including diabetes mellitus and its complications, cardiovascular disease, sleep apnea, and premature osteoarthritis. This is the first use of left gastric artery embolization in the Western Hemisphere to treat morbid obesity.



This is also the first radial artery access experience with implications for the morbidly obese where groin access may be more challenging.

#### **RC314-13   Bariatric Embolization. Is This the Next Big Thing?**

Tuesday, Dec. 1 11:15AM - 11:30AM Location: E351

Participants

Mubin I. Syed, MD, Dayton, OH (*Presenter*) Consultant, CareFusion Corporation;

##### **LEARNING OBJECTIVES**

View learning objectives under main course title.

##### **ABSTRACT**

Bariatric embolization is an exciting new procedure for the postential treatment of obesity. This talk outlines the background behind the procedure as well as the latest human experience.

#### **RC314-14   Visceral Aneurysms**

Tuesday, Dec. 1 11:30AM - 11:45AM Location: E351

Participants

Michael D. Darcy, MD, Saint Louis, MO (*Presenter*) Speakers Bureau, W. L. Gore & Associates, Inc; Speaker, Cook Group Incorporated;

##### **LEARNING OBJECTIVES**

1) The incidence and presentation of visceral aneurysms. 2) The indications for treating visceral aneurysms. 3) Techniques for treating visceral aneurysms. 4) Potential complications from treatment of visceral aneurysms.

#### **RC314-15   Wrap Up and Discussion**

Tuesday, Dec. 1 11:45AM - 12:00PM Location: E351

Participants

RC318

## Interactive Quiz Cases in Neuro-oncologic Imaging (An Interactive Session)

Tuesday, Dec. 1 8:30AM - 10:00AM Location: E352



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

### Participants

#### LEARNING OBJECTIVES

Please bring your charged mobile wireless device (phone, tablet or laptop) to participate.

### Sub-Events

#### RC318A Spine

##### Participants

James C. Anderson, MD, Portland, OR (*Presenter*) Nothing to Disclose

#### LEARNING OBJECTIVES

1) Review imaging of tumors of the spine. 2) Identify aspects of spinal tumors that affect staging, treatment and management  
3) Highlight roles of various imaging modalities.

#### ABSTRACT

Review imaging of tumors of the spine Review aspects of spinal tumors that affect staging, treatment and management Review roles of various imaging modalities

#### RC318B Head and Neck/ENT

##### Participants

Suresh K. Mukherji, MD, Northville, MI (*Presenter*) Nothing to Disclose

#### LEARNING OBJECTIVES

1) Review common head and neck tumors. 2) Identify pertinent imaging findings that show how imaging affects staging. 3) Highlight specific imaging findings that will affect staging, treatment and management.

#### ABSTRACT

Review common tumors of the head and neck Review imaging findings in head and neck malignancies that specifically change staging Review the value of imaging in directly affecting management and treatment

#### RC318C Brain

##### Participants

Megan K. Strother, MD, Nashville, TN (*Presenter*) Nothing to Disclose

#### LEARNING OBJECTIVES

1) Identify basic anatomic, pathologic, and physiologic principles as they apply to neuro-oncologic imaging of the brain.

#### ABSTRACT

Five interactive neuro-oncologic cases will be presented in an interactive format. Participants will review basic knowledge and skills that are relevant to the clinical practice of neuroradiology, while evaluating the results of the latest research in neuro-oncologic imaging.



**Pediatric Series: CV/Chest**

Tuesday, Dec. 1 8:30AM - 12:00PM Location: E353A

CH

VA

CT

MR

PD

AMA PRA Category 1 Credits™: 3.25  
ARRT Category A+ Credits: 3.50

FDA

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

Shreyas S. Vasanawala, MD, PhD, Palo Alto, CA (*Moderator*) Research collaboration, General Electric Company; Consultant, Arterys; Research Grant, Bayer AG;  
Lorna Browne, MD, FRCR, Denver, CO (*Moderator*) Nothing to Disclose  
Rajesh Krishnamurthy, MD, Houston, TX (*Moderator*) Research support, Koninklijke Philips NV; Research support, Toshiba Corporation  
R. Paul Guilleman, MD, Houston, TX (*Moderator*) Nothing to Disclose

**Sub-Events****RC313-01 Imaging of Aortopathies**

Tuesday, Dec. 1 8:30AM - 8:50AM Location: E353A

**Participants**

Cynthia K. Rigsby, MD, Chicago, IL, (crigsby@luriechildrens.org) (*Presenter*) Nothing to Disclose

**LEARNING OBJECTIVES**

1) Define aortopathy. 2) Describe the imaging features of common aortopathies. 3) Show potential complications associated with aortopathies.

**RC313-02 4D flow MRI Based Volumetric Aortic Peak Velocity Quantification: Efficiency, Observer Variability and Comparison to 2D Phase Contrast MRI**

Tuesday, Dec. 1 8:50AM - 9:00AM Location: E353A

**Participants**

Michael Rose, Chicago, IL (*Presenter*) Nothing to Disclose  
Kelly Jarvis, Chicago, IL (*Abstract Co-Author*) Nothing to Disclose  
Varun Chowdhary, MD, BS, Chicago, IL (*Abstract Co-Author*) Nothing to Disclose  
Alex Barker, Chicago, IL (*Abstract Co-Author*) Nothing to Disclose  
Bradley D. Allen, MD, Chicago, IL (*Abstract Co-Author*) Nothing to Disclose  
Joshua D. Robinson, MD, Chicago, IL (*Abstract Co-Author*) Nothing to Disclose  
Michael Markl, PhD, Chicago, IL (*Abstract Co-Author*) Nothing to Disclose  
Susanne Schnell, Chicago, IL (*Abstract Co-Author*) Nothing to Disclose  
Cynthia K. Rigsby, MD, Chicago, IL (*Abstract Co-Author*) Nothing to Disclose

**PURPOSE**

Standard methods for measuring peak blood flow velocity include Doppler echocardiography and 2D CINE phase contrast (PC) MRI. Due to their reliance on single-direction velocity encoding and regional flow analysis (2D planes) both methods can underestimate peak velocities, especially in cases of complex flow jets as commonly seen in patients with abnormal aortic valves. The aim of this study was to test the feasibility and efficiency of a new method for volumetric peak velocity quantification of aortic peak systolic blood flow velocities in a cohort of pediatric BAV patients using 4D flow MRI and velocity maximum intensity projections (MIPs).

**METHOD AND MATERIALS**

51 pediatric BAV patients (age =  $14 \pm 5$ , range = 3-24 years, 18 female) underwent aortic 4D flow MRI (1.5T Aera, Siemens, Germany). After pre-processing (velocity anti-aliasing, phase offset correction) and 3D segmentation of the aorta, velocity MIPs were generated to determine peak velocities in the ascending aorta, arch, and descending aorta by two independent observers. 4D flow derived peak velocities were compared to results from 2D CINE PCMRI from the same study for 36 BAV patients.

**RESULTS**

4D flow peak systolic velocities were significantly higher than 2D CINE PC MRI ( $2.02 \pm 0.72$  m/s vs  $1.72 \pm 0.81$  m/s,  $p = 0.0001$ , Wilcoxon signed-rank test). Bland-Altman analysis of peak velocity assessment showed excellent inter-observer variability (mean difference =  $-0.005$  m/s, limits of agreement =  $\pm 0.192$  m/s) with low average inter-observer error 2.0 %. The estimated time for 4D flow MRI pre-processing and segmentation was 20 min. Average analysis time (calculation of velocity MIP, ROI analysis) was  $92 \pm 49$  s.

**CONCLUSION**

4D flow MRI in combination with 3D segmentation of the aorta and velocity MIP analysis can be used to determine aortic peak systolic velocity with high efficiency and low observer variability. The full volumetric coverage and 3-directional velocity of 4D flow MRI fully captures complex aortic flow patterns and is thus better suited to identify the highest velocity in an entire aortic segment compared to 2D CINE PC MRI, which underestimated peak velocities in our BAV cohort by 15%.

**CLINICAL RELEVANCE/APPLICATION**

In patients with aortic valve disease such as bicuspid aortic valve (BAV), the severity of valve disease is characterized using peak blood velocity to estimate the peak transvalvular pressure gradient (via the simplified Bernoulli equation).

### **RC313-03 Accuracy of Ventricular Septal Defect Measurements by High Pitch Computed Tomography Angiography of the Thorax in Pediatric Patients Younger Than One Year Compared to Echocardiographic and Intraoperative Measurements**

Tuesday, Dec. 1 9:00AM - 9:10AM Location: E353A

#### **Participants**

Matthias S. May, Erlangen, Germany (*Presenter*) Speakers Bureau, Siemens AG  
David Nau, Erlangen, Germany (*Abstract Co-Author*) Nothing to Disclose  
Oliver Rempel, MD, Erlangen, Germany (*Abstract Co-Author*) Nothing to Disclose  
Matthias Hammon, MD, Erlangen, Germany (*Abstract Co-Author*) Nothing to Disclose  
Michael Uder, MD, Erlangen, Germany (*Abstract Co-Author*) Speakers Bureau, Bracco Group; Speakers Bureau, Siemens AG; Research Grant, Siemens AG;  
Michael M. Lell, MD, Erlangen, Germany (*Abstract Co-Author*) Research Grant, Siemens AG; Speakers Bureau, Siemens AG; Research Grant, Bayer AG ; Speakers Bureau, Bayer AG; Research Consultant, Bracco Group; ;  
Wolfgang Wust, MD, Erlangen, Germany (*Abstract Co-Author*) Speakers Bureau, Siemens AG

#### **PURPOSE**

Preoperative assessment of VSDs is routinely performed by echocardiography. However, it seems to be challenging to obtain precise and reproducible findings, due to the limited angulations that are available. Additional preoperative evaluation by Computed Tomography (CT) has become reasonable in the recent years for complex congenital heart disease and allow for assessment of the size of VSDs in a static and isovolumetric dataset. Our aim was to evaluate the accuracy of size measurement of congenital ventricular septal defects (VSD) using High Pitch Computed Tomography Angiography of the thorax compared to echocardiography and intraoperative findings in children with congenital heart disease below 1 year.

#### **METHOD AND MATERIALS**

Angiography of the chest was performed using a second and third generation Dual-Source CT in 54 patients (median age 7 days, range 1-348 days) with a high-pitch protocol ( $p=3.2-3.4$ ) at low tube voltages (70-80 kV). The margins of the VSDs were angulated by Multiplanar Reformations and Minimum Intensity Projection (MinIP) was used to overcome partial volume effects. The results were compared to the measurements from echocardiography and intraoperative measurements served as reference.

#### **RESULTS**

Mean deviation of the CT-measurements compared to the intraoperative findings was not statistically significant ( $3.5 \pm 3.0$  mm,  $p=0.21$ ), while the mean difference compared to echocardiography was significantly higher ( $7.4 \pm 4.8$  mm,  $p<0.01$ ). The VSDs can be classified into four different types by CT. With the exception of apical septal defects the size of the defects seems not to correlate with a specific location. Median radiation dose was as low as 0.37 mSv (range 0.12 - 2.00 mSv).

#### **CONCLUSION**

High Pitch Computed Tomography Angiography of the thorax provides precise measurements of VSDs in pediatric patients with congenital heart disease younger than one year.

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

Preoperative High Pitch Computed Tomography Angiography of the thorax, besides the advantages in imaging of the coronaries and great intrathoracic vessels, provides precise measurements of VSDs at reasonable low radiation dose.

### **RC313-04 Image Quality and Accuracy of a Prototype Self-Navigated 3D Whole-heart Sequence for the Assessment of Coronary Artery Anomalies in a Pediatric Patient Population**

Tuesday, Dec. 1 9:10AM - 9:20AM Location: E353A

#### **Participants**

Giuseppe Muscogiuri, MD, Charleston, SC (*Presenter*) Nothing to Disclose  
Akos Varga-Szemes, MD, PhD, Charleston, SC (*Abstract Co-Author*) Nothing to Disclose  
Carlo N. De Cecco, MD, PhD, Charleston, SC (*Abstract Co-Author*) Nothing to Disclose  
Pal Suranyi, MD, PhD, Charleston, SC (*Abstract Co-Author*) Nothing to Disclose  
Julian L. Wichmann, MD, Charleston, SC (*Abstract Co-Author*) Nothing to Disclose  
U. Joseph Schoepf, MD, Charleston, SC (*Abstract Co-Author*) Research Grant, Bracco Group; Research Grant, Bayer AG; Research Grant, General Electric Company; Research Grant, Siemens AG; Research support, Bayer AG; ;  
Paola Maria Cannao, MD, San Donato Milanese, Italy (*Abstract Co-Author*) Nothing to Disclose  
Stefanie Mangold, MD, Charleston, SC (*Abstract Co-Author*) Nothing to Disclose  
Davide Piccini, Lausanne, Switzerland (*Abstract Co-Author*) Employee, Siemens AG  
Wolfgang Rehwald, Erlangen, Germany (*Abstract Co-Author*) Employee, Siemens AG  
Anthony M. Hlavacek, MD, Charleston, SC (*Abstract Co-Author*) Investigator, Siemens AG Research Grant, Siemens AG  
Arni C. Nutting, MD, Charleston, SC (*Abstract Co-Author*) Research Grant, Siemens AG

#### **PURPOSE**

The aim of this study was to assess the feasibility, image quality, and diagnostic performance of a prototype non-contrast enhanced self-navigated 3D (SN3D) whole-heart MRA acquisition in comparison with coronary CT angiography (cCTA) for delineating the coronary artery origin and proximal course in pediatric patients with suspected coronary artery anomalies.

#### **METHOD AND MATERIALS**

Seven patients (13 $\pm$ 3 years) with suspected coronary artery anomalies underwent a reference standard cCTA (SOMATOM Flash, Siemens Healthcare, Forchheim, Germany) and a research non-contrast cardiac MRA (MAGNETOM Avanto 1.5T, Siemens Healthcare, Erlangen, Germany) for the assessment of the origin and proximal course of the coronary arteries. The steady-state free precession based SN3D MRA was performed using the following parameters: TR/TE 3.1/1.5ms, flip angle 115°, FOV 220mm, voxel size: 1.1mm<sup>3</sup>, and 12064 radial views distributed over 377 heartbeats. Subjective image quality of the SN3D MRA and cCTA was evaluated using a 4-grade scale (1, nondiagnostic; 2, sufficient; 3, good; 4, excellent). Visualization of the left main, left anterior descending (LAD), circumflex (LCX) and right coronary arteries (RCA), as well as the time of acquisition and signal to noise

ratio (SNR), were assessed. Wilcoxon test was used to compare subjective image quality between cCTA and MRA.

## RESULTS

The acquisition time of the SN3D MRA was  $5.9 \pm 1.4$  min with an average heart rate of 81 bpm, while the mean SNR was  $27 \pm 9$ . MRA and cCTA image quality ratings were  $2.3 \pm 0.7$  and  $3.3 \pm 0.7$ , respectively ( $p > 0.05$ ). SN3D MRA allowed the visualization of the left main, the LAD and the RCA with good agreement to cCTA in all cases, but failed to visualize the LCX in a single case.

## CONCLUSION

In this preliminary study there was good agreement for the evaluation of coronary artery anatomy between SN3D MRA and cCTA. The novel radial SN3D sequence allows for the acquisition of an isotropic volume in a free-breathing fashion in about half the time as a standard respiratory-navigated coronary MRA, with an improved ease of use, without penalties in image quality, and without radiation exposure, contrast agent administration or the need for general anesthesia.

## CLINICAL RELEVANCE/APPLICATION

This non-contrast self-navigated MRA sequence provides relatively rapid, free-breathing radiation-free evaluation of anomalies of the coronary artery origin and proximal course in children.

### RC313-05 Contrast Material Injection via Fenestrated Catheters is Useful in Pediatric Patients with Congenital Heart Disease Undergoing CT Angiography

Tuesday, Dec. 1 9:20AM - 9:30AM Location: E353A

#### Participants

Takanori Masuda, Hiroshima, Japan (*Presenter*) Nothing to Disclose  
Yoshinori Funama, PhD, Kumamoto, Japan (*Abstract Co-Author*) Nothing to Disclose  
Masao Kiguchi, RT, Hiroshima, Japan (*Abstract Co-Author*) Nothing to Disclose  
Takayuki Oku, Hiroshima, Japan (*Abstract Co-Author*) Nothing to Disclose  
Naoyuki Imada, Hiroshima, Japan (*Abstract Co-Author*) Nothing to Disclose  
Kazuo Awai, MD, Hiroshima, Japan (*Abstract Co-Author*) Research Grant, Toshiba Corporation; Research Grant, Hitachi, Ltd; Research Grant, Bayer AG; Research Grant, DAIICHI SANKYO Group; Medical Advisor, DAIICHI SANKYO Group; Research Grant, Eisai Co, Ltd; Research Grant, Nemoto-Kyourindo; ; ; ;  
Tomoyasu Sato, Hiroshima, Japan (*Abstract Co-Author*) Nothing to Disclose  
Noritaka Noda, Hiroshima, Japan (*Abstract Co-Author*) Nothing to Disclose

## PURPOSE

While 3D CT angiography (CTA) images are useful for evaluating the complex anatomy in patients with congenital heart disease, they require higher contrast enhancement to identify blood vessels and soft tissues. However, the thin pediatric vessel wall imposes an injection pressure limit and can result in poor CT enhancement. As the gauge of the fenestrated- is smaller than of the conventional nonfenestrated catheter, optimal enhancement can be achieved by controlling the injection pressure. We compared the injection rate, aortic enhancement, and injection pressure when intravenous contrast material was injected with fenestrated- and conventional non-fenestrated catheters.

## METHOD AND MATERIALS

We randomly divided 34 pediatric patients seen between December 2014 and March 2015 into two groups. Group A consisted of 18 children (age one week to 8 months, body weight  $3.6 \pm 1.2$  kg) and group B of 16 (age one week to 12 months, body weight  $3.3 \pm 0.9$  kg). In group A we delivered the contrast medium via a 22-gauge conventional non-fenestrated catheter and in group B we used a 24-gauge fenestrated catheter. Whole-heart helical CTA scans were performed on a 64-detector scanner (GE VCT, tube voltage 80 kVp, detector configuration  $64 \times 0.625$  mm, rotation time 0.4s/r, helical pitch 1.375, preset AEC noise index 12) and the injection rate, aortic enhancement, and injection pressure were compared in groups A and B.

## RESULTS

The mean injection rate and aortic enhancement were  $0.9 \pm 0.1$  ml/sec and  $468 \pm 45.0$  HU in group A and  $0.87 \pm 0.3$  ml/sec and  $444 \pm 63.5$  HU in group B. There was no significant difference in the injection rate and aortic enhancement ( $p = 0.34$ ,  $p = 0.38$ ). The maximum injection pressure was significantly lower in group B than group A ( $0.33$  vs.  $0.55$  kg/cm<sup>2</sup>,  $p < 0.05$ ).

## CONCLUSION

Use of the fenestrated catheter decreases the injection pressure limit while retaining the injection rate and aortic enhancement of conventional catheters.

## CLINICAL RELEVANCE/APPLICATION

With use of the fenestrated catheter, pediatric CT angiography obtains the optimal aortic enhancement by changing injection rate in safety.

### RC313-06 The Impact of Dual-source Parallelradiofrequency Transmission with Patient-adaptive Shimming on the 3.0 T Cardiac Magnetic Resonance in Children

Tuesday, Dec. 1 9:30AM - 9:40AM Location: E353A

#### Participants

Haipeng Wang, Jinan, China (*Abstract Co-Author*) Nothing to Disclose  
Cuiyan Wang, MD, PhD, Jinan, China (*Abstract Co-Author*) Nothing to Disclose  
Fei Gao, Jinan, China (*Abstract Co-Author*) Nothing to Disclose  
Bin Zhao, MD, Jinan, China (*Presenter*) Nothing to Disclose

## PURPOSE

To evaluate the effect of dual-source parallel RF transmission on the B1 homogeneity, the image quality (image contrast and off-resonance artifacts) in the cine b-SSFP sequence and the repeatability of left-ventricle cardiac function in 3.0T CMR of children.

## METHOD AND MATERIALS

The prospective intraindividual comparison study was approved by the institutional ethics committee and written informed consent was obtained. The 3.0T cardiac magnetic resonance (CMR) was performed in 30 chronic myocarditis children by using the dual-source radiofrequency (RF) transmission with patient-adaptive RF shimming. B1 homogeneity and image contrast with and without RF shimming were quantitatively evaluated and t-test was used for statistical significance. The off-resonance artifacts were evaluated independently by two readers. Statistical significance was assessed by the Mann-Whitney U test and inter-observer agreement by Cohen's kappa test. The inter-observer agreement of LV cardiac function with dual-source RF transmission was evaluated by Bland-Altman analysis and the intra-class correlation coefficient (ICC).

## RESULTS

Compared with single-source RF transmission, dual-source RF transmission with patient-adaptive RF shimming performed a higher mean percentage of flip angle (FA), lower coefficient of variation (CV) and higher image contrast in both free-breathe (NBH) and breathe-hold (BH) scanning (  $P < 0.05$  for all). The scores of off-resonance artifacts with patient-adaptive RF shimming were lower than that without RF shimming (  $P < 0.05$ ) and inter-observer agreement between two readers was good to very good (kappa values from 0.66 to 0.86). A high level inter-observer agreement for cardiac function with RF shimming was acquired both in NBH scanning (CV: 1.91%-11.84%; ICC, 0.83-0.98) and BH scanning (CV: 0.52%-4.44%; ICC, 0.98-0.99).

## CONCLUSION

Dual-source parallel RF transmission with patient-adaptive RF shimming could significantly improve the B1 homogeneity and image contrast, reduce the off-resonance artifacts in the b-SSFP cine image and show excellent reproducibility of cardiac function in the 3.0T CMR of children.

## CLINICAL RELEVANCE/APPLICATION

Dual-source parallel RF transmission could significantly improve the B1 homogeneity and image quality and is suitable for the 3.0T cardiac magnetic resonance in children.

### RC313-07 Estimation of Functional Lung Capacity and Correlation with the Results of Infant Pulmonary Function Test and Quantitative CT Assessment in Infants with Postinfectious Bronchiolitis Obliterans

Tuesday, Dec. 1 9:40AM - 9:50AM Location: E353A

#### Participants

Mi-Jung Lee, MD, PhD, Seoul, Korea, Republic Of (*Presenter*) Nothing to Disclose  
Yoon Hee Kim, Seoul, Korea, Republic Of (*Abstract Co-Author*) Nothing to Disclose  
Hyun Joo Shin, MD, Seoul, Korea, Republic Of (*Abstract Co-Author*) Nothing to Disclose  
Myung-Joon Kim, MD, Seoul, Korea, Republic Of (*Abstract Co-Author*) Nothing to Disclose  
Myung Hyun Sohn, Seoul, Korea, Republic Of (*Abstract Co-Author*) Nothing to Disclose

## PURPOSE

To investigate the possibility for estimating functional lung capacity from ventilation inhomogeneity using infant pulmonary function test (iPFT) and quantitative CT assessment for air trapping in infants with postinfectious bronchiolitis obliterans (BO).

## METHOD AND MATERIALS

This prospective study included infants with clinically and radiologically proven BO since 2009. We performed iPFT in these patients and measured tidal volume (TV), functional residual capacity (FRC) and lung clearance index (LCI) by sulphur hexafluoride multiple breath washout using an ultrasonic flow meter. From chest CT, we calculated total lung volume (CT-TLV) and imaging functional lung volume (CT-FLV) which showed higher attenuation than the mean attenuation of the grossly normal and air trapping areas. We compared iPFT and CT parameters using Spearman correlation analysis.

## RESULTS

Thirteen infants (M:F = 11:2) were included in this study. The age was 3-17 months with the mean of  $10.4 \pm 4.5$  months. The mean body weight and height were  $9.4 \pm 1.7$  kg and  $75.9 \pm 8.0$  cm. The values of TV, FRC and LCI were  $82.0 \pm 19.9$  ml,  $184.1 \pm 49.1$  ml and  $8.2 \pm 1.3$ , respectively. For chest CT, the effective radiation dose was 0.2-1.8 mSv with the mean of  $1.0 \pm 0.5$  mSv. The values of normal lung attenuation and air trapping attenuation on CT were  $-571.3 \pm 63.1$  HU and  $-767.1 \pm 58.3$  HU. And the calculated CT-TLV and CT-FLV were  $268.8 \pm 90.9$  ml and  $202.9 \pm 70.4$  ml. In the correlation analysis, CT-TLV had a positive correlation with TV ( $\gamma = 0.602$ ,  $p = 0.029$ ) and FRC ( $\gamma = 0.731$ ,  $p = 0.005$ ). CT-FLV also showed a significant negative correlation with LCI ( $\gamma = -0.670$ ,  $p = 0.012$ ) which represented ventilation inhomogeneity.

## CONCLUSION

Both iPFT and chest CT can demonstrate ventilation inhomogeneity and estimate functional lung capacity in infants with postinfectious BO with good correlation. Both methods can be useful and complementary for evaluating in these patients.

## CLINICAL RELEVANCE/APPLICATION

Not only infant pulmonary function test but also quantitative chest CT assessment can demonstrate ventilation inhomogeneity and estimate functional lung capacity in infants who are not easy to evaluate lung function due to limited compliance.

### RC313-08 Coronary Artery Imaging in Children

Tuesday, Dec. 1 9:50AM - 10:10AM Location: E353A

#### Participants

Lorna Browne, MD, FRCR, Denver, CO (*Presenter*) Nothing to Disclose

## LEARNING OBJECTIVES

1) How to successively image the coronary arteries in children with both MR and CT. 2) How to interpret a range of coronary artery anomalies and pathologies.

## RC313-09 Dynamic Airway Imaging

Tuesday, Dec. 1 10:30AM - 10:50AM Location: E353A

### Participants

Rajesh Krishnamurthy, MD, Houston, TX (*Presenter*) Research support, Koninklijke Philips NV; Research support, Toshiba Corporation

### LEARNING OBJECTIVES

1) Discuss indications and protocols for dynamic airway imaging in children using CT and MRI, with emphasis on advantages offered by new generation CT scanners. 2) Learn appropriate use of common post-processing tools and measurement metrics for the pediatric airway that correlate well with bronchoscopy. 3) Understand imaging findings that distinguish between intrinsic and extrinsic airway pathology. 4) Review common applications for dynamic airway imaging, including tracheobronchomalacia, vascular mediated airway compromise, complete tracheal rings, mediastinal masses, and airway tumors.

### ABSTRACT

This talk will provide an overview of indications and protocols for dynamic airway imaging in children using CT and MRI, with emphasis on advantages offered by new generation CT scanners, and post-processing tools that allow derivation of metrics similar to bronchoscopy. We will review examples of intrinsic and extrinsic airway pathology in children, including tracheobronchomalacia, vascular mediated airway compromise, complete tracheal rings, mediastinal masses, and airway tumors.

## RC313-10 Comparison of a ROI-based and a Whole-lung Segmentation Based Approach for MR Lung Perfusion Quantification in Two-year Old Children after Congenital Diaphragmatic Hernia Repair

Tuesday, Dec. 1 10:50AM - 11:00AM Location: E353A

### Participants

Meike Weidner, Mannheim, Germany (*Presenter*) Nothing to Disclose

Verena Sommer, Mannheim, Germany (*Abstract Co-Author*) Nothing to Disclose

Frank G. Zoellner, Mannheim, Germany (*Abstract Co-Author*) Nothing to Disclose

Claudia Hagelstein, MD, Mannheim, Germany (*Abstract Co-Author*) Nothing to Disclose

Thomas Schaible, Mannheim, Germany (*Abstract Co-Author*) Nothing to Disclose

Stefan O. Schoenberg, MD, PhD, Mannheim, Germany (*Abstract Co-Author*) Institutional research agreement, Siemens AG

Wolfgang Neff, MD, PhD, Alzey, Germany (*Abstract Co-Author*) Nothing to Disclose

### PURPOSE

By the means of a region-of-interest (ROI) based approach it has been demonstrated that 2-year old children after congenital diaphragmatic hernia (CDH) repair show reduced MR lung perfusion values on the ipsilateral side. As ROI-based approaches only cover parts of the lung tissue, this study aimed to evaluate if results can be reproduced by segmentation of whole lung, whether there are differences between both approaches and as a consequence which technique should be applied.

### METHOD AND MATERIALS

DCE-MRI was performed in 30 children (24.3±1.8 month) after CDH repair using a 3D TWIST sequence (Siemens Healthcare, Germany). 0.05 mmol/kg body weight of contrast agent (Dotarem, Guerbet, France) were administered. Pulmonary blood flow (PBF) was calculated based on a pixel-by-pixel deconvolution approach. For ROI-based quantification, three circular ROIs (apical, middle and basal) per lung side were used both in the ventral and dorsal lung. Propagation of those circular ROIs through five adjacent slices generated 6 cylindrical ROIs in the ventral and dorsal lung respectively. For whole-lung analysis, the whole lung was contoured. In both techniques larger vessels were excluded from analysis (Fig. A).

### RESULTS

In the ROI-based approach, PBF was significantly reduced on the ipsilateral side (74.5±30.3 ml/100ml/min) in comparison to the contralateral side (113.1±40.4 ml/100ml/min;  $p<0.0001$ ). Also in the whole-lung based approach ipsilateral PBF was significantly lower (73.9±25.5 ml/100ml/min) than in the contralateral lung (102.3±31.8 ml/100ml/min;  $p<0.0001$ ). In the ipsilateral lungs, quantification results of the ROI-based and the whole-lung segmentation based approach were equal ( $p=0.50$ ). In the contralateral lungs, the ROI-based approach significantly overestimated PBF in comparison to the whole-lung approach by approximately 9.5% ( $p=0.0013$ ; Fig. B).

### CONCLUSION

MR lung perfusion in 2-year children after CDH is significantly reduced ipsilaterally, both when quantified by a ROI-based and a whole-lung based approach. In the contralateral lung, the ROI-based approach significantly overestimates perfusion results and therefore whole lung segmentation should be preferred.

### CLINICAL RELEVANCE/APPLICATION

With MR lung perfusion imaging, perfusion deficits after congenital diaphragmatic hernia can be depicted. Whole-lung segmentation for quantification is advisable, as a ROI-based approach can overestimate results.

## RC313-11 Functional Lung MRI for Non-invasive Monitoring of Regional Effects of Inhaled Hypertonic Saline in Children with Cystic Fibrosis

Tuesday, Dec. 1 11:00AM - 11:10AM Location: E353A

### Participants

Till F. Kairait, Hannover, Germany (*Presenter*) Nothing to Disclose

Julius Renne, MD, Hannover, Germany (*Abstract Co-Author*) Nothing to Disclose

Christian O. Schoenfeld, MD, Hannover, Germany (*Abstract Co-Author*) Nothing to Disclose

Andreas Voskrebenez, Hannover, Germany (*Abstract Co-Author*) Nothing to Disclose

Marcel Gutberlet, Dipl Phys, Hannover, Germany (*Abstract Co-Author*) Nothing to Disclose

Angela Schulz, Hannover, Germany (*Abstract Co-Author*) Nothing to Disclose

Gesine Hansen, Hannover, Germany (*Abstract Co-Author*) Nothing to Disclose



Tobias Welte, MD, Hannover, Germany (*Abstract Co-Author*) Nothing to Disclose  
Frank K. Wacker, MD, Hannover, Germany (*Abstract Co-Author*) Research Grant, Siemens AG Research Grant, Pro Medicus Limited  
Burkhard Tuemmler, Hannover, Germany (*Abstract Co-Author*) Nothing to Disclose  
Jens Vogel-Claussen, MD, Hannover, Germany (*Abstract Co-Author*) Nothing to Disclose

## PURPOSE

Quantification of regional effects of inhaled hypertonic saline (7% NaCl) by functional lung MRI in adolescents with cystic fibrosis (CF).

## METHOD AND MATERIALS

The clinical effect of a single treatment with hypertonic saline inhalation in patients with CF is still under debate. 17 CF patients prospectively underwent two functional lung MRI scans and pulmonary function tests on the same day before and 1h after a single treatment of inhaled hypertonic saline (n=10, mean 15,2y, mean FEV1% 80±21) or without any treatment (n=7, mean 13,9y, mean FEV1% 80±20) at 1.5T. As a 2nd control group 12 healthy volunteers (mean 28,5y) were included. Assessed parameters for both cohorts were as follows: MRI-derived T1 relaxation measurements breathing room air (T1(21)) and 100% oxygen as well as the calculated oxygen transfer function (OTF), normalized fractional ventilation (FV) obtained by ventilation-weighted Fourier Decomposition MRI; pulmonary blood flow (PBF) obtained by dynamic contrast enhanced MRI, a morpho-functional CF-MRI score and the lung clearance index (LCI). After manual segmentation of each lobe mean and coefficient of variation (CoV) were calculated.

## RESULTS

Comparing the CF group to healthy controls, mean values of T1(21) (1176ms vs. 1246 ms,  $p < 0.01$ ) and FV (0.67 vs. 0.95,  $p < 0.001$ ) were significantly lower and the CoV significantly higher (CoV T1(21) 0.08 vs. 0.04; CoV FV 0.73 vs. 0.37,  $p < 0.001$  for all). In CF group receiving treatment, mean values in the whole lung of OTF (pre 13.1/post 12.7 10<sup>-4</sup>/s/%O<sub>2</sub>), FV (pre 0.69/post 0.76), PBF (pre 98/post 102ml/100 ml/min), LCI (pre 12.1/post 13.1) and the morpho-functional score (pre 15 / post 17) did not show a significant difference between pre and post treatment measurements ( $p > 0.05$ ). Also data on a lobar level in the treatment group as well as measurements in the CF-control group did not show any significant differences between the 2 MRI exams ( $p > 0.05$ ).

## CONCLUSION

Compared to healthy controls functional lung MRI detects significantly increased ventilation heterogeneity in CF patients. After a single treatment with inhalation of hypertonic saline (7% NaCl) neither functional lung MRI nor LCI detected a significant change in CF patients.

## CLINICAL RELEVANCE/APPLICATION

This study shows the feasibility of functional lung MRI, as a non-invasive, radiation-free tool for visualization and quantification of potential regional treatment effects in patients with CF.

## RC313-12 Comparison of Lung Ultrasound and Chest Radiography in Estimating Lung Edema after Surgery for Congenital Heart Disease in Children

Tuesday, Dec. 1 11:10AM - 11:20AM Location: E353A

### Participants

Laura Martelius, Helsinki, Finland (*Presenter*) Nothing to Disclose  
Anu Kaskinen, Helsinki, Finland (*Abstract Co-Author*) Nothing to Disclose  
Kirsi Lauerma, MD, Helsinki, Finland (*Abstract Co-Author*) Nothing to Disclose  
Paula Rautiainen, Helsinki, Finland (*Abstract Co-Author*) Nothing to Disclose  
Sture Andersson, Helsinki, Finland (*Abstract Co-Author*) Nothing to Disclose  
Olli Pitkanen, Helsinki, Finland (*Abstract Co-Author*) Nothing to Disclose

## PURPOSE

Lung edema is a frequent complication after surgery for congenital heart disease in children. A readily available accurate measure for lung edema is lacking. Chest radiographs (CXR) are commonly used for this purpose. CXR, however, is inaccurate especially in intensive care when portable supine radiographs are used. In lung ultrasound (US) vertical artifacts known as B-lines have been shown to correlate with lung liquid. In adults with congestive heart disease B-lines in US correlates with lung edema scored from CXR. Our aim was to compare lung US and CXR in estimating lung edema in children after surgery for congenital heart disease.

## METHOD AND MATERIALS

Lung US was performed on 50 children 1-6 h postoperatively using a high-frequency linear transducer. Videoclips from three anterolateral intercostal spaces on both sides were stored. An observer blinded to the patient data and CXR scored the abundance of B-lines on each videoclip using a 5-step scale (0 = no artefact, 1 = B-lines in <25% of surface area, 2 = <50%, 3 = <75%, and 4 = >75%). The postoperative CXR were evaluated for lung edema at the right and left upper and lower lobes, the middle lobe and lingula using a 4-step scale (0 = normal lung, 1 = minimal opacity, 2 = opacity partially obscuring lung vessels, 3 = opacity totally obscuring lung vessels). For each patient a mean score for lung US (B-line score), and for CXR (CXR LE score) was calculated.

## RESULTS

There was a significant positive correlation between the B-line score and the CXR LE score ( $R = 0.65$ ,  $p < 0.001$ ).

## CONCLUSION

Lung US is a promising diagnostic tool in evaluation of postoperative lung edema in patients with congenital heart disease.

## CLINICAL RELEVANCE/APPLICATION

Lung US has great potential since the current methods for estimating lung edema are unsatisfactory (CXRs are nonspecific, invasive techniques are unreliable in patients with intracardiac shunts).

## RC313-13 Computerized Texture Analysis of Pulmonary Nodules in Pediatric Osteosarcoma Patients:

## Differentiation of Pulmonary Metastases from Non-metastatic Nodules

Tuesday, Dec. 1 11:20AM - 11:30AM Location: E353A

### Participants

Yeon Jin Cho, Seoul, Korea, Republic Of (*Presenter*) Nothing to Disclose  
Young Hun Choi, MD, Seoul, Korea, Republic Of (*Abstract Co-Author*) Nothing to Disclose  
Yoo Jin Kim, MD, Seoul, Korea, Republic Of (*Abstract Co-Author*) Nothing to Disclose  
Ji-Eun Park, Seoul, Korea, Republic Of (*Abstract Co-Author*) Nothing to Disclose  
Hyun Suk Cho, Seoul, Korea, Republic Of (*Abstract Co-Author*) Nothing to Disclose  
Sang Joon Park, PhD, Seoul, Korea, Republic Of (*Abstract Co-Author*) Nothing to Disclose  
Jung-Eun Cheon, MD, Seoul, Korea, Republic Of (*Abstract Co-Author*) Nothing to Disclose  
Woo Sun Kim, MD, Seoul, Korea, Republic Of (*Abstract Co-Author*) Nothing to Disclose  
In-One Kim, MD, Seoul, Korea, Republic Of (*Abstract Co-Author*) Nothing to Disclose

### PURPOSE

To evaluate the value of computerized 3D texture analysis for differentiation of pulmonary metastases from non-metastatic lesions in pediatric osteosarcoma patients.

### METHOD AND MATERIALS

Our study comprised 42 pathologically confirmed pulmonary nodules in 16 children with osteosarcoma who had undergone preoperative CT scans between January 2009 and December 2014. Each pulmonary nodule was manually segmented and its computerized texture features were extracted by using an in-house software program. Multivariate logistic regression analysis was performed to investigate the differentiating factors of metastatic nodules from non-metastatic lesions. A subgroup analysis was performed to identify significant differentiating parameters in non-calcified pulmonary nodules. The ROC curve was created to evaluate the discriminating performance of established model.

### RESULTS

There were 24 metastatic pulmonary nodules and 18 non-metastatic pulmonary lesions. Pulmonary metastases and non-metastatic lesions exhibited significant differences in various histograms and volumetric parameters ( $P < .05$ ). Multivariate analysis revealed that higher mean Hounsfield units (HU) (adjusted odds ratio (OR), 1.02) and larger effective diameter (OR, 17.03) are significant differentiators ( $P < .05$ ). The subgroup analysis with non-calcified pulmonary nodules (13 metastases and 18 non-metastases) revealed significant differences between metastases and non-metastases in various parameters. Multivariate logistic regression analysis revealed that lower entropy (OR, 0.01) and larger effective diameter (OR, 38.92) are significant predictors of non-calcified pulmonary metastases ( $P < .05$ ). The established logistic regression model of subgroup showed excellent discriminating performance in ROC analysis (AUC, 0.927).

### CONCLUSION

Metastatic pulmonary nodules from osteosarcoma can be accurately differentiated from non-metastatic pulmonary lesions by using computerized texture analysis. High HU and larger effective diameter were the significant predictors for pulmonary metastases, while lower entropy and larger effective diameter were for non-calcified pulmonary metastases from non-metastatic lesions.

### CLINICAL RELEVANCE/APPLICATION

The computerized 3D texture analysis can accurately differentiate pulmonary metastases from non-metastatic pulmonary lesions in pediatric osteosarcoma patients.

## RC313-14 Extralobar pulmonary sequestration: initial CT findings predicting spontaneous regression in neonates

Tuesday, Dec. 1 11:30AM - 11:40AM Location: E353A

### Participants

Hee Mang Yoon, MD, Seoul, Korea, Republic Of (*Presenter*) Nothing to Disclose  
Jin Seong Lee, MD, Seoul, Korea, Republic Of (*Abstract Co-Author*) Nothing to Disclose  
Ahyoung Jung, Seoul, Korea, Republic Of (*Abstract Co-Author*) Nothing to Disclose  
Young Ah Cho, Seoul, Korea, Republic Of (*Abstract Co-Author*) Nothing to Disclose  
Chong Hyun Yoon, Seoul, Korea, Republic Of (*Abstract Co-Author*) Nothing to Disclose

### PURPOSE

In general, it is accepted that extralobar pulmonary sequestration (EPS) may spontaneously regress. However, radiologic features associated with spontaneous regression of EPS have not been well documented. Therefore, we tried to find the CT features predicting spontaneous regression of EPS.

### METHOD AND MATERIALS

A total of 51 patients were included in our study with the following inclusion criteria: (a) antenatally diagnosed with EPS, (b) underwent a CT scan within 1 month after birth, and (c) had more than one follow-up CT without treatment. Spontaneous regression of EPS was determined by percent decrease of volume (PDV) and decrease in diameter of feeders. Volume of EPS and diameters of feeding systemic arteries (FSA) were evaluated on all 148 CT. For the enhancement degree of EPS, CT attenuation number of EPS and the back muscle were measured on initial CT and the ratio of EPS-to-back muscle was calculated. The PDV and the changes in diameter of FSA between initial and follow-up CT scans were calculated. Univariate and multivariate linear regression analysis were performed to assess factors related to PDV and decrease in diameter of FSA.

### RESULTS

PDV more than 50% ( $PDV \geq 50\%$ ) was noted in 20 patients (38.5%) within one year, in other 12 patients (23.1%) between one and two years, and in 6 patients after two years. The enhancement degree of EPS was significantly different between 38 patients with  $PDV \geq 50\%$  and 13 patients with  $PDV < 50\%$  ( $1.0 \pm 5.4$  vs  $2.1 \pm 1.1$ , respectively,  $p < 0.001$ ). Enhancement degree of EPS was the only significant factors predicting  $PDV \geq 50\%$  ( $B = -26.227$ ,  $p < 0.001$ ), and the decrease in diameter of FSA ( $B = -21.476$ ,  $p = 0.009$ ). In addition, PDV showed significant correlation with decrease in the diameter of the FSA ( $r = 0.602$ ,  $p < 0.001$ ).

## CONCLUSION

The volume of EPS had spontaneously decreased more than 50 % within 2 years without treatment in 63% of patients. The most important factor predicting spontaneous regression of the EPS was the enhancement degree on initial CT scan. Therefore, a significant volume regression and decrease in diameter of FSA can be expected without any treatment in a neonate with EPS showing hypoenhancement on initial CT scan.

## CLINICAL RELEVANCE/APPLICATION

The enhancement degree of EPS on initial CT scan is significantly associated with spontaneous regression of EPS during follow-up. Based on this result, we can more confidently predict spontaneous regression of EPS in neonates.

## RC313-15 Pediatric Chest Interventions

Tuesday, Dec. 1 11:40AM - 12:00PM Location: E353A

### Participants

Kamlesh U. Kukreja, MD, Bellaire, TX (*Presenter*) Nothing to Disclose

## LEARNING OBJECTIVES

1. Describe different types of chest interventions for children.



## Characterization of Complex and Sonographically Indeterminate Adnexal Masses (An Interactive Session)

Tuesday, Dec. 1 8:30AM - 10:00AM Location: E353B



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

### Participants

### Sub-Events

#### RC329A Overview of the Clinical Indications for Using MRI

### Participants

Andrea G. Rockall, MRCP, FRCR, London, United Kingdom (*Presenter*) Nothing to Disclose

### LEARNING OBJECTIVES

1) To be familiar with the typical clinical presentation of adnexal masses. 2) To understand the role of ultrasound in the initial evaluation and diagnosis of adnexal masses. 3) To know the current indications for MRI in the characterisation of adnexal masses.

### ABSTRACT

Clinical presentation of adnexal masses can be due to symptoms (such as acute or chronic pelvic pain or sepsis) or may be incidental. Ultrasound is the initial investigation in almost every case, although CT may be used initially in patients presenting with an acute abdomen. Ultrasound features that can differentiate benign from malignant adnexal masses are well defined and over 80% of cases can be confidently characterised on the basis of ultrasound findings. However, when the nature of a mass is indeterminate on ultrasound, MRI can be useful in further characterisation of the mass. This can be particularly useful in cases where fertility preservation is of paramount importance or where the risks of surgery are high due to other co-morbidities. This lecture will include a full discussion of the current indications for MRI in characterisation of adnexal masses.

#### RC329B Review of Scoring System for Complex and Sonographically Indeterminate Adnexal Masses (The RULES)

### Participants

Isabelle Thomassin-Naggara, MD, Paris, France (*Presenter*) Speakers Bureau, General Electric Company; Research Consultant, Olea Medical

### LEARNING OBJECTIVES

1) To learn how to optimise the MRI protocol and how to improve the characterisation of indeterminate complex adnexal masses. 2) To understand the added value of functional sequences (DCE MRI and DWI) in diagnosing adnexal masses. 3) To present a novel diagnostic score named ADNEX MR score for classified adnexal masses using MR imaging according to their positive predictive value.

### ABSTRACT

For complex adnexal masses, MR imaging add to conventional criteria of malignancy common to all imaging modalities (bilaterality, tumor diameter larger than 4 cm, predominantly solid mass, cystic tumor with vegetations, and secondary malignant features, such as ascites, peritoneal involvement, and enlarged lymph nodes) specific features based on the characterization of the solid tissue (including vegetation, thickened irregular septa and solid portion) of the adnexal tumor. Using ADNEX MR-SCORING system for adnexal masses, areas under the curve for diagnosis of malignancy is high both for experienced and junior reader (AUCR1/R2=0.980/0.961). A score is 4 or greater is associated with malignancy with a sensitivity of 93.5% (58/62) and specificity of 96.6% (258/267), the risk of malignancy is high, and the patient should be referred to a cancer center. When the diagnostic score is 3 or less, the association with malignancy is minimal and the patient may benefit from more imaging follow-up or conservative treatment. Finally, if the diagnostic score is 2, the mass has a very low risk to be malignant (<2%). This new MR diagnosis classification will be detailed with interactive clinical cases during this session

#### RC329C Interactive Cases

### Participants

Elizabeth A. Sadowski, MD, Madison, WI (*Presenter*) Nothing to Disclose

Isabelle Thomassin-Naggara, MD, Paris, France (*Presenter*) Speakers Bureau, General Electric Company; Research Consultant, Olea Medical

### LEARNING OBJECTIVES

1) Develop a method for classifying adnexal masses on MRI by assessing their signal characteristics and enhancement patterns. 2) Assess the risk of ovarian cancer based on the MRI appearance of an adnexal lesion and clinical information. 3) Emphasize the role of MRI in the evaluation of adnexal lesions.

### ABSTRACT

ABSTRACT There is a spectrum of ovarian neoplasms ranging from benign to malignant. Identifying the MR imaging features suggestive of benign versus worrisome lesions can help appropriately triage adnexal lesions into follow up versus surgical consultation. The purpose of the interactive session is to review the imaging features of benign and worrisome adnexal lesions on MRI and to discuss the appropriate follow up in each case.

**Learn Image Segmentation Basics with Hands-on Introduction to ITK-SNAP (Hands-on)**

Tuesday, Dec. 1 8:30AM - 10:00AM Location: S401AB

**IN**

AMA PRA Category 1 Credits™: 1.50

ARRT Category A+ Credits: 1.50

**FDA**

Discussions may include off-label uses.

**Participants**Paul Yushkevich, PhD, Philadelphia, PA, (paul2@upenn.edu) (*Presenter*) Nothing to DiscloseGuido Gerig, Brooklyn, NY (*Presenter*) Nothing to DiscloseJeffrey Ware, MD, Philadelphia, PA, (jeffrey.ware2@uphs.upenn.edu) (*Presenter*) Nothing to DisclosePhilipose G. Mulugeta, MD, Philadelphia, PA, (philipose.mulugeta@uphs.upenn.edu) (*Presenter*) Nothing to Disclose**LEARNING OBJECTIVES**

1) To use a free interactive software tool ITK-SNAP to view and manipulate 3D medical image volumes such as multi-parametric MRI, CT and ultrasound. 2) To label anatomical structures in medical images using a combination of manual and user-guided automatic segmentation tools.

**ABSTRACT**

Quantitative analysis of medical imaging data is increasingly relevant in a growing number of radiological applications. Almost invariably, such quantitative analysis requires some structures of interest (organs, tumors, lesions, etc.) to be labeled in the image. Labeling anatomical structures is a complex task, particularly when the imaging data is complex, such as in the case of multi-parametric MRI or fusion of different imaging modalities. ITK-SNAP is a free, open-source, and easy to use interactive software tool that allows users to view multiple image volumes of the same anatomy and label structures using information from all volumes concurrently. For example, ITK-SNAP allows users to label tumors (core, edema, necrosis) using a combination of T1-weighted, contrast-enhanced T2-weighted, T2-weighted and FLAIR MRI. ITK-SNAP provides easy to use user-guided automatic segmentation functionality rooted in statistical machine learning and deformable modeling algorithms, as well as built in tools for manual editing and correction of segmentations. ITK-SNAP runs on Windows, MacOS and Linux platforms. During this hands-on course, the participants will use ITK-SNAP to label organs and tumors in various imaging modalities. After completing the course, participants will be well equipped for performing quantitative analyses of medical image data using ITK-SNAP and other compatible free software tools.

**Handout:Paul Yushkevich**

[http://abstract.rsna.org/uploads/2015/15003102/handout\\_exercises.pdf](http://abstract.rsna.org/uploads/2015/15003102/handout_exercises.pdf)

**Creating Radiology eBooks for the iPad (Hands-on)**

Tuesday, Dec. 1 8:30AM - 10:00AM Location: S401CD



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

**Participants**

Henry J. Baskin JR, MD, Salt Lake Cty, UT (*Presenter*) Nothing to Disclose  
Justin Cramer, MD, Salt Lake City, UT (*Presenter*) Nothing to Disclose  
Justin La Plante, MD, Sayre, PA (*Presenter*) Nothing to Disclose

**LEARNING OBJECTIVES**

1) Become familiar with Apple's free ebook authoring tool, iBooks Author. 2) Create a sample radiology ebook during the course. 3) Learn how to freely share your ebook with others.

**ABSTRACT**

The iPad is rapidly becoming the de facto learning tool used by radiology residents and fellows. iBooks Author, a free authoring tool from Apple, enables the creation of ebooks with a near-limitless number of high-resolution images, movies, and other interactive elements. Unfortunately, most radiologists lack the expertise to leverage the advantages of this application. This hands-on workshop will cover the basics of iBooks Author. During the course, attendees will create their own interactive radiology ebook and learn how to freely share it with anyone who has an iPad. iBooks author is only available for Mac OS and bringing your own Mac is required for the hands-on portion of the course. Attendees are encouraged to download iBooks Author prior to attending; the link is provided below. Attendees are also encouraged to come with an idea for their own iBook, ideally with a text file and folder of images they would like to turn into an ebook during the course. Sample text and images will be provided for those who do not bring their own material.

**URL**

RC350

## CTA from Head to Toe

Tuesday, Dec. 1 8:30AM - 10:00AM Location: S404AB



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

### Participants

Alison Wilcox, MD, Los Angeles, CA (*Moderator*) Speaker, Toshiba Corporation

### Sub-Events

#### RC350A Cardiac CT- Pre, Peri and Post Procedural Management

### Participants

Cameron Hassani, MD, Los Angeles, CA (*Presenter*) Nothing to Disclose

### LEARNING OBJECTIVES

1) Review pre-procedural patient preparation including appropriate patient selection, beta blockade, contraindications and alternatives to beta blockers 2) Discuss how to manage non-standard scenarios (atrial fibrillation, pacemaker, young adults) 3) Peri-procedural issues including vasodilation, continued heart rate control, and breathholding requirements. 4) Image acquisition including radiation dose reduction techniques, technique choice, and post CABG patient. 5) Postprocedural complications include contrast reactions and their management.

### ABSTRACT

Cardiac CTA involve slightly more preparation than the standard CT acquisition. Heart rate control is the most important aspect that needs to be addressed prior to the patient arriving in the radiology department. Periprocedural issues mostly involved how to optimize technique while having the lowest radiation dose especially in the new age of dose reduction. Almost as important as heart rate management is how to treat postprocedural complications especially contrast reactions. This presentation will discuss these aspects and include treatment options as well as their alternatives.

#### RC350B TEVAR/EVAR- Pre, Post and Periprocedural Evaluation

### Participants

Alison Wilcox, MD, Los Angeles, CA (*Presenter*) Speaker, Toshiba Corporation

### LEARNING OBJECTIVES

1) What are some clinical indications for acute aortic imaging. 2) What are some CT parameters that can aid in various diagnosis? 3) What are some of common complications seen in TEVAR and EVAR? 4) What are the important measurements and vessel variants that help guide surgical approach. 5) New suggestions for type B management. 6) What are some imaging problems and pitfall and some methods to assist. 7) Briefly discuss TAVR acquisition.

### ABSTRACT

The acute aorta is part of a syndrome of diseases affecting the aorta with significant overlap of findings and clinical presentations. Clinically the diagnosis is difficult as there is overlap between patients with suspected coronary disease, pulmonary embolism and acute aortic syndrome. In the past several years, minimally invasive surgery with Thoracic Endovascular Aortic Repair (TEVAR) or Endovascular Aortic Repair (EVAR) have become increasingly popular. The images choices include gated vs non gated studies, non-contrast imaging, and delayed imaging. The literature is mixed on how and when to use these modalities. The complications of these procedures is often complex and subtle as well. Knowledge of these vascular complications is imperative for patient management. In addition, these patients often have significant atherosclerotic disease elsewhere that might be limiting factors for stent placement, including renal insufficiency. Newer scanners and imaging techniques can reduce radiation dose, and limit the amount of contrast delivery to preserve renal function while preserving image quality. TAVR is an example of another minimally invasive technique gaining popularity that has imaging challenges. Again, newer scanning techniques with limited contrast delivery can provide excellent image quality while limiting radiation dose and preserving renal function.

#### RC350C Peripheral CTA-A How-to

### Participants

Ilya Lekht, MD, Los Angeles, CA (*Presenter*) Nothing to Disclose

### LEARNING OBJECTIVES

1) Enhance knowledge of normal and abnormal coronary and cardiac anatomy, with an emphasis on differentiating benign from significant variants. 2) Demonstrate the spectrum of nonatherosclerotic congenital and acquired diseases that may affect the coronary arteries. 3) Demonstrate the spectrum of non-atherosclerotic congenital and acquired diseases that may affect the heart.

### ABSTRACT

A variety of non-atherosclerotic conditions are detectable on cardiac CT scans, including diseases of the heart, and disease processes which may affect the coronary arteries, or other vascular structures. Cardiac CT has a number of unique advantages in detecting non-atherosclerotic conditions, including congenital and acquired diseases. The focus of this presentation will be non-atherosclerotic conditions of the coronary arteries and of the heart. Variants of normal and abnormal anatomy of the coronary arteries will be discussed, including tips for identifying when coronary anatomic variants are significant. Acquired, non-atherosclerotic diseases of the coronary arteries will also be discussed. This presentation will also discuss the spectrum of non-

atherosclerotic diseases of the heart which may be detected at cardiac CT, including congenital and acquired valvular and cardiac diseases. At the end of this exhibit, the viewer will have a better appreciation for abnormal coronary and cardiac anatomy and the broad spectrum of non-atherosclerotic cardiovascular diseases which may be seen at cardiac CT.

RC354

## Meaningful Use for Radiology: Pros and Cons

Tuesday, Dec. 1 8:30AM - 10:00AM Location: S404CD



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

### Participants

Ramin Khorasani, MD, Roxbury Crossing, MA (*Moderator*) Consultant, Medicalis Corp

Ramin Khorasani, MD, Roxbury Crossing, MA (*Presenter*) Consultant, Medicalis Corp

Alberto F. Goldszal, PhD, MBA, East Brunswick, NJ, (AGoldszal@UniversityRadiology.com) (*Presenter*) Advisory Board, FUJIFILM Holdings Corporation; Advisory Board, MedInformatix, Inc

Keith D. Hentel, MD, MS, New York, NY, (keh9003@med.cornell.edu) (*Presenter*) Nothing to Disclose

James Whitfill, MD, Scottsdale, AZ (*Presenter*) President, Lumetis, LLC; Co-author, Hitachi, Ltd

### LEARNING OBJECTIVES

1) Understand how a radiology practice that was a later adopter of meeting meaningful use criteria has achieved successful results for two years running. 2) Learn about CMS MU audits and the audit process 3) Learn about challenges for meaningful use stage 2 and radiology.

### ABSTRACT

MSCC31

## Case-based Review of Nuclear Medicine: PET/CT Workshop-Head and Neck Cancers (In Conjunction with SNMMI) (An Interactive Session)

Tuesday, Dec. 1 8:30AM - 10:00AM Location: S406A



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

### Participants

Janis P. O'Malley, MD, Birmingham, AL (*Director*) Nothing to Disclose

Jonathan E. McConathy, MD, PhD, Saint Louis, MO (*Presenter*) Research Consultant, Eli Lilly and Company; Research Consultant, Blue Earth Diagnostics Ltd; Research Consultant, Siemens AG; Research support, GlaxoSmithKline plc

### LEARNING OBJECTIVES

1) Participants will use FDG-PET/CT more effectively in their clinical practice through better understanding of the anatomy, clinical scenarios, and differential diagnoses relevant to the diagnostic imaging of head and neck cancers.

**Cardiac Series: Imaging of Coronary Artery Disease**

Tuesday, Dec. 1 8:30AM - 12:00PM Location: S405AB



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

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

**Participants**

Arthur E. Stillman, MD, PhD, Atlanta, GA (*Moderator*) Nothing to Disclose  
Robert M. Steiner, MD, Philadelphia, PA (*Moderator*) Consultant, Educational Symposia; Consultant, Johnson & Johnson  
Suhny Abbata, MD, Dallas, TX (*Moderator*) Author, Reed Elsevier; Editor, Reed Elsevier; Institutional research agreement, Koninklijke Philips NV; Institutional research agreement, Siemens AG

**Sub-Events****RC303-01 MRI of Coronary Ischemia (Coronary MRA, Stress Perfusion)**

Tuesday, Dec. 1 8:30AM - 9:10AM Location: S405AB

**Participants**

David A. Bluemke, MD, PhD, Bethesda, MD (*Presenter*) Research support, Siemens AG

**LEARNING OBJECTIVES**

1) Describe the role of CMR for evaluation of myocardial perfusion. 2) Describe the results of CMR for evaluation of myocardial ischemia. 3) Indicate potential uses and methods for coronary artery evaluation by CMR.

**ABSTRACT**

Cardiac MRI (CMR) is an established modality for evaluation of ischemic myocardial disease; appropriateness criteria increasingly recognize the role of CMR in this role. CMR has outstanding temporal resolution allowing for accurate representation of myocardial volumes and function. Excellent soft tissue contrast for myocardial ischemia evaluation is achieved with the use of a gadolinium contrast agent. Stress perfusion CMR during adenosine infusion compares favorably to nuclear medicine methods but can additionally assess volumes and mass very accurately. Stress CMR is used in combination with late gadolinium enhancement (LGE) techniques to depict viable myocardium to improve the specificity of the method. Coronary artery imaging with CMR is best performed at 1.5 T and is useful to assess for anomalous coronary artery imaging and confirm perfusion results. This session will describe the techniques, indications, results and interpretation of CMR for evaluation of ischemic disease of the myocardium.

**Active Handout: David A. Bluemke**

<http://abstract.rsna.org/uploads/2015/15003318/RC303-01 Bluemke RSNA coronary and stress CMR.pdf>

**RC303-02 Evaluation of Obstructive Coronary Artery Disease in Patients with Agatston Score More than 500: Comparison of Computed Tomographic Angiography and Magnetic Resonance Angiography**

Tuesday, Dec. 1 9:10AM - 9:20AM Location: S405AB

**Participants**

Makoto Amanuma, MD, Takasaki, Japan (*Presenter*) Nothing to Disclose  
Takeshi Kondo, Takasaki, Japan (*Abstract Co-Author*) Nothing to Disclose  
Hideyuki Matsutani, Takasaki, Japan (*Abstract Co-Author*) Nothing to Disclose  
Takako Sekine, Takasaki, Japan (*Abstract Co-Author*) Nothing to Disclose  
Tomoko Miyata, Saitama, Japan (*Abstract Co-Author*) Employee, Toshiba Corporation  
Shigehide Kuhara, MS, Otawara, Japan (*Abstract Co-Author*) Nothing to Disclose  
Shinichi Takase, Takasaki, Japan (*Abstract Co-Author*) Nothing to Disclose

**PURPOSE**

One of the limitations of coronary computed tomographic angiography (CCTA) is poor diagnostic accuracy for segments with severe calcification. On the other hand, the effect of calcification is considered limited on coronary magnetic resonance angiography (CMRA). The purpose of this study was to compare clinical feasibility of CCTA and CMRA for evaluation of obstructive coronary artery disease in patients with severe calcification.

**METHOD AND MATERIALS**

Written informed consent was obtained from all patients. In 29 patients (72±12 years, M:F=21:8) with high grade calcification (Agatston score >500) CCTA and CMRA findings were compared with the ICA findings as a reference standard. A 320-row area detector CT system (Aquilion ONE/Vision Edition, Toshiba) was used for CCTA and a 1.5T MR unit (Vantage Titan, Toshiba) was used to obtain CMRA. For CCTA prospective one or two-beat scanning targeted at mid diastole was performed with the cardiac phase for scanning set to R-R 75%. For CMRA non-contrast 3D steady-state gradient echo technique with ECG gating and respiratory navigation technique was used. The coronary arteries were divided to 7 proximal segments (#1-#3, #5-#7, #11) based on the AHA classification and evaluated. Luminal stenosis (>50%) was judged both on CCTA and CMRA by consensus of two experienced readers with the ICA findings as a reference standard.

**RESULTS**

The mean Agatston score of the 29 patients was 1763 (SD: 1092, Range: 502-4674, median: 1348). With non-assessable segments considered to be stenotic, the diagnostic accuracy of CCTA and CMRA was 76.6% and 83.6% on a per-segment basis. When non-assessable segments were considered to be an incorrect diagnosis, the diagnostic accuracy of CCTA and CMRA was 72.1% and



82.6%, showing no statistically significant difference. When evaluation was limited to the segments with severe calcification involving 50% or more of the vessel wall, accurately assessable segment was 49.1% on CCTA and 78.4% on CMRA, showing a statistically significant difference ( $p=0.0001$ ).

## CONCLUSION

CMRA provides a higher diagnostic accuracy than does CCTA in patients with severe calcification.

## CLINICAL RELEVANCE/APPLICATION

Coronary MRA provides a high diagnostic accuracy and recommended for evaluation of obstructive coronary arterial disease in patients with severe calcification.

### RC303-03 Rosuvastatin Effect on Coronary Atherosclerosis Plaques Evaluated by 64-detector CT in Patients with Stable Coronary Heart Disease and Hyperlipidemia

Tuesday, Dec. 1 9:20AM - 9:30AM Location: S405AB

#### Participants

Jian-Xing Qiu, MD, Beijing, China (*Presenter*) Nothing to Disclose

Xiaoying Wang, MD, Beijing, China (*Abstract Co-Author*) Nothing to Disclose

Xiaochao Guo, MD, Beijing, China (*Abstract Co-Author*) Nothing to Disclose

## PURPOSE

To evaluate the coronary atherosclerosis plaque changes by 64-detector CT on the follow-up examination of the patients, who treated by rosuvastatin, with stable coronary heart disease and hyperlipidemia.

## METHOD AND MATERIALS

The study included 30 patients, (27 males and 3 females), with stable coronary heart disease (stable angina for more than one month) and hyperlipidemia ( $LDL-C \geq 130$  mg/dl without treatment,  $LDL-C \geq 100$  mg/dl with treatment). Every patient underwent 64-detector CT coronary angiography twice before and after 76 weeks treatment with Rosuvastatin 20 mg q.d. The initial CT angiography at least detected one or more soft plaques with lumen stenosis  $\geq 25\%$ . We detected 35 target plaques totally. The volume of target plaques, the maximum sectional area(MASA) of plaques, the mean CT value(MCTV), the stenosis degree caused by the target plaques were measured on the initial and the follow-up CT examinations using the semi-automatic atherosclerosis plaque analysis software. The paired-samples t test was used to analyze the measurements in SPSS 10.0.

## RESULTS

After Rosuvastatin treatment for 76 weeks, the volume of target plaques decreased significantly from  $53.8 \pm 38.9$  mm<sup>3</sup> to  $41.5 \pm 27.4$  mm<sup>3</sup> ( $p=0.011$ ). After Rosuvastatin treatment, the MASA of target plaques decreased from  $7.56 \pm 3.86$  mm<sup>2</sup> to  $6.11 \pm 2.81$  mm<sup>2</sup> ( $p=0.038$ ). The MCTV of target plaques had nonsignificant decrease from  $66.42 \pm 28.62$  Hu to  $60.99 \pm 39.18$  Hu ( $p=0.687$ ), the stenosis degree caused by the target plaques decreased significantly from 55% to 46%.

## CONCLUSION

The measurement change of target plaques demonstrated by 64-detector CT coronary angiography for the patients with stable coronary heart disease and hyperlipidemia include a decrease of the plaque volume, the maximum sectional area, and the stenosis degree.

## CLINICAL RELEVANCE/APPLICATION

The 64-detector CT coronary angiography could analyze the effect of Statin for coronary atherosclerosis plaque.

### RC303-04 Late Gadolinium Enhancement

Tuesday, Dec. 1 9:30AM - 10:10AM Location: S405AB

#### Participants

Scott D. Flamm, MD, Cleveland, OH, (flamm@ccf.org) (*Presenter*) Medical Director, Precision Image Analysis, Inc; Board of Directors, Precision Image Analysis, Inc;

## ABSTRACT

Learning Objectives: 1. Understand the distinct advantages of late gadolinium enhancement imaging by cardiac MRI. 2. Articulate the mechanisms responsible for the increased signal intensity in irreversibly damaged myocardium. 3. Recognize the clinical situations appropriate for cardiac MRI late gadolinium enhancement imaging. Abstract: CMR has the unique ability to evaluate several markers of myocardial viability that are of proven value. Reliable and accurate assessment of myocardial scar burden, coronary perfusion, and contractile reserve by CMR are all well established. Direct imaging of myocardial fibrosis has been possible for well over a decade using an inversion-recovery prepared T1-weighted sequence following the intravenous administration of a gadolinium-chelate (Gd). This CMR technique has been named "late gadolinium enhancement" (LGE) and demonstrates non-viable tissue as "hyperenhanced" or bright. Both interstitial and replacement fibrosis enhance similarly with LGE for reasons described below. The hyperenhancement of interstitial fibrosis is more commonly seen in infiltrative entities such as hypertrophic cardiomyopathy and amyloidosis, where the issue of viability is less prominent. The excellent spatial resolution and tissue characterization afforded by CMR makes it ideal for both: 1) quantification of significant areas of viable myocardium, and 2) defining discrete regions of non-viability. Accurate quantification of areas of scar and viable tissue is clearly important in predicting mortality as the benefits of revascularization rise steeply when the area of dysfunctional but viable myocardium reaches a critical size. Further, characterization of non-ischemic patterns of LGE allows differentiation of the breadth of non-ischemic cardiomyopathies, and quantification may similarly provide prognostic information. This presentation will review the LGE technique in its various forms, define evaluation of both ischemic and non-ischemic cardiomyopathies, and address where LGE fits within the diagnostic and prognostic pathways in patients with cardiovascular diseases.

### RC303-05 Coronary CT Angiography and Perfusion/Scar Imaging

Tuesday, Dec. 1 10:20AM - 11:00AM Location: S405AB

#### Participants

U. Joseph Schoepf, MD, Charleston, SC, (schoepf@musc.edu) (*Presenter*) Research Grant, Bracco Group; Research Grant, Bayer AG; Research Grant, General Electric Company; Research Grant, Siemens AG; Research support, Bayer AG; ;

#### LEARNING OBJECTIVES

1) Identify suitable CT techniques for the comprehensive assessment of ischemic heart disease. 2) Discuss different CT approaches for evaluating myocardial perfusion. 3) Compare CT to other modalities for determining the hemodynamic significance of coronary artery stenosis.

#### ABSTRACT

Appropriate non-invasive evaluation of patients with suspected coronary artery disease (CAD) has traditionally rested on the two pillars of morphological assessment for coronary artery stenosis and functional evaluation for determining the downstream hemodynamic significance of lesions. This approach has been informed by the fundamental realization that morphological assessment of coronary artery stenoses rarely reflects the actual level of myocardial ischemia. Further, patient evaluation, prognostication, and management are more reliable and effective when functional and morphological assessments are used in concert. Due to recent advancements in CT technology, coronary CTA (cCTA) has become an integral part of the non-invasive diagnostic work-up for the anatomic evaluation of the coronary arteries of patients with suspected CAD. According to the current appropriate use criteria, cCTA is the method of choice for the exclusion of significant coronary artery stenosis in patients with low and intermediate CAD risk profiles. The diagnostic accuracy of cCTA has been demonstrated by its high sensitivity (96%) and specificity (86%). Furthermore, cCTA can provide global and regional functional evaluation if acquired with an ECG-synchronization technique. In addition to its role in assessing coronary morphology and left ventricular function, cCTA has been utilized in the evaluation of a third aspect in the diagnostic algorithm of ischemic heart disease - myocardial perfusion. As cCTA may provide diagnostic information for each of these three cornerstones of ischemic heart disease management, this emerging technology has the potential to become the stand-alone method for the evaluation of patients with suspected CAD with a single modality, and within a single imaging session. The purpose of this presentation is to review the growing body of evidence on the CT assessment of myocardial perfusion and provide a systematic overview of presently available techniques.

#### RC303-06 Reduced-Dose Dual-Source Coronary Computed Tomography Angiography (CCTA): Is Raw-Data-Based Iterative Reconstruction Able to Maintain the Diagnostic Confidence?

Tuesday, Dec. 1 11:00AM - 11:10AM Location: S405AB

#### Participants

Francois Pontana, MD, PhD, Lille, France (*Abstract Co-Author*) Nothing to Disclose  
Isabel A. Castellano, PhD, London, United Kingdom (*Abstract Co-Author*) Nothing to Disclose  
Tevfik F. Ismail, PhD, MRCP, London, United Kingdom (*Abstract Co-Author*) Nothing to Disclose  
Natalie Gartland, London, United Kingdom (*Abstract Co-Author*) Nothing to Disclose  
Michael B. Rubens, MBBS, London, United Kingdom (*Abstract Co-Author*) Nothing to Disclose  
Edward Nicol, MBBS, London, United Kingdom (*Presenter*) Nothing to Disclose

#### PURPOSE

To evaluate image quality and diagnostic confidence of a raw-data-based iterative reconstruction technique (SAFIRE) in reduced-dose CCTA images in comparison with standard-dose filtered back projection (FBP) images.

#### METHOD AND MATERIALS

107 consecutive patients (72 males; 35 females), referred for a CCTA were prospectively included using a dual source CT system in a high pitch (n=51) or a sequential prospective gating scanning mode (n=56) according to the heart rate (mean DLP value = 204.6 mGy.cm). From each acquisition 4 series of images were reconstructed: (a) standard-dose images, reconstructed with FBP considered as the reference standard (Group 1) and (b) 3 series of reduced-dose images, obtained with a prototype software which virtually increased the level of noise simulating a 30% dose reduction, and reconstructed with FBP (Group 2) and SAFIRE with a preset strength of 3 (Group 3) and 5 (Group 4). Two readers blindly evaluated each series for (a) objective noise and CNR; (b) coronary border sharpness, lesion detection and (c) diagnostic confidence level using a 5-point scale.

#### RESULTS

In Group 2, there was a significant increase in the mean level of objective noise compared to Group 1 (36.8  $\pm$  6.7 vs 30.4  $\pm$  5.2; p<0.0001) and an impairment of the CNR (15.6  $\pm$  4.3 vs 18.7  $\pm$  4.5; p<0.0001), which hampered the detection of 9 plaques. In Group 3 and 4, despite the 30% dose reduction, all the lesions depicted in Group 1 were seen and SAFIRE restored or improved the objective image quality respectively: (a) mean noise= 31.1  $\pm$  5.4; p=0.1 and 22.3  $\pm$  4.2; p<0.0001, and (b) CNR= 18.5  $\pm$  5.0; p=0.9 and 25.8  $\pm$  7.0; p<0.0001. However the diagnostic confidence was altered when compared with Group 1 (p<0.0001), mainly rated as moderate with a blurred aspect of the coronary borders (81/107; 75.7% and 103/107; 96.3%)(p<0.0001) and a significant number of artefactual non stenosing soft plaques described in vessels considered as normal in Group 1 (105/222; 47.3% and 194/222; 87.4%)(p<0.0001).

#### CONCLUSION

Raw-data-based iterative reconstruction allowed significant image noise reduction but may be associated with blurring of the coronary luminal borders, which can decrease diagnostic confidence.

#### CLINICAL RELEVANCE/APPLICATION

When reporting reduced-dose CCTA with iterative reconstruction, blurred-border and false smooth plaque artifacts must be considered in diagnostic assessment and subsequent patient management.

#### RC303-07 Prognostic Value of CT Coronary Angiography in Asymptomatic Patients with Suspected Coronary Artery Disease. Meta-Analysis of Observational Studies

Tuesday, Dec. 1 11:10AM - 11:20AM Location: S405AB

#### Participants

Michele Fusaro, MD, Treviso, Italy (*Presenter*) Nothing to Disclose  
Salvatore Cassese, MD, Munich, Germany (*Abstract Co-Author*) Nothing to Disclose  
Massimiliano Fusaro, MD, Munich, Germany (*Abstract Co-Author*) Nothing to Disclose  
Giovanni Balestriero, Treviso, Italy (*Abstract Co-Author*) Nothing to Disclose  
Leonardo E. La Torre, MD, TREVISO, Italy (*Abstract Co-Author*) Nothing to Disclose  
Giovanni Morana, MD, Treviso, Italy (*Abstract Co-Author*) Nothing to Disclose

## **PURPOSE**

To assess the prognostic value of CCTA as a screening tool in asymptomatic patients with suspected coronary artery disease (CAD).

## **METHOD AND MATERIALS**

A meta-analysis of observational coronary computed tomographic angiography (CCTA) imaging studies was conducted, by means of search in electronic scientific databases for studies investigating the use of CCTA in asymptomatic patients with suspected CAD. The endpoints were the incidence of acute coronary syndrome (ACS) requiring hospitalization, revascularization and cardiac death. Exclusion criteria were composite outcomes and duplicated data. Odds ratio (OR) with 95% confidence interval [CI 95%] was used as summary statistic.

## **RESULTS**

A total of 7,931 asymptomatic patients from 6 studies received a CCTA for suspected CAD. The proportion of patients without CAD, with CAD<50% and with CAD>50% was 78%, 14% and 8%, respectively. After a median follow-up of 27.1 months [22.0-31.2], Patients without CAD did not show any of the endpoints. Compared to patients with CAD>50%, patients with CAD<50% showed a similar risk of ACS (0.16 [0.02-1.50]; P=0.11) but a lower risk of revascularization (0.04 [0.02-0.10]; P<0.001) and death (0.05 [0.01-0.44]; P=0.007).

## **CONCLUSION**

Two-third of asymptomatic patients receiving CCTA for suspected CAD had no evidence of disease and no events at follow-up. The presence of CAD>50% significantly increases the risk of revascularization and death as compared to CAD<50%, although the percentage is quite low. Nevertheless, patients with CAD>50% have a risk of ACS comparable to those with CAD<50%.

## **CLINICAL RELEVANCE/APPLICATION**

In asymptomatic patients there is not evidence of the utility of CCTA as a screening tool.

## **RC303-08 The Role of Imaging for Management of Coronary Artery Disease - State of the Evidence**

Tuesday, Dec. 1 11:20AM - 12:00PM Location: S405AB

### **Participants**

Leslee Shaw, PhD, Atlanta, GA (*Presenter*) Nothing to Disclose

MSQI31

## Quality Improvement Symposium: The Value of Practice Quality Improvement

Tuesday, Dec. 1 8:30AM - 10:00AM Location: S406B

**SQ**

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

### Participants

Ella A. Kazerooni, MD, Ann Arbor, MI (*Moderator*) Nothing to Disclose

### Sub-Events

#### MSQI31A ABMS: Why Practice Quality Improvement is an MOC Requirement

### Participants

Lois Margaret Nora, MD, JD, MBA, Chicago, IL (*Presenter*) Nothing to Disclose

### LEARNING OBJECTIVES

1) Explain the role of practice assessment and performance improvement in Board Programs of Maintenance of Certification. 2) Explain new standards of MOC and how boards are increasing relevance and decreasing burden for practicing physicians doing practice assessment and performance improvement. 3) Assess the role of professional self-regulation in the future of health system change.

### ABSTRACT

ABMS Board Certification is a longstanding and important component of the medical profession's professional self-regulation. The ABMS Program for Maintenance of Certification MOC (ABMS MOC®) activities emphasize ongoing professional development and assessment that is aligned with other professional expectations and requirements within health care. The ABMS Program for MOC incorporates the six core competencies defined by ABMS and the Accreditation Council for Graduate Medical Education (ACGME) [(1) practice-based learning and improvement, (2) patient care and procedural skills, (3) systems-based practice, (4) medical knowledge, (5) interpersonal and communication skills and (6) professionalism] within a four-part framework: Professionalism and Professional Standing; Lifelong Learning and Self-Assessment; Assessment of Knowledge, Judgment, and Skills; and, Improvement in Medical Practice. While these elements are consistent across all Member Boards, each board tailors the expectations within each element to meet the particular specialties for which it provides certification. This presentation will explain some of the changes and innovations that ABMS Member Boards are incorporating into their MOC Programs and particularly the element related to Improvement in Medical Practice.

#### MSQI31B ACR Perspective: How ACR Supports PQI

### Participants

Bibb Allen JR, MD, Birmingham, AL (*Presenter*) Nothing to Disclose

### LEARNING OBJECTIVES

1) Describe the mandate for higher value care and such as the federal Physician Quality Reporting System and the American Board of Radiology Practice Quality Improvement as it relates to Maintenance of Certification. 2) Describe the process for development of metrics appropriate to radiology. 3) Examine ways their practices can participate in these programs using workflow tools and registry reporting. 4) Examine how registry reporting can provide benchmarks and dashboards for continuing practice improvement.

### ABSTRACT

In an article in the New England Journal of Medicine in March 2015, Health and Human Services Secretary Sylvia Burwell set new targets for value-based payments in Medicare. She states their goal is that 85% of Medicare fee-for-service payments will be tied to quality or value by 2016. Most likely this will be administered through the Medicare Physician Quality Reporting System (PQRS); however, has been difficult thus far for many radiology practices to achieve full participation in PQRS. Additionally, the American Board of Radiology requires documentation of Practice Improvement Project (PQI) for participation in Maintenance of Certification (PQI). In an effort to prepare radiologists to be successful in demonstrating higher value care and because we believe radiologists will be more likely to participate if what we measure provides value to ourselves and our patients, the American College of Radiology is working with CMS and the ABR to develop meaningful metrics for radiology to be used for quality reporting. Radiologists are also working to develop tools to capture the information as part of our daily workflow either through PACS, dictation software or EHR. While the information could be used internally for process improvement, if metrics are standardized, we have an opportunity for national registry reporting which offers not only opportunity for internal process improvement but also benchmarking, and since CMS now allows reporting PQRS metrics through a Qualified Clinical Data Registry, by reporting through these registries practices and individuals can qualify for PQRS and by using this reporting as a basis for ABR quality activities, physicians may seamlessly participate in PQI for MOC. Finally, registry reporting allows data mining and supports socioeconomic research in radiology, so we can learn where there are opportunities for further improvement in the care of our patients.

#### MSQI31C ABR Perspective: New PQI Efforts

### Participants

Milton J. Guiberteau, MD, Houston, TX, (guiberteau@theabr.org) (*Presenter*) Nothing to Disclose

### LEARNING OBJECTIVES

1.) Explain the implications of the ABMS MOC 2015 Standards for tailoring the American Board of Radiology's (ABR) MOC program requirements to the practice environments and culture of radiological professionals. 2) Articulate the rationale for changes in the

ABR MOC Program to alleviate duplication of effort and overall resource burden in complying with MOC program requirements. 3) Implement changes in diplomates' personal MOC compliance plans to meet the requirements of MOC employing new options. 4) Explain ABR efforts to explore additional improvements to promote diplomate satisfaction and sense of accomplishment in MOC participation in the future.

#### **ABSTRACT**

In the 2015 MOC Standards, ABMS has reiterated and expanded its acknowledgment that the fundamental structure of MOC intended for all ABMS Board MOC programs may be best implemented by creating options for compliance which recognize the unique cultures and practice environments of each medical specialty represented by its 24 member Boards. In response, the American Board of Radiology has instituted changes in its MOC program to alleviate duplication of effort in meeting the requirements of its MOC program by recognizing and giving credit for diplomate efforts already expended as part of their ordinary workday, especially those pertinent to Quality Improvement (MOC Part IV). By doing so, the ABR is delivering on its goal of reducing the time and resource burdens of meeting the requirements of MOC while increasing diplomate satisfaction and sense of accomplishment in MOC participation.

RC325

## Quantitative Imaging Mini-course: Modality Independent Issues

Tuesday, Dec. 1 8:30AM - 10:00AM Location: S502AB

**BQ** **CT** **PH**

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

### Participants

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

### Sub-Events

#### RC325A The Role of Physical Phantoms in Quantitative Imaging

### Participants

Paul E. Kinahan, PhD, Seattle, WA (*Presenter*) Research Grant, General Electric Company; Co-founder, PET/X LLC

### LEARNING OBJECTIVES

1) To understand the definitions and requirements of quantitative medical imaging. 2) To learn the role of phantoms and tradeoffs in comparison with simulations and patient studies. 3) To review the classes of phantoms available: Commercial, experimental, and virtual (digital reference objects).

### ABSTRACT

#### RC325B Digital Reference Objects

### Participants

Daniel P. Barboriak, MD, Durham, NC (*Presenter*) Advisory Board, General Electric Company

### LEARNING OBJECTIVES

1) Explain why digital reference objects are useful for evaluation of software packages used to derive quantitative imaging biomarkers. 2) State the difference between bias and precision, and describe how aggregate and disaggregate measures of software performance differ.

### ABSTRACT

This lecture will familiarize the audience with digital reference objects (DROs) and their place in the development of quantitative imaging biomarkers (QIBs). To determine whether a quantitative imaging study is measuring a pathological or physiological process in an unbiased way, the quantitative imaging result would need to be compared to an independently ascertained unbiased measurement in the imaged subject or animal. Unfortunately, obtaining a precise and unbiased measurement (also known as ground truth) is generally impractical or impossible. Frequently there are several software packages that can be used to create maps reflecting the spatial distribution of the QIB. Because different software packages often give different quantitative results, the choice of software contributes to the variability of the result. Without ground truth data, it can be difficult to determine which softwares calculate the underlying biomarker with sufficient precision and lack of bias to be applicable for a particular use case. DROs are synthetic images whose pixel values are partially or completely determined by mathematical equations. Although these images may be designed to mimic real imaging data, their content is ultimately determined by mathematical models. Even though DROs do not perfectly simulate real data, they are useful because they are created assuming particular underlying parameter values, which can be regarded as ground truth for these objects. DROs can be particularly valuable for evaluation of software packages. Because they are created using known ground truth, they can be used to determine whether a particular image analysis strategy introduces biases when used to extract a QIB. (This is not possible with real data if the ground truth is not known). Assuming that realistic image noise and/or artifact can be included in the DRO, they can also be used to estimate how precisely a software package is deriving quantitative metrics in real images. This lecture will describe how DROs are used in the RSNA Quantitative Imaging Biomarker Alliance (QIBA) process. Topics that will be discussed include: 1) the variety of metrics that can be used to evaluate software performance with DROs; 2) the differences between aggregated and disaggregated measures of performance, and the relevance of this for determining whether software complies with a standard; and 3) best practices for creation of DROs.

### Honored Educators

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Daniel P. Barboriak, MD - 2013 Honored Educator

#### RC325C CT Image Analysis and Sources of Variation

### Participants

Binsheng Zhao, DSc, New York, NY (*Presenter*) License agreement, Varian Medical Systems, Inc; License agreement, Keosys SAS; License agreement, Hinacom Software and Technology, Ltd; License agreement, ImBio, LLC; License agreement, AG Mednet, Inc

### LEARNING OBJECTIVES

1) To familiarize the audience with the basic image analysis methods such as segmentation and feature extraction, using tumor

quantification in oncology as an example. 2) To discuss sources of variation in image analysis, using both phantom and in-vivo tumors as examples. 3) To raise awareness of the need for harmonization of imaging and quantification techniques in quantitative radiology.



## Confluence of Diagnostic Radiology and Radiation Oncology in Management of Pediatric Malignancies

Tuesday, Dec. 1 8:30AM - 10:00AM Location: S403A



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

### Participants

Stephanie A. Terezakis, MD, Baltimore, MD (*Moderator*) Speaker, Elekta AB

### Sub-Events

#### RC320A Supratentorial CNS Tumors

### Participants

Stephanie M. Perkins, MD, Saint Louis, MO (*Presenter*) Nothing to Disclose

Tina Y. Poussaint, MD, Boston, MA (*Presenter*) Nothing to Disclose

### LEARNING OBJECTIVES

1) Identify the common supratentorial brain tumors of childhood. 2) Evaluate the imaging features of supratentorial brain tumors.

### ABSTRACT

The most common type of solid tumor among children is the pediatric brain tumor, which is the second most frequent childhood malignancy after leukemia, and the leading cause of death from solid tumors in this population. Among children aged 0-19, the incidence rate for all primary brain and central nervous system tumors was roughly 5.3 per 100,000, with approximately 4350 cases of new cases of childhood primary malignant and non-malignant CNS tumors were expected to be diagnosed each year in the United States in 2013. Supratentorial tumors are most common in the first 2-3 years of life and in children older than 10 years, supratentorial and infratentorial are of equal frequency. This lecture will focus on the standard and advanced MR imaging features of the common supratentorial tumors of childhood affecting the cerebral hemispheres, suprasellar/sellar regions and pineal regions.

#### RC320B Infratentorial Central Nervous System Tumors

### Participants

David B. Mansur, MD, Cleveland, OH (*Presenter*) Nothing to Disclose

Thierry Huisman, MD, Baltimore, MD, (thuisma1@jhmi.edu) (*Presenter*) Nothing to Disclose

### LEARNING OBJECTIVES

1) Identify the types of diagnostic imaging most useful in the management of infratentorial CNS tumors. 2) Describe how proper diagnostic imaging aids in target delineation, staging, and treatment planning in posterior fossa CNS radiotherapy. 3) Define how conventional and advanced neuroimaging may characterize and differentiate brain neoplasms from treatment-related imaging findings following radiotherapy.

### ABSTRACT

The radiotherapeutic management of infratentorial CNS tumors requires close collaboration between neuroradiology and radiation oncology. This process begins with accurate initial tumor description and delineation in the pre-operative setting. Detection of drop metastases is another critical role for neuroimaging which can be done either preoperatively or post operatively. Post-operative imaging is essential to assist with determining extent of resection as well as defining radiotherapy treatment volumes. Finally, neuroimaging after radiotherapy can aid in determining benign radiation therapy changes from recurrent or progressive tumor.

#### RC320C Pediatric Sarcomas: MR Imaging

### Participants

Oren Cahlon, Princeton, NJ (*Presenter*) Investor, ProCure Treatment Centers, Inc

Laura M. Fayad, MD, Baltimore, MD (*Presenter*) Nothing to Disclose

### LEARNING OBJECTIVES

1) Examine the roles MRI plays in the evaluation of pediatric sarcomas. 2) Assess the utility of various imaging sequences for the initial assessment and post-treatment follow-up of sarcomas. 3) Apply anatomic, functional and metabolic techniques for the identification of tumor extent and character.

### ABSTRACT

MRI plays a critical role in the assessment of pediatric musculoskeletal tumors, both osseous and soft tissue masses. Although such neoplasms may initially be evaluated on other modalities, such as sonography or radiography, the most salient role for MRI is in determining the extent of disease. MRI sequences also offer information for tumor detection, characterization, the assessment of treatment response and the distinction of post-operative scar from recurrence. With conventional MRI, excellent anatomic detail is obtained, but with the advent of non-contrast chemical shift imaging, diffusion weighted imaging and MR spectroscopy, functional and metabolic features of a neoplasm can be evaluated noninvasively. In this presentation, a comprehensive MRI approach to assessing pediatric musculoskeletal tumors will be reviewed, focusing on the roles of anatomic, functional and metabolic MRI sequences.

RCC31

## The RSNA Image Share Network - How It Operates and How to Put It into Your Office

Tuesday, Dec. 1 8:30AM - 10:00AM Location: S501ABC



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

### Participants

David S. Mendelson, MD, Larchmont, NY (*Moderator*) Spouse, Employee, Novartis AG; Advisory Board, Nuance Communications, Inc; Advisory Board, General Electric Company; Advisory Board, Toshiba Corporation  
Wyatt M. Tellis, PhD, San Francisco, CA (*Presenter*) Officer, EyePACS, LLC

### LEARNING OBJECTIVES

1) Understand the goals of the RSNA Image Share project. 2) Understand the technical architecture of the RSNA Image Share. 3) Learn the steps necessary to implement in your local environment.

### URL

RC302

## Technologies to Enable Residency Program Administration

Tuesday, Dec. 1 8:30AM - 10:00AM Location: S504AB

ED

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

### Participants

Terry S. Desser, MD, Stanford, CA (*Moderator*) Nothing to Disclose

### LEARNING OBJECTIVES

1) Educate program directors about software tools and work strategies that can make data collection for the Next Accreditation System more efficient. 2) Illustrate hardware and software technology that is useful in delivery of educational content to residents during conferences and for just-in-time learning. 3) Learn about the tools developed by the RSNA that can be useful to residents and program directors for delivery of educational content and in residency program administration. 4) Discover ways that the popular video portal YouTube can be used to deliver educational content and track learning activities.

### ABSTRACT

Radiology residency administration is an increasingly time- and labor-intensive activity for Program Directors and Coordinators. Under the Next Accreditation System, learning activities for each of the 12 Radiology Resident Milestones must be developed, and each resident's progress toward mastery must be tracked and reported semi-annually to the ACGME. Much work has been done in the Radiology community in developing materials that can be used for imparting both clinical and non-clinical skills to residents. This Refresher Course will present technologies and strategies that can be helpful to program directors to disseminate this information and content to resident learners, and to efficiently measure and report their progress to ACGME.

**Active Handout:** Terry S. Desser

<http://abstract.rsna.org/uploads/2015/15002491/RC302.pdf>

### Sub-Events

#### RC302A Technologies for Educational Content Delivery

### Participants

Harprit S. Bedi, MD, Boston, MA (*Presenter*) Nothing to Disclose

### LEARNING OBJECTIVES

View learning objectives under main course title.

#### RC302B RSNA Technologies for Resident Education

### Participants

William J. Weadock, MD, Ann Arbor, MI (*Presenter*) Owner, Weadock Software, LLC

### LEARNING OBJECTIVES

View learning objectives under main course title.

#### RC302C YouTube: Pros and Cons as an Educational Outlet

### Participants

Christopher F. Beaulieu, MD, PhD, Stanford, CA (*Presenter*) Nothing to Disclose

### LEARNING OBJECTIVES

1) Describe the steps involved in creation and posting of a YouTube video. 2) List the benefits of free, worldwide accessible radiology education videos. 3) Explain current limitations of YouTube as pertaining to radiology education.

### ABSTRACT

Most radiology conferences are delivered locally to small groups of learners and are not recorded. For the presenter, these efforts involve many hours of preparation, and it can be disappointing that only a subset of trainees attend a given conference. YouTube makes it possible to post large video files at no cost, enabling any time, anywhere viewing. This makes teaching materials continuously accessible to large numbers of viewers. Creation of a video can be quite time efficient if it is recorded simultaneously to the live presentation. Several software programs provide both live web streaming and video/audio capture. For radiology, high quality video recording is critical. Audio quality can be excellent with use of a microphone. Benefits of YouTube include its no-cost hosting, high quality playback, the ability to obtain viewer comments, and quantitative "analytics" related to viewership. Analytics include number of views, location, viewing time, gender, and numerous other metrics. YouTube videos can also be "embedded" in other web sites. One can also elect to "monetize" content to collect a small amount of ad-sharing revenue (~0.2 cents per view) if ads are included. Disadvantages of YouTube include the time required to create and post the content, varying educators' viewpoints in terms of whether they want to record and post, and limited feedback. There are also copyright and branding issues that have yet to be fully understood. Thus far, my experience with YouTube has been very positive. Residents and fellows appreciate the ability to view or review the content on their own time. Trainees can preview a didactic video before conference and use conference time for related cases. Worldwide viewership has resulted in over 50,000 views in the last year, translating into over 5000 virtual lecture hours (live lecture time 11 hours). To view my channel, see: <https://www.youtube.com/user/MozchopsMD>

RC311

## Imaging Alzheimer's Disease -The Search for the Holy Grail

Tuesday, Dec. 1 8:30AM - 10:00AM Location: S505AB



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

### Participants

#### LEARNING OBJECTIVES

1) Discuss the potential roles and limitations of PET imaging for amyloid and tau protein in evaluating patients with dementia. 2) Describe anatomic and functional MRI techniques for evaluating Alzheimer's disease. 3) Understand the clinical challenges of diagnosing and managing patients with dementia.

### Sub-Events

#### RC311A PET Imaging, Tracers

##### Participants

Terence Z. Wong, MD, PhD, Chapel Hill, NC (*Presenter*) Nothing to Disclose

#### LEARNING OBJECTIVES

View learning objectives under main course title.

#### RC311B MRI and fMRI

##### Participants

Jeffrey R. Petrella, MD, Durham, NC (*Presenter*) Advisory Board, Johnson & Johnson Speakers Bureau, Quintiles Inc Advisory Board, Piramal Enterprises Limited

#### LEARNING OBJECTIVES

View learning objectives under main course title.

#### RC311C Clinical Examples

##### Participants

P. M. Doraiswamy, MD, Durham, NC (*Presenter*) Research Consultant, Bristol-Myers Squibb Company Research Consultant, Eli Lilly and Company Research Consultant, Neuronetrix, Inc Research Consultant, Medivation, Inc Research Grant, Bristol-Myers Squibb Company Research Grant, Eli Lilly and Company Research Grant, Neuronetrix, Inc Research Grant, Medivation, Inc Stockholder, Sonexa Therapeutics, Inc Stockholder, Clarimedix, Inc Speaker, Forest Medical, LLC

#### LEARNING OBJECTIVES

View learning objectives under main course title.

RC324

## Reviewing Manuscripts for the RSNA Journals (Sponsored by the RSNA Publications Council)

Tuesday, Dec. 1 8:30AM - 10:00AM Location: E260



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

### Participants

Herbert Y. Kressel, MD, Boston, MA (*Moderator*) Royalties, Bayer AG

Jeffrey S. Klein, MD, Burlington, VT, (jklein@rsna.org) (*Presenter*) Nothing to Disclose

### LEARNING OBJECTIVES

1) Discuss the similarities and differences in the peer review process for the RSNA journals. 2) Discuss the functions of the reviewer in the peer review process. 3) Enumerate the desired elements for peer review of a manuscript 4) Detail how a reviewer can receive AMA PRA Category 1 CME credit for manuscript review

### ABSTRACT

Peer review is, in a major way, responsible for the quality of the manuscripts published in a given journal. In this refresher course, the Editors of both of the peer-reviewed journals published by the RSNA will discuss the peer review processes of their respective journals. The Editors will also emphasize the important functions served by the peer reviewers and will indicate the types of information which they would like the peer reviewers to consider when the peer reviewers review a given manuscript. Benefits and responsibilities of the peer review process will be detailed. There will be ample time for questions and answers.

### URL

**Carotid and Renal Doppler (Hands-on)**

Tuesday, Dec. 1 8:30AM - 10:00AM Location: E264



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

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

**Participants**

Gowthaman Gunabushanam, MD, New Haven, CT, (gowthaman.gunabushanam@yale.edu) (*Moderator*) Editor, WebMD Health Corp ;  
 Gowthaman Gunabushanam, MD, New Haven, CT, (gowthaman.gunabushanam@yale.edu) (*Presenter*) Editor, WebMD Health Corp ;  
 Mark E. Lockhart, MD, Birmingham, AL, (mlockhart@uabmc.edu) (*Presenter*) Nothing to Disclose  
 Shweta Bhatt, MD, MBBS, Rochester, NY (*Presenter*) Nothing to Disclose  
 Wui K. Chong, MD, Chapel Hill, NC, (wk\_chong@med.unc.edu) (*Presenter*) Nothing to Disclose  
 Corinne Deurdulian, MD, Los Angeles, CA (*Presenter*) Nothing to Disclose  
 Vikram S. Dogra, MD, Rochester, NY (*Presenter*) Editor, Reed Elsevier  
 Edward G. Grant, MD, Los Angeles, CA (*Presenter*) Research Grant, General Electric Company ; Medical Advisory Board, Nuance Communications, Inc  
 Ulrike M. Hamper, MD, MBA, Baltimore, MD (*Presenter*) Nothing to Disclose  
 Felix A. Hester, Helena, AL (*Presenter*) Nothing to Disclose  
 Michelle L. Robbin, MD, Birmingham, AL, (mrobbin@uabmc.edu) (*Presenter*) Consultant, Koninklijke Philips NV;  
 Leslie M. Scoutt, MD, New Haven, CT (*Presenter*) Consultant, Koninklijke Philips NV  
 Ravinder Sidhu, MD, Rochester, NY, (ravinder\_sidhu@urmc.rochester.edu) (*Presenter*) Nothing to Disclose  
 Sadhna Verma, MD, Cincinnati, OH (*Presenter*) Nothing to Disclose  
 Margarita V. Revzin, MD, Wilton, CT, (margarita.revzin@yale.edu) (*Presenter*) Nothing to Disclose  
 Davida Jones-Manns, Hampstead, MD (*Presenter*) Nothing to Disclose

**LEARNING OBJECTIVES**

1) Describe the technique and optimally perform carotid Doppler ultrasound. 2) Describe the technique and optimally perform renal Doppler ultrasound. 3) Review qualitative and quantitative criteria for diagnosing abnormalities in carotid and renal ultrasound Doppler examinations.

**ABSTRACT**

This hands-on course will provide participants with a combination of didactic lectures and an extended 'live' scanning opportunity on normal human volunteers, as follows: Didactic lectures (30 minutes): 1. Carotid Doppler Ultrasound: scanning technique, diagnostic criteria and interesting teaching cases. 2. Renal Doppler Ultrasound: scanning technique, diagnostic criteria and interesting teaching cases. Mentored scanning (60 minutes): Following the didactic lectures, the participants will proceed to a scanning area with normal human volunteers and ultrasound machines from different manufacturers. Participants will be able to perform live scanning with direct assistance (if needed) by faculty. Faculty will be able to offer feedback, help participants improve their scanning technique as well as answer any questions. Faculty will also be available to answer general questions relating to all aspects of vascular Doppler, not limited to carotid and renal Doppler studies.

**Honored Educators**

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Leslie M. Scoutt, MD - 2014 Honored Educator  
 Sadhna Verma, MD - 2013 Honored Educator

MSES31

## Essentials of Chest Imaging

Tuesday, Dec. 1 8:30AM - 10:00AM Location: S100AB



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

### Participants

### Sub-Events

#### MSES31A Large Airway Disease

### Participants

Phillip M. Boiselle, MD, Boston, MA (*Presenter*) Nothing to Disclose

### LEARNING OBJECTIVES

1) Accurately identify normal large airway anatomy, variants, and common forms of pathology on MDCT scans. 2) Employ a pattern-based approach to facilitate accurate diagnosis of congenital and acquired causes of large airways disease on MDCT scans. 3) Recognize the overlap of MDCT airway findings between health and disease states.

### ABSTRACT

1. Accurately identify normal large airway anatomy, variants, and common forms of pathology on MDCT scans. 2. Employ a pattern-based approach to facilitate accurate diagnosis of congenital and acquired causes of large airways disease on MDCT scans. 3. Recognize the overlap of MDCT airway findings between health and disease states.

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Phillip M. Boiselle, MD - 2012 Honored Educator

#### MSES31B Pleural Disease

### Participants

Travis S. Henry, MD, San Francisco, CA (*Presenter*) Spouse, Medical Director, F. Hoffmann-La Roche Ltd

### LEARNING OBJECTIVES

1) Identify pleural thickening and differentiate the appearance from normal pleura on imaging. 2) Differentiate different causes of unilateral and bilateral pleural effusions to help narrow a differential diagnosis or provide a specific diagnosis. 3) Identify different manifestations of asbestos-related pleura disease. 4) Provide a differential diagnosis for pleural tumors.

### ABSTRACT

#### MSES31C HRCT Reticular Pattern

### Participants

Susan J. Copley, MD, FRCR, London, United Kingdom, ([sue.copley@imperial.nhs.uk](mailto:sue.copley@imperial.nhs.uk)) (*Presenter*) Consultant, Boehringer Ingelheim GmbH; Consultant, InterMune, Inc

### LEARNING OBJECTIVES

1) Accurately identify the Reticular pattern on HRCT. 2) List the differential diagnosis for the reticular pattern. 3) Recognize distinguishing features of particular entities that may result in this pattern.

### ABSTRACT

1) Accurately identify the Reticular pattern on HRCT. 2) List the differential diagnosis for the reticular pattern. 3) Recognize distinguishing features of particular entities that may result in this pattern.



RC322

## Proton: Imaging for Treatment Planning

Tuesday, Dec. 1 8:30AM - 10:00AM Location: S102D

RO PH

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

### Participants

Jon J. Kruse, PhD, Rochester, MN (*Moderator*) Research Grant, Varian Medical Systems, Inc

### ABSTRACT

Proton therapy has the potential to deliver very conformal dose distributions which may lead to higher cure rates or lower treatment toxicities than conventional or intensity modulated x-ray therapy. Like modern photon modalities, proton therapy relies heavily on advanced imaging techniques for treatment planning and dose calculation. This course will describe imaging requirements which are unique to proton therapy treatment planning. Much of the advantage of proton therapy is derived from the particle beam's finite range, and calculation of proton range within a patient requires a conversion between CT Hounsfield Units (HU) and proton stopping power. This calibration process is significantly different from the HU to electron density conversion which is performed for x-ray dose calculation. Uncertainties in the stopping power conversion are currently managed by expanding normal tissue margins around the clinical target volume and through appropriate beam selection. Improved CT techniques and alternative imaging modalities promise to deliver a more reliable image of stopping power within the patient, allowing for reduced treatment volumes. Tumor motion also presents a unique challenge in proton therapy, as a moving target exhibits not only variable position within a beam's eye view, but varying range as well. Modern proton therapy facilities which deliver treatments via a scanning beam are additionally susceptible to the interplay effect, in which the time dependent dose delivery is altered by motion of the target and surrounding anatomy. Four-dimensional imaging and dose calculation are then critically important in proton therapy to ensure that the treatment plan is robust against tumor motion.

### Sub-Events

#### RC322A Imaging Considerations for Proton Treatment Planning

### Participants

Andrew Wroe, PhD, Loma Linda, CA (*Presenter*) Nothing to Disclose

### LEARNING OBJECTIVES

1) Describe the stoichiometric calibration technique for deriving proton stopping power from CT Hounsfield Units. 2) Identify common sources of uncertainty in the predicted proton range within a patient. 3) Explain near- and long-term developments in CT imaging and alternative modalities which may reduce the uncertainty in proton range calculation.

#### RC322B Uncertainties in Motion for Treatment Planning

### Participants

Heng Li, Houston, TX (*Presenter*) Research funded, Varian Medical Systems, Inc

### LEARNING OBJECTIVES

1) Describe the impact of tumor motion on a proton dose distribution. 2) Compare the relative value of various four-dimensional imaging modalities in the evaluation of a proton plan for a mobile target. 3) Explain the process for incorporating four-dimensional imaging into dose calculation.

**Mitigation of Litigation (Sponsored by the RSNA Professionalism Committee)**

Tuesday, Dec. 1 8:30AM - 10:00AM Location: S104A

**PR**AMA PRA Category 1 Credits™: 1.50  
ARRT Category A+ Credits: 1.50**Participants**Leonard Berlin, MD, Skokie, IL (*Moderator*) Nothing to DiscloseDavid M. Yousem, MD, Baltimore, MD (*Moderator*) Royalties, Oakstone Publishing, LLC; Author with royalties, Reed Elsevier; Research Grant, Bayer AG; ; ;**LEARNING OBJECTIVES**

1) To understand the implications of the four components of a medical negligence case: a. duty to the patient, b. breach in the standard of care, c. causation between breach and harm, and d) damages (economic, pain and suffering, punitive). 2) To reflect on the patient and physician experience in going through a malpractice trial. 3) To apply practice habits that reduce the chance that you will be the subject of a medical malpractice suit, enhance patient safety, increase the likelihood of good outcomes, and prevent frivolous lawsuits. 4) To learn dos and don'ts once sued. 5) To comprehend the role of medical experts in establishing the standard of care and ensuring an equitable and fair judicial process. 6) To discuss ethics of testifying as expert.

**ABSTRACT**

A medical malpractice case requires establishing four components of the case: 1) the duty of the physician to the patient, 2) a breach in the standard of care (what a reasonably prudent person would do in a similar situation), 3) the establishment that the breach caused the subsequent harm to the patient, and 4) damages to the patient. Most malpractice cases are won or lost in determining whether a deviation in the standard of care occurred and whether that deviation truly caused the patient's damages. Expert witnesses are commonly employed to help establish the standard of care for the setting in question, although some experts also provide guidance as to the expected economic costs that will be incurred by the damaged plaintiff. Because of the high cost of medicolegal litigation, most cases that have minor damages never come to court but may be dropped or settled out of court. because of the vagaries of a lay jury, many substantive cases are also settled out of court. One can reduce the chances that one will be sued by being cognizant of professional standards and guidelines that dictate certain behaviors such as timeliness of reporting, communication of important/relevant/critical/unexpected findings, and establishing good peer review systems that identify errors before they occur. Applying behaviors or work habits that enhance accuracy and efficiency and good practice patterns while also developing good physician-patient relationships are helpful for mitigation of litigation. Effective expert witnesses can help a lay jury understand the nuances of a case and establishing whether negligence has occurred. The credibility of expert witnesses is enhanced when they are impartial, do blinded unbiased reads, understand the specific practice patterns in which the defendant physicians are employed, and can explain complex issues to non-medical jury members.

**Sub-Events****RC316A Elements of Legal Suits: Duty, Breach, Causation, Damages and the Links between Them****Participants**Rosemary Schnall, Philadelphia, PA (*Presenter*) Stockholder, Johnson & JohnsonKelly Yousem, JD, Owings Mills, MD (*Presenter*) Nothing to Disclose**LEARNING OBJECTIVES**

View learning objectives under main course title.

**ABSTRACT**

The purpose of this presentation is to understand the main elements of a medical malpractice lawsuit. You will gain an understanding of the process as well as the legal reasoning behind litigation objectives. Additionally, we will discuss the standards of proof required and how expert witnesses are a necessary requirement in this process, for both Plaintiffs and Defendants.

**RC316B Mitigation of Litigation: What the Radiologist Can Do To Reduce the Risk of Being Named in a Lawsuit****Participants**Michael M. Raskin, MD, JD, Tamarac, FL, (drraskin@bellsouth.net) (*Presenter*) Nothing to Disclose**LEARNING OBJECTIVES**

1) Identify the different types of errors radiologists may make. 2) Analyze and compare specific actions to reduce errors. 3) Demonstrate understanding why failure to communicate is one of the greatest problems facing radiologists today. 4) Apply survival strategies to reduce the risk of being named in a lawsuit.

**ABSTRACT**

Failure to diagnose and failure to communicate are the two most frequent reasons why a radiologist is named in a lawsuit. Perception and interpretation errors will be analyzed and specific actions to reduce these errors will be compared. The communication of unexpected findings directly impacts on the ability of the radiologist to deliver quality patient care. The courts have consistently held that timely communication may be as important as the diagnosis itself. Radiology is so advanced in imaging technology but not in communicating imaging findings. Specific examples of communication errors will be discussed and analyzed. Potential solutions involving closed-loop communication will be addressed. Finally, a plan for implementation of specific strategies will be suggested.

**RC316C Expert Witness Testimony: Ethics and Qualifications for Being an Expert Witness**

#### Participants

Ronald L. Eisenberg, MD, JD, Boston, MA, (rleisenb@bidmc.harvard.edu) (*Presenter*) Nothing to Disclose

#### LEARNING OBJECTIVES

1) Understand the role of an expert witness in malpractice lawsuits and ethical issues to consider to become a more effective and valuable expert witness.

#### ABSTRACT

Expert witnesses play essential roles in malpractice lawsuits. Radiologists considering becoming expert witnesses need to clearly understand that their duty is to provide honest opinions on technical issues to educate members of the jury so that they can render a more accurate verdict, rather than being advocates for the party that engaged them.

#### Honored Educators

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

Ronald L. Eisenberg, MD, JD - 2012 Honored Educator

Ronald L. Eisenberg, MD, JD - 2014 Honored Educator

RC312

## Vascular Series: MR Angiography: New Techniques and Their Application

Tuesday, Dec. 1 8:30AM - 12:00PM Location: S102AB



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

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

### Participants

Dominik Fleischmann, MD, Palo Alto, CA (*Moderator*) Research support, Siemens AG;

### Sub-Events

#### RC312-01 Non-contrast MRA Techniques

Tuesday, Dec. 1 8:30AM - 8:55AM Location: S102AB

### Participants

Scott B. Reeder, MD, PhD, Madison, WI (*Presenter*) Institutional research support, General Electric Company Institutional research support, Bracco Group

#### RC312-02 Depiction of Transplant Renal Vascular Anatomy and Complications: Unenhanced MR Angiography by Using Spatial Labeling with Multiple Inversion Pulses

Tuesday, Dec. 1 8:55AM - 9:05AM Location: S102AB

### Participants

Hao Tang, Wuhan, China (*Presenter*) Nothing to Disclose

### PURPOSE

To evaluate the ability to depict anatomy and complications of renal vascular transplant with unenhanced magnetic resonance (MR) angiography with spatial labeling with multiple inversion pulses (SLEEK) and to compare the results with color Doppler (CD) ultrasonography (US), digital subtraction angiography (DSA), and intraoperative findings.

### METHOD AND MATERIALS

This study was approved by the institutional review board, and written informed consent was received before examination. Seventy-five patients who underwent renal transplantation were examined with unenhanced MR angiography with SLEEK and CD US. DSA was performed in 15 patients. Surgery was performed in eight patients. The ability of SLEEK to show transplant renal vascular anatomy and complications was evaluated by two experienced radiologists who compared the results with CD US, DSA, and intraoperative findings.

### RESULTS

Patients successfully underwent SLEEK MR angiography. Transplant renal vascular anatomy was assessed in 87 arteries and 78 veins. Renal vascular complications from transplantation were diagnosed in 23 patients, which included 14 with arterial stenosis, three with arterial kinking, two with arteriovenous fistulas, two with venous stenosis, one with pseudoaneurysms, and one with fibromuscular dysplasia. Three patients had two renal transplants and nine patients had nine accessory renal arteries. More accessory renal arteries were detected with SLEEK than with CD US. Correlation was excellent between the stenosis degree with SLEEK and DSA ( $r = 0.96$ ;  $P < .05$ ). For those with significant artery stenosis ( $>50\%$  narrowing) proved with DSA ( $n = 7$ ) or surgery ( $n = 3$ ), positive predictive value was  $91\%$  (10 of 11).

### CONCLUSION

Unenhanced MR angiography with SLEEK preliminarily proved to be a reliable diagnostic method for depiction of anatomy and complications of renal vascular transplant. It may be used for evaluation of patients with renal transplant, and in particular for those with renal insufficiency.

### CLINICAL RELEVANCE/APPLICATION

Unenhanced MR angiography with SLEEK may be used for evaluation of patients with renal transplant, and in particular for those with renal insufficiency.

#### RC312-03 Nonenhanced ECG-gated Quiescent-interval Single Shot (QISS) MRA of the Lower Extremity for Planning of Interventional Procedures: Results in 43 PAD Patients

Tuesday, Dec. 1 9:05AM - 9:15AM Location: S102AB

### Awards

#### RSNA Country Presents Travel Award

### Participants

Peter Liersch, Duesseldorf, Germany (*Presenter*) Nothing to Disclose  
Patric Kroepil, MD, Duesseldorf, Germany (*Abstract Co-Author*) Nothing to Disclose  
Christoph K. Thomas, MD, Dusseldorf, Germany (*Abstract Co-Author*) Speaker, Siemens AG  
Joel Aissa, Duesseldorf, Germany (*Abstract Co-Author*) Nothing to Disclose  
Gerald Antoch, MD, Duesseldorf, Germany (*Abstract Co-Author*) Nothing to Disclose  
Rotem S. Lanzman, MD, Duesseldorf, Germany (*Abstract Co-Author*) Nothing to Disclose

## PURPOSE

To assess the clinical value of nonenhanced ECG-gated Quiescent-Interval Single-Shot MR angiography (QISS-MRA) for planning of interventional procedures in patients with peripheral artery disease (PAD).

## METHOD AND MATERIALS

43 patients (mean age  $68.5 \pm 10.8$  years) with peripheral artery disease were included in this study. Nonenhanced QISS-MRA of the distal aorta and the lower extremity were acquired at 1.5T with 3mm slice thickness, with 0.6 mm overlap and an inplane resolution of  $1.0 \times 1.0$  mm, resulting in a total scan time of approx. 9 min. ECG-gating was applied for synchronization of the quiescent interval with the period of maximum systolic inflow. The degree of stenosis was assessed by using a 4-point scale (grade 1, normal appearing vessel; grade 2, vessel narrowing < 50%; grade 3, stenosis 50%-99%; grade 4, vessel occlusion) for 15 predefined anatomical segments. QISS-MRA was used to plan interventional procedures. Interventional digital subtraction angiography (DSA) served as the reference standard.

## RESULTS

QISS-MRA was performed successfully in all patients. 434 of 645 segments visible on QISS-MRA were evaluated with DSA during interventional procedures and were considered for further analysis. With QISS-MRA the degree of stenosis was assessed correctly in 404 of 434 (93.1%) segments, overestimated in 26 of 434 (5.9%) segments and underestimated in 4 of 434 (0.9%) segments. As compared to DSA, QISS-MRA had a high sensitivity (99.3%), specificity (97.2%) as well as positive and negative predictive value (89.3% and 97.3%) for the detection of significant stenosis (grade 3 and 4). Based on QISS-MRA, an appropriate arterial access was selected in all patients and the estimated length of stenosis or vessel occlusion was assessed correctly. 6 of 6 (100%) stented segments were not assessable.

## CONCLUSION

ECG-gated QISS-MRA is a solid nonenhanced imaging technique for assessment of stenosis of the lower extremities and provides a reliable basis for interventional procedures. A limitation of QISS-MRA is the evaluation of stented segments.

## CLINICAL RELEVANCE/APPLICATION

QISS-MRA is a reliable and precise nonenhanced imaging technique for assessment of peripheral arterial disease and can be applied safely in patients with contraindications for contrast material.

### RC312-04 Qualitative and Quantitative Image Quality of Lower Extremity Angiography Using Non-Contrast-Enhanced Quiescent Interval Single-Shot (QISS) MRA: Comparison with CTA

Tuesday, Dec. 1 9:15AM - 9:25AM Location: S102AB

#### Participants

Akos Varga-Szemes, MD, PhD, Charleston, SC (*Presenter*) Nothing to Disclose  
Giuseppe Muscogiuri, MD, Charleston, SC (*Abstract Co-Author*) Nothing to Disclose  
Carlo N. De Cecco, MD, PhD, Charleston, SC (*Abstract Co-Author*) Nothing to Disclose  
Pal Suranyi, MD, PhD, Charleston, SC (*Abstract Co-Author*) Nothing to Disclose  
Julian L. Wichmann, MD, Charleston, SC (*Abstract Co-Author*) Nothing to Disclose  
U. Joseph Schoepf, MD, Charleston, SC (*Abstract Co-Author*) Research Grant, Bracco Group; Research Grant, Bayer AG; Research Grant, General Electric Company; Research Grant, Siemens AG; Research support, Bayer AG; ;  
Stefanie Mangold, MD, Charleston, SC (*Abstract Co-Author*) Nothing to Disclose  
Paola Maria Cannao, MD, San Donato Milanese, Italy (*Abstract Co-Author*) Nothing to Disclose  
Shivraman Giri, PhD, Chicago, IL (*Abstract Co-Author*) Employee, Siemens AG  
Thomas M. Todoran, MD, Charleston, SC (*Abstract Co-Author*) Nothing to Disclose

## PURPOSE

To evaluate the qualitative and quantitative image quality of non-contrast quiescent interval single-shot (QISS) MRA in patients with peripheral artery disease (PAD).

## METHOD AND MATERIALS

Twenty patients ( $67 \pm 6$  years, 11 male) with PAD referred for a clinically indicated lower extremity CTA were consented for a non-contrast enhanced lower extremity MRA on a 1.5 clinical scanner (MAGNETOM Avanto, Siemens AG, Erlangen, Germany) using an investigational prototype QISS sequence (FOV  $400 \times 260$  mm<sup>2</sup>, TR/TE 3.5/1.4 ms, flip angle 90°, acquisition length 144 mm). Contrast to noise ratio (CNR) based on the vascular and peri-vascular signal was measured according to an 18-segment model. The segmental vascular enhancement and the image noise were rated on five-point scales (1-poor/non-diagnostic, 5-excellent) by two readers. Additionally, the number of non-diagnostic segments were counted and compared between CTA and QISS-MRA.

## RESULTS

A total of 360 segments were evaluated. The average CNR measured in QISS-MRA images was  $63.4 \pm 17.5$ . QISS-MRA vascular enhancement ratings by the two readers were  $3.7 \pm 0.5$  and  $3.8 \pm 0.4$ , respectively, while the CTA readings were  $4.0 \pm 0.4$  and  $4.1 \pm 0.5$ , respectively, resulting in no significant difference between the two modalities. QISS-MRA image noise ratings were  $3.4 \pm 0.7$  and  $3.6 \pm 0.5$ , respectively, while those for CTA were  $4.0 \pm 0.5$  and  $4.2 \pm 0.5$ , respectively. Excellent inter-reader agreement was found in image quality ratings ( $\kappa > 0.8$ ). Thirty-one segments (8.6%) were excluded from the CTA analysis due to stent artifacts (11), total occlusion (14), or heavy calcification (6) and 26 segments (7.2%) were non-diagnostic at MRA due to major image artifacts (12) or total occlusion (14). Five out of the six heavily calcified segments were diagnostic at QISS MRA.

## CONCLUSION

In this study, image quality of non-contrast QISS-MRA was comparable to that of contrast enhanced CTA. In certain circumstances, such as in heavily calcified segments, QISS-MRA provides superior lumen visibility compared to CTA. Such a non-contrast technique may have potential advantage in patients with severe renal disease or with other risk factors that prohibit the use of iodinated or gadolinium-based contrast material.

## CLINICAL RELEVANCE/APPLICATION

QISS-MRA enables non-contrast evaluation of the lower extremity arteries with comparable image quality to CTA and is potentially

less than 100% contrast resolution of the renal arteries, showed high comparable image quality to CT, and is potentially beneficial for patients with severe renal disease.

### **RC312-05 Role of Preoperative Dynamic Time Resolved MRA (DTR MRA) for Detection and Localization of Perforators in Patients Undergoing Free Fibula Flap (FFF) for Head and Neck Reconstruction**

Tuesday, Dec. 1 9:25AM - 9:35AM Location: S102AB

#### **Participants**

Manohar Kuruva, MBBS, MD, Little Rock, AR (*Presenter*) Nothing to Disclose  
Mauricio A. Moreno, MD, Little Rock, AR (*Abstract Co-Author*) Nothing to Disclose  
Tarun Pandey, MD, FRCR, Little Rock, AR (*Abstract Co-Author*) Nothing to Disclose  
Roopa Ram, MD, Little Rock, AR (*Abstract Co-Author*) Nothing to Disclose  
Kedar Jambhekar, MD, Little Rock, AR (*Abstract Co-Author*) Nothing to Disclose

#### **PURPOSE**

This study aimed at evaluating the accuracy of preoperative DTR MRA for the detection and localization of lower extremity septo-cutaneous perforators in patients undergoing free fibula flap (FFF) for head and neck reconstruction.

#### **METHOD AND MATERIALS**

Retrospective chart review of 43 patients who underwent pre-operative DTR MRA prior to FFF in a tertiary academic setting from 2009-2015. DTR MRA scans were evaluated for presence of perforators and their location relative to fibular head, and subsequently correlated with intra-operative findings. We considered location of perforator to be in concordance if the vessel was within 3cms based on DTR MRA and surgical findings, and hypothesized that differences within this range could represent distal perforator branches presenting radiologically as separate vessels.

#### **RESULTS**

DTR MRA and surgery identified at least one perforator in 42/43, and 41/43 patients respectively. The technique appropriately detected the presence of perforators in 40/41 patients and ruled out perforators in 1/2 patients, yielding a sensitivity, specificity and accuracy of 97.5%, 50% and 95.3%. Collectively, DTR-MRA accurately predicted the location of the perforators in 75% of the cases (48/64). On a patient-based analysis, DTR MRA correctly predicted the location of at least one perforator in 37/41 patients yielding an accuracy of 90% for this purpose.

#### **CONCLUSION**

DTR MRA accurately predicts the presence and location of cutaneous perforators in patients undergoing FFF reconstruction.

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

To our knowledge, this is one of the largest study validating the role of MRA for this purpose. Preoperative localization of the vessels significantly impacts surgical planning and may prevent unnecessary surgical explorations in a percentage of patients.

### **RC312-06 One-stop-shop Preoperative Evaluation for Living Liver Donors with Gd-EOB-DTPA-enhanced MRI: Can it be More Cost-effective and Convenient?**

Tuesday, Dec. 1 9:35AM - 9:45AM Location: S102AB

#### **Participants**

Shuangshuang Xie, Tianjin, China (*Presenter*) Nothing to Disclose  
Wen Shen, Tianjin, China (*Abstract Co-Author*) Nothing to Disclose  
Chenhao Liu SR, PhD, PhD, Tianjin, China (*Abstract Co-Author*) Nothing to Disclose  
Tao Ren, Tianjin, China (*Abstract Co-Author*) Nothing to Disclose  
Lihua Chen, Tianjin, China (*Abstract Co-Author*) Nothing to Disclose  
Lixiang Huang, MD, Tianjin, China (*Abstract Co-Author*) Nothing to Disclose  
Yue Cheng, Tianjin, China (*Abstract Co-Author*) Nothing to Disclose  
Qian Ji, PhD, Tianjin, China (*Abstract Co-Author*) Nothing to Disclose  
Jianzhong Yin, MD, Tianjin, China (*Abstract Co-Author*) Nothing to Disclose

#### **PURPOSE**

To compare the efficacy, cost-effectiveness and convenience between one-stop-shop gadoxetic-acid-disodium (Gd-EOB-DTPA)-enhanced MR imaging (MRI) and multi-detector CT combined with conventional magnetic resonance cholangiopancreatography (MDCT-MRCP) in preoperative evaluation for living liver donors.

#### **METHOD AND MATERIALS**

Eighty living liver donors were included in this prospective study. They were randomly grouped in Gd-EOB-DTPA-enhanced MRI group (n=40) and MDCT-MRCP group (n=40). Anatomical variations determined by pre- and intra-operative findings, costs, and time for preoperative images were recorded. Image quality for the depiction of hepatic vessels, bile ducts and graft volume were ranked on a 4-point scale and compared between both groups.

#### **RESULTS**

Gd-EOB-DTPA-enhanced MRI provided better image quality than MDCT-MRCP for the depiction of hepatic and portal veins, and graft volume by both reviewers ( $P<0.01$ ), and for the depiction of bile ducts by one reviewer ( $P<0.01$ ). MDCT provided better image quality than Gd-EOB-DTPA-enhanced MRI for the depiction of hepatic arteries by both reviewers ( $P<0.01$ ). Fifty nine living donors proceeded to liver donation (n=21 for Gd-EOB-DTPA-enhanced MRI group and n=38 for MDCT-MRCP group) with all anatomical findings of hepatic vessels and bile ducts accurately confirmed by intraoperative findings ( $P>0.05$ ). The repeatability for graft volume measurements on Gd-EOB-DTPA-enhanced MRI was higher than MDCT-MRCP. Gd-EOB-DTPA-enhanced MRI was cheaper than MDCT-MRCP (US\$519.72 vs US\$631.85). The effective "in room" time in the Gd-EOB-DTPA-enhanced MRI was 3 minutes longer than MDCT-MRCP (25±5 min vs 28±6 min,  $P<0.05$ ).

#### **CONCLUSION**

One-stop-shop Gd-EOB-DTPA-enhanced MRI is a more cost-effective and convenient modality with the similar diagnostic accuracy



One-stop-shop Gd-EOB-DTPA-enhanced MRI is a more cost-effective and convenient modality with the similar diagnostic accuracy as MDCT-MRCP in preoperative evaluation.

## CLINICAL RELEVANCE/APPLICATION

Gd-EOB-DTPA-enhanced MRI is equal to MDCT-MRCP in preoperative evaluation of hepatic vessels, bile ducts and graft volume and is more cost-effective and convenient for living donors.

### RC312-07 Contrast Enhanced MRA with Gadolinium and Ferumoxytol

Tuesday, Dec. 1 9:45AM - 10:10AM Location: S102AB

#### Participants

J. Paul Finn, MD, Los Angeles, CA (*Presenter*) Research Grant, Bracco Group; ; ;

## LEARNING OBJECTIVES

1) Be familiar with the major clinical applications of Contrast Enhanced MRA using Gadolinium Agents and Ferumoxytol. 2) Be aware of the relative advantages and disadvantages of Gadolinium agents and Ferumoxytol for CEMRA in various clinical scenarios. 3) Be familiar with differences in techniques and acquisition protocols for CEMRA using Gadolinium agents and Ferumoxytol.

## ABSTRACT

Contrast enhanced MR angiography (CEMRA) with gadolinium based contrast agents (GBCA) is well established as a reliable clinical tool for a variety of applications. Within the past decade, concerns about the risk of nephrogenic systemic fibrosis (NSF) has impacted the utilization of CEMRA and has stimulated the search for safer GBCA and alternatives to gadolinium agents. High stability and high relaxivity GBCA are now recommended for CEMRA to minimize risk of NSF in patients with renal failure, and dose reduction strategies have become standard. Also, early results with non-gadolinium CEMRA, specifically with ferumoxytol, are becoming available and suggest that in many cases, ferumoxytol may be a powerful alternative to GBCA for CEMRA. In this talk, we will review techniques and applications for CEMRA both with GBCA and ferumoxytol in adults and children over a spectrum of disease states.

### RC312-08 Principles and Applications of 4D-flow

Tuesday, Dec. 1 10:20AM - 10:45AM Location: S102AB

#### Participants

James C. Carr, MD, Chicago, IL (*Presenter*) Research Grant, Astellas Group Research support, Siemens AG Speaker, Siemens AG Advisory Board, Guerbet SA

### RC312-09 4D Flow can Depict and Quantify the Reflected Flow in the Lower Abdominal Aorta in Patients with Arteriosclerosis

Tuesday, Dec. 1 10:45AM - 10:55AM Location: S102AB

#### Participants

Masataka Sugiyama, Hamamatsu-Shi, Japan (*Presenter*) Nothing to Disclose  
Yasuo Takehara, MD, Hamamatsu, Japan (*Abstract Co-Author*) Nothing to Disclose  
Naoki Ooishi, Hamamatsu, Japan (*Abstract Co-Author*) Nothing to Disclose  
Marcus T. Alley, PhD, Stanford, CA (*Abstract Co-Author*) Research Funding, General Electric Company; Research Consultant, Arterys;  
Tetsuya Wakayama, PhD, Hino-shi, Japan (*Abstract Co-Author*) Employee, General Electric Company  
Atsushi Nozaki, Hino, Japan (*Abstract Co-Author*) Employee, General Electric Company  
Hiroyuki Kabasawa, Bunkyo, Japan (*Abstract Co-Author*) Employee, General Electric Company  
Shuhei Yamashita, MD, Hamamatsu, Japan (*Abstract Co-Author*) Nothing to Disclose  
Hatsuko Nasu, Hamamatsu, Japan (*Abstract Co-Author*) Nothing to Disclose  
Harumi Sakahara, MD, Hamamatsu, Japan (*Abstract Co-Author*) Nothing to Disclose

## PURPOSE

Majorities of physiological evidences indicate that the increase of Oscillatory Shear Index (OSI) produces an expression of pro-atherogenic genes. In patients with arteriosclerosis, reflected flow appears within the lower abdominal aorta during early diastolic phase. 3D cine PC MRI (4D-Flow) has enabled the coverage of full spatial and cardiac phase resolved data of the velocity vectors of the flowing blood within the whole abdominal aorta, thereby allow OSI mapping and flow volume analysis. The purpose of our study was to test if 4D Flow can depict reflected flow in the lower abdominal aorta, to quantitate the retrograde flow volume, and to verify their association with atherosclerosis, in the non-dilated lower abdominal aorta.

## METHOD AND MATERIALS

37 patients (30 to 84 y.o.) underwent 3.0T MR study including 4D-Flow and Gd-3D MRA. The wall shear stress (WSS), the OSI, and aortic flow volume were measured for abdominal aorta. The ratio of retrograde to antegrade flow (R/A ratio) volume was calculated. Two experienced radiologists rated the presence of atherosclerosis in three grades in terms of the presence of the intimal lipidemic deposits with CT. Multiple regression analysis with explanatory variables of age, sex, systolic and diastolic blood pressure, diameters, systolic and diastolic WSS, OSI, maximum progressive and retrograde flow volume, and the R/A ratio was performed. The response variable was CT determinations of atheroma in the lower abdominal aorta.

## RESULTS

Among flow dynamic parameters R/A ratio ( $p=0.019$ ), and OSI ( $p=0.0364$ ) were the determinant factors for the presence of atheroma. Prominent back flow collided with antegrade flow was also visually observed at early diastole in atherosclerotic patients and was considered to have induced instable shear stress directions, which resulted in higher OSI. The prominent retrograde flow represents reflected flow from the iliac arteries, which may be due to the lack of compliance of the atherosclerotic aorta and peripheral arteries.

## CONCLUSION

4Dflow can depict and quantify the prominent retrograde flow during early diastole, which is closely related to the presence of



atheroma in the lower abdominal aorta.

#### CLINICAL RELEVANCE/APPLICATION

4DFlow could be an indicator of a loss of arterial volumetric compliance and increased OSI in the lower abdominal aorta, which might be the initiation factors of atherosclerotic degradation that leads to various fatal aortic diseases.

#### RC312-10 Assessment of Wall Shear Stress in Patients without Aortic Disease, with Aortic Aneurysms and with Penetrating Aortic Ulcers using Velocity Encoding 4D MRI

Tuesday, Dec. 1 10:55AM - 11:05AM Location: S102AB

##### Participants

Michael Rasper, Munich, Germany (*Presenter*) Nothing to Disclose  
Jan Rudolph, Munich, Germany (*Abstract Co-Author*) Nothing to Disclose  
Christian Maegerlein, Munich, Germany (*Abstract Co-Author*) Nothing to Disclose  
Bettina M. Gramer, MD, Munich, Germany (*Abstract Co-Author*) Nothing to Disclose  
Marcus Settles, PhD, Munich, Germany (*Abstract Co-Author*) Nothing to Disclose  
Christian Reeps, MD, Muenchen, Germany (*Abstract Co-Author*) Nothing to Disclose  
Hans-Henning Eckstein, MD, Muenchen, Germany (*Abstract Co-Author*) Nothing to Disclose  
Ernst J. Rummeny, MD, Munich, Germany (*Abstract Co-Author*) Nothing to Disclose  
Armin M. Huber, MD, Munchen, Germany (*Abstract Co-Author*) Nothing to Disclose

##### PURPOSE

To determine whether patients with aortic aneurysms and penetrating aortic ulcers have an increased or reduced peak average wall shear stress magnitude compared to patients without aortic disease.

##### METHOD AND MATERIALS

26 patients (10 patients without aortic disease, 8 patients with aortic aneurysms (AA) and 8 patients with penetrating aortic ulcers (PAU)) underwent velocity encoded time resolved 3D MRI (4D PC MRI) of the aorta after contrast material (0.15 mmol/kg gadobenate dimeglumine) application during high resolution contrast-enhanced MR angiography of the aorta. 4D PC MRI was performed using ECG Gating and navigator echo based respiratory gating. Data acquisition was accelerated by SENSE in two directions (AF 1.5 x 2.5). The spatial resolution was 1.5 x 1.5 x 1.5 mm<sup>3</sup>. The temporal resolution was 40 ms. The peak velocity and the peak average wall shear stress magnitude were determined using the software GT-Flow (Version 2.0.10, Gyrotools, Switzerland).

##### RESULTS

The peak velocity was 71.6 ± 6.8 cm/s in patients without aortic disease, 35.6 cm/s ± 3.2 cm/s in patients with penetrating aortic ulcer and 18.2 ± 2.7 cm/s in patients with aortic aneurysms. The peak average wall shear stress magnitude was 0.35 ± 0.09 N/m<sup>2</sup> in patients without aortic disease, 0.13 ± 0.004 N/m<sup>2</sup> in patients PAU and 0.07 ± 0.018 N/m<sup>2</sup> in AA patients. Both patients with aortic ulcers and patients with aortic aneurysms showed lower mean values for peak velocity (p < 0.001 and p < 0.00001) and peak average wall shear stress magnitude (p < 0.01 and p < 0.004) compared to patients without aortic disease. Patients with AA had significantly lower wall shear stress magnitude values than PAU patients.

##### CONCLUSION

Compared to patients without aortic disease, peak velocity and wall shear stress were significantly reduced in patients with penetrating aortic ulcers and patients with aortic aneurysms.

#### CLINICAL RELEVANCE/APPLICATION

Aortic segmental wall shear stress and flow velocity can reliably be determined with velocity encoded 4D MRI. Reduced wall shear stress is associated with aneurysm growth and might therefore help to identify patients at risk.

#### RC312-11 A Speeding Ticket for Perfusion MRI? Acceleration Techniques and Their Effect on Arterial Input Function Sampling: Non-accelerated versus View-sharing and Compressed Sensing Sequences

Tuesday, Dec. 1 11:05AM - 11:15AM Location: S102AB

##### Participants

Matthias Benz, MD, Basel, Switzerland (*Presenter*) Nothing to Disclose  
Georg M. Bongartz, MD, Basel, Switzerland (*Abstract Co-Author*) Research Grant, Bayer AG; Research Grant, Siemens AG; Research Grant, Guerbet SA  
Sebastian T. Schindera, MD, Basel, Switzerland (*Abstract Co-Author*) Research Grant, Siemens AG; Research Grant, Ulrich GmbH & Co KG; Research Grant, Bayer AG  
Johannes M. Froehlich, PhD, Bern, Switzerland (*Abstract Co-Author*) Consultant, Guerbet SA  
Tobias Heye, MD, Basel, Switzerland (*Abstract Co-Author*) Nothing to Disclose

##### PURPOSE

Initiatives such as the Quantitative Imaging Biomarkers Alliance and the American College of Radiology Imaging Network seek to identify sources of variation that may contribute to the overall measurement error in dynamic contrast-enhanced magnetic resonance imaging (DCE-MRI). The aim of this study was to determine the ability of various DCE-MRI sequences to image the arterial input function (AIF) of an arterial bolus in comparison to a reference standard in a flow-phantom.

##### METHOD AND MATERIALS

The dynamic flow-phantom consists of three input ports representing the venous backflow and three mixing chambers simulating the cardiopulmonary circulation with 4L/min. A 25 mm diameter cylindrical outflow representing the aorta, a water- and a muscle-phantom were scanned on a 3T MRI (Magnetom Prisma, Siemens Healthcare, Erlangen, Germany) using fast low angle shot 2d (FI2d; temporal resolution [tr] 0.6s; reference standard) and 3d (FI3d; tr 2.4s [P2=parallel imaging factor 2] and 3.9s), time-resolved imaging with stochastic trajectories (TWIST; tr 2.2s), and golden-angle radial sparse parallel imaging (GRASP, tr 1.1s) GRE sequences. Each acquisition with administration of 10 ml contrast agent (Dotarem, Guerbet) via a power injector (2ml/s flow rate)

was repeated three times. Essential sequence parameters were standardized: flip angle 15°; spatial resolution 2.3x2.3x3mm<sup>3</sup>. Signal over time curves were normalized and analyzed by full width half maximum (FWHM) measurements to assess within sequence (coefficient of variation [COV]) and between sequence variations (percentage difference).

## RESULTS

Water and muscle signal COV ranged from 0.1-0.8%. Within sequence FWHM COV was 1.0% for FI3d, 1.0% for FI3dP2, 9.1% for TWIST and 0.3% for GRASP. Percentage difference FWHM in comparison to FI2d as reference standard was 2.2% for FI3d, 0.3% for FI3dP2, 45.9% for TWIST, and 7.8% for GRASP.

## CONCLUSION

MRI acceleration techniques vary in reproducibility and sampling of arterial input function. Incomplete coverage of the k-space with TWIST as representative of view-sharing techniques demonstrates incoherent data over time and thus limitations in the evaluation of AIF.

## CLINICAL RELEVANCE/APPLICATION

In order to establish DCE-MRI as a reproducible quantitative imaging biomarker it is necessary to assess how various forms of accelerated sequences handle the dynamic signal over time.

### RC312-12 Clinical Impact of MRA in Site Selection in Patients Undergoing Free Fibular Flap Transfer (FFF)

Tuesday, Dec. 1 11:15AM - 11:25AM Location: S102AB

#### Participants

Manohar Kuruva, MBBS, MD, Little Rock, AR (*Presenter*) Nothing to Disclose  
Roopa Ram, MD, Little Rock, AR (*Abstract Co-Author*) Nothing to Disclose  
Kedar Jambhekar, MD, Little Rock, AR (*Abstract Co-Author*) Nothing to Disclose  
Mauricio A. Moreno, MD, Little Rock, AR (*Abstract Co-Author*) Nothing to Disclose  
Tarun Pandey, MD, FRCR, Little Rock, AR (*Abstract Co-Author*) Nothing to Disclose

## PURPOSE

To evaluate the role and clinical impact of Dynamic Time-Resolved Magnetic Resonance Angiography (DTR MRA) for selecting the site for free fibula flap (FFF) harvest.

## METHOD AND MATERIALS

A retrospective review of medical records of 69 patients who underwent pre-operative lower extremity DTR MRA prior to head and neck reconstructive surgery was done. Clinical findings were compared with MRA in determining the appropriate site of graft harvest.

## RESULTS

DTR MRA identified vascular abnormalities, which led to change in management plan in 18/67 (27%) patients. Clinical findings were abnormal only in 4/18 (22%) of these patients. The two most common abnormalities included atherosclerotic narrowing (12 patients) and anatomical variations (4 patients). DTR MRA had significantly higher sensitivity to detect vascular abnormalities with implications in management than clinical examination alone ( $p=0.002$ ). Addition of venous phase of imaging led to clinically occult venous pathologies in 4 patients, including deep venous thrombosis (2), varicose veins (1) and arteriovenous malformation/fistula (1).

## CONCLUSION

Preoperative DTR MRA detected significant vascular abnormalities in patients undergoing FFF for head and neck reconstructive surgeries when compared to clinical examination, with a change in management in 28% of patients..

## CLINICAL RELEVANCE/APPLICATION

DTR MRA prior to FFF can identify vascular pathology and anatomic variations and can potentially reduce the rate of complications and morbidity post fibular transfer for head and neck reconstructive surgeries.

### RC312-13 Contrast-enhanced T1 Free-breathing Gradient Echo Sequences in the Assessment of Aortic Disease: Diagnostic Efficacy in Comparison with Standard T1 Breath-hold Gradient Echo Sequences

Tuesday, Dec. 1 11:25AM - 11:35AM Location: S102AB

#### Participants

Camillo R. Talei Franzesi, Milan, Italy (*Presenter*) Nothing to Disclose  
Davide Ippolito, MD, Monza, Italy (*Abstract Co-Author*) Nothing to Disclose  
Pietro A. Bonaffini, MD, Monza, Italy (*Abstract Co-Author*) Nothing to Disclose  
Davide Fior, MD, Monza, Italy (*Abstract Co-Author*) Nothing to Disclose  
Giulia Querques, MD, Monza, Italy (*Abstract Co-Author*) Nothing to Disclose  
Sandro Sironi, MD, Monza, Italy (*Abstract Co-Author*) Nothing to Disclose

## PURPOSE

To assess the diagnostic accuracy of contrast-enhanced T1 free-breathing gradient echo sequences in comparison with standard MR-angiographic sequences in the evaluation of aortic disease.

## METHOD AND MATERIALS

From January 2012 to January 2015, 57 patients (35 men; mean age 62.1 years) with aortic disease were evaluated. All patients were examined with a 1.5T magnet (Achieva, Philips), using a phased array multi-coil, after the intravenous injection of 0.1 mL\*Kg of gadobutrol. The standard thoracoabdominal MR angiography (MRA) protocol included 3D-angiographic T1 gradient-echo fat-suppressed (3D-HR) sequences and T1 breath-hold gradient-echo fat-suppressed sequences (THRIVE). Multiplanar T1 free-breathing gradient-echo fat-suppressed (THRIVE-FB) sequences were additionally performed in all the examinations. Two

radiologists independently compared the diagnostic quality of the different angiographic sequences, in terms of visualization of aortic wall and lumen and main arterial branches. The vascular calipers at different aortic levels were calculated, compared and statistically analyzed among the different sequences. The interobserver agreement was then evaluated using the Intraclass Correlation Coefficient (ICC).

## RESULTS

THRIVE-FB sequences showed high diagnostic accuracy in the assessment of vascular calipers and walls, with no significant differences in comparison with standard breath-hold sequences. They also demonstrated high sensitivity and specificity in the evaluation of vascular plaques, thrombus and adjacent structures. Not significant differences were obtained in terms of overall diagnostic quality between THRIVE-FB sequences and standard angiographic sequences (interobserver agreement ICC of 0.97).

## CONCLUSION

Contrast-enhanced T1 free-breathing gradient-echo fat-suppressed sequences have shown higher diagnostic efficacy, with any significant differences, in comparison with standard breath-hold angiographic sequences, permitting to correctly visualize and evaluate the aorta and its major branches.

## CLINICAL RELEVANCE/APPLICATION

Free-breathing angiographic protocol represents a useful tool, even in not-compliant patients, offering high diagnostic quality images, able to correctly evaluate thoracic and abdominal arteries.

## RC312-14 Role of MR in Cardiovascular Disease Research

Tuesday, Dec. 1 11:35AM - 12:00PM Location: S102AB

### Participants

Tim Leiner, MD, PhD, Utrecht, Netherlands, (t.leiner@umcutrecht.nl) (*Presenter*) Speakers Bureau, Koninklijke Philips NV; Research Grant, Bayer AG; Research Grant, Bracco Group

## LEARNING OBJECTIVES

1) To identify how MRI can contribute to understanding the pathophysiology of non-cardiac vascular disease and to describe its merits and shortcomings in relation to other commonly used imaging modalities. 2) To describe different MR methods that can be used to study vascular disease such as vessel wall imaging, atherosclerotic plaque imaging and measurement of pulse wave velocity. 3) To explain which of the above MR methods can be used clinically, and which methods are primarily experimental.

MSRO31

## **BOOST: Breast-Oncology Anatomy (An Interactive Session)**

Tuesday, Dec. 1 8:30AM - 10:00AM Location: S103AB



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

### **Participants**

Cristina Fuss, MD, Portland, OR, (fussc@ohsu.edu) (*Presenter*) Nothing to Disclose

Jean L. Wright, MD, New York, NY (*Presenter*) Nothing to Disclose

### **LEARNING OBJECTIVES**

1) Understand breast and regional lymph node anatomy. 2) Be familiar with how the basic anatomic images appear on a variety of imaging modalities. 3) Be familiar with breast and regional lymph node contouring techniques used in radiation treatment planning for breast cancer. 4) Apply principles of critical thinking to ideas from experts and peers in the radiologic sciences.

MSRO34

## **BOOST: CNS-Oncology Anatomy (An Interactive Session)**

Tuesday, Dec. 1 8:30AM - 10:00AM Location: S103CD



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

### **Participants**

Christina I. Tsien, MD, Saint Louis, MO (*Presenter*) Speaker Bureau, Merck & Co, Inc  
Soonmee Cha, MD, San Francisco, CA (*Presenter*) Nothing to Disclose

### **LEARNING OBJECTIVES**

1) Describe the imaging characteristics of gliomas. 2) Recognize substantial heterogeneity exists within these tumor types and understand the prognostic and predictive variables to allow for the selection of the appropriate therapy. 3) Explain the role of each modality including surgery, radiotherapy and chemotherapy in managing gliomas.

### **ABSTRACT**

Significant progress has been made in the treatment of CNS tumors with an emphasis on molecular prognostic and predictive biomarkers that allow for appropriate treatment selection. The role of advanced neuro-imaging will help clinicians improve the diagnosis, treatment and response assessment for CNS tumors will be emphasized. This session highlights the need for a multi-disciplinary treatment approach.

RC332

## Aligning Incentives Along the Imaging Value Chain

Tuesday, Dec. 1 8:30AM - 10:00AM Location: S102C



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

### Participants

Geraldine B. McGinty, MD,MBA, New York, NY (*Presenter*) Nothing to Disclose

Richard Duszak JR, MD, Atlanta, GA (*Presenter*) Nothing to Disclose

Giles W. Boland, MD, Boston, MA (*Presenter*) Principal, Radiology Consulting Group; Royalties, Reed Elsevier

### LEARNING OBJECTIVES

1) To understand value-focused healthcare imperatives in the evolution of healthcare delivery systems and how they impact medical imaging. 2) To implement practice changes aligned with Imaging 3.0 so as to maximize the relevance of radiology and radiologists in ongoing health system changes. 3) To improve the delivery of imaging care by focusing on value chain opportunities. (This course is part of the Leadership Track)

### ABSTRACT

Although radiology's dramatic evolution over the last century has profoundly affected patient care for the better, our current system is fragmented with many providers focusing more on technology and physician needs rather than what really matters to patients: better value and outcomes. This latter dynamic is aligned with current national health care reform initiatives and creates both challenges and opportunities for radiologists to find ways to deliver new value for patients. The American College of Radiology has responded to this challenge with the introduction of Imaging 3.0, which represents a call to action to all radiologists to assume leadership roles in shaping America's future health care system through 5 key pillars: imaging appropriateness, quality, safety, efficiency, and satisfaction. That enhanced value will require modulation of imaging work processes best understood through the concept of the imaging value chain, which will be the focus of this course.

RC317

## PET-MR/Hyperpolarized MR

Tuesday, Dec. 1 8:30AM - 10:00AM Location: S504CD

**MR** **NM** **BQ**

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

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

### Participants

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

### Sub-Events

#### RC317A Hyperpolarized <sup>13</sup>C MR-A Complementary Method to PET for Imaging in Vivo Metabolism

### Participants

Daniel M. Spielman, PhD, Stanford, CA (*Presenter*) Nothing to Disclose

### LEARNING OBJECTIVES

1) Assess the basic principles of hyperpolarized <sup>13</sup>C MRS, including sample preparation, image acquisition, and data analysis. 2) Differentiate metabolic parameters measurable by hyperpolarized <sup>13</sup>C MRS from those obtained with PET. 3) Compare PET versus hyperpolarized <sup>13</sup>C MRS sensitivities, spatial resolution, and temporal resolution.

#### RC317B PET/MR: Applications in Clinical Imaging

### Participants

Karin A. Herrmann, MD, PhD, Cleveland, OH (*Presenter*) Nothing to Disclose

### LEARNING OBJECTIVES

1) To understand technical limitations, workflow and current challenges of PET/MR compared to PET/CT. 2) To learn about most successful applications of PET/MR in clinical practice. 3) To be informed about the incremental value of PET/MR over current imaging strategies in selected clinical scenarios. 4) Identify appropriate clinical indications for PET/MR in current clinical practice. 5) Understand and manage procedural and logistic challenges of PET/MR.

#### RC317C The Emerging Clinical Role of Hyperpolarized <sup>13</sup>C MR in Prostate Cancer Imaging

### Participants

John Kurhanewicz, PhD, San Francisco, CA (*Presenter*) Nothing to Disclose

### LEARNING OBJECTIVES

1) Understand the clinical need and biochemical rationale for the use of hyperpolarized [1-<sup>13</sup>C] pyruvate for prostate cancer imaging. 2) Demonstrate a multi-hyperpolarized probe approach for simultaneously measuring prostate cancer metabolism and tumor micro-environment. 3) Demonstrate the utility of hyperpolarized <sup>13</sup>C MR for measuring prostate cancer aggressiveness and response to therapy. 4) Demonstrate the safety, clinical feasibility, sensitivity and resolution, and future availability of clinical hyperpolarized <sup>13</sup>C MR.



## The Emperor's Wearing a Speedo! Clinical Challenges with Electronic Health Records (Sponsored by the Associated Sciences Consortium) (An Interactive Session)

Tuesday, Dec. 1 8:30AM - 10:00AM Location: S105AB



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

### Participants

Dana Aragon, RT, Albuquerque, NM (*Moderator*) Nothing to Disclose

Patricia Kroken, Albuquerque, NM (*Moderator*) Nothing to Disclose

Rena Zimmerman, MD, Sequim, WA, (rzimmerman@olympicmedical.org) (*Presenter*) Nothing to Disclose

### LEARNING OBJECTIVES

1) Lack of interoperability of systems. 2) Necessity of creating a useful database. 3) Training of personnel and communication with the Information Technology department. 4) Data entry. 5) Copy/Paste - Document bloat - Meaningful Use. 6) Therapeutic relationship with the patient.

### ABSTRACT

With the passage of the Patient Protection and Affordable Healthcare Act, electronic health records (EHR) are being widely adopted in all healthcare settings. While there are many possible benefits to widespread adoption of EHRs, there are inherent clinical challenges that must be addressed to improve outcomes. These will be illustrated using examples from my personal experience with different systems as a practicing radiation oncologist and surveyor for the American College of Radiology.

MSAS32

## **Economics in Imaging/Business Intelligence (Sponsored by the Associated Sciences Consortium) (An Interactive Session)**

Tuesday, Dec. 1 10:30AM - 12:00PM Location: S105AB



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

### **Participants**

William A. Undie, PhD, RT, Houston, TX (*Moderator*) Nothing to Disclose  
Morris A. Stein, BArch, Phoenix, AZ (*Moderator*) Nothing to Disclose

### **Sub-Events**

#### **MSAS32A One Hospital's Experience: Tightening the Belts Using LEAN and Green Methodologies**

### **Participants**

Janet Champagne, MBA, RT, Houston, TX, (jlchampa@texaschildrens.org) (*Presenter*) Nothing to Disclose  
Alex Koroll, Houston, TX (*Presenter*) Nothing to Disclose

### **LEARNING OBJECTIVES**

1) Learn the value of implementing LEAN and Six Sigma Green Belt tools and processes to improve patient and employee satisfaction. 2) Demonstrate understanding of the seven elements of waste and apply methodologies to eliminate or improve its negative impact in your workflows. 3) Utilizing the Six Sigma processes to gain credibility and demonstrate value within the organization.

#### **MSAS32B Using Evidence Based Design to Increase Operational and Planning Efficiencies**

### **Participants**

Carlos L. Amato, Los Angeles, CA (*Presenter*) Nothing to Disclose

### **LEARNING OBJECTIVES**

1) Learn how to apply evidence based design planning and design principles to improve efficiency and patient satisfaction. 2) Understand how to plan an "intelligent" department that is flexible enough to deal with imaging complex processes and constant technology changes. 3) Understand why good design is good business.

SSG09

## Molecular Imaging (Gynecologic Oncology)

Tuesday, Dec. 1 10:30AM - 12:00PM Location: S504CD

**BR** **GU** **MI** **MR** **RO**

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

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

### Participants

Kathryn A. Morton, MD, Salt Lake City, UT (*Moderator*) Nothing to Disclose  
Zaver M. Bhujwala, PhD, Baltimore, MD (*Moderator*) Nothing to Disclose

### Sub-Events

#### SSG09-01 First Clinical Trial on Ultrasound Molecular Imaging Using KDR-Targeted Microbubbles in Patients with Breast and Ovarian Lesions

Tuesday, Dec. 1 10:30AM - 10:40AM Location: S504CD

### Participants

Juergen K. Willmann, MD, Stanford, CA (*Presenter*) Research Consultant, Bracco Group; Research Consultant, Triple Ring Technologies, Inc; Research Grant, Siemens AG; Research Grant, Bracco Group; Research Grant, Koninklijke Philips NV; Research Grant, General Electric Company  
Lorenzo Bonomo, MD, Rome, Italy (*Abstract Co-Author*) Nothing to Disclose  
Antonia Testa, Rome, Italy (*Abstract Co-Author*) Nothing to Disclose  
Pierluigi Rinaldi, MD, Rome, Italy (*Abstract Co-Author*) Nothing to Disclose  
Guido Rindi, Rome, Italy (*Abstract Co-Author*) Nothing to Disclose  
Sanjiv S. Gambhir, MD, PhD, Stanford, CA (*Abstract Co-Author*) Board Member, Enlight Biosciences; Board Member, ImaginAb, Inc; Board Member, FUJIFILM Holdings Corporation; Board Member, ClickDiagnostics, Inc; Consultant, FUJIFILM Holdings Corporation; Consultant, Gamma Medica, Inc; Speaker, ImaginAb, Inc; Stock, Enlight Biosciences; Stock options, Enlight Biosciences; Travel support, Gamma Medica, Inc

### PURPOSE

To assess if clinical ultrasound molecular imaging (USMI) using a novel clinical grade human kinase domain receptor (KDR)-targeted microbubble (BR55, Bracco) is safe and allows assessment of KDR expression in patients with breast and ovarian lesions, using immunohistochemistry (IHC) as gold standard.

### METHOD AND MATERIALS

21 women (34-66 yrs) with focal breast lesions and 24 women (48-79 yrs) with focal ovarian lesions were injected IV with BR55 (0.03-0.08 mL/kg bw) and 2D USMI of the target lesions was performed dynamically every 2 min starting 5 min after injection up to 29 min, using the linear 15L8 probe (Siemens) or the endocavitary 1123 probe (Esaote). Normal breast tissues surrounding the lesion or the contralateral presumed normal ovary served as intra-patient controls. Blood pressure, EKG, oxygen levels, heart rate, CBC, and metabolic panel were obtained before, and 30 min, 1h, 24h after BR55 administration. Persistent focal BR55 binding on USMI was visually assessed in consensus by 2 blinded offsite radiologists as none, possibly or definitely. Patients underwent surgical resection of the target lesions and tissues were stained for CD31 and KDR. A pathologist assessed vascular KDR expression using a 4-point scale (none, weak, intermediate, high). Adjudication was performed in consensus (offsite radiologists and pathologist) to match clinically.

### RESULTS

USMI with BR55 was well tolerated by all patients at all doses, without safety concerns. Among the 40 patients included in the analysis, KDR expression was higher in malignant breast and ovarian lesions (score  $2.40 \pm 0.63$  and  $2.08 \pm 0.64$ , respectively) compared to benign breast and ovarian lesions ( $2.08 \pm 0.64$  and  $1.33 \pm 0.50$ ). KDR expression matched well with presence of focal BR55 binding on USMI in malignant breast (13/15; 86.7%) and ovarian (11/13; 84.6%) lesions, as well as benign breast (2/3; 66.7%) and ovarian (8/9; 88.9%) lesions. Focal USMI signal could be detected up to 29 min after injection.

### CONCLUSION

Use of BR55 in USMI of breast and ovarian lesions is safe and effective and preliminary data indicate that KDR-targeted USMI signal matches well with vascular KDR expression on IHC.

### CLINICAL RELEVANCE/APPLICATION

This study provides proof of principle on feasibility and safety of KDR-targeted USMI in patients with breast and ovarian lesions and lays the foundation for further clinical trials.

#### SSG09-02 Imaged EGFR Expression Level Reflects Inhibited Growth-Pathway Node in Model of Triple-Negative Breast Cancer

Tuesday, Dec. 1 10:40AM - 10:50AM Location: S504CD

### Participants

Eric Wehrenberg-Klee, MD, Boston, MA (*Presenter*) Nothing to Disclose  
Nafize S. Turker, PhD, Boston, MA (*Abstract Co-Author*) Nothing to Disclose  
Pedram Heidari, MD, Boston, MA (*Abstract Co-Author*) Nothing to Disclose  
Mauri Scaltriti, PhD, New York, NY (*Abstract Co-Author*) Nothing to Disclose  
Umar Mahmood, MD, PhD, Charlestown, MA (*Abstract Co-Author*) Research Grant, Sabik Medical Inc; Advisory Board, Blue Earth

## PURPOSE

Triple-negative breast cancer (TNBC) is an aggressive breast cancer subtype for which targeted inhibitors of the RTK/PI3K/AKT/mTOR growth pathway have demonstrated early treatment success. The surface receptor EGFR is one of the dominant RTKs mediating downstream growth signals along this pathway and changes in EGFR expression may be predictive of therapeutic inhibition. We sought to demonstrate that the changes in EGFR expression predictive of treatment response could be non-invasively assessed.

## METHOD AND MATERIALS

64Cu-DOTA-cetuximab F(ab')<sub>2</sub> was prepared from cetuximab monoclonal antibody and probe affinity for EGFR assessed. A panel of TNBC cell lines (MDMBA468, MDMBA231, HCC70) was treated with the AKT inhibitor GDC-0068 or the PI3K inhibitor GDC-0941 for one day at a range of concentrations. Following treatment, we assessed in vitro EGFR probe uptake. In vitro uptake study results were compared to protein quantification as assessed by Western blot. After treatment of HCC70 mouse xenografts with control, GDC-0068, or GDC-0941 for two days, PET-CT imaging of HCC-70 tumors with 64Cu-DOTA-EGFR F(ab')<sub>2</sub> was performed.

## RESULTS

In vitro treatment with GDC-0068 resulted in increased EGFR Probe uptake of 25%, 139%, and 16% for MDAMB468, MDMBA231, and HCC70, respectively. In vitro treatment with GDC-0941 resulted in increased EGFR uptake of 6%, 87%, and 88%, for the same panel of cell lines. In vitro uptake studies demonstrate close correlation with changes in EGFR expression as assessed by Western blot. In vivo imaging of HCC70 mouse xenografts with EGFR PET Probe after treatment with control, GDC-0068, or GDC-0941 demonstrate SUVmean of 0.32 (±0.03), 0.50 (±0.01), 0.62 (±0.01), with all comparisons significant (p<0.01).

## CONCLUSION

We demonstrate in a murine model of triple-negative breast cancer that changes in EGFR expression induced by targeted therapeutics can be non-invasively assessed using a 64Cu-DOTA-EGFR F(ab')<sub>2</sub> PET imaging probe. We demonstrate that changes in the level of EGFR expression, potentially indicative of therapeutic response, differ depending on the growth-pathway inhibited.

## CLINICAL RELEVANCE/APPLICATION

Noninvasive assessment of changes in EGFR expression could be a valuable clinical tool for rapid assessment of therapeutic efficacy of targeted growth pathway inhibitors in TNBC, allowing for dynamic clinical decision making in response to imaged resistance profiles.

### SSG09-03 FACBC PET/CT Before and After Neoadjuvant Therapy in Locally Advanced Breast Cancer: A Prospective Pilot Clinical Trial

Tuesday, Dec. 1 10:50AM - 11:00AM Location: S504CD

#### Participants

Gary A. Ulaner, MD, PhD, New York, NY (*Presenter*) Research support, General Electric Company; Research support, F. Hoffmann-La Roche Ltd

Serge Lyashchenko, New York, NY (*Abstract Co-Author*) Nothing to Disclose

Hanh Pham, New York, NY (*Abstract Co-Author*) Nothing to Disclose

Jason S. Lewis, PhD, New York, NY (*Abstract Co-Author*) Nothing to Disclose

## PURPOSE

Genes for amino acid transport proteins are highly upregulated in both invasive ductal carcinoma (IDC) and ILC, as compared to normal breast epithelium. This molecular phenotype may allow for the development of imaging agents based on amino acid metabolism. We evaluated whether Fluorine-18 labeled 1-amino-3-fluorocyclobutane-1-carboxylic acid (FACBC), an amino acid analog labelled with fluorine-18, could be used as an imaging agent for local staging of locally advanced breast cancer before and after neoadjuvant therapy.

## METHOD AND MATERIALS

This prospective clinical trial is being performed under IRB approval. In this trial, newly diagnosed breast cancer patients that are planned for neoadjuvant systemic therapy followed by surgical resection undergo FACBC PET/CT prior to systemic therapy and then again following completion of systemic therapy. Maximum Standardized Uptake Values (SUVmax) and other quantitative measures of FACBC-avidity are measured for the primary breast tumor and nodal metastases before and after systemic therapy. Following surgery, FACBC results are correlated with postoperative histopathologic results.

## RESULTS

Of 28 planned patients, we have currently accrued 23. All 23 accrued patients have undergone the pre-neoadjuvant therapy FACBC PET/CT. All 23 primary breast lesions were FACBC avid with SUVmax values of 2.3 to 17.5. 18 of 23 patients (78%) had FACBC avid axillary nodes with SUVmax values of 1.2 to 14.6. In 2 of 23 patients (9%), an unsuspected extra-axillary local nodal metastasis was detected on the pre neoadjuvant therapy FACBC PET/CT. SUVmax of these nodes was 2.1 and 2.2, and both were pathologically proven to be metastases. 15 of 23 patients (65%) have completed both pre- and post-neoadjuvant PET/CT scans and histological analysis following surgical resection. In 13 of these 15 patients (87%), a reduction of SUVmax in the primary breast cancer of greater than 90% could accurately identify the presence or absence of complete response/near complete response as defined by post surgical histologic analysis.

## CONCLUSION

This pilot trial of FACBC PET/CT in locally advanced breast cancer demonstrates potential uses of FACBC PET/CT before and after neoadjuvant therapy.

## CLINICAL RELEVANCE/APPLICATION

Further work on FACBC as a radiotracer in locally advanced breast cancer is warranted.

### SSG09-04 Operation-naïve Invasive Ductal Carcinoma of the Breast. Comparison of Staging Performed with

## Whole Body DWI, PET, PET-CT, and PET-MR

Tuesday, Dec. 1 11:00AM - 11:10AM Location: S504CD

### Participants

Onofrio A. Catalano, MD, Napoli, Italy (*Presenter*) Nothing to Disclose  
Bruce R. Rosen, MD, PhD, Charlestown, MA (*Abstract Co-Author*) Research Consultant, Siemens AG  
Angelo Luongo, Napoli, Italy (*Abstract Co-Author*) Nothing to Disclose  
Mark Vangel, PhD, Charlestown, MA (*Abstract Co-Author*) Nothing to Disclose  
Marco Catalano, Napoli, Italy (*Abstract Co-Author*) Nothing to Disclose  
Umar Mahmood, MD, PhD, Charlestown, MA (*Abstract Co-Author*) Research Grant, Sabik Medical Inc; Advisory Board, Blue Earth Diagnostics Limited;  
Emanuele Nicolai, Napoli, Italy (*Abstract Co-Author*) Nothing to Disclose  
Andrea Soricelli, MD, Napoli, Italy (*Abstract Co-Author*) Nothing to Disclose  
Marco Salvatore, MD, Napoli, Italy (*Abstract Co-Author*) Nothing to Disclose

### PURPOSE

To compare the performance of whole body (WB) DW, WB-PET, WB-PETCT, and WB-PETMR in patients with newly diagnosed invasive ductal breast cancer, before undergoing treatment.

### METHOD AND MATERIALS

49 consecutive women with newly diagnosed invasive ductal carcinoma of the breast underwent WB-DWI, WB-PET, WB-contrast enhanced (CE) PETCT and WB-CE-PETMR before treatment. A radiologist and a nuclear medicine physician evaluated in consensus the studies and searched for occurrence, number, and location of metastases. Final staging and number of lesions, according to each technique, were compared. Pathology and imaging follow up were used as the ground truth reference.

### RESULTS

All the techniques correctly staged 32/49 patients: stage2b in 8, 2c in 7, 3c in 4, 4 in 13. They provided discordant stages in 17/49 patients: 1 (stage 2a): staged-4 by WB-PET; 4 (stage 2b): 3/4 staged-2a by WB-PET and WB-PETCT, 1/4 staged-4 by WB-DWI; 3 (stage 3a): 2/3 staged-2b by WB-PET and WB-PETCT, 1/3 staged-4 by WB-DWI; 3 (stage 3c): 2/3 staged-2a by WB-PET and WB-PETCT, 1/3 staged-4 by WB-PET and WB-PETCT; 6 (stage 4): 1/6 staged-3a by WB-PET, WB-DWI, and WB-PETCT, 1/6 staged-2b by WB-PET and WB-PETCT, 1/6 staged-2b by WB-PET, WB-DWI, and WB-PETCT, 1/6 staged-3a by WB-DWI, 1/6 staged-3c by WB-DWI, and 1/6 staged-3a by WB-PET, WB-PETCT and 3c by WB-DWI. Staging performance of WB-PETMR (49 correctly staged) was significantly better than WB-PETCT (38 correctly staged) ( $P=0.001$ , chi square-test). The best performing modality for malignant lymph-node detection was WB-PETMR (47 of 49 patients), followed by WB-DWI (37/49), followed by WB-PET and WB-PETCT (15 patients each). Significantly more malignant nodes were detected by WB-PETMR ( $P<0.0001$ , paired t-tests). At least as many true-positive lesions were detected by WB-PETMR than by any of the other three modalities for 46 patients. The corresponding number of patients for WB-PET, WB-PETCT, and WB-DWI were 40, 39 and 34, respectively.

### CONCLUSION

PETMR allows a better accuracy in initial staging of surgical-naïve ductal invasive breast cancer. The higher performance is likely related to the additive information of PET, DWI, as well as of the other sequences (STIR, T1-weighted Dixon, HASTE, ADC maps, and CE-T1-weighted images) of WB-PETMR.

### CLINICAL RELEVANCE/APPLICATION

When available WB-PETMR should be considered for proper staging of naïve ductal invasive breast cancer.

## SSG09-05 Multiparametric 18F-FMISO PET/MRI for Assessment of Treatment Response to Chemo-radiation and Hypoxia Monitoring in Cervix Cancer Patients: A Feasibility Study

Tuesday, Dec. 1 11:10AM - 11:20AM Location: S504CD

### Participants

Petra Georg, MD, PhD, Wiener Neustadt, Austria (*Abstract Co-Author*) Nothing to Disclose  
Piotr Andrzejewski, MA, Vienna, Austria (*Abstract Co-Author*) Nothing to Disclose  
Pascal A. Baltzer, MD, Vienna, Austria (*Abstract Co-Author*) Nothing to Disclose  
Stephan H. Polanec, MD, Vienna, Austria (*Abstract Co-Author*) Nothing to Disclose  
Wolfgang Wadsak, Vienna, Austria (*Abstract Co-Author*) Speaker, General Electric Company; Consultant, THP Medical; Research Grant, ABX GmbH; Research Grant, Rotem GmbH  
Alina Sturdza, MD, Vienna, Austria (*Abstract Co-Author*) Nothing to Disclose  
Georgios Karanikas, MD, Vienna, Austria (*Abstract Co-Author*) Nothing to Disclose  
Stephan Polterauer, MD, Vienna, Austria (*Abstract Co-Author*) Nothing to Disclose  
Richard Poetter, MD, Vienna, Austria (*Abstract Co-Author*) Nothing to Disclose  
Thomas H. Helbich, MD, Vienna, Austria (*Abstract Co-Author*) Research Grant, Medicor, Inc; Research Grant, Siemens AG; Research Grant, C. R. Bard, Inc  
Dietmar Georg, PhD, Vienna, Austria (*Abstract Co-Author*) Nothing to Disclose  
Katja Pinker, MD, New York, NY (*Presenter*) Nothing to Disclose

### PURPOSE

To demonstrate feasibility of combined multiparametric positron emission tomography/magnetic resonance imaging at 3T (3T MP PET/MRI) and to assess treatment response and hypoxia monitoring in cervix cancer patients undergoing chemo-radiation therapy.

### METHOD AND MATERIALS

In this IRB-approved prospective study 7 patients underwent sequential 3T MP 18F-FMISO PET/MRI at baseline; 2 and 5 weeks (w) after start and 3 months (FU) after treatment. MRI protocol consisted of a high-resolution isotropic T2-w SPACE, a DWI EPI ( $b=50/850$  sec/mm<sup>2</sup>) and a high-resolution contrast-enhanced (CE) T1-w VIBE sequence. Patients were injected with 330 MBq 18F-FMISO and scanning was started 240 min after injection. CT data was used for attenuation correction. PET and MR image registrations were performed using Mirada RTx (Mirada Medical, Oxford, UK, ver. 1.4.0.23) software. Gross tumour volume (GTV)

was contoured by an experienced radiation oncologist on PET/MRI data sets. The volume of GTV was assessed for tumor size, CE-kinetics, restricted diffusivity and 18F-FMISO-avidity using SUVmax and SUV (SUVnorm) normalized to gluteal muscle uptake. At follow up, cervix was contoured, since all patients showed clinically complete remission.

## RESULTS

3T MP 18F-FMISO PET/MRI was successfully performed in all patients at every time-point. Median GTV volume was 43.9cc at baseline, 22.4cc after 2w (20-25Gy) and 7.7cc after 5w (40-45Gy). Mean ADC values were  $1.02 \times 10^{-3} \text{mm}^2/\text{sec}$  increasing to  $1.18 \times 10^{-3} \text{mm}^2/\text{sec}$  after 2w and to  $1.27 \times 10^{-3} \text{mm}^2/\text{sec}$  after 5w and to  $1.37 \times 10^{-3} \text{mm}^2/\text{sec}$  at FU. All GTVs showed mean initial-enhancement (IE) followed by a plateau with an increasing IE at 2w and 5w and wash-out at 5w. At FU, there was a persistent enhancement. The mean 18F-FMISO SUVnorm was 3.1 at baseline and decreased to 2.3 at 2w and 2.0 at 5w and follow-up. In all patients there was never the whole tumor 18F-FMISO-avid, but 18F-FMISO-avid spots within the tumor indicative of hypoxia could be identified before and during the course of therapy.

## CONCLUSION

MP 18F-FMISO PET/MRI in cervix cancer patients at 3T is feasible and enables non-invasive monitoring of morphological and functional changes during treatment.

## CLINICAL RELEVANCE/APPLICATION

3T MP 18F-FMISO PET/MRI can depict areas of tumor hypoxia during therapy and thus identify patients at risk who need an aggressive treatment approach.

### SSG09-06 Correlation of PET-MR Biomarkers with Breast Cancer Molecular Subtypes, Grading and Presence of Distant Metastases at Time of Presentation

Tuesday, Dec. 1 11:20AM - 11:30AM Location: S504CD

#### Participants

Onofrio A. Catalano, MD, Napoli, Italy (*Presenter*) Nothing to Disclose  
Bruce R. Rosen, MD, PhD, Charlestown, MA (*Abstract Co-Author*) Research Consultant, Siemens AG  
Carlo Iannace, MD, San Leucio del Sannio, Italy (*Abstract Co-Author*) Nothing to Disclose  
Angelo Luongo, Napoli, Italy (*Abstract Co-Author*) Nothing to Disclose  
Marco Catalano, Napoli, Italy (*Abstract Co-Author*) Nothing to Disclose  
Mark Vangel, PhD, Charlestown, MA (*Abstract Co-Author*) Nothing to Disclose  
Umar Mahmood, MD, PhD, Charlestown, MA (*Abstract Co-Author*) Research Grant, Sabik Medical Inc; Advisory Board, Blue Earth Diagnostics Limited;  
Maria Lepore, MD, Avellino, Italy (*Abstract Co-Author*) Nothing to Disclose  
Bethany L. Niell, MD, Boston, MA (*Abstract Co-Author*) Nothing to Disclose  
Emanuele Nicolai, Napoli, Italy (*Abstract Co-Author*) Nothing to Disclose  
Andrea Soricelli, MD, Napoli, Italy (*Abstract Co-Author*) Nothing to Disclose

## PURPOSE

To evaluate if PET-MR biomarkers correlate with molecular genetic subtypes, grading, and presence of distant metastases at time of presentation in naïve ductal invasive breast cancers.

## METHOD AND MATERIALS

21 consecutive patients with naïve ductal invasive breast cancer and genetic molecular subtype profiling underwent whole-body contrast enhanced FDG-PET-MR (Biograph mMR, Siemens). Two readers, using commercially available software, measured the following PET-MR biomarkers: ADC, Ktrans, Ve, Kep, IAUC, SUVmax, SUVmean, and MTV. They were correlated with genetic molecular subtypes, grading and occurrence of distant metastases.

## RESULTS

Genetic molecular subtypes were as follows: ER-7, ER+14; PR-8, PR+13; HER2-11, HER2+10; Ki67-low ( $\leq 35\%$ ), Ki67 medium/high ( $> 35\%$ ). Grading was G2 in 14 and G3 in 7. Six patients had distant metastases. The following biomarkers were higher in the ER- and PR- compared to ER+ and PR+ patients: Kep ( $9234 \pm 1320$  versus  $6492 \pm 2358$ ,  $p0.01$ ), SUVmax ( $14.19 \pm 7.17$  versus  $6.17 \pm 4.24$ ,  $p0.004$ ), and SUVmean ( $8.44 \pm 4.01$ ,  $p0.004$ ). ADC directly correlated with the degree of Ki67 expression ( $1019 \pm 256$  for Ki67  $\leq 35\%$ ,  $1338 \pm 105$  for Ki67  $> 35\%$ ,  $p0.002$ ). The following biomarkers were lower in HER2- patients compared to HER2+ cases: ADC ( $1050 \pm 280$  versus  $1306 \pm 122$ ,  $p0.009$ ), Kep ( $6726 \pm 2240$  versus  $8599 \pm 2122$ ,  $p0.028$ ), SUVmax ( $6.29 \pm 4$  versus  $11.8 \pm 7.65$ ,  $p0.046$ ), and SUVmean ( $3.72 \pm 2.28$  versus  $7.03 \pm 4.43$ ,  $p0.04$ ). G2 patients experienced lower Kep ( $6638 \pm 2391$  versus  $8944 \pm 1764$ ,  $p0.04$ ) and lower SUVmax ( $6.83 \pm 4.73$  versus  $12.89 \pm 8.07$ ,  $p0.04$ ) than G3 patients. No biomarkers correlated with presence of distant metastases.

## CONCLUSION

In naïve ductal invasive breast cancers, PET-MR biomarkers correlate with molecular genetic subtypes and with grading, but not with the presence of distant metastases.

## CLINICAL RELEVANCE/APPLICATION

PET-MR biomarkers might have prognostic and therapeutic implications on patients' management.

### SSG09-07 Impact of Estrogen Receptor Gene Mutations on [18F]-Fluoroestradiol Uptake in Breast Cancer

Tuesday, Dec. 1 11:30AM - 11:40AM Location: S504CD

#### Participants

Manoj Kumar, MS, Madison, WI (*Abstract Co-Author*) Nothing to Disclose  
Ginny L. Powers, PhD, Madison, WI (*Abstract Co-Author*) Nothing to Disclose  
Justin Jeffery, Madison, WI (*Abstract Co-Author*) Nothing to Disclose  
Yongjun Yan, PhD, Madison, WI (*Abstract Co-Author*) Nothing to Disclose  
Amy M. Fowler, MD, PhD, Saint Louis, MO (*Presenter*) Nothing to Disclose



## PURPOSE

Accurately predicting therapeutic responsiveness in women with breast cancer remains challenging. Positron emission tomography (PET) imaging using [18F]-16alpha-17beta-fluoroestradiol (FES) provides a way to non-invasively and longitudinally examine the subset of tumors expressing estrogen receptor alpha (ERα) which comprise approximately 70% of all breast cancers. However, the effect of mutations in the gene encoding ERα, recently identified in patients with endocrine-resistant, metastatic breast cancer, on FES uptake is unknown. We developed a model system to test how mutations in ERα influence the uptake of FES.

## METHOD AND MATERIALS

Stable cell lines expressing either wild-type ERα (231-ER) or a point mutation in the ligand-binding pocket, G521R (231-G521R), were created in the ERα-negative human breast cancer cell line MDA-MB-231. ERα-positive MCF7 human breast cancer cells were used as a positive control and parental MDA-MB-231 cells were used as a negative control. Cell uptake of FES was measured in vitro with microPET/CT imaging and gamma counting. In addition, in vivo FES uptake was measured in MCF7 and 231-ER tumors grown as xenografts in athymic nude mice.

## RESULTS

FES uptake was observed both in vitro and in vivo in the MCF7 and 231-ER cells/tumors. However, there was no significant FES uptake in the 231-G521R cells or parental MDA-MB-231 cells. The 231-ER cells had a similar dose response curve to MCF7 in competition assays using increasing doses of cold estradiol, and as consistent with the uptake data, 231-G521R binding was not altered by cold competition.

## CONCLUSION

These data support the use of stable cell lines expressing variant forms of ERα as models for demonstrating the effects of ERα gene mutations on FES uptake. Ongoing studies are focusing on the effects of recently identified clinically-relevant ERα mutations on FES uptake and on the prediction of response to ER-targeted therapies.

## CLINICAL RELEVANCE/APPLICATION

FES-PET imaging provides a non-invasive way to probe ERα function and may prove useful in identifying the development of ERα gene mutations and thus predicting endocrine resistance in ERα-positive breast cancer patients.

### SSG09-08 Imaging Patients with Breast and Prostate Cancers Using Combined 18F NaF/18F FDG and TOF simultaneous PET/ MRI

Tuesday, Dec. 1 11:40AM - 11:50AM Location: S504CD

#### Participants

Ryogo Minamimoto, MD, PhD, Stanford, CA (*Presenter*) Nothing to Disclose  
Andreas M. Loening, MD, PhD, San Francisco, CA (*Abstract Co-Author*) Nothing to Disclose  
Valentina Taviani, PhD, Stanford, CA (*Abstract Co-Author*) Nothing to Disclose  
Sanjiv S. Gambhir, MD, PhD, Stanford, CA (*Abstract Co-Author*) Board Member, Enlight Biosciences; Board Member, ImaginAb, Inc; Board Member, FUJIFILM Holdings Corporation; Board Member, ClickDiagnostics, Inc; Consultant, FUJIFILM Holdings Corporation; Consultant, Gamma Medica, Inc; Speaker, ImaginAb, Inc; Stock, Enlight Biosciences; Stock options, Enlight Biosciences; Travel support, Gamma Medica, Inc  
Shreyas S. Vasanawala, MD, PhD, Palo Alto, CA (*Abstract Co-Author*) Research collaboration, General Electric Company; Consultant, Arterys; Research Grant, Bayer AG;  
Andrei Iagaru, MD, Stanford, CA (*Abstract Co-Author*) Research Grant, General Electric Company; Research Grant, Bayer AG

## PURPOSE

We previously reported the pilot evaluation of a simultaneous PET/MRI scanner with TOF capability, as well as the use of combined 18F NaF/18F FDG PET/CT in cancer patients. Here we prospectively compared the combined 18F NaF/18F FDG PET/ MRI against 99mTc-MDP in patients with breast and prostate cancers for the detection of metastatic disease.

## METHOD AND MATERIALS

Fifteen patients referred for 99mTc-MDP bone scans were prospectively enrolled from Oct 14 - Mar 15. The cohort included 7 men with prostate cancer and 8 women with breast cancer, 41 - 85 year-old (average 61 ± 13). 18F NaF (0.7-2.2 mCi, mean: 1.2 mCi) and 18F FDG (3.8-5.2 mCi, mean: 4.2 mCi) were subsequently injected from separate syringes. The PET/MRI was done 6-30 days (average 9.3 ± 3.2) after bone scan. The whole body MRI protocol consisted of T2-weighted, DWI, and contrast-enhanced T1-weighted imaging. Lesions detected with each test were tabulated and the results were compared.

## RESULTS

All patients tolerated the PET/MRI exam, and PET image quality was diagnostic despite the marked reduction in the administered dosage of radiopharmaceuticals (80% less for 18F NaF and 67% less for 18F FDG compared to standard protocols). Five patients had no bone metastases identified on either scans. Bone scintigraphy and PET/MRI showed osseous metastases in 9 patients, but more numerous bone findings were noted on PET/MRI than on bone scintigraphy in 3 patients. One patient had negative bone scan, but bone metastases were seen on PET/MRI. Lesions outside the skeleton were identified by PET/MRI in 3 patients.

## CONCLUSION

The combined 18F NaF/18F FDG PET/MRI is superior to 99mTc-MDP scintigraphy for evaluation of skeletal disease extent. Further, it detected extra-skeletal disease that may change the management of these patients, while allowing a significant reduction in radiation exposure from lower dosages of PET radiopharmaceuticals administered. A combination of 18F NaF/18F FDG PET/MRI may provide the most accurate staging of patients with breast and prostate cancers prior to the start of treatment.

## CLINICAL RELEVANCE/APPLICATION

The combined 18F NaF/18F FDG PET/MRI is superior to 99mTc-MDP scintigraphy for evaluation of skeletal disease extent.

### SSG09-09 In Vivo Assessment of Ovarian Tumor Response to Tyrosine Kinase Inhibitor Pazopanib using Hyperpolarized 13C-Pyruvate MRS and 18F-FDG PET/CT Imaging in a Mouse Model



#### Participants

Murali Ravoori, Houston, TX (*Abstract Co-Author*) Nothing to Disclose

Sheela Singh, Houston, TX (*Abstract Co-Author*) Nothing to Disclose

Jaehyuk Lee, Houston, TX (*Abstract Co-Author*) Nothing to Disclose

James Bankson, PhD, Houston, TX (*Abstract Co-Author*) Nothing to Disclose

Vikas Kundra, MD, PhD, Houston, TX (*Presenter*) License agreement, Introgen Therapeutics, Inc

#### PURPOSE

Early response measures for ovarian cancer are needed to common targets such as tyrosine kinases. Via effects on signaling within tumor cells or via effects on angiogenesis, such inhibitory drugs have the potential to alter tumor metabolism. 18Fluorodeoxyglucose (18F-FDG) mimics glucose and can be used to evaluate early glycolysis. Hyperpolarization magnetic resonance spectroscopy (MRS) imaging can be used to study pyruvate, which can be produced by glycolysis and other pathways and sits at a decision point for aerobic versus anaerobic metabolism. Our purpose was to assess whether either early or late components of metabolism can serve as indicators of response of ovarian cancer to tyrosine kinase inhibitor (including angiogenesis inhibitor via VEGF receptor inhibition) Pazopanib.

#### METHOD AND MATERIALS

Seventeen days after injection of  $2 \times 10^6$  human ovarian SKOV3 tumors cells into female nude mice, treatment with vehicle or Pazopanib (2.5 mg/mouse po) was initiated. Longitudinal T2-weighted MR, hyperpolarized pyruvate MRS, and 18F-FDG PET/CT imaging were performed pre-treatment as well as 2 days and 2 weeks after treatment.

#### RESULTS

Pazopanib was effective in inhibiting ovarian tumor growth compared to control ( $p < 0.05$ ). Significantly higher pyruvate to lactate conversion (lactate/pyruvate+lactate ratio) was found 2 days after treatment with pazopanib compared to pre-therapy ( $p < 0.005$ ,  $n=8$ ). This was not seen with control or with 18F-FDG PET/CT imaging.

#### CONCLUSION

Findings suggest that later metabolic events (pyruvate to lactate conversion) may serve as as an early indicator of response of ovarian cancer to tyrosine kinase (angiogenesis) inhibitor pazopanib in mouse models, even when early glycolytic events do not.

#### CLINICAL RELEVANCE/APPLICATION

Hyperpolarized  $^{13}\text{C}$ -Pyruvate MRS may serve as an early indicator of response to tyrosine kinase (angiogenesis) inhibitors such as pazopanib in ovarian cancer even when 18F-FDG PET/CT does not.

**BOOST: CNS-Integrated Science and Practice (ISP) Session**

Tuesday, Dec. 1 10:30AM - 12:00PM Location: S103CD



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

**Participants**

Jun Deng, PhD, New Haven, CT (*Moderator*) Nothing to Disclose  
Edward Melian, MD, Maywood, IL (*Moderator*) Nothing to Disclose

**Sub-Events****MSRO35-01 Invited Speaker: Single Fraction or Multisession SBRT for Spinal Metastases?**

Tuesday, Dec. 1 10:30AM - 10:40AM Location: S103CD

**Participants**

Simon S. Lo, MD, Cleveland, OH (*Presenter*) Research support, Elekta AB;

**MSRO35-02 Impact of Posterior Fossa Boost Volume on Tumor Recurrence and Incidental Hippocampal Dose in Medulloblastoma**

Tuesday, Dec. 1 10:40AM - 10:50AM Location: S103CD

**Participants**

Palak Kundu, Stanford, CA (*Presenter*) Nothing to Disclose  
Ben Durkee, MD, PhD, Palo Alto, CA (*Abstract Co-Author*) Nothing to Disclose  
Rie von Eyben, Stanford, CA (*Abstract Co-Author*) Nothing to Disclose  
Sarah S. Donaldson, MD, Palo Alto, CA (*Abstract Co-Author*) Nothing to Disclose  
Iris C. Gibbs, MD, Stanford, CA (*Abstract Co-Author*) Nothing to Disclose

**ABSTRACT**

**Purpose/Objective(s):** Radiation boost is critical for local control in MB, yet targeting the whole posterior fossa is associated with neurocognitive morbidity. The incidental hippocampal dose may account for these effects. Despite traditional tumor bed vs. posterior fossa categorization, the relative irradiated volume of posterior fossa may vary significantly. We model boost volume more rigorously as a continuous variable to investigate associations with hippocampal dose and recurrence rates. **Materials/Methods:** Bilateral hippocampi and posterior fossa were contoured on T1 axial images for 25 medulloblastoma patients [3-21 years; 5 female; 15 average risk (7 18Gy, 8 23.4Gy), 10 high risk (36Gy)]. There were 9 total recurrences: 5 exoprimary (3 high risk 36Gy, 2 average risk 18Gy), 2 primary (2 average risk: 1 18Gy, 1 23.4Gy), 2 both (2 high risk 36Gy). Minimum dose received by 100% of each hippocampus (D100%) and percent volume of posterior fossa receiving 100% of boost dose (V100%) were extracted from dose-volume histograms. Analysis of covariance was used to investigate the effect of V100% as a continuous variable while controlling for total craniospinal dose categorically (Low Dose 18-23.4Gy, High Dose 36Gy). Ordinal logistic regression was used to estimate probability of overall, primary and exoprimary recurrences. **Results:** Right and left total incidental hippocampal BED were both greater for the high dose group by 13.9Gy ( $p=0.00040$ ) and 14.0Gy ( $p=0.00010$ ) respectively. Right and left D100% significantly varied with V100% by 0.18Gy ( $p=0.022$ ) and 0.15Gy ( $p=.032$ ) per percent volume respectively. Probability of any recurrences ( $p=0.079$ ) and exoprimary recurrences ( $p=0.098$ ) exhibited negative trends with V100%. Primary recurrences were not associated with V100%, and dose group was not significant. **Conclusion:** Incidental hippocampal doses are positively associated with boost volumes and may account for neurocognitive decline in medulloblastoma patients. Posterior fossa V100% can be a useful metric to more accurately describe boost volumes given the heterogeneity within risk groups, and new hippocampal sparing techniques may allow for greater posterior fossa coverage. Aggressive posterior fossa management may further augment metastatic compartment therapies.

**MSRO35-03 Predictive Factors of Brain Metastasis in Non-Small Cell Lung Cancer Patients: Implications for Patient Selection for Prophylactic Cranial Irradiation**

Tuesday, Dec. 1 10:50AM - 11:00AM Location: S103CD

**Participants**

Santosh Nori, New York, NY (*Presenter*) Nothing to Disclose  
Anthony Pham, MD, San Jose, CA (*Abstract Co-Author*) Nothing to Disclose  
Paul Christos, New York, NY (*Abstract Co-Author*) Nothing to Disclose  
Himanshu Nagar, MD, New York, NY (*Abstract Co-Author*) Nothing to Disclose  
Gabiella Wernicke, New York, NY (*Abstract Co-Author*) Nothing to Disclose  
Dattatreya Nori, MD, New York, NY (*Abstract Co-Author*) Nothing to Disclose  
Bhupesh Parashar, MD, New York, NY (*Abstract Co-Author*) Nothing to Disclose

**ABSTRACT**

**Purpose/Objective(s):** The medical community has suspected a correlation between Non-Small Cell Lung Cancer and brain metastasis for quite some time. Identifying reliable predicting characteristics of brain metastasis in NSCLC patients can allow for effective treatment with Prophylactic Cranial Irradiation (PCI) to minimize the risk of metastasis. We sought to identify predictive factors for patients with NSCLC to develop brain metastasis. **Materials/Methods:** MOSAIQ databases were queried for patients that received radiotherapy treatment at the institution. Details of patients that received radiotherapy to the brain were collected for further data collection using the EPIC database. Pathology records of these patients were examined for presence of certain biomarkers (TTF-1, CK7, CK20, Synaptophysin, p63, and CK 5/6) and histology (adenocarcinoma or SCLC, with neuroendocrine differentiation). Radiological reports were examined for tumor site(s), tumor size information, nodal involvement, and number of nodules present. Information on age, sex, and tumor stage were also collected. **Results:** A total of 193 patients were identified and included in this analysis. Among these, 67 patients developed brain metastasis and 126 patients did not. A univariate analysis of

data determined that tumor stages 3 and 4 (pA multivariable logistic regression model of data determined higher stage (stages 3 or 4:  $p=0.004$ , Adjusted OR=3.612) and tumor size (Above 3 cm:  $p=0.06$  and 0.40, respectively). Conclusion: Identifying the presence of predictive characteristics in NSCLC patients can help patient survival through the administration of prophylactic cranial irradiation. In this study, we showed that NSCLC of stages 3 or 4, with tumors greater than 3 cm in at least one dimension, or more than two nodes or nodules involved are predictive of brain metastasis. Presence of CK7 may also be a reliable predictor of brain metastasis. This evidence can be helpful to doctors in evaluating whether or not patients should receive PCI.

#### **MSR035-04 Roles of Tumor Size and Histology in Outcomes Following Resection and Stereotactic Radiosurgery for Brain Metastases**

Tuesday, Dec. 1 11:00AM - 11:10AM Location: S103CD

##### **Awards**

##### **Trainee Research Prize - Medical Student**

##### **Participants**

Chase Escott, Lebanon, NH (*Presenter*) Nothing to Disclose

Linton T. Evans, MD, Lebanon, NH (*Abstract Co-Author*) Nothing to Disclose

Zhongze Li, Lebanon, NH (*Abstract Co-Author*) Nothing to Disclose

Nathan Simmons, MD, Lebanon, NH (*Abstract Co-Author*) Nothing to Disclose

David W. Roberts, MD, Lebanon, NH (*Abstract Co-Author*) Scientific Advisory Board, Carthera AB; Scientific Advisory Board, IMRIS Inc; Scientific Advisory Board, Alcyon Lifesciences, Inc; Equipment support, Medtronic, Inc; Research support, Medtronic, Inc; Equipment support, Carl Zeiss AG; Research support, Carl Zeiss AG;

Andrew Zureick, BA, Ann Arbor, MI (*Abstract Co-Author*) Nothing to Disclose

Alan C. Hartford, MD, PhD, Lebanon, NH (*Abstract Co-Author*) Nothing to Disclose

##### **PURPOSE**

Stereotactic radiosurgery (SRS) following resection of a brain metastasis improves disease control at the surgical site. Our prior published work demonstrated a relationship between size of the resected tumor and risk of local recurrence (LR). In this analysis we expanded our database to examine the role of tumor histology among factors that may predict recurrence and overall survival (OS).

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

We retrospectively reviewed all patients treated through Jan 2013 who underwent SRS to the surgical bed, deferring whole brain radiation therapy (WBRT). Multiple factors - including histology, tumor size, planning target volume (PTV), dose, meningeal contact (SUP), development of leptomeningeal disease (LMD), gross total resection (GTR), number of metastases (MET#), and the RTOG's histology-specific Graded Prognostic Assessment (GPA) - were analyzed for time to local recurrence at the tumor bed (LR), to distant recurrence within the brain (DR), to intracranial recurrence (ICR), to salvage WBRT, and for OS.

##### **RESULTS**

122 lesions in 118 patients were treated with resection and SRS between February 2002 and January 2013. With median follow-up 18.3 months, local control rates at the resection cavity were 91.2% at 1-year, 83.4% at 2-years. Overall survival (OS) rates at 1-year and 2-years were 51.2% and 24.4%, respectively. On univariate analysis tumors > 3.0 cm, compared to smaller tumors, had a marginally significant higher risk of local recurrence (28.6% versus 9.6% at 2-years,  $p=.057$ ) and a significantly higher rate of WBRT (66.2% versus 35.6% at 2-years,  $p<.05$ ). Multivariate Cox regressions showed pre-op size to be significant for risk of LR in patients with non-lung tumors ( $p<.05$ ), but not significant for patients with NSCLC metastases. In multivariate analysis of the entire dataset, only GPA was significantly associated ( $p<.0001$ ) with OS, while size, PTV, GTR, histology, SUP, dose, LMD, and MET# were not -- arguing for successful salvage of recurrences.

##### **CONCLUSION**

SRS without WBRT is efficacious in controlling disease recurrence following resection of brain metastases. This study supports tumor size and histology as important factors prognostic for disease control in this group of patients.

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

Pre-operative tumor size and tumor histology are important prognostic factors for efficacy of stereotactic radiosurgery following resection for brain metastases.

#### **MSR035-05 Gamma Knife Radiosurgery for Intracranial Grade 2 Meningiomas**

Tuesday, Dec. 1 11:10AM - 11:20AM Location: S103CD

##### **Participants**

Tamer Refaat Abdelrhman, MD, PhD, Chicago, IL (*Presenter*) Nothing to Disclose

Michelle S. Gentile, MD, PhD, Cambridge, MA (*Abstract Co-Author*) Nothing to Disclose

Orin Bloch I, MD, Chicago, IL (*Abstract Co-Author*) Nothing to Disclose

Maryanne Marymont, MD, Chicago, IL (*Abstract Co-Author*) Nothing to Disclose

James P. Chandler, MD, Chicago, IL (*Abstract Co-Author*) Nothing to Disclose

John A. Kalapurakal, MD, Chicago, IL (*Abstract Co-Author*) Nothing to Disclose

Irene Helenowski, Chicago, IL (*Abstract Co-Author*) Nothing to Disclose

##### **PURPOSE**

There has been few reports addressing the treatment outcomes of Gamma knife radiosurgery (GKRS) for grade 2 meningiomas. This study aims to report clinical outcomes after GKRS for intracranial grade 2 meningiomas.

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

In this IRB approved study, we reviewed the records of all patients with histopathologically confirmed meningiomas treated with GKRS between 1998 and 2014. The median GKRS dose was 15 Gy (range 11-20) prescribed to the 50% isodose line.

## RESULTS

A total of 209 meningiomas were treated consecutively and postoperatively with GKRS; of them 96 were histopathologically confirmed grade 2 meningiomas and were included in this study. Median age was 61 years, 57.3 % were females and 42.7% were males. Tumor sites included anterior (11.5%), middle (11.5%), and posterior (18.7%) cranial fossae, convexity (32.3%), parasagittal (12.5%), temporal (10.4%), and others (3.1%). Mean tumor size was 3.3 cm3 (median 2.2 cm3). Among 41 (48.8%) symptomatic patients, most common symptoms were headache (21.9%), visual impairment (14.6%), hearing deficit (5.2%) and motor deficits (9.4%). After a mean follow up of 40 months (range 3 - 174), the local control rate was 70 % of all treated meningiomas. The median time to recurrence was 89 months (range 47 - 168 months). Of symptomatic patients, 54%, 39%, and 7% reported improved, stable, or worse initial symptoms, respectively. The 3, and 5-year actuarial local control rates were 69.9%, and 55.6%, respectively. The 3, and 5-years overall survival were 80.7%, and 65.6%, respectively. Multivariate analysis including tumor size, site, status (residual versus recurrent), dose, age, sex, race, previous irradiation, previous surgery, time since surgery, will be presented during the meeting in order to identify most contributing factors for local failure and provide recommendations for optimal treatment. The most common acute toxicities after GKRS were headache (1.1%), sensory loss (1.1%), visual impairment (1.1 %), and dementia (3.4%). Chronic toxicities included, headache (1.1%), and visual impairment (2.2%). There were no radiation necrosis or second malignant tumors noted in our series.

## CONCLUSION

This report, one of the largest GKRS series for grade 2 meningiomas, demonstrates that GKRS is a safe and effective treatment modality for grade 2 meningiomas with durable tumor control and minimal toxicity.

## CLINICAL RELEVANCE/APPLICATION

GKRS is a safe and effective treatment modality for grade 2 meningiomas patients.

### MSRO35-07 Stereotactic Radiosurgery for Treatment of Brain Metastases from Colorectal Cancer: A Single-Institution Experience

Tuesday, Dec. 1 11:30AM - 11:40AM Location: S103CD

#### Participants

Michael A. Cummings, MD, MS, Rochester, NY (*Presenter*) Nothing to Disclose  
Kevin Walter, Rochester, NY (*Abstract Co-Author*) Nothing to Disclose  
Kenneth Usuki, Rochester, NY (*Abstract Co-Author*) Nothing to Disclose  
Paul G. Okunieff, MD, Rochester, NY (*Abstract Co-Author*) Nothing to Disclose  
Alan W. Katz, MD, Rochester, NY (*Abstract Co-Author*) Nothing to Disclose  
Michael T. Milano, MD, PhD, Chicago, IL (*Abstract Co-Author*) Nothing to Disclose

#### ABSTRACT

**Purpose/Objective(s):** To review outcomes of patients with colorectal adenocarcinoma who underwent stereotactic radiosurgery for brain metastasis. **Materials/Methods:** A retrospective review of patients with biopsy proven colorectal adenocarcinoma treated with stereotactic radiosurgery for brain metastases from 2001-2013 was conducted under an IRB approved protocol. End points were radiologic response, neurologic symptom response, overall survival, and treatment related complications. Radiographic response to treatment was defined as stable or shrinking lesion size (accounting for expected post-radiation changes) on follow-up imaging, which was MRI in all except 1 patient. Neurologic symptom response was defined as improved or stable deficits on follow up exam with decreasing steroid dosage and no interval novel-to-patient systemic therapy. **Results:** Twenty-three patients received single fraction SRS using either a frame based (2002-2010) or frameless (2011-2013) technique. Mean follow up was 5.4 months (range 1 to 13) which was dictated by overall survival. A total of 46 lesions were treated. The mean lesion size on MRI was 17 mm in greatest dimension (range 2 - 35 mm) with mean PTV size of 3.4 cm3 (0.02 to 14.94 cm3). The median number of lesions treated in a single course was 2 (range 1 to 5). Median prescribed dose to isocenter was 16.5 Gy (12.5 to 20) with median minimal PTV dose of 14 Gy (10 to 19.6). Eight lesions were recurrent after previous resection. Six lesions were treated with SRS and then required retreatment with SRS. Eleven patients had previous WBRT with median dose of 30 Gy. Radiographically 72% of lesions were stable or decreasing in size using last available assessment with mean interval of 4.1 months (1 to 19.2). Mean overall survival was 6 months. Two patients died within 1 month of treatment from causes other than disease (MI, MVA). Sixteen courses of treatment coincided with presentation of neurologic symptoms, with previous WBRT in 14. Seven of these sixteen patients had improvement in their presenting deficit, first noted on assessment at median interval of 2 months after SRS (range 1.3 to 6 mos). Two patients remained steroid dependent, both on substantially decreased doses. None of the patients with neurologic response had recurrence of their presenting neurologic symptom prior to death. No patients required hospitalization for adverse effects of treatment. Two patients proceeded to resection post SRS for progressive lesion. Two patients who did not have WBRT had progression of CNS disease outside the treatment volumes. **Conclusion:** Stereotactic radiosurgery was well tolerated with excellent radiographic response and no major reported adverse events. In this review 44% of patients with neurologic symptoms prior to SRS had clinical improvement with length and time course not attributable to steroid therapy.

### MSRO35-08 Long-term Follow-up of Intensive Chemotherapy Followed by Reduced Dose and Field Irradiation for Intracranial Germ Cell Tumors

Tuesday, Dec. 1 11:40AM - 11:50AM Location: S103CD

#### Participants

Akinori Takada, MD, Tsu, Japan (*Presenter*) Nothing to Disclose  
Noriko Ii, MD, PhD, Tsu, Japan (*Abstract Co-Author*) Nothing to Disclose  
Toshio Matsubara, MD, PhD, Tsu, Japan (*Abstract Co-Author*) Nothing to Disclose  
Yoshihiro Komada, MD, PhD, Tsu, Japan (*Abstract Co-Author*) Nothing to Disclose  
Hajime Sakuma, MD, Tsu, Japan (*Abstract Co-Author*) Departmental Research Grant, Siemens AG; Departmental Research Grant, Koninklijke Philips NV; Departmental Research Grant, Bayer AG; Departmental Research Grant, Guerbet SA; Departmental Research Grant, DAIICHI SANKYO Group; Departmental Research Grant, FUJIFILM Holdings Corporation; Departmental Research Grant, Nihon Medi-Physics Co, Ltd  
Yoshihito Nomoto, Tsu, Japan (*Abstract Co-Author*) Nothing to Disclose  
Hidemi Toyoda, MD, PhD, Tsu, Japan (*Abstract Co-Author*) Nothing to Disclose  
Takao Deguchi, MD, PhD, Tsu, Japan (*Abstract Co-Author*) Nothing to Disclose  
Yutaka Toyomasu, MD, Tsu, Japan (*Abstract Co-Author*) Nothing to Disclose

## ABSTRACT

**Purpose/Objective(s):** The purpose of this study is to report the treatment outcomes of intensive chemotherapy followed by reduced dose and field irradiation for the treatment of intracranial germ cell tumors (GCTs). **Materials/Methods:** 22 patients (18 males and 4 females) with intracranial GCTs were treated at our facility between 1991 and 2012. They were classified three groups based on serological and histological findings. Five patients (23%) with pure germinoma were treated with conventional-dose chemotherapy (ifosfamide-cisplatin-etoposide) followed by 24 Gy ventricular field irradiation as good prognosis group, and 14 patients (64%) germinoma with syncytiotrophoblastic giant cells and 3 patients (14%) with nongerminomatous GCTs were treated with high-dose chemotherapy (HDC) with stem-cell support followed by 24-50.4 Gy reduced field irradiation as intermediate and poor prognosis group, respectively. The Median age was 14 years and primary sites were at pineal region for 11(50%) patients, suprasellar region for 4(18%) patients and others for 7(32%) patients. Disseminated tumors were present in 4 patients. Ten patients (45%) were diagnosed with hydrocephalus before treatment. Four patients who relapsed after initial chemotherapy were included in this study. **Results:** The median follow-up duration was 113 months, 10-year overall survival rate and progressive-free survival rate was 80.1% and 69.8%, respectively. Regarding late adverse effect, pituitary dysfunction (short stature, insufficiency of secondary sexual feature, hypothyroidism); 8 patients (36%), hearing impairment; 5 patients (23%), intelligence diminution; 6 patients (27%), convulsion•electroencephalogram abnormality; 5 patients (23%), treatment induced secondary neoplasm; 2 patients (9.1%), motility disorder; 2 patients (9.1%), azoospermia; 1 patient (4.5%) and treatment-related death (brain hemorrhage); 1 patient (4.5%) appeared. In addition, 5 (23%) patients needed intervention of a psychiatrist due to school refusal, anxiety disorder, eating disorder and self-injury behavior etc. In contrast, patients who received irradiation less than 30 Gy tended to have no late adverse effect. **Conclusion:** Intensive chemotherapy followed by reduced dose and field irradiation resulted in preferable outcomes. Based on our results, further study will be required from the perspective of radiation dose and field, especially for patients classified as intermediate and poor prognosis group.

## MSRO35-09 Incidence, Treatment, and Survival Patterns for Sacral Chordoma in the United States, 1973-2011

Tuesday, Dec. 1 11:50AM - 12:00PM Location: S103CD

### Participants

Esther Yu, MD, Boston, MA (*Presenter*) Nothing to Disclose

## PURPOSE

**Purpose/Objective(s):** Sacral chordomas represent approximately a third of all chordomas, a rare neoplasm of notochordal remnants. Current NCCN guidelines recommend surgical resection with or without adjuvant radiotherapy, or definitive radiation for unresectable cases. Recent advances in radiation for chordomas include conformal photon and proton beam radiation. We investigated the incidence, treatment, and survival outcomes for sacral chordomas to observe any trends in response to improvements in surgical and radiation techniques over a near 40 year time period.

## METHOD AND MATERIALS

**Materials/Methods:** 345 microscopically confirmed cases of sacral chordoma were identified between 1974 and 2011 from the Surveillance, Epidemiology, and End Results (SEER) program of the National Cancer Institute. Incidence and survival rates were adjusted for age. Cases were divided into three cohorts by calendar year, 1974-1989, 1990-1999, and 2000-2011, as well as into two groups by age less than or equal to 65 versus greater than 65 to investigate trends over time and by age via Chi-square analysis. Kaplan-Meier analyses were performed to determine effects of treatment on survival.

## RESULTS

**Results:** Median age at diagnosis was 64. The age-adjusted incidence rate of sacral chordomas was .03 per 100,000. 5-year relative survival for the entire cohort was 60%. Overall survival correlated significantly with treatment modality, with 44% surviving at 5 years with no treatment, 52% with radiation alone, 82% surgery alone, and 78% surgery and radiation (pTable 1. Trends of Radiation, Surgery, and Survival by Time. 1974-1989(N=68)1990-1999(N=78)2000-2011(N=199)P-valuePatients Receiving Radiation153%40%33%.03Patients Receiving Surgery165%74%70%.555-year Overall Survival (%)63%59%63%2.991Treatments were not mutually exclusive.2Calculated from 94 cases between 2000-2006 with median follow-up 84 months.

## CONCLUSION

**Conclusion:** Surgery remains an important component in the treatment of sacral chordomas in current practice. Fewer patients were treated with radiation more recently despite advances in photon and proton beam radiation. Overall survival remains unchanged. Additional analyses of margin status, radiation modality, and local control in current practice are warranted.

## ABSTRACT

**Conclusion:** Surgery remains an important component in the treatment of sacral chordomas in current practice. Fewer patients were treated with radiation more recently despite advances in photon and proton beam radiation. Overall survival remains unchanged. Additional analyses of margin status, radiation modality, and local control in current practice are warranted.



**BOOST: Breast-Integrated Science and Practice (ISP) Session**

Tuesday, Dec. 1 10:30AM - 12:00PM Location: S103AB



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

**Participants**

Anna Shapiro, MD, Syracuse, NY (*Moderator*) Nothing to Disclose  
Katherine L. Griem, MD, Chicago, IL (*Moderator*) Nothing to Disclose

**Sub-Events****MSRO32-01 Invited Speaker:**

Tuesday, Dec. 1 10:30AM - 10:40AM Location: S103AB

**Participants**

William Small JR, MD, Maywood, IL (*Presenter*) Speakers Bureau, Carl Zeiss AG

**MSRO32-02 Potencial Benefits of Neoadjuvant Radiation Therapy in Overall Survival of Advanced Breast Cancer Patients**

Tuesday, Dec. 1 10:40AM - 10:50AM Location: S103AB

**Participants**

Lilian Faroni, Rio De Janeiro, Brazil (*Abstract Co-Author*) Nothing to Disclose  
Daniel Przybysz, MD, RIO DE JANEIRO, Brazil (*Presenter*) Nothing to Disclose

**ABSTRACT**

**Purpose/Objective(s):** To analyze 66 patients with inoperable breast cancer who failed to neoadjuvant chemotherapy and were rescued with radiotherapy prior to surgery. **Materials/Methods:** From a total of 10.199 registered breast cancer patients, 3.365 new cases of advanced disease were treated and their charts revised. 1.641 patients received neoadjuvant chemotherapy (NeoCh) and 229 failed it. In 66 cases, they received neoadjuvant radiotherapy (NeoRT). Endpoints were resectability and response rate. Chi-square test was used for comparison among groups. NeoRT was delivered in a conventional course of 50 Gy @ 25 fractions or 40 Gy @ 16 fractions to breast, supraclavicular fossae and axilla, with tangential and non-pair irregular opposed fields, and 6 MV photons energy. If inoperable, they received a 10 Gy boost on the breast area. Surgery was intended to be done four weeks after RT. **Results:** From a total of 66 patients analyzed, the median age was 55 years, and 97% of patients were staged as IIIB. Invasive ductal carcinoma was the most frequent histopathological diagnose. Regarding NeoCh, 43 (65.15%) received FAC; 16 (24.2%) FAC plus Docetaxel and 6 (10%) CMF. Tamoxifen was used in 8 (12%) cases. After NeoCh, 34 (52%) showed stable disease (SD); 24 (36%), progression disease (PD) and 8 (12%), partial response (PR). After NeoRT, 33 (50%) showed SD; 24 (36%), PR and 4 (6%) had clinical complete response (CR). 5 cases (8%) showed PD. 32 patients (48.5%) were eligible to mastectomy. In pathological study, 4 (12.5%) had pathological CR and 20 (61%) showed PR, with a response rate of 73.5% and median volume of surgical specimen of 2,68 cm<sup>3</sup>. Axillary dissection was performed in all patients, and the mean number excised and positive nodes were respectively 11 (5-22) and 2 (0-18). In the hypofractionated group (13 cases), 4 (31%) patients were considered operable. In the conventional group (49 cases), 28 (57%) had their tumor respected. 4 patients received an additional whole breast boost of 10 Gy @ 5 fractions. Median time of RT was, respectively, 26 and 37 days in the hypofractionated and in the conventional group (including boosted patients). Patients who remained inoperable after RT, showed 91% of distant metastasis. With a median follow up of 84 months, 7 operated patients (21.8%) are alive without evidence of disease and no patients at the inoperable group; last follow-up: Dec/2014. Regarding operated and non-operated patients, 3 years OS, were respectively 75% and 50% (p Conclusion: NeoRT in patients with poor response to NeoCh, who remained inoperable, is a feasible treatment approach. It has allowed almost half of them to become eligible to surgery, with significant benefit on OS when compared to those that remained inoperable. Although, further studies should be done before this protocol becomes standard of care for advanced breast cancer patients.

**MSRO32-03 Intraoperative Radiation Therapy as a Boost After Neoadjuvant Chemotherapy: DFS after a Median Follow-up of 4 Years**

Tuesday, Dec. 1 10:50AM - 11:00AM Location: S103AB

**Participants**

Hans-Christian Kolberg, Bottrop, Germany (*Presenter*) Advisory Boards, Novartis AG; Advisory Boards, GlaxoSmithKline plc; Advisory Boards, Carl Zeiss AG; Advisory Boards, Genomic Health, Inc; Advisory Boards, LIV Pharma GmbH; Speaker, Novartis AG; Speaker, GlaxoSmithKline plc; Speaker, Carl Zeiss AG; Speaker, F. Hoffmann-La Roche Ltd; Speaker, Teva Pharmaceutical Industries Ltd; Speaker, Theraclion; Speaker, Genomic Health, Inc; Speaker, Amgen Inc; Gyorgy Lovey, Bottrop, Germany (*Abstract Co-Author*) Nothing to Disclose  
Leyla Akpolat-Basci, Bottrop, Germany (*Abstract Co-Author*) Nothing to Disclose  
Miltiades Stephanou, Bottrop, Germany (*Abstract Co-Author*) Nothing to Disclose  
Michael Untch, Berlin, Germany (*Abstract Co-Author*) Nothing to Disclose

**ABSTRACT**

**Purpose/Objective(s):** The expected local recurrence rate in 5 year follow-up after breast conserving therapy and whole breast irradiation is 7,6%. Adding a boost of the index region results in a reduced recurrence rate of 4,3%. The boost irradiation as an intraoperative procedure showed a further decrease of local recurrence rates down to 1,75%. We adapted this approach to patients after neoadjuvant chemotherapy (NACT) and are reporting the DFS after a median of 4 years of follow up. To our knowledge this is the first time that data concerning intraoperative radiotherapy with a 50 kV X-ray source after neoadjuvant chemotherapy are presented. **Materials/Methods:** Between April 2010 and November 2011 we treated 61 patients after NACT (+/-

Trastuzumab according to HER2-status) with an intraoperative boost of 20 Gy with a 50 kV X-ray source followed by an external radiation with 50 Gy. The patient characteristics were as follows and represent the high risk cohort typical for a cohort of patients treated with NACT: median age 54,9 years, 24 pts premenopausal / 37 pts postmenopausal, 31 pts G2 / 30 pts G3, 39 pts ER positive / 22 pts ER negative, 29 pts PR positive / 32 pts PR negative, 24 pts HER2 positive / 37 pts HER2 negative, 36 pts T1 / 24 pts T2 / 1 pt T3, 28 pts node negative / 33 pts node positive. 19 patients reached a pCR. 17 patients needed more than one operation. No patient was lost to follow up and at the time of data closure the median follow up was 49,56 months. Results: At a median follow up of 49,55 months the DFS was 86,89%, the DDFS 93,44%. 18 of the 19 patients were disease free in the group of patients who reached a pCR (DFS 94,74%). In the group of 42 patients who had residual tumor after NACT, 35 were disease free (DFS 83,33%). Conclusion: A DFS of 86,89% compares favorably to the DFS expected for patients after NACT. The higher DFS in the pCR-group was expected due to the fact that a pCR after NACT +/- Trastuzumab is predictive for DFS. Still the DFS in the non pCR-group compares favorably to the known data for patients not reaching a pCR. Our data are the first on IORT as a boost after neoadjuvant chemotherapy and show a favorable outcome of the patients in this high risk group. They strongly encourage the design of prospective trials in this indication.

#### **MSRO32-04 Preliminary Results of a Phase I Trial Evaluating Nipple Sparing Mastectomy with Immediate Reconstruction Followed by Prophylactic Nipple Areola Complex Irradiation in Early-Stage Breast Cancer: Patient Reported Satisfaction and Cosmesis Outcomes**

Tuesday, Dec. 1 11:00AM - 11:10AM Location: S103AB

##### **Participants**

Cristiane Takita, MD, Miami, FL (*Presenter*) Nothing to Disclose

##### **ABSTRACT**

**Purpose/Objective(s):** Breast conserving therapy has become the standard option for patients with early stage breast cancer. Still, there are some patients in need for mastectomy due to multicentric disease or diffuse microcalcifications. If mastectomy is to be performed, keeping the nipple areola complex (NAC) is still controversial. Studies have shown that preservation of the NAC provided higher patient's satisfaction and less psychological impact after mastectomy. Previous studies have used nipple sparing approach using intraoperative radiation (RT) to the NAC. This study is to report preliminary data of a prospective phase I trial using nipple sparing mastectomy with immediate reconstruction, followed by prophylactic NAC RT at weeks 5 to 8 postoperative. **Materials/Methods:** From 2009 to 2014, 10 patients with 11 breast cancers primary (one patient had bilateral disease) were enrolled in the study. The first 6 patients were treated to the NAC using 25 Gy in 10 fractions, BID, 6 hours apart, over 5 consecutive days, using electrons (dose level II; dose escalation/de-escalation design). The next 3 patients received dose level III, 30 Gy in 10 fractions, using same regimen. Radiation was delivered 5 to 8 weeks postoperative. Patient's cosmesis was assessed by the patient and physicians during 1, 3, 6, and 12 months after completion of protocol therapy. Patient's satisfaction was also evaluated at same interval. **Results:** Nine out of ten patients were able to complete treatment per protocol. At the last follow up, patient's evaluation of cosmesis was excellent in 78% (7/9), good in 11% (1/9), and poor in 11% (1/9). Overall patient satisfaction with nipple sparing protocol was Good/Excellent in all patients during the time interval of evaluations. Physician's evaluation of NAC cosmesis was excellent in 34% (3/9), good 66% (6/9). In regard toxicity, only one patient developed grade 3 infection and loss of NAC postoperative; this patient did not receive NAC RT. Of the 9 evaluable patients in the protocol, there was no NAC loss or need for treatment interruption. There was no grade 4, 5 toxicity in patients treated with NAC RT. The most common toxicity was acute radiation dermatitis and NAC pain, mostly grade 2, which completely resolved in subsequent follow up. **Conclusion:** The preliminary results of this nipple sparing protocol for early stage breast cancer showed a high level of patient's satisfaction and self-reported good/excellent cosmesis in the majority of patients treated. Toxicity appeared to be acceptable so far, mostly related to acute radiation dermatitis, grade 2. There was no NAC loss with the use of prophylactic NAC RT. Final results will be presented at completion of the trial.

#### **MSRO32-06 Dose to Organs in the Supraclavicular Region When Covering the Internal Mammary Nodes (IMN) in Breast Cancer Patients: A Comparison of VMAT Versus 3-D and VMAT**

Tuesday, Dec. 1 11:20AM - 11:30AM Location: S103AB

##### **Participants**

Vishruta A. Dumane, PhD, Chicago, IL (*Presenter*) Nothing to Disclose  
Richard L. Bakst, MD, New York, NY (*Abstract Co-Author*) Nothing to Disclose  
Sheryl Green, MD, New York, NY (*Abstract Co-Author*) Nothing to Disclose

##### **ABSTRACT**

**Purpose/Objective(s):** VMAT has been reported to offer improved dosimetric sparing of the ipsilateral lung, total lung and heart compared to 3D conformal planning while covering IMNs. However OARs in the supraclavicular region often receive higher doses compared to 3D conformal planning. We aim to compare VMAT versus a combination of 3D and VMAT to improve sparing of OARs in this region without compromising target coverage or the dosimetric advantage that is already offered on using VMAT alone. **Materials/Methods:** 10 patients previously treated with VMAT at our institution were re-planned with 3D conformal planning in the supraclavicular region and VMAT inferiorly to the chestwall. VMAT planning consisted of 2 complementary arcs within a 230° arc range with 6 MV. The supraclavicular region was planned either with a single off-cord AP field or with off-cord AP/PA and field in field employing 6 MV and/or 16 MV depending on the depth of nodal coverage. Coverage criteria were PTV D95 = 50 Gy, V95 = 98% and PTV D05 = 115%. Doses to the esophagus, trachea, larynx, brachial plexus, thyroid and cord were noted in addition to the heart, lungs and contralateral breast. **Results:** Combining 3D with VMAT significantly reduced the maximum dose to the esophagus, trachea and spinal cord by 15 Gy, 11 Gy and 12 Gy and also significantly reduced mean dose to the thyroid, larynx and trachea by 15 Gy, 12 Gy and 18 Gy respectively (Table 1). No significant differences were seen in the mean dose to the heart, ipsilateral lung, total lung and contralateral breast or in the maximum dose to the brachial plexus. A statistically significant increase in the V20 Gy to the ipsilateral lung and total lung was observed but was = 2%. **Conclusion:** 3D conformal planning in the supraclavicular region while restricting VMAT to the chestwall helps reduce dose to additional OARs without compromising doses to the heart, lungs and contralateral breast when VMAT alone is used. OARVMAT3D + VMAT Esophagus Max (Gy)45.65\* (SE 2.32)30.8\* (SE 4.54) Esophagus Mean (Gy) 9.16\* (SE 0.64) 6.54\* (SE 0.54)Trachea Max (Gy)43.97\* (SE 1.51)33.24\* (SE 5.44) Trachea Mean (Gy)26.53\* (SE 1.65)8.52\* (SE 1.38)Cord Max (Gy)28.25\* (SE 1.64)15.93\* (SE 3.46) Thyroid Mean (Gy)29.61\* (SE 2.91)14.36\* (SE 3.25)Larynx Mean (Gy)14.24\* (SE 2.15)2.26\* (SE 0.64) Brachial Plexus Max (Gy)56.03 (SE 1.2)55.95 (SE 1.83)Heart Mean (Gy)5.54 (SE 0.71)5.49 (SE 0.7) Ipsilateral Lung Mean (Gy)15.31 (SE 0.27)16.01 (SE 0.24)Ipsilateral Lung V20Gy (%)24.69\* (SE 0.72)26.85\* (SE 0.62) Total Lung Mean (Gy)9.78 (SE 0.24)9.97 (SE 0.23)Total Lung V20Gy (%)13.04\* (SE 0.61)14.06\* (SE 0.49) Contralateral Lung Mean (Gy)3.6\* (SE 0.37)3.23\* (SE 0.32)Contralateral Breast Mean (Gy)4.13 (SE 0.2)4.05 (SE 0.23)SE= standard error\*p <0.05



## MSRO32-07 SBRT for Secondary Lung and Liver Lesions in 35 Breast Cancer Oligometastatic Patients

Tuesday, Dec. 1 11:30AM - 11:40AM Location: S103AB

### Participants

Slavisa Tubin, Empoli, Italy (*Presenter*) Nothing to Disclose  
Franco Casamassima, Empoli, Italy (*Abstract Co-Author*) Nothing to Disclose  
Claudia Menicelli, Empoli, Italy (*Abstract Co-Author*) Nothing to Disclose  
Silvia Grespi, Empoli, Italy (*Abstract Co-Author*) Nothing to Disclose  
Alessandro Fanelli, Empoli, Italy (*Abstract Co-Author*) Nothing to Disclose  
Gabiella Pastore, Empoli, Italy (*Abstract Co-Author*) Nothing to Disclose  
Cecilia Arrichiello, Empoli, Italy (*Abstract Co-Author*) Nothing to Disclose

### ABSTRACT

**Purpose/Objective(s):** This retrospective study explores the impact of SBRT as an aggressive local treatment on the disease evolution and survival of patients with oligometastatic breast cancer treated for lung and liver metastases. **Materials/Methods:** 24 lung lesions in 11 patients and 39 liver lesions in 24 patients (total of 63 lesions) were irradiated using SBRT between Feb.'07-Nov.'14. All 35 patients treated (KPS =70) were oligometastatic which according to our criteria implied the presence of = 5 in lung- or in liver-only metastases, or = 3 if presented in > 1 site. 7 patients (20%) were with single metastases while 28 (80%) with multiple. 11 patients were irradiated for lung lesions while 24 for liver lesions. Histology was ductal ADK in 81% of patients, lobular in 10%, mixed in 2% and other histologies or no data in 7%. The median diameter of the lung lesions was 1 cm (range 0.5-5) and of the liver metastases 3.5 cm (range 1-9.1). Planning Target Volume was created by adding a 3 mm margin to the Gross Tumor Volume. SBRT was delivered with VMAT by 6 MV LINAC and planned by TPS with Montecarlo algorithm. All lesions were treated in Breath-hold with different dose levels depending on tumor site and size. Almost all lung lesions (83.3%) were irradiated with 26 Gy in a single fraction prescribed to the 70% isodose (BED10 to isocenter = 175). Liver lesions were treated mainly (72%) with 37.5 Gy in 3 fractions prescribed to the 67% isodose (BED10 to isocenter = 161). Set-up and isocenter were assessed by CBCT. All patients treated for liver lesions underwent Gold fiducials insertion 1 week before CT simulation. The response was evaluated after 60 days by CT and PET, and every 3 months subsequently. Toxicity was assessed by CTCAE score. **Results:** Considering all treated lesions, both lung and liver, only 5 (7.9%) "in field" recurrences were observed, all occurred in liver during the first year from SBRT so the local control rate at 1 year was 92.1%; Dividing irradiated lesions by anatomic site 1 year local control rate for lung lesions was 100% while for liver-group 87.2%. At 1 and 2 years Overall Survival (OS) rates were 86% and 69% (91% and 70% in lung-group vs. 83% and 50% in liver-group), and Progression Free Survival rates were 37% and 20%, respectively (median F.U. 19.9 months, range 2,2-60). No predictive factors of local failure were found. No toxicity > G2 (4 patients) was recorded. **Conclusion:** SBRT for Lung and Liver metastases in Breast oligometastatic patients is a safe and well tolerated treatment. High local control rate (only 5 recurrences in field) confirms the ablative role of SBRT using high BED doses (> 100). The low number of relapses does not allow statistical analysis on predictive factors of local failure but high local control rate in the subset of patients with primary breast cancer indicates an trend for better local control respect to other primitive tumors (92.1% at 1 year that appears stable over the time).

## MSRO32-08 Salvage Radiation Therapy for 2nd Oligo-Recurrence in Patients With Breast Cancer

Tuesday, Dec. 1 11:40AM - 11:50AM Location: S103AB

### Participants

Mari Miyata, MD, Kitakyushu, Japan (*Abstract Co-Author*) Nothing to Disclose  
Takayuki Ohguri, Kitakyushu, Japan (*Presenter*) Nothing to Disclose  
Katsuya Yahara, Kitakyushu, Japan (*Abstract Co-Author*) Nothing to Disclose  
Yukunori Korogi, MD, PhD, Kitakyushu, Japan (*Abstract Co-Author*) Nothing to Disclose

### ABSTRACT

**Purpose/Objective(s):** A new concept of "oligo-recurrence (OR)" indicates one to several distant metastases/recurrences in one or several organs which can be treated with local therapy, while the primary site of the cancer was once controlled. A previous study demonstrated that first failure detected as the state of OR (e.g. isolated loco-regional recurrence (LRR) or isolated pulmonary metastasis) could be salvaged by local therapy. However, a subset of once salvaged patients with OR could have a second failure which is also detected as the state of OR. We have often experienced this situation in patients with breast cancer and have defined that as "2nd OR." The purpose of this study was to assess the efficacy and toxicity of salvage radiotherapy (RT) for the 2nd OR of breast cancer. **Materials/Methods:** All the 23 patients satisfied the following requirements of our definition for 2nd OR: (i) disease-free status after initial therapy for clinically localized breast cancer had been once confirmed; (ii) first failure was detected as OR (1st OR), and disease control of the 1st OR after salvage local therapy was confirmed, while simultaneously there were no other distant metastases/recurrences; (iii) second failure was also detected as OR (2nd OR) which was treated with salvage RT. The sites of the 2nd OR were LRR in 9 patients and distant metastasis in 14 patients. The total radiation dose of the salvage RT ranged from 40–76 Gy (median, 60 Gy), the daily dose was 2.0–3.0 Gy (median, 2.0 Gy). Efficacy and toxicity of the salvage RT for the 2nd OR were retrospectively evaluated, and the predictors of a long-term survival were analyzed. **Results:** Twenty-one (91%) patients had an objective response. The median overall survival and progression-free survival times were 40 and 20 months after salvage RT for the 2nd OR, respectively. The three-year local (in-field) control rates were 84%. The toxicities were mild; acute toxicities = Grade 3 were seen in one patient with Grade 3 dermatitis, and no late toxicity = Grade 2 was observed, except for one patient who had a Grade 3 lymphatic edema of the arm. The first sites of disease progression after the salvage RT for the 2nd OR were out-field alone in 11 patients (48%) and both in-field and out-field in 4 patients (17%); none of the patients had first sites in local (in-field) alone. The univariate analyses indicated that age (Conclusion: Salvage RT for the 2nd OR was able to achieve a better local control rate and longer progression-free survival time without inducing severe toxicity, and therefore may be a potentially effective modality for inducing long-term survival in select patients).

## MSRO32-09 Cost-Effectiveness of Pertuzumab in HER2-positive Metastatic Breast Cancer

Tuesday, Dec. 1 11:50AM - 12:00PM Location: S103AB

### Participants

Yushen Qian, MD, Stanford, CA (*Presenter*) Nothing to Disclose

### ABSTRACT

**Purpose/Objective(s):** The Clinical Evaluation of Pertuzumab and Trastuzumab (CLEOPATRA) study showed a benefit in overall

survival with the addition of pertuzumab (P) to docetaxel (T) and trastuzumab (H) (THP) compared to TH as first-line treatment for patients with HER2-positive metastatic breast cancer. With median follow-up of 50 months, median overall survival for the THP and TH groups were 56.5 and 40.8 months, respectively [Swain, NEJM 2015]. Based on these results, we performed a cost-effectiveness analysis to determine the impact of pertuzumab on the treatment of HER2-positive metastatic breast cancer. Materials/Methods: Cost-effectiveness was evaluated from a societal perspective. A four-state Markov model was constructed to evaluate the cost-effectiveness of TH with or without P. Health states included: stable disease, progression of disease, hospice, and death. The model was run over 10 years with cycle length of 1 week. Transition probabilities were based on the results of the CLEOPATRA study. Costs were based upon 2014 Medicare reimbursement rates and manufacturers' Average Sales Price. Interventions were evaluated with a willingness-to-pay threshold (WTP) of \$100,000 per quality-adjusted life years (QALY) gained. One-way and multi-way sensitivity analyses were performed to explore the effects of specific assumptions. Results: Our modeled overall survival and progression-free survival intervals compared well with the results of the CLEOPATRA study. Modeled median survival was 171 weeks (39.5 months) and 253 weeks (58.3 months) for TH and THP group, respectively. The addition of P resulted in an additional 0.73 QALY at an increased cost of \$426,039 compared with TH, resulting in an incremental cost-effectiveness ratio (ICER) of \$582,141 per QALY. Two-way sensitivity analysis showed that in the scenario where baseline costs (including cost of trastuzumab) were half of predicted, THP would not become cost-effective until discounted by 96% of the current Medicare Average Sales Price. Conclusion: The addition of pertuzumab to docetaxel and trastuzumab in metastatic HER2(+) breast is unlikely to be cost-effective at a WTP threshold of \$100,000 per QALY gained. This finding is attributed to 1) the expense of pertuzumab, and 2) that patients treated with pertuzumab have prolonged progression-free survival, and, therefore, accrue higher costs for prolonged treatment with both pertuzumab and trastuzumab. Additional results from the adjuvant trials of pertuzumab will be important to characterize the overall cost-benefit of this agent in both metastatic and early stage HER2-positive breast cancer.

SSG07

## ISP: Health Service, Policy and Research (Miscellaneous)

Tuesday, Dec. 1 10:30AM - 12:00PM Location: S102D



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

### Participants

David C. Levin, MD, Philadelphia, PA (*Moderator*) Consultant, HealthHelp, LLC; Board of Directors, Outpatient Imaging Affiliates, LLC  
Kimberly E. Applegate, MD, MS, Zionsville, IN (*Moderator*) Nothing to Disclose

### Sub-Events

#### SSG07-01 Health Service, Policy and Research Keynote Speaker: Will Use of Imaging Expand in the Near Future - Or Contract?

Tuesday, Dec. 1 10:30AM - 10:40AM Location: S102D

### Participants

David C. Levin, MD, Philadelphia, PA (*Presenter*) Consultant, HealthHelp, LLC; Board of Directors, Outpatient Imaging Affiliates, LLC

#### SSG07-02 Access to Clinical Imaging Reports in Patient Portals and the Role of the Radiologist: The Patient Perspective

Tuesday, Dec. 1 10:40AM - 10:50AM Location: S102D

### Participants

Eduardo Hernandez-Rangel, MD, Orange, CA (*Presenter*) Nothing to Disclose  
Wanda Marfori, MD, Orange, CA (*Abstract Co-Author*) Nothing to Disclose  
Alessandra Miranda, MD, Orange, CA (*Abstract Co-Author*) Nothing to Disclose  
Mayil S. Krishnam, MBBS, MRCP, Orange, CA (*Abstract Co-Author*) Nothing to Disclose

### PURPOSE

To determine patient perspective in regard to 1) access to imaging reports in patient portals 2) how imaging results are received and communicated to them.

### METHOD AND MATERIALS

Combined electronic/paper survey was administered to adult outpatients at UCIMC. Survey questions focused on: 1) accessibility and satisfaction with patient portal (PP) 2) information about imaging procedures and concerns 3) access to imaging reports 4) patient preference as to who would explain imaging test procedures and from whom they receive imaging results: PCP, ordering/referring physician, radiologist, NP, PA or nurse 5) and potential role of radiologists in communicating results. Results were tabulated and analyzed.

### RESULTS

Total of 66 participants completed the survey, mean age:  $54 \pm 18$  S.D.; 60% female, 40% male. 70% had college level education and insured (97%). 53% percent had access to PP, 85% were satisfied; 47% with no access would like to have one. 89.4% had recent and multiple (56%) imaging tests; individual tests mostly CT (10%). Procedures and risks explained by technicians (53%). Radiation exposure not a major concern (61%) and most (75%) were unaware of radiation reduction strategies. 17% were concerned with side effects, contrast allergy, cost, cancer, quality and diagnosis. Access to imaging report in PP was important (92%) and timely reporting (85%); having access will not create anxiety, stress or confusion. Patients prefer to discuss results with referring physician 48%, PCP 26%, radiologist 21%, other 5%. Question re: discussing results with Radiologist showed 57.6% preference, due to the following: first person who knows the findings, is the expert and will have more complete, better and accurate information. 34% prefer a discussion with radiologist immediately post-procedure, and access to results within 24 hours 34%.

### CONCLUSION

Overall participants preferred and are satisfied with PP and want more control of their health information. There is preference for direct discussion with radiologist but timely access to imaging results via a PP, from referring physician, PCP, or radiologist is much more important rather than from whom they receive or discuss results with.

### CLINICAL RELEVANCE/APPLICATION

Our project is in line with RSNA and ACR campaign for patient centered practice with goal of promoting awareness of radiologist role in patient care and benefits of direct interaction with patients

#### SSG07-03 Image-Rich Radiology Reports: A Value-Based Model to Improve Clinical Workflow

Tuesday, Dec. 1 10:50AM - 11:00AM Location: S102D

### Participants

Bhavik N. Patel, MD,MBA, Durham, NC (*Presenter*) Nothing to Disclose  
Jose Lopez, BS, Raleigh, NC (*Abstract Co-Author*) Nothing to Disclose  
Christopher J. Roth, MD, Durham, NC (*Abstract Co-Author*) Nothing to Disclose  
Rendon C. Nelson, MD, Durham, NC (*Abstract Co-Author*) Consultant, General Electric Company Consultant, Nemoto Kyorindo Co, Ltd Consultant, VoxelMetrix, LLC Research support, Bracco Group Research support, Becton, Dickinson and Company Speakers Bureau, Siemens AG Royalties, Wolters Kluwer nv

## PURPOSE

To determine the clinical value of an image-rich radiology report (IRRR) by evaluating unmet needs, interest, and preferences of referring physicians and the willingness of radiologists to create them.

## METHOD AND MATERIALS

Referring physicians and radiologists of various experience and from different specialties were interviewed in this prospective, HIPAA-compliant study. Willingness to voluntarily participate for interview was solicited via email. A single investigator conducted all interviews using standard questionnaires, one for clinicians and one for radiologists. All subjects were walked through a PowerPoint mockup demonstration of an IRRR and its potential use in clinical workflow. Three methods for viewing images were presented: 1) clicking hyperlinks to access a stacked image series popup, 2) embedded clickable image thumbnails, 3) scrollable but not enlargeable medium-sized image series within the report. Questionnaire answers, free comments, and general impressions were captured and analyzed.

## RESULTS

A total of 44 physicians (33M, 11F, 36 clinicians, 8 radiologists) were interviewed. Number of years in practice was < 5 (27%), 5-9 (30%), 10-14 (9%), 15-19 (11%), and > 19 (23%). 31 (70%) clinicians expressed interest in using IRRR. Of these, 81% believed IRRR would improve communication. 29 and 26 subjects stated they would very frequently use IRRR for CT and MR images, respectively, while 10 would use it for ultrasound. With regards to how images are embedded, 10 (28%) preferred method 1, 18 (50%) preferred method 2, and 8 (22%) preferred method 3. 30 subjects (83%) stated IRRR would somewhat or substantially improve efficiency. 100% of radiologists believed IRRR was a valuable concept. 5 (63%) preferred right clicking an image whereas 3 (38%) preferred pressing a function key to embed images. On the average, radiologists would be willing to spend 83 seconds per case to embed the images.

## CONCLUSION

Referring physicians believe IRRR would add value by improving communication between them and radiologists as well as have some improvement on their time efficiency. Radiologists are open to providing IRRR so as long as the process of embedding images is expeditious.

## CLINICAL RELEVANCE/APPLICATION

In the current era of transforming health care, novel solutions that increase value of radiology must be employed. IRRR may improve clinical workflow and communication between referring physicians and radiologists, ultimately translating into improved patient outcomes.

## SSG07-04 Investigating Occult Malignancy in Patients with Unprovoked Venous Thromboembolism - A Single-centre Retrospective Study

Tuesday, Dec. 1 11:00AM - 11:10AM Location: S102D

### Participants

Tarryn Carlsson, MBChB, Bristol, United Kingdom (*Presenter*) Nothing to Disclose  
Babu Pusuluri, Bristol, United Kingdom (*Abstract Co-Author*) Nothing to Disclose  
John Ho, Bristol, United Kingdom (*Abstract Co-Author*) Speaker, Boehringer Ingelheim GmbH;  
Ladli Chandratreya, MBBS, FRCP, Bristol, United Kingdom (*Abstract Co-Author*) Nothing to Disclose

## PURPOSE

In June 2012 the National Institute for Health and Care Excellence (NICE) published guidelines for investigating occult malignancy (CG144: section 1.5) in patients diagnosed with unprovoked venous thromboembolism (VTE). Screening for cancer in these patients remains controversial and its survival benefit is yet to be proven. Our objectives are to determine the frequency of unprovoked VTE in our institution, assess the way we investigate these patients for occult malignancy and to determine the frequency of occult malignancies in this group of patients.

## RESULTS

740 investigations were undertaken to investigate a possible diagnosis of VTE of which only 108 were positive (15%). Further analysis showed that 60.2% (n = 65) were provoked, 37% (n = 40) were unprovoked and 3% (n = 3) could not be categorised. The age range of patients diagnosed with an unprovoked VTE was between 27-94 years old with a mean age of 65 years. The majority were male (n = 24). In the unprovoked VTE category 69.2% (n = 27) had a physical examination; 97.4% (n = 38) had a FBC; 84.6% (n = 33) had LFTs; 48.7% (n = 19) had a serum calcium and only 33.3% (n = 13) had a urinalysis performed within one month of the initial VTE investigation. In those patients who had a lower limb deep vein thrombosis (DVT), only 47.1% (n = 8/17) had a chest radiograph performed within one month of the VTE diagnosis. Computed Tomography (CT) of the abdomen and pelvis was performed in 57.9% (n = 22) of patients with an unprovoked VTE and 17.9% (n = 7) underwent ultrasound of the abdomen/pelvis. No further imaging was performed in 31.2% (n = 12). Of note, no mammograms were performed. In patients that went on to have cross-sectional imaging, all of them had a FBC, 86.4% had LFTs, 54.5% had a serum calcium and only 36.4% had a urinalysis performed. An occult malignancy was only identified in 2.9% (n = 1). This patient was shown to have an enlarged prostate on cross-sectional imaging of the abdomen and pelvis and a raised serum prostate specific antigen (PSA). Subsequent biopsy proved positive for prostate malignancy. Ultrasound did not detect any occult malignancies.

## CONCLUSION

Invasive radiological investigations are not without significant morbidity. A normal physical examination, basic blood work up (FBC, LFTs, serum calcium), CXR and urinalysis may reasonably obviate the need for unnecessary invasive radiological investigations for unprovoked VTE. Patients in our study did not have satisfactory baseline investigations before being subjected to more invasive investigations such as cross sectional CT imaging, V/Q scan or mammography as recommended by NICE. Interestingly, the rate of occult malignancies in our study is very low (2.9%), which begs the question whether cross-sectional imaging/mammography is warranted at all in these patients. A further study evaluating the final outcome of the subgroup that did not undergo invasive investigation may throw additional light on this question. Based on our observations, we recommend that patients with unprovoked VTE should have a physical examination and baseline investigations (as per NICE guideline) before being considered for invasive radiological investigations.

## METHODS

In this retrospective, observational study, patients who underwent a Computed Tomography Pulmonary Angiogram (CTPA), ventilation/perfusion (V/Q) scan or unilateral lower limb Doppler over a period of just over two months or bilateral lower limb Dopplers over a period of just over four months were assessed and categorised into 'provoked', 'unprovoked' and 'uncertain' using the clinical history provided in the imaging request form. Provoking factors included but were not limited to: surgery within 3 months of investigation, immobility, recent hospital admission, recent long haul flight and known malignancy. Using clinical notes, laboratory results and the institution's picture archiving and communicating system (PACS), the patients labelled 'unprovoked' or 'uncertain' were analysed to determine whether the following investigations had been performed: physical examination at time of admission, full blood count (FBC), liver function tests (LFT), serum calcium, urinalysis and a chest radiograph (CXR) in those with lower limb VTE within one month of the initial investigation for a VTE. In addition, any imaging of the abdomen/pelvis (and mammograms in women) within 6 months of the initial investigation for a VTE was analysed by the primary investigator and a consultant radiologist. The frequency of occult malignancies was subsequently identified.

#### **SSG07-05 Performance Characteristics of a Multi-Institutional Phase II Hodgkin Lymphoma Adaptive Trial Utilizing Early Interim FDG-PET**

Tuesday, Dec. 1 11:10AM - 11:20AM Location: S102D

##### **Participants**

Jun Zhang, PhD, Columbus, OH (*Presenter*) Nothing to Disclose  
Heiko Schoder, MD, New York, NY (*Abstract Co-Author*) Nothing to Disclose  
Nathan C. Hall, MD, PhD, Columbus, OH (*Abstract Co-Author*) Nothing to Disclose  
Lawrence H. Schwartz, MD, New York, NY (*Abstract Co-Author*) Committee member, Celgene Corporation; Committee member, Novartis AG; Committee member, ICON plc; Committee member, BioClinica, Inc  
Olliver W. Press, MD, PhD, Seattle, WA (*Abstract Co-Author*) Nothing to Disclose  
Michael V. Knopp, MD, PhD, Columbus, OH (*Abstract Co-Author*) Nothing to Disclose

##### **PURPOSE**

To evaluate the overall trial implementation and performance characteristics of a NCI National Clinical Trial Network sponsored South West Oncology Group (SWOG) phase II multi-institutional Hodgkin's lymphoma trial using a response-adapted therapy approach based on interim FDG-PET imaging.

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

A comprehensive standardized workflow for this multi-institutional adaptive FDG-PET/CT clinical trial was established by the imaging team of the network group and associated imaging corelab (ICL). A detailed quality control system in fully SOP driven was developed for data quality assessment and imaging compliance monitoring using 15 criteria. Patient accrual, data compliance, site credentialing, real-time central review as well as endpoint data analysis were evaluated. AG Mednet was utilized for all electronic data transmission from the participating sites to the ICL, and an Intellispace Portal (Philips Healthcare) workstation environment was used to support the virtualized remote reader panel.

##### **RESULTS**

372 patients with 1093 PET/CT studies from 126 credentialed institutions were accrued between 2009 and 2014. 93% of all studies were determined as compliant, 5% acceptable and 2% noncompliant. For patients based analysis, 89% were compliant and 11% acceptable with 0% noncompliant. Challenges of site credentialing, major protocol violations and overall turn-around time of data submission, quality check confirmation and real-time central reviews were analyzed in detail. A success rate of collecting evaluable imaging exams of better than 91% has been achieved while evaluating over 1000 real-time central reviews of which 75% were accomplished within 24-48hr turn-around time from data receipt to results notification. A broad based (n=8), trained and assisted central review reader panel successfully used the remote access, thin client based approach for all the imaging reviews

##### **CONCLUSION**

The performance of a large scale, multi-institutional, phase II response adaptive clinical trial utilizing early interim FDG-PET was successfully demonstrated and establishes best practices as well as its feasibility. This should encourage to increase the appropriate use of imaging methodologies to guide response adaptive clinical trials.

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

A multi-institutional, response adaptive clinical trial using centralized PET image assessment was successfully demonstrated and has established standards for workflows and quality control.

#### **SSG07-06 Legal Issues of Vertebroplasty and the Standard of Care: A Survey of Musculoskeletal Radiologists**

Tuesday, Dec. 1 11:20AM - 11:30AM Location: S102D

##### **Participants**

Jonathan Mezrich, MD, New Haven, CT (*Presenter*) Nothing to Disclose  
Charles S. Resnik, MD, Baltimore, MD (*Abstract Co-Author*) Nothing to Disclose

##### **PURPOSE**

Percutaneous vertebroplasty is a procedure intended to address severe pain caused by vertebral compression fractures refractory to conventional pain regimens. In 2010, the American Academy of Orthopedic Surgeons (AAOS), relying on two controversial 2009 studies, issued a guideline recommending against vertebroplasty for neurologically intact patients presenting with symptomatic osteoporotic spinal compression fractures. Clinical guidelines in radiology, however, do not oppose vertebroplasty for appropriately selected patients. A survey was circulated to determine the extent musculoskeletal radiologists perform vertebroplasty, their experiences, and whether there is an apparent standard of care in the subspecialty.

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

An online survey of the approximately 1140 members of the Society of Skeletal Radiology (SSR) was conducted through SurveyMonkey.com. There were 253 responses, representing a 22.2 % response rate.

##### **RESULTS**

40% of the 1140 members of the Society of Skeletal Radiology (SSR) responded to the survey. 22.2% of the 1140 members of the Society of Skeletal Radiology (SSR) responded to the survey.



40 respondents (16%) indicated they perform vertebroplasty. Of those who perform vertebroplasty, 23% indicated that they question the methodology of the AAOS guideline, 48% base their actions on their own experience/data, and 13% only offer the procedure as a last resort treatment. Respondents indicated that the majority of their patients did not require multiple level vertebroplasty, did not develop fractures at adjacent levels, or require their original pain medication regimen, post-procedure.

## CONCLUSION

Based on the survey results, a small minority of members of SSR perform vertebroplasty, with the majority of patients doing well with the procedure. A standard of care is the degree of care a reasonably prudent clinician in the community should exercise under similar circumstances. If a minority of clinicians in a subspecialty perform a procedure, does that reflect on the standard of care? To what extent does the AAOS guideline impact the standard of care for radiologists? Might this guideline be admitted in litigation? Might an orthopedic surgeon be called as an expert witness in a case involving a radiologist? Although not prohibited under radiology guidelines, radiologists need to consider whether the controversy creates an unfavorable legal footing.

## CLINICAL RELEVANCE/APPLICATION

This study is relevant to all radiologists who perform vertebroplasty or care for patients with vertebral compression fractures.

### SSG07-07 Rounding Radiologists: Does Clinical Collaboration Strengthen the Relationship between Radiology Residents and Internal Medicine Teams?

Tuesday, Dec. 1 11:30AM - 11:40AM Location: S102D

#### Participants

Allison Aripoli, MD, Kansas City, KS (*Presenter*) Nothing to Disclose  
Rustain L. Morgan, MD, MS, Kansas City, KS (*Abstract Co-Author*) Nothing to Disclose  
Jacqueline Hill, MPH, Kansas City, KS (*Abstract Co-Author*) Nothing to Disclose  
Arnie Robinson, BS, RT, Kansas City, KS (*Abstract Co-Author*) Nothing to Disclose  
Shelby J. Fishback, MD, Kansas City, MO (*Abstract Co-Author*) Nothing to Disclose

## PURPOSE

To determine if incorporating radiology residents into clinical rounds as consultants strengthens the relationship between referring clinicians and radiologists.

## METHOD AND MATERIALS

In this prospective pilot study, senior radiology residents attended daily sit-down rounds with oncology, hematology, and pulmonary inpatient teams for four-week rotations during the 2014-2015 academic year. Radiology residents reviewed and discussed imaging studies and were available by dedicated mobile phone throughout the day for questions. Pre- and post-pilot surveys were distributed to clinicians and consulting radiology residents. Survey results were analyzed to measure the pilot's effect on clinician/radiologist relationships and overall patient care.

## RESULTS

Analysis of 60 pre- and 47 post-pilot surveys revealed that referring clinicians find having dedicated time to review imaging during rounds is beneficial and useful for clinical knowledge. While only 38% of clinicians originally believed patients would benefit from incorporating a radiologist into rounds, this increased to 62% post-pilot ( $p=0.02$ ). Further, 8 of 10 scaled responses measuring aspects of clinician/radiologist relationships increased, including clinician trust in radiology resident interpretation expertise ( $p=0.03$ ) and clinicians' inclination to work directly with radiologists more often ( $p=0.004$ ). Radiology residents ( $n=4$ ) also reported a benefit, with 75% strongly agreeing that clinical team interaction improves exam interpretation (vs. 20% pre-pilot).

## CONCLUSION

Clinicians, radiologists, and patients benefit from incorporating radiologists into daily clinical rounds, as evidenced by improved clinical relationships and perceived benefit to patient care. Our results suggest implementation of daily consultation between specialists is possible and can result in measurable patient care advantages.

## CLINICAL RELEVANCE/APPLICATION

Developing methods to increase collaboration between radiologists and referring clinicians is crucial to improving diagnostic and patient management decisions in the digital technology era.

### SSG07-08 Emergency Radiology Evaluation: A Systematic Literature Review of Emergency Radiology Studies Assessing Efficiency, Workflow, Time, Throughput, Cost, and/or Productivity

Tuesday, Dec. 1 11:40AM - 11:50AM Location: S102D

#### Participants

Brian W. Bresnahan, PhD, Seattle, WA (*Presenter*) Stockholder, Johnson & Johnson;  
Daniel S. Hippe, MS, Seattle, WA (*Abstract Co-Author*) Research Grant, Koninklijke Philips NV; Research Grant, General Electric Company  
Claire K. Sandstrom, MD, Seattle, WA (*Abstract Co-Author*) Speaker, Siemens AG  
Michael McNeeley, MD, Seattle, WA (*Abstract Co-Author*) Nothing to Disclose  
Bruce E. Lehnert, MD, Seattle, WA (*Abstract Co-Author*) Research support, Koninklijke Philips NV  
Daniel Willems, Seattle, WA (*Abstract Co-Author*) Nothing to Disclose  
Steven H. Mitchell, MD, Seattle, WA (*Abstract Co-Author*) Nothing to Disclose  
Ken F. Linnau, MD, MS, Seattle, WA (*Abstract Co-Author*) Speaker, Siemens AG; Royalties, Cambridge University Press;

## PURPOSE

To describe and characterize the emergency radiology published literature for studies reporting on efficiency, workflow, time, throughput, cost, and/or productivity.

## METHOD AND MATERIALS

We conducted a systematic literature review via PubMed (prior to January 1, 2015), using search terms related to emergency

department (ED), radiology, and efficiency-related topics. We used pre-specified criteria to screen abstracts and identify manuscripts for full text review. Manuscripts selected for analysis were assessed for study time period, countries, age of participants, modalities, comparators (if any), study design, and outcomes. We characterized studies and assessed trends in the frequency of manuscripts over time using a chi-squared test.

## RESULTS

Our initial search identified 208 abstracts for screening with 124 meeting full text review criteria and 80 included in final analysis. The United States was included in 73% of studies, European countries (19%), with few studies in other countries (Table 1). Most studies were in adults (78%). Multiple imaging modalities were assessed, with CT-related questions being predominant (75%). The vast majority of articles (93%) were research related rather than specifying quality improvement or education. However, 54% of publications did not include a comparator intervention. Cohort and database studies were most prevalent, whereas there were few randomized trials. Fewer than 15% included either modeling or cost assessments. Outcome measures included time estimates of varying types, including time to imaging, time to diagnosis or decision, and time of ED length of stay. Time to event and ED length of stay were included in more than 50% of reported studies. We found an increased frequency of more recent studies when assessing trends in five-year, time-period groupings ( $p < 0.001$ ).

## CONCLUSION

A systematic literature review identified limited publications assessing emergency radiology efficiency-related metrics. More high-quality studies, including randomized controlled trials and modeling evaluations are needed to better assess ED radiology throughput, workflow, productivity, and financial implications.

## CLINICAL RELEVANCE/APPLICATION

Emergency Department throughput is a mandated reporting metric, however, the evidence base is limited for comparative, high-quality research studies assessing efficiency-related radiology processes.

### **SSG07-09 Health Service, Policy and Research Keynote Speaker: Preventing Errors in Radiology: Implementing Safety Culture and Systems Thinking**

Tuesday, Dec. 1 11:50AM - 12:00PM Location: S102D

#### Participants

Kimberly E. Applegate, MD, MS, Zionsville, IN (*Presenter*) Nothing to Disclose





**Essentials of GI Imaging**

Tuesday, Dec. 1 10:30AM - 12:00PM Location: S100AB



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

**Participants****Sub-Events****MSES32A Imaging Esophageal Cancer****Participants**

Peter L. Davis, MD, Pittsburgh, PA, (davispl@upmc.edu) (*Presenter*) Nothing to Disclose

**LEARNING OBJECTIVES**

1) Discuss how esophageal cancer treatment and prognosis is initially determined by stage of the cancer. 2) Understand the present TMN staging system for esophageal cancer. 3) Know how imaging techniques such as endoscopic ultrasound, computed tomography and PET/CT are used to determine the stage and, therefore, the treatment of esophageal cancer.

**ABSTRACT**

The treatment of esophageal cancer is initially determined by its pretreatment stage. The American Joint Committee on Cancer and the Union for International Cancer Control have recently revised the TNM (primary Tumor, lymph Node involvement, distant Metastasis) staging of esophageal cancer to reflect evidence-based findings supporting different treatments at different stages. The primary tumor stage is dependent on the depth of invasion of the esophageal wall. The T stage will determine if the tumor is resectable. The depth of tumor invasion is best determined by endoscopic ultrasound. CT may help tumor staging by identifying invasion of adjacent structures. Since there is an extensive submucosal lymphatic network that enables early lymph node spread, local-regional lymph node involvement is an important prognostic factor. Although esophageal cancers with lymph node involvement may be treated with just surgical resection, clinical trials have shown increased survival with the addition of neoadjuvant chemoradiotherapy or chemotherapy. Lymph node involvement is also best detected by endoscopic ultrasound, but may be supplemented by PET/CT and CT. Metastatic esophageal cancer has a very poor survival rate that is not significantly improved with surgical resections. Therefore, only chemotherapy is commonly used to treat patients with metastatic disease. PET/CT appears to be best for detecting and precisely locating metastatic disease, but may be supplemented by high quality CT. This lecture will review the recent staging changes. The appropriate use and imaging findings of endoscopic ultrasound, computed tomography, and PET/CT to determine the proper stage will be shown.

**MSES32B Imaging of Colorectal Cancer****Participants**

Seong Ho Park, MD, Seoul, Korea, Republic Of, (parksh.radiology@gmail.com) (*Presenter*) Nothing to Disclose

**LEARNING OBJECTIVES**

1) Define the role of radiological imaging in the management of colorectal cancer patients. 2) Apply state-of-the-art imaging techniques to evaluate colorectal cancer patients. 3) Explain the typical and atypical imaging findings of colorectal cancer lesions and differentiate them from treatment-related findings.

**ABSTRACT**

Not applicable

**Handout:Seong Ho Park**

<http://abstract.rsna.org/uploads/2015/15001853/RSNA2015-MSES32B-Imaging of CRC-Park.pdf>

**MSES32C Liver Lesions in Cancer Patients****Participants**

Jeong Min Lee, MD, Seoul, Korea, Republic Of (*Presenter*) Grant, Guerbet SA; Support, Siemens AG; Support, Koninklijke Philips NV ; Grant, Bayer AG; Consultant, Bayer AG; Grant, General Electric Company; Support General Electric Company; Grant, STARmed Co, Ltd; Grant, RF Medical Co, Ltd; Grant, Toshiba Corporation; Grant, Dong-Seo Medical Industrial Col, Ltd

**LEARNING OBJECTIVES**

1) Describe common incidental lesions in the liver at various stages of a cancer patient's journey. 2) To recognize the role of MRI in comparison with CT in characterization of incidental liver lesion in cancer patients, and explain how technical advances in MR can help address challenges in characterization of those incidental lesions. 3) To illustrate the diagnostic assessment of morphologic features of incidental liver lesions in cancer patients and review

**Cardiac (MRI/CT Outcomes and Risk Stratification)**

Tuesday, Dec. 1 10:30AM - 12:00PM Location: S504AB



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

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

**Participants**

Bernd J. Wintersperger, MD, Toronto, ON (*Moderator*) Speakers Bureau, Siemens AG; Research support, Siemens AG  
David A. Bluemke, MD, PhD, Bethesda, MD (*Moderator*) Research support, Siemens AG

**Sub-Events****SSG02-01 Predictive Value of Cardiovascular Magnetic Resonance-Derived Myocardial Strain for Poor Outcome in Patients with Acute Myocarditis**

Tuesday, Dec. 1 10:30AM - 10:40AM Location: S504AB

**Participants**

Minkyu Kwak, MD, Busan, Korea, Republic Of (*Presenter*) Nothing to Disclose  
Ji Won Lee, MD, Busan, Korea, Republic Of (*Abstract Co-Author*) Nothing to Disclose  
Yeon Joo Jeong, MD, Busan, Korea, Republic Of (*Abstract Co-Author*) Nothing to Disclose  
Geewon Lee, MD, Seoul, Korea, Republic Of (*Abstract Co-Author*) Nothing to Disclose  
Jin You Kim, MD, Busan, Korea, Republic Of (*Abstract Co-Author*) Nothing to Disclose  
Suk Kim, MD, Pusan, Korea, Republic Of (*Abstract Co-Author*) Nothing to Disclose  
Ki Seok Choo, MD, Yangsan, Korea, Republic Of (*Abstract Co-Author*) Nothing to Disclose

**PURPOSE**

To evaluate the value of cardiovascular magnetic resonance (CMR)-derived myocardial strain for predicting poor outcome in patients with acute myocarditis.

**METHOD AND MATERIALS**

We retrospectively included 37 consecutive patients with acute myocarditis who performed CMR (23 male, mean age 41.5 yrs). Myocardial strain parameters, left ventricular (LV) end-diastolic and end-systolic volumes, LV myocardial mass, LV ejection fraction (EF) and right ventricular EF were derived from CMR. Presence of late gadolinium enhancement (LGE) was also recorded. Primary outcome was major adverse cardiovascular events (MACE). Incomplete LV functional recovery was used as secondary outcome in the group of patients who performed follow-up echocardiography after 1 year.

**RESULTS**

During an average follow-up of  $41 \pm 34$  months, 11 of 37 patients (29.7%) suffered MACE, including cardiac death ( $n = 2$ ), heart transplantation ( $n = 1$ ), cardiac pacemaker ( $n = 1$ ), rehospitalization due to cardiac events ( $n = 4$ ) or embolic stroke ( $n = 3$ ). Multivariable Cox proportional hazard regression analysis revealed the presence of LGE (hazard ratio 42.88,  $p = 0.014$ ) and radial strain obtained from the long axis views (ErrLax, hazard ratio 0.77,  $p = 0.004$ ) were significant predictors of MACE. Kaplan-Meier analysis showed worse outcome in patients with LGE or ErrLax  $\leq 9.48$ . Thirty one of 37 patients (83.7%) performed follow-up echocardiography. Multivariable backward stepwise regression analysis revealed ErrLax was the sole significant predictor of LV functional recovery (hazard ratio 1.87,  $p = 0.042$ ). Receiver operating characteristic curve of ErrLax was used to find optimal cut-off values for prediction of incomplete LV functional recovery, with corresponding area under the curve of 0.96. Cut-off value with the best combination of sensitivity and specificity for ErrLax was  $\leq 14.86$  (sensitivity 88.9%, specificity 95.5%).

**CONCLUSION**

CMR-derived ErrLax can predict poor outcome such as MACE or incomplete LV functional recovery in the patients with acute myocarditis.

**CLINICAL RELEVANCE/APPLICATION**

CMR-derived ErrLax can predict poor outcome in the patients with acute myocarditis. Furthermore, presence of scar indicated by LGE is also the good independent predictor of MACE. This results support the necessity for future large longitudinal follow-up studies to establish LGE and CMR-derived myocardial strain as an independent predictor of MACE in acute myocarditis.

**SSG02-02 Characterization of the Right Ventricle by T1-mapping and T2-mapping in Patients with Pulmonary Arterial Hypertension**

Tuesday, Dec. 1 10:40AM - 10:50AM Location: S504AB

**Participants**

Celia P. Corona-Villalobos, MD, Baltimore, MD (*Abstract Co-Author*) Nothing to Disclose  
Yan Zhang, MD, PhD, Jinan, China (*Abstract Co-Author*) Nothing to Disclose  
Kristin Porter, MD, PhD, Baltimore, MD (*Abstract Co-Author*) Stockholder, Pfizer Inc  
Paul M. Hassoun, MD, Baltimore, MD (*Abstract Co-Author*) Scientific Advisory Board, Gilead Sciences, Inc  
Stephen M. Mathai, Baltimore, MD (*Abstract Co-Author*) Nothing to Disclose  
Ihab R. Kamel, MD, PhD, Baltimore, MD (*Abstract Co-Author*) Nothing to Disclose  
Stefan L. Zimmerman, MD, Baltimore, MD (*Presenter*) Nothing to Disclose  
Rachel Damico, MD, PhD, Baltimore, MD (*Abstract Co-Author*) Nothing to Disclose  
Todd Kolb, MD, PhD, Baltimore, MD (*Abstract Co-Author*) Nothing to Disclose

## PURPOSE

Right ventricular (RV) function is a major determinant of prognosis in pulmonary arterial hypertension. Pressure overload triggers compensatory mechanisms such as RV hypertrophy, dilatation, fibrosis and RV failure. Diffuse myocardial fibrosis and inflammation have been detected in the left ventricle non-invasively by T1 and T2-mapping using cardiac magnetic resonance (CMR) imaging. The purpose of our study was to evaluate whether T1- and T2-mapping could detect myocardial fibrosis and/or edema of the RV in patients with pulmonary arterial hypertension (PAH).

## METHOD AND MATERIALS

A prospective, IRB-approved, HIPAA-compliant study identified from February of 2013 to March of 2015, 34 (6 males and 33 females with mean age of  $58 \pm 15$  years) subjects with PAH (24 subjects had scleroderma-induced PAH (SSc-PAH) and 10 had idiopathic PAH (IPAH). Fifteen age-matched normal controls underwent the same CMR protocol. Standard multi-sequence CMR protocol including pre-contrast (native) short-MOLLI and T2-mapping was performed. Images were processed on a dedicated workstation by drawing a region of interest on the RV inferior wall. Reproducibility was assessed by independently blinded by a second reader.

## RESULTS

Right ventricular inferior wall native T1 and T2 times were significantly higher in patients compared to controls (T1:  $1017 \pm 96$  ms vs.  $930 \pm 94$  ms,  $p=0.009$ ; T2:  $55 \pm 6$  ms vs.  $49 \pm 6$  ms,  $p<0.001$ ). Both measures were reproducible with strong repeated measure linear regression correlations for interobserver analysis (T1:  $r=0.79$ ,  $p<0.001$ ; T2:  $r=0.72$ ,  $p<0.001$ ). There was a weak correlation between T1 values and pulse pressure ( $r=0.37$ ,  $p<0.05$ ). No significant correlation was found between T1 or T2 values with CMR-derived RV-ejection fraction, RV-end diastolic volume and RV wall thickness or hemodynamic measures of PAH severity from RHC such as mean pulmonary artery pressure and pulmonary vascular resistance.

## CONCLUSION

T1- and T2-mapping of the right ventricle is feasible and shows high reproducibility. Future studies with a larger sample size are needed to determine its clinical utility.

## CLINICAL RELEVANCE/APPLICATION

T1 and T2-mapping of the RV are potentially novel measures of fibrosis and edema for the assessment of pulmonary arterial hypertension.

## Honored Educators

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

Ihab R. Kamel, MD, PhD - 2015 Honored Educator  
Stefan L. Zimmerman, MD - 2012 Honored Educator  
Stefan L. Zimmerman, MD - 2015 Honored Educator

## SSG02-03 The Prognostic Value of Coronary Computed Tomography Angiography in Asymptomatic Adults at Intermediate Risk

Tuesday, Dec. 1 10:50AM - 11:00AM Location: S504AB

### Participants

Su Jin Hong, MD, Seoul, Korea, Republic Of (*Presenter*) Nothing to Disclose  
Yeo Koon Kim, Seongnam-Si, Korea, Republic Of (*Abstract Co-Author*) Nothing to Disclose  
Jae Yeon Wi, MD, Seoul, Korea, Republic Of (*Abstract Co-Author*) Nothing to Disclose  
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## PURPOSE

The risk stratification methods based on conventional risk factors have limitations to predict the coronary artery disease. The purpose of this study is to evaluate the prognostic value of coronary CT angiography (CCTA) over traditional risk factors and coronary artery calcium score (CACS) in asymptomatic subjects at intermediate risk.

## METHOD AND MATERIALS

From January 2006 to December 2007, 1156 asymptomatic patients at intermediate risk who underwent both CACS and CCTA for health surveillance were included. Basic demographic data, medical history, family history, laboratory data were acquired for risk factor assessment. CCTA images were analyzed by 2 cardiac radiologists in consensus. Analysis included degree of stenosis and type of plaque. The follow-up information was obtained from the hospital medical records or data on National health insurance review and assessment service by two trained researchers. Follow-up was made for cardiac events (cardiac death, nonfatal myocardial infarction, unstable angina requiring hospital stay, or revascularization later than 90 days after CCTA).

## RESULTS

During a median 76 months of follow-up, the cardiac event occurred in 5.2% ( $n=60$ ). For the prediction of both cardiac events and major adverse cardiac events (MACE; cardiac death, myocardial infarction and unstable angina), all of the CCTA parameters correlated significantly with outcome (all  $p<0.01$ ). For the prediction of all cardiac events, the area under curves (AUCs) of Framingham risk score (FRS), FRS with CACS, and FRS with CCTA showed gradual increase (AUC 0.64 for FRS alone, 0.81 for FRS + CACS and 0.91 for FRS + CCTA; all  $p<0.05$ ). However, the addition of CACS on CCTA with FRS did not add the prediction power (AUC 0.90) to the CCTA with FRS (AUC 0.91). The results for the prediction of MACE were similar. The addition of CACS or CCTA to FRS had the incremental predictive power than FRS alone (AUC 0.65 for FRS alone, 0.80 for FRS + CACS, and 0.91 for FRS + CCTA, all  $p<0.05$ ). The CACS did not have the incremental value over FRS with CCTA (AUC 0.90 for FRS + CACS + CCTA and 0.91 for FRS + CCTA).

## CONCLUSION

CCTA has incremental prognostic value over FRS and CACS in the asymptomatic subjects at intermediate risk.

#### CLINICAL RELEVANCE/APPLICATION

CCTA has a potential to replace the screening role of CACS in the asymptomatic subjects at intermediate risk.

#### SSG02-04 Assessment of Semi-automatic Quantification of Non-Calcified Plaque as a Predictor of Outcome in Acute Chest Pain Patients at Coronary CT Angiography

Tuesday, Dec. 1 11:00AM - 11:10AM Location: S504AB

##### Participants

Andreas Bucher, MD, Frankfurt, Germany (*Presenter*) Nothing to Disclose  
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##### PURPOSE

To assess the predictive value of quantified non-calcified plaque volume on clinical outcome in acute chest pain patients.

##### METHOD AND MATERIALS

Total plaque volume was analyzed using semi-automated segmentation software from CTA datasets of 151 acute chest pain patients (90 female; age 59.1±11.0 years). CT series were acquired on a 64 detector-row dual source CT system and reconstructed in 0.75 mm slice thickness. Non-calcified plaque volume (ncPV) was sub-categorized by density: necrotic plaque volume (nPV): -30-75 HU; fibrous fatty plaque volume (ffPV): 76-130 HU; fibrous plaque volume (fPV): 131-350 HU. As a primary endpoint, major adverse cardiac events (MACE) were recorded on follow-up. Total plaque burden (TPB) was calculated as sum of all analyzed coronary segments. Cox proportional-hazards regression, correlation coefficient and student-t tests were used for statistical evaluation.

##### RESULTS

Twenty-one MACE (14.4% of cases) occurred during follow-up (mean follow-up: 12.1±6.2 months). In patients who experienced MACE ncPV was significantly higher (median: 760.5 mm<sup>3</sup>; inter-quartile range: 535.7-873.2 mm<sup>3</sup>) compared to patients without MACE (median: 607.2 mm<sup>3</sup>; inter-quartile range: 448.8-760.5 mm<sup>3</sup>; P=0.024), while TPB was comparable (P=0.220). ffPV was a statistically significant predictor of MACE (P=0.001). Necrotic and fibrous plaque volume did not show significant predictive value (P>0.1).

##### CONCLUSION

Non-calcified fibrous fatty plaque volume was a significant predictor of subsequent MACE events in acute chest pain patients.

#### CLINICAL RELEVANCE/APPLICATION

Semi-automated non-calcified plaque quantification might provide reproducible predictive parameters in acute chest pain patients to predict outcome.

#### SSG02-05 Benefit of Four-Dimensional Computed Tomography Derived Ejection Fraction of the Left Atrial Appendage to Predict Thromboembolic Risk in the Patients with Valvular Heart Disease

Tuesday, Dec. 1 11:10AM - 11:20AM Location: S504AB

##### Participants

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##### PURPOSE

Decreased left atrial appendage (LAA) emptying velocity in transesophageal echocardiography (TEE) is related with higher incidence of thrombus in LAA and increased risk of stroke. Patients with valve disease are at higher risk of thrombus formation before and after surgery. The aim of this study is to investigate the role of four-Dimensional (4D) CT performed for the evaluation of valvular heart disease to predict the risk of thrombus formation.

##### METHOD AND MATERIALS

Between March 2010 to March 2015, total of 62 patients who underwent 4D CT scan and TEE for cardiac valve evaluation before

surgery in Younsei Cardiovascular Hospital were retrospectively included in the current study. LAA was observed during TEE between 45 to 90 degree. Fractional area change (FAC) in TEE view (FACTEE) and emptying velocity at LAA (VeTEE) was measured. Ejection fraction (EF) of LAA (EFCT) was calculated by 4D CT with full volume analysis. The best cut-off value of EFCT to predict the presence of SEC or thrombus and correlation between the parameters were also estimated.

## RESULTS

Mean age was  $60 \pm 15$  years old and 53.2% were male. Spontaneous echo contrast (SEC) or thrombus was observed in 45.2%. Correlation between EFCT and VeTEE was noted ( $r=0.452$ ,  $p<0.001$ ). However, FACTEE was not significantly related to VeTEE ( $r=0.085$ ,  $p=0.512$ ).  $EFCT < 37.5\%$  best predicted SEC or thrombus in the patients with valve disease who underwent 4D CT and TEE (AUC = 0.654,  $p = 0.038$ , sensitivity = 0.824, specificity = 0.536).

## CONCLUSION

In the patients who are undergoing 4D CT before surgery, LAA EF by volume analysis might provide additional benefit to predict the risk of thromboembolic event.

## CLINICAL RELEVANCE/APPLICATION

Valve CT with 4D reconstruction might provide useful information predicting SEC or thrombus.

### SSG02-06 A Prospective Observational Single Blinded Study on the Role of Preoperative Computed Tomography Coronary Angiogram in Cardiac Risk Stratification in Non-Cardiac Surgery

Tuesday, Dec. 1 11:20AM - 11:30AM Location: S504AB

#### Participants

Eric You-Ten, MD, PhD, Toronto, ON (*Abstract Co-Author*) Nothing to Disclose

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Narinder S. Paul, MD, Richmond Hill, ON (*Presenter*) Research Grant, Toshiba Corporation; Research Grant, Carestream Health, Inc

## PURPOSE

To determine the role of wide volume CT Coronary Angiography (CTCA) in assessing the cardiac risk of patients undergoing intermediate and high risk surgery.

## METHOD AND MATERIALS

Prospective recruitment of 91 patients undergoing elective intermediate-major non-cardiac surgery and vascular surgery. All patients were seen and assessed in a pre-operative high risk clinic and assigned a Revised Cardiac Risk Index (RCRI). Patients with a RCRI  $\geq 1$  were eligible for inclusion in the trial. Patients had 12 lead ECG, cardiac stress tests and/or TTE; and all patients had preoperative CTCA using 320x0.5mm detector rows (AqONE, TMS, Japan), 0.35ms GR, 80-135kVp and 350-580mA depending on x-ray absorption profile. MACE were assessed on postoperative days: 0 - 3 and 30 using elevated blood Troponin I plus positive ECG changes, and/or cardiac symptoms, and by telephone for cardiac symptoms requiring medical attention on day 30 (if discharged at home). The results of CTCA were blinded to the clinical team unless high grade disease; severe stenosis ( $\geq 50\%$ ) of left main, critical stenosis ( $\geq 70\%$ ) of proximal LAD, and/or critical stenosis in  $\geq 2$  major coronary arteries (2VD)

## RESULTS

The physical characteristics, risk factors and medications were similar between patients who were positive for MACE ( $n=12$ ) and those who were not ( $n=79$ ). Preoperative CTCA was unblinded in 5 patients of low-intermediate cardiac risk with high grade lesions; left main (2), LAD (2), and 2VD (1). After intervention these 5 patients had their surgery without experiencing MACE. Six blinded patients experienced MACE with an elevated troponin and ischemic ECG within 3 days post-surgery. In these patients, CTCA showed severe 2VD (1 patient) and 3VD (1 patient) and non-significant stenosis (4 patients). One patient died of a fatal MI on postoperative day 31 and CTCA showed non-significant stenosis.

## CONCLUSION

CTCA can detect severe and high grade disease in patients assessed as low to intermediate cardiac risk (1-2 RCRI) with conventional methods.

## CLINICAL RELEVANCE/APPLICATION

Preoperative CTCA has a promising role in cardiac risk stratification and may lead to development of optimization strategies that improve patient outcome and safety

### SSG02-07 CMR in Pulmonary Arterial Hypertension before and after Therapy in Systemic Sclerosis-Induced Pulmonary Arterial Hypertension

Tuesday, Dec. 1 11:30AM - 11:40AM Location: S504AB

#### Participants

Celia P. Corona-Villalobos, MD, Baltimore, MD (*Presenter*) Nothing to Disclose

Kristin Porter, MD, PhD, Baltimore, MD (*Abstract Co-Author*) Stockholder, Pfizer Inc

Paul M. Hassoun, MD, Baltimore, MD (*Abstract Co-Author*) Scientific Advisory Board, Gilead Sciences, Inc

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Stefan L. Zimmerman, MD, Baltimore, MD (*Abstract Co-Author*) Nothing to Disclose

## PURPOSE

Pulmonary arterial hypertension (PAH) is one of the most lethal complications of systemic sclerosis (SSc) and RV function is the



...treatment, exercise intolerance (ET) is one of the most common complications of systemic sclerosis (SSc), and ET function is the major determinant of prognosis. Management of systemic sclerosis induced PAH (SSc-PAH) is challenging and despite therapeutic advances, there is still limited evidence that these therapies improve RV function. The purpose of our study was to evaluate whether CMR can identify RV functional changes in response to treatment in patients with SSc-PAH.

## METHOD AND MATERIALS

Prospective, multicenter, IRB-approved, HIPAA-compliant study. Twenty-four treatment naïve subjects with SSc-PAH underwent right heart catheterization (RHC) and CMR assessment at baseline and after 36 weeks of treatment with tadalafil (40 mg daily) and ambrisentan (10mg daily). A standard multi-sequence CMR was acquired. All images were analyzed by a single reader on a dedicated workstation for both LV and RV quantitative volumes and function.

## RESULTS

Treatment had a significant impact on CMR measurements such as RV end-systolic (ES) volume index, RV stroke volume (SV), RV ejection fraction (EF), RV cardiac index (CI), LV end-diastolic (ED) volume index, LV SV and LV CI. There was also a significant reduction of mean pulmonary arterial pressure (mPAP), pulmonary vascular resistance (PVR) and cardiac output by RHC. Exercise capacity improved significantly after treatment in this cohort (Table 1).

## CONCLUSION

Patients treated for SSc-PAH demonstrated significant improvements in RV volumes and function by CMR with corresponding improved hemodynamics on RHC and improved exercise capacity.

## CLINICAL RELEVANCE/APPLICATION

CMR can be used to non-invasively monitor improvements in RV function in patients undergoing treatment for SSc-PAH.

## Honored Educators

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

Ihab R. Kamel, MD, PhD - 2015 Honored Educator  
Stefan L. Zimmerman, MD - 2012 Honored Educator  
Stefan L. Zimmerman, MD - 2015 Honored Educator

## SSG02-08 Clinical Significance of Coexistent Coronary Artery Disease in Hypertrophic Cardiomyopathy Using Coronary CT Angiography

Tuesday, Dec. 1 11:40AM - 11:50AM Location: S504AB

## Participants

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## PURPOSE

To evaluate the prevalence and clinical significance of coexistent coronary artery disease (CAD) in patients with hypertrophic cardiomyopathy (HCM) using coronary CT angiography (CCTA).

## METHOD AND MATERIALS

Among the CCTA data registry which was composed of 41,588 consecutive patients with suspected CAD, a total of 248 patients with HCM diagnosed by clinical findings, electrocardiography, and echocardiography were retrospectively enrolled. Using CCTA, we evaluated the obstructive CAD (>50% stenosis) and plaque types (calcified, non-calcified, high-risk plaque [HP]) according to the 16-segment model. HP was defined as plaque density with <30HU and positive remodeling with >1.1, napkin ring sign and spotty calcification. Clinical risk factors and echocardiographic functional parameters were also evaluated from all the patients. The endpoint was defined as cardiac death, myocardial infarction, unstable angina requiring hospitalization, revascularization after 90 days from CCTA, or implantable cardioverter defibrillator insertion.

## RESULTS

In patients with HCM, the prevalence of obstructive and non-obstructive CAD was 16.5% and 42.7%, respectively. During the median of 37-months observation period (range; 3-108 months), total cardiac events were occurred in 11.7% of patients with HCM. Using univariate Cox regression analysis, age, family history of previous heart disease, atrial fibrillation, lower ejection fraction (EF < 55%), Framingham risk score, calcium scoring, obstructive CAD and HP were significantly related with cardiac events (all p<0.05). After adjustment of these factors, lower EF (hazard ratio [HR], 5.7) and obstructive CAD (HR, 7.3) were independent factors (all p<0.001).

## CONCLUSION

The prevalence of obstructive CAD was approximately one-fifth of the HCM population, and the presence of obstructive CAD was one of the independent factor for cardiac events. Therefore, the evaluation of CAD should not be overlooked.

## CLINICAL RELEVANCE/APPLICATION

In our study, the coexistent CAD was one of the prognostic factor for cardiac events in HCM. In this regard, CCTA is helpful to provide the information not only myocardial hypertrophy but also CAD.

## SSG02-09 Association between Late Gadolinium Enhancement and Three Types of Ventricular Tachyarrhythmia in Patients with Hypertrophic Cardiomyopathy



#### Participants

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#### PURPOSE

Myocardial scarring may be related to ventricular tachyarrhythmia, one of the most serious complications associated with hypertrophic cardiomyopathy (HCM). We aimed to assess the association between late gadolinium enhancement (LGE) on MRI and 3 types of ventricular tachyarrhythmia, including ventricular fibrillation (VF), sustained ventricular tachycardia (SVT) and non-sustained ventricular tachycardia (NSVT), in patients with HCM.

#### METHOD AND MATERIALS

LGE MRI was performed in 167 patients with HCM. We assessed the association between the 3 types of ventricular tachyarrhythmia and the myocardial LGE, clinical risk markers (e.g., family history of sudden cardiac death [SCD], syncope) and cine MRI data (e.g., ejection fraction, myocardial mass). The myocardial LGE was defined as the region with the mean signal intensity  $\geq 6$  SD above the remote myocardium. Extent of LGE was estimated based on the American Heart Association (AHA) 17-segment model.

#### RESULTS

Of the 167 patients with HCM, 8, 4, and 23 had VF, SVT and NSVT, respectively. The remaining 132 patients had no ventricular tachyarrhythmia. Overall, 104 patients (62.3%) had myocardial segments displaying LGE. The patients with NSVT frequently showed a family history of SCD, more risk markers, and more presence and wider extent of LGE compared with patients without tachyarrhythmia ( $P < 0.05$ ). The LGE extent, a family history of SCD and risk markers were significantly related to NSVT ( $P < 0.01$ ), whereas there were no apparent MRI findings related to VF and SVT. The LGE extent  $\geq 3$  segments was related to the family history of SCD, episode of cardiac arrest and prevention ICD installation for NSVT.

#### CONCLUSION

There is a significant association between the extent of LGE and NSVT in patients with HCM, but we find no apparent relationship between MRI findings and VF or SVT. We should discriminate between NSVT and the other types of ventricular tachyarrhythmia and be vigilant for the LGE extent when applying LGE MRI to risk stratification for HCM with NSVT.

#### CLINICAL RELEVANCE/APPLICATION

Extent of late gadolinium enhancement is associated with non-sustained ventricular tachycardia among the 3 types of ventricular tachyarrhythmia in patients with hypertrophic cardiomyopathy.

**Nuclear Medicine (PET/MRI for Oncology)**

Tuesday, Dec. 1 10:30AM - 12:00PM Location: S505AB



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

**Participants**

Farrokh Dehdashti, MD, Saint Louis, MO (*Moderator*) Nothing to Disclose  
Samuel E. Almodovar-Reteguis, MD, Homewood, AL (*Moderator*) Nothing to Disclose

**Sub-Events****SSG11-01 Outcome of Missed Lung Nodules in 18F-FDG-PET/MRI Compared to 18F-FDG-PET/CT in Cancer Patients**

Tuesday, Dec. 1 10:30AM - 10:40AM Location: S505AB

**Participants**

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Gerald Antoch, MD, Dusseldorf, Germany (*Abstract Co-Author*) Nothing to Disclose

**PURPOSE**

To evaluate the clinical relevance of small pulmonary nodules missed by 18F-fluorodesoxyglucose positron emission tomography/magnetic resonance (18F-FDG PET/MR) imaging compared to 18F-FDG PET/computed tomography (18F-FDG PET/CT).

**METHOD AND MATERIALS**

Fifty cancer patients (mean age: 56.4 years, range: 18-84, 29 female, 21 male) who underwent 18F-FDG-PET/CT and 18F-FDG-PET/MRI for tumor staging on the same day were retrospectively enrolled. 18F-FDG-PET/CT and 18F-FDG-PET/MRI datasets were analyzed by two independent readers in random order in separate session with a minimum of four weeks apart. Presence, location, size and presence of focal tracer uptake was noted for each lung detected on 18F-FDG-PET/CT and on 18F-FDG-PET/MRI using T1w VIBE with fat saturation as morphological dataset. Follow-up CT or 18F-FDG-PET/CT (mean time-to-follow-up 11 months, range: 3-11) was used as reference standard to define each nodule as benign or malignant based on changes in size and under consideration of administered therapies. A nodule-to-nodule comparison between 18F-FDG-PET/CT and 18F-FDG-PET/MRI was performed using descriptive statistics.

**RESULTS**

Forty-two lung nodules detected on 18F-FDG-PET/CT were missed on 18F-FDG-PET/MRI. Average size of missed nodules was 4 mm +/- 1.3 mm; range: 2 mm - 7 mm. None of the missed lung nodules presented with increased tracer uptake. Of the 42 lung nodules missed on 18F-FDG-PET/MRI 33 (79%) nodules were rated benign, while 9 (21%) nodules were rated malignant according to follow-up examinations.

**CONCLUSION**

Even though the majority of small lung nodules missed on 18F-FDG-PET/MRI was rather benign, there was a relevant number of undetected potential metastases. The impact of these small additional metastases on therapeutic decisions and prognosis still has to be evaluated

**CLINICAL RELEVANCE/APPLICATION**

Lower detection rate of PET/MRI vs. PET/CT for small lung nodules must be considered in cancer staging. Our data indicate that there is a small but relevant number of undetected potential metastases.

**SSG11-02 PET/MR versus PET/CT in the Initial Staging of Head and Neck Cancer**

Tuesday, Dec. 1 10:40AM - 10:50AM Location: S505AB

**Participants**

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Gustav K. Von Schulthess, MD, PhD, Zurich, Switzerland (*Abstract Co-Author*) Research Grant, General Electric Company; Speaker, General Electric Company;  
Patrick Veit-Haibach, MD, Zurich, Switzerland (*Abstract Co-Author*) Research Grant, Bayer AG; Research Grant, F. Hoffmann-La Roche Ltd; Research Grant, General Electric Company  
Martin W. Huellner, MD, Zurich, Switzerland (*Abstract Co-Author*) Nothing to Disclose

**PURPOSE**

To compare the diagnostic accuracy of PET/MR with PET/CT for newly diagnosed head and neck cancer.

**METHOD AND MATERIALS**

This prospective study was approved by the institutional review board and by national government authorities. In this study.

This prospective study, approved by the institutional review board and by national government authorities in this study, sequential contrast-enhanced PET/CT-MR was performed in 27 patients (median age 66, 16 males) with newly diagnosed head and neck cancer. MR sequences were: LAVA-Flex (whole body); axial T2-weighted, axial T1-weighted with and without contrast, sagittal and coronal T1-weighted with contrast, and DWI (head and neck). PET/CT and PET/MR were evaluated separately, and the TNM stage and factors that could impact on the potential resectability were assessed. Wilcoxon signed-ranks test was used.

## RESULTS

The T/N/M staging by PET/CT was correct in 17 patients (63.0%) / 19 (70.4%) / 22 (81.5%), equivocal in 8 patient (29.6%) / 3 (11.1%) / 3 (11.1%), and incorrect in 2 patients (7.4%) / 5 (18.5%) / 2 (7.4%). The T/N/M staging by PET/MR was correct in 20 patients (74.1%) / 21 (77.8%) / 26 (96.3%), equivocal in 6 patients (22.2%) / 2 (7.4%) / 1 (3.7%), and incorrect in 1 patient (3.7%) / 4 (14.8%) / 0 (0%). Consistently, the TNM staging by PET/MR was comparable to PET/CT (T:  $p = 0.331$ , N:  $p = 0.453$ , M:  $p = 0.034$ ). The sensitivity/specificity/accuracy of resectability-defining factors by PET/CT and PET/MR were 0.68/0.93/0.97, and 0.80/1.00/0.99, respectively.

## CONCLUSION

Whole-body staging with PET/MR yields equal diagnostic accuracy as PET/CT in determining the stage of head and neck cancer.

## CLINICAL RELEVANCE/APPLICATION

Patients with newly diagnosed head and neck cancer may be effectively staged with contrast-enhanced PET/MR instead of contrast-enhanced PET/CT.

### SSG11-03 Added Value of PET/MRI to MDCT for the Assessment of Preoperative Staging and Resectability in Gastric Cancer

Tuesday, Dec. 1 10:50AM - 11:00AM Location: S505AB

#### Participants

Dong Ho Lee, MD, Seoul, Korea, Republic Of (*Presenter*) Nothing to Disclose

Se Hyung Kim, Seoul, Korea, Republic Of (*Abstract Co-Author*) Research Grant, Mallinckrodt plc; Research Grant, Samsung Electronics Co Ltd

Bo Yun Hur, 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 investigate whether PET/MRI can improve the diagnostic performance of TNM staging and can help making accurate decision for resectability in patients with gastric cancer compared to MDCT alone.

## METHOD AND MATERIALS

The institutional review board of our hospital approved this retrospective study. Twenty-nine patients with histologically confirmed gastric cancers underwent preoperative MDCT and PET/MRI for staging and decision of resectability. Two abdominal radiologists independently assessed MDCT without and with PET/MRI and determined preoperative TNM staging as well as resectability of gastric cancer. The diagnostic performance using MDCT without and with PET/MRI was compared by using McNemar test and receiver operating characteristic analysis.

## RESULTS

Diagnostic accuracies for assessing T and N staging were not significantly improved by adding PET/MRI in both readers. However, PET/MRI showed significantly improved diagnostic accuracy for M staging in one reader ( $P=0.031$ ) and marginal improvement in the other reader ( $P=0.063$ ) compared to MDCT alone. Regarding resectability of gastric cancer, the diagnostic accuracy of MDCT with PET/MRI was significantly higher than that of MDCT alone in both readers ( $P=0.016$  for reader 1 and  $P=0.004$  for reader 2). Additional seven patients (7/23, 30.4%) in reader 1 and nine patients (9/23, 39.1%) in reader 2 were correctly classified according to the resectability of gastric cancer by adding PET/MRI.

## CONCLUSION

PET/MRI could significantly improve the diagnostic accuracy for preoperative M staging as well as resectability of gastric cancer compared to those of MDCT alone, and additional one-third of patients were correctly classified according to the resectability by using PET/MRI.

## CLINICAL RELEVANCE/APPLICATION

PET/MRI could significantly improve the diagnostic accuracy for preoperative M staging as well as resectability of gastric cancer compared to those of MDCT alone, and additional one-third of patients were correctly classified according to the resectability by using PET/MRI.

### SSG11-04 Combined Reading of PET and MR Datasets in Integrated PET/MR: A Comparison of Different MR Sequences in Whole-body Oncological Imaging

Tuesday, Dec. 1 11:00AM - 11:10AM Location: S505AB

#### Participants

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Verena Ruhlmann, Essen, Germany (*Abstract Co-Author*) Nothing to Disclose

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Christian Buchbender, Duesseldorf, Germany (*Abstract Co-Author*) Nothing to Disclose

## PURPOSE

To compare the performance of different magnetic resonance (MR) sequences in tracer uptake allocation and visual detectability in integrated [18]F-fluorodeoxyglucose ([18]F-FDG) positron emission tomography (PET)/MR examinations intraindividually and with

computed tomography (CT) from PET/CT.

## METHOD AND MATERIALS

Whole-body, contrast-enhanced PET/CT and subsequent PET/MR was performed in 61 patients for an oncological tumor staging. In PET/MR, the protocol comprised the following sequences: T2, turbo inversion recovery magnitude (TIRM), non-enhanced T1, contrast-enhanced T1, and diffusion-weighted imaging (DWI). Per patient, visual lesion detectability and anatomical allocation of the PET finding were assessed using a four-point ordinal scale (scored from 0 to 3) in a maximum of ten [18]F-FDG-avid lesions in the different MR sequences and in CT from PET/CT. Malignancy of each lesion was confirmed using radiological follow-up and histopathology as standard of reference. Differences in each category were analyzed using Wilcoxon rank sum tests. To prevent  $\alpha$ -error accumulation, Bonferroni-Holm correction was performed

## RESULTS

A total of 225 PET positive lesions were analyzed. 156 lesions were confirmed as malignant by radiological follow up and 69 by histopathology. T2 (mean  $2.4 \pm 0.9$ ), TIRM (mean  $2.5 \pm 0.9$ ), DWI (mean  $2.5 \pm 1.0$ ), and CT (mean  $2.5 \pm 0.9$ ) had a comparable visual detectability and were superior to non-enhanced T1 (mean  $2.2 \pm 1.0$ ). Anatomic allocation of the PET finding was similar in T2 (mean  $2.6 \pm 0.7$ ), TIRM (mean  $2.8 \pm 0.7$ ), and CT (mean  $2.6 \pm 0.7$ ) but was significantly higher compared to non-enhanced T1 (mean  $2.4 \pm 0.8$ ) and DWI (mean  $2.1 \pm 1.0$ ).

## CONCLUSION

In whole-body imaging, T2, TIRM and contrast-enhanced T1 provide a lesion detectability and an anatomical allocation of a PET finding that is comparable to PET/CT. While non-enhanced T1 may be omitted, the necessity of DWI has to be investigated further in specific diagnostic problems.

## CLINICAL RELEVANCE/APPLICATION

The results of this study help to optimize PET/MR protocols, leading to reduced examination times, improved workflow and increased patient comfort in every day clinical practice.

### SSG11-05 Evaluation of a FAST-protocol for Simultaneous 18F-FDG PET/MR Imaging for the Evaluation of Patients with Lymphoma

Tuesday, Dec. 1 11:10AM - 11:20AM Location: S505AB

#### Participants

Johannes Grueneisen, Essen, Germany (*Presenter*) Nothing to Disclose  
Lino Sawicki, MD, Dusseldorf, Germany (*Abstract Co-Author*) Nothing to Disclose  
Saravanabavaan Suntharalingam, Essen, Germany (*Abstract Co-Author*) Nothing to Disclose  
Christian Buchbender, Dusseldorf, Germany (*Abstract Co-Author*) Nothing to Disclose  
Michael Forsting, MD, Essen, Germany (*Abstract Co-Author*) Nothing to Disclose  
Thomas C. Lauenstein, MD, Essen, Germany (*Abstract Co-Author*) Nothing to Disclose  
Lale Umutlu, MD, Essen, Germany (*Abstract Co-Author*) Consultant, Bayer AG

## PURPOSE

PET/CT with 18F-FDG is widely accepted as the diagnostic standard of care for patients with lymphoma. The purpose of this study was to evaluate the diagnostic performance of a FAST-protocol for integrated PET/MR imaging, used for pretreatment staging, therapy monitoring and surveillance of patients with lymphoma in comparison to PET/CT.

## METHOD AND MATERIALS

44 consecutive lymphoma patients were prospectively enrolled for a clinically indicated PET/CT and a subsequent PET/MR examination. For PET/MRI readings, a whole-body FAST-protocol was implemented, comprising (1) a transversal DWI (EPI) sequence, (2) a transversal T2w HASTE sequence and (3) a transversal post-contrast T1w VIBE sequence. Two readers separately evaluated both examinations and were instructed to identify all tumor lesions. Furthermore, the standardized uptake value (SUV) for all 18F-FDG-avid lesions was determined in PET/CT and PET/MRI, using volume of interest (VOI) analysis. Agreement between PET/CT and PET/MRI regarding SUVmax and SUVmean was tested using Pearson's product-moment correlation.

## RESULTS

Malignant lesions were present in 24 of the 44 patients. Both, PET/CT and PET/MRI correctly identified disease presence in all 24 patients. Furthermore, all PET-positive lesions that were visible on PET/CT were also detectable on PET/MRI. Determined SUVs were significantly higher in PET/MRI than in PET/CT (SUVmax 9.8 vs 7.2,  $p < 0.001$ ; SUVmean 5.3 vs 4.2,  $p < 0.001$ ), however, there was a strong correlation between SUVmax and SUVmean of the two imaging modalities ( $R = 0.89$ ,  $p < 0.001$  and  $R = 0.90$ ,  $p < 0.001$ ). Estimated scan duration of one whole-body PET/CT examination as well as for the standard and fast protocol for whole-body PET/MR imaging amounted to  $18.5 \pm 1.0$  min and  $27.5 \pm 2.0$  min, respectively. Furthermore, calculated mean effective-dose for a whole-body PET/CT scan was 66.5% higher than for a FAST-PET/MRI examination.

## CONCLUSION

The FAST-protocol for PET/MR imaging offers an equivalently high diagnostic performance for staging lymphoma patients in comparison to PET/CT with only a slightly prolonged examination time.

## CLINICAL RELEVANCE/APPLICATION

With regard to patient comfort related to scan duration and a markedly reduced radiation exposure, FAST-PET/MRI may serve as a powerful alternative to PET/CT for a diagnostic work-up of patients with lymphoma.

### SSG11-06 Diagnostic Accuracy of Whole-body 18F-FDG PET/MRI and Whole-body DWI/MRI for the Evaluation of Patients with Lymphoma

Tuesday, Dec. 1 11:20AM - 11:30AM Location: S505AB

#### Participants

Johannes Grueneisen, Essen, Germany (*Presenter*) Nothing to Disclose  
Lino Sawicki, MD, Dusseldorf, Germany (*Abstract Co-Author*) Nothing to Disclose  
Benedikt M. Schaarschmidt, MD, Dusseldorf, Germany (*Abstract Co-Author*) Nothing to Disclose  
Thomas C. Lauenstein, MD, Essen, Germany (*Abstract Co-Author*) Nothing to Disclose  
Michael Forsting, MD, Essen, Germany (*Abstract Co-Author*) Nothing to Disclose  
Lale Umutlu, MD, Essen, Germany (*Abstract Co-Author*) Consultant, Bayer AG

## PURPOSE

To prospectively evaluate the diagnostic performance of integrated 18F-FDG PET/MRI for whole-body staging of patients with lymphoma in comparison to DWI/MRI.

## METHOD AND MATERIALS

42 consecutive patients underwent a whole-body 18F-FDG PET/MRI (Biograph mMR, Siemens) including diffusion-weighted imaging (DWI) for pretreatment staging as well as for therapy monitoring and surveillance of lymphoma disease. Two radiologists separately evaluated the DWI/MRI datasets, followed by a second reading of 18F-FDG PET/MRI datasets. Both readers were instructed to identify the total number of tumor lesions. Apparent diffusion coefficients (ADC) and standardized uptake values (SUV) were determined and served as an orientation for a differentiation between malignant and benign lesions. Sensitivity, specificity, positive predictive value, negative predictive value and diagnostic accuracy in the detection of malignant lesions were calculated for DWI/MRI and 18F-FDG PET/MRI.

## RESULTS

Malignant lesions were present in 23 of 42 patients. 18F-FDG PET/MRI enabled correct identification of all 23 (100%) patients and was true negative in 18/19 (95%) cases. DWI/MRI detected disease presence in 20/23 (87%) patients and was true negative in 17/19 (89%) patients. Furthermore, the calculated sensitivity, specificity, positive predictive value, negative predictive value and diagnostic accuracy of 18F-FDG PET/MRI for the detection of malignant lesions were 97%, 91%, 97%, 91% and 95%, respectively. The respective values for DWI/MRI were 80%, 74%, 89%, 59% and 79%.

## CONCLUSION

The results demonstrate the superiority of 18F-FDG PET/MRI in detecting malignant and benign lesions in lymphoma patients in comparison to DWI/MRI alone.

## CLINICAL RELEVANCE/APPLICATION

The present study underlines the usefulness of 18F-FDG PET data as a valuable additive to MR imaging for a more accurate evaluation of patients with lymphomas, enabling a reduction of false-positive findings.

### SSG11-07 [18F]-FDG-PET/MR versus [18F]-FDG-PET/CT for the Assessment of Lymphoma: A Prospective Study in 30 Patients

Tuesday, Dec. 1 11:30AM - 11:40AM Location: S505AB

#### Participants

Chiara Giraudo, MD, Vienna, Austria (*Presenter*) Nothing to Disclose  
Michael Weber, Vienna, Austria (*Abstract Co-Author*) Nothing to Disclose  
Georgios Karanikas, MD, Vienna, Austria (*Abstract Co-Author*) Nothing to Disclose  
Matthias Pones, MD, Vienna, Austria (*Abstract Co-Author*) Nothing to Disclose  
Cathrin Skrabs, Vienna, Austria (*Abstract Co-Author*) Nothing to Disclose  
Edith Porpaczy, Vienna, Austria (*Abstract Co-Author*) Nothing to Disclose  
Barbara Kieseewetter, MD, Vienna, Austria (*Abstract Co-Author*) Nothing to Disclose  
Markus Raderer, MD, Vienna, Austria (*Abstract Co-Author*) Nothing to Disclose  
Marius E. Mayerhoefer, MD, PhD, Vienna, Austria (*Abstract Co-Author*) Nothing to Disclose

## PURPOSE

To assess and compare the diagnostic performances of [18F]-FDG-PET/MR and [18F]-FDG-PET/CT in patients with Hodgkin (HL) and Non-Hodgkin lymphoma (NHL).

## RESULTS

Thirty patients were included: MALT lymphoma, n=14 patients; mantle cell lymphoma, n=4; nodal marginal zone lymphoma, n=3; Burkitt, follicular lymphoma, and HL, n=2 respectively; and DLBCL, T-cell, and post-transplant NHL, n=1, respectively. Five patients were scanned twice: 3 for staging and restaging and 2 twice for restaging. Overall 35 examinations were available for this study. PET/MR showed 100% Se and Sp (95%CI, 86.7-100%; and 72.2-100%; respectively). PET/CT showed 80% Se and Sp (95%CI, 60.9-91.1%; and 49-94.3%; respectively). The region-based agreement between PET/MR and PET/CT was 98.9%. Three patients were upstaged by PET/MR (stage I instead of 0; all MALT lymphomas).

## CONCLUSION

[18F]-FDG-PET/MR showed a higher diagnostic value for the detection of lymphoma than PET/CT, particularly for MALT lymphoma.

## CLINICAL RELEVANCE/APPLICATION

[18F]-FDG-PET/MR showed a higher diagnostic value for lymphoma than PET/CT. Since PET/MR also offers a lower radiation exposure, it may possibly become the preferred imaging technique for lymphoma.

### SSG11-08 PET/MRI versus PET/CT: Qualitative and Quantitative Assessment of Bone Lesion Conspicuity

Tuesday, Dec. 1 11:40AM - 11:50AM Location: S505AB

#### Participants

Tyler J. Fraum, MD, Saint Louis, MO (*Presenter*) Nothing to Disclose  
Kathryn J. Fowler, MD, Chesterfield, MO (*Abstract Co-Author*) Research support, Bracco Group



Jonathan E. McConathy, MD, PhD, Saint Louis, MO (*Abstract Co-Author*) Research Consultant, Eli Lilly and Company; Research Consultant, Blue Earth Diagnostics Ltd; Research Consultant, Siemens AG; Research support, GlaxoSmithKline plc

## PURPOSE

Because standard MRI-based attenuation correction (AC) does not account for the effects of cortical bone on PET photons, PET/MRI may have reduced sensitivity for FDG-avid focal bone lesions (FFBLs). In contrast, the CT-based AC used in PET/CT does correct for cortical bone attenuation. This study evaluates whether MRI-based AC compromises detection of FFBLs, by comparing their conspicuity on PET/MRI versus PET/CT.

## METHOD AND MATERIALS

190 general oncology patients underwent whole-body PET/CT followed by whole-body PET/MRI, utilizing the same FDG dose. Thirteen patients with a total of 50 FFBLs were identified. Using auto-contouring software, a region of interest (ROI) was generated for each FFBL and for an adjacent region of normal background bone (BB). For each ROI, SUV-max and SUV-mean were determined. Lesion-to-background SUV ratios served as quantitative metrics of conspicuity. Additionally, two blinded readers evaluated the relative conspicuity of FFBLs on PET images derived from PET/MRI. 35 of 50 FFBLs (70%) had CT correlates, while 40 of 50 FFBLs (80%) had correlates on at least one MRI sequence. The mean tracer-to-image time was longer ( $p < 0.001$ ) for PET/MRI (127 v. 62 min). The visibility of FFBLs on corresponding CT and MR images was also assessed.

## RESULTS

As expected, the average SUV-mean was lower on PET/MRI for both FFBLs (-8.8%,  $p = 0.009$ ) and BB (-22.7%,  $p < 0.001$ ). The average SUV-max was lower on PET/MRI for BB (-14.3%,  $p = 0.002$ ) but not for FFBLs (-7.4%,  $p = 0.068$ ). On average, the ratio of FFBL SUV-mean to BB SUV-mean was higher for PET/MRI (+29.5%,  $p < 0.001$ ). 40 of 50 lesions (80%) were visually deemed to be of equal or greater conspicuity on PET images derived from PET/MRI. 35 of 50 FFBLs (70%) had CT correlates, while 40 of 50 FFBLs (80%) had correlates on at least one MRI sequence. The mean tracer-to-image time was longer ( $p < 0.001$ ) for PET/MRI (127 v. 62 min).

## CONCLUSION

Both FFBLs and BB had lower mean SUVs on PET/MRI. This discrepancy was likely due to differences in the handling of cortical bone by MRI-based AC versus CT-based AC. Despite this systematic bias, FFBLs had greater conspicuity on PET/MRI, when assessed both qualitatively and quantitatively. This difference was at least in part due to the longer tracer-to-image time for PET/MRI, which allowed for more tracer accumulation by FFBLs and more tracer washout from BB.

## CLINICAL RELEVANCE/APPLICATION

Our results suggest that whole-body PET/MRI and PET/CT provide comparable sensitivity for detection of FDG-avid focal bone lesions.

## SSG11-09 Simulation of Tracer Dose Reduction in PET by Retrospective Undersampling of PET Listmode Data

Tuesday, Dec. 1 11:50AM - 12:00PM Location: S505AB

### Participants

Sergios Gatidis, MD, Tubingen, Germany (*Presenter*) Nothing to Disclose  
Christian Wuerslin, Tubingen, Germany (*Abstract Co-Author*) Nothing to Disclose  
Juergen F. Schaefer, MD, Tuebingen, Germany (*Abstract Co-Author*) Nothing to Disclose  
Konstantin Nikolaou, MD, Tuebingen, Germany (*Abstract Co-Author*) Speakers Bureau, Siemens AG Speakers Bureau, Bracco Group Speakers Bureau, Bayer AG  
Nina Schwenzer, MD, Tuebingen, Germany (*Abstract Co-Author*) Nothing to Disclose  
Holger Schmidt, PhD, Tuebingen, Germany (*Abstract Co-Author*) Nothing to Disclose

## PURPOSE

To implement and validate a method for simulation of low-dose PET images.

## METHOD AND MATERIALS

In order to simulate a reduction of PET tracer dose, PET images acquired in list mode data were retrospectively undersampled by random deletion of predefined proportions of PET events. The resulting undersampled PET data were then reconstructed resulting in PET images simulating PET images acquired at lower tracer doses. In order to validate this proposed approach, phantom experiments were performed using a dedicated PET phantom according to the National Electrical Manufacturers Association (NEMA). Phantom compartments were filled with different activity concentrations of  $^{18}\text{F}$ -Fluoride. PET data were acquired at different time points corresponding to decreasing tracer dose concentrations (according to the radioactive decay of  $^{18}\text{F}$ ) on a combined PET/MR scanner (Biograph mMR, Siemens). Reduced-dose PET images were additionally derived from the measured data set with the highest activity concentration (first measurement) using the proposed method. Measured and corresponding simulated PET images were compared by visual inspection and by quantification of image quality metrics signal-to-noise ratio (SNR), background variability (BV) and contrast recovery coefficients (CRC).

## RESULTS

PET images acquired by measurement at different activity concentrations were visually equivalent to the corresponding simulated PET images. Quantitative analysis of the measured image quality metrics also revealed a high similarity between measured and simulated low-dose PET images. Deviations of SNR, BV and CRCs were lower than 20 % for all activity concentrations.

## CONCLUSION

Simulation of low-dose PET images is possible by retrospective undersampling of PET list mode data and enables the generation of PET images with similar characteristics as PET images actually measured at low activity concentrations.

## CLINICAL RELEVANCE/APPLICATION

The proposed approach will enable the simulation and comparison of different tracer dose regimes in a clinical setting. Thus, it will be possible to derive optimal dose regimes with minimal diagnostic radiation exposure and sufficient diagnostic image quality.

RCC32

## Clinical Applications of 3D Printing

Tuesday, Dec. 1 10:30AM - 12:00PM Location: S501ABC



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

### Participants

Shi-Joon Yoo, MD, Toronto, ON (*Moderator*) Owner, 3D HOPE Medical; CEO, IMIB-CHD;  
Vincent B. Ho, MD, MBA, Bethesda, MD (*Moderator*) In-kind support, General Electric Company

### Sub-Events

#### RCC32A Role of 3D Printing in Congenital Heart Disease

##### Participants

Shi-Joon Yoo, MD, Toronto, ON (*Presenter*) Owner, 3D HOPE Medical; CEO, IMIB-CHD;

##### LEARNING OBJECTIVES

- 1) Understand 3D printing process for heart models.
- 2) Know how 3D printing helps pediatric cardiac surgery, with case examples.
- 3) Know the future directions of 3D printing for cardiac surgery.

##### ABSTRACT

Using rapid prototyping or 3D printing, physical replicas of the hearts can be provided to surgeons before their surgical decision and procedure. The replicas fill the gap between the imagination from the medical images and the reality. By having the replicas in hands, the surgeons can make optimum surgical decision and simulate the intended procedures on the replica prior to the procedure. This allows precise surgical procedures with reduced procedure and anesthesia time. In cases in the grey zone for biventricular versus univentricular repair, the replicas are of tremendous help in a binary decision. The presentation will include a few clinical cases where 3D printing played a crucial role in surgical decision making.

#### RCC32B 3D Surgical Planning Using Printed Models: The Surgeon's Perspective

##### Participants

Edward J. Caterson, MD, PhD, Boston, MA (*Presenter*) Nothing to Disclose

#### RCC32C 3D Surgical and Treatment Planning Using Printed Models

##### Participants

Frederik L. Giesel, MD, MBA, Heidelberg, Germany (*Presenter*) Nothing to Disclose

##### LEARNING OBJECTIVES

- 1) History of 3D-Printing.
- 2) Imaging modalities and post-processing procedures to provide data surrogates for 3D-printing.
- 3) Concept of 3D-printing for improved clinical services.
- 4) Limitations and challenges of 3D-printing in surgical planning.

##### ABSTRACT

This presentation outlines the impact of 3D-printing in the imaging environment. Applications in the medical field are reviewed and growing clinical applications are discussed. Starting with an overview of current 3D-printing technologies including fused deposition modelling (FDM), selective laser sintering (SLS), and stereolithography (SLA) common techniques for generating 3D object models based on medical imaging are illustrated. Typically, imaging source data from different modalities are post-processed using dedicated algorithms and software in order to generate triangle mesh surface data. These surface data are usually exported to STL-files that are commonly understood by current 3D printing machines. 3D-printed objects are most often made from plastic, such as ABS, PA, or PLA, but metal or other material is even possible. Finally the presentation will demonstrate how 3D-printed objects are valuable for treatment planning, treatment procedures in several clinical subspecialties, intra-operative surgical navigation, or for prosthesis production. However, medical applications of 3D-printing are still in a very early phase but the growing awareness in the medical and non-medical field nowadays support the promising utilization and development in the very near future.

#### RCC32D Validation of Coronary Contrast Gradients Using 3D Coronary Phantoms

##### Participants

Dimitris Mitsouras, PhD, Boston, MA (*Presenter*) Research Grant, Toshiba Corporation; Speakers Bureau, Toshiba Corporation

##### LEARNING OBJECTIVES

- 1) Learn about which 3D printing technologies can produce physiological compliant vascular phantoms.
- 2) Recognize those in vivo imaging techniques that can be translated into vascular models that can be 3D printed.
- 3) Be able to describe the steps required in developing an in silico plus in vitro experiment to explain an imaging finding.
- 4) Be able to explain the reason for the coronary contrast enhancement gradient seen in standard coronary CT angiography.

##### ABSTRACT

3D-printed cardiovascular models are poised to become a disruptive force in the development of novel functional CT and MR imaging techniques. With 3D printing, patient-specific models can be produced for physiologically accurate - with respect to both pathophysiology and underlying physics - validation studies that are not otherwise feasible due to e.g., radiation burden, scan time,



and cost. Multiple 3D printing technologies are key for such applications, particularly regarding vascular compliance and incorporation of hard materials for e.g., calcifications. Similarly, multiple imaging techniques such as rotational DSA, CT and MRI can be used to produce such models. A particularly important application is validation of in silico computational fluid dynamics (CFD) simulations that have been used to advance our understanding of cardiovascular disease and imaging methods developed to diagnose it in the last two decades. A given patient-specific model simulated with CFD can now concurrently be realized for identical in vitro flow experiments to validate conclusions drawn from the numerical model. Two examples are the coronary Transluminal Attenuation Gradient (TAG) and simulated fractional flow reserve (FFR) being developed for the non-invasive detection of significant coronary artery disease from standard CT angiography. We will showcase in vitro CTA experiments to elucidate the intra-luminal kinetics of iodinated contrast that give rise to TAG as an example of the steps from in vivo image acquisition, to lumen segmentation and preparation for 3D printing, and in vitro experimentation. Just as numerical 3D modeling has been a disruptive application of computational fluid dynamics methods with the potential to bridge the gap between understanding anatomy and function, 3D printing is poised to be a disruptive application of in vivo imaging and additive manufacturing to advance our understanding of pathophysiology, and new imaging techniques and devices.

## **RCC32E      Blood Flow in the Thoracic Aorta Elucidated with 3D Models**

### **Participants**

Michael Markl, PhD, Chicago, IL (*Presenter*) Nothing to Disclose

### **LEARNING OBJECTIVES**

1) Describe the use of 3D models of the aorta for the in-vitro simulation of aortic hemodynamics. 2) Explain the potential of in-vitro 4D flow MRI for the modeling and systematic analysis of the influence of common aortic pathologies on local and global 3D flow patterns in the aorta.

### **ABSTRACT**

Flow sensitive MRI offers the ability to assess anatomy as well as flow characteristics in healthy and pathological blood vessels and is therefore an attractive tool for the diagnosis of vascular diseases. However, in-vivo studies do not allow the prediction of hemodynamic changes due to vascular modifications. Realistic vascular in-vitro 3D phantoms in combination with MRI flow measurements allow to model different vascular deformations and evaluate their effect on blood flow dynamics. This presentation will provide a review of the methods for the in-vitro simulation of aortic 3D blood flow with realistic boundary conditions and review previously reported application for the simulation of common aortic pathologies and their impact on aortic hemodynamics.

**Physics (Image Processing/Analysis II)**

Tuesday, Dec. 1 10:30AM - 12:00PM Location: S502AB

**CT PH**AMA PRA Category 1 Credits™: 1.50  
ARRT Category A+ Credits: 1.50**FDA** Discussions may include off-label uses.**Participants**Yulei Jiang, PhD, Chicago, IL (*Moderator*) Consultant, Quantitative Insights, Inc; Research Agreement, QView Medical, Inc**Sub-Events****SSG16-01 Multi-material Electronic Cleansing for Non-cathartic Ultra-Low-Dose Dual-Energy CT Colonography**

Tuesday, Dec. 1 10:30AM - 10:40AM Location: S502AB

**Participants**

Nadja Kohlhasse, Niederaula, Germany (*Presenter*) Nothing to Disclose  
 Rie Tachibana, Boston, MA (*Abstract Co-Author*) Nothing to Disclose  
 Janne J. Nappi, PhD, Boston, MA (*Abstract Co-Author*) Royalties, Hologic, Inc; Royalties, MEDIAN Technologies;  
 Junko Ota, Suita, Japan (*Abstract Co-Author*) Nothing to Disclose  
 Daniele Regge, MD, Candiolo, Italy (*Abstract Co-Author*) Speakers Bureau, General Electric Company  
 Hiroyuki Yoshida, PhD, Boston, MA (*Abstract Co-Author*) Patent holder, Hologic, Inc; Patent holder, MEDIAN Technologies;  
 Toru Hironaka, Boston, MA (*Abstract Co-Author*) Nothing to Disclose

**PURPOSE**

To develop and evaluate accuracy of a novel multi-material electronic cleansing (MUMA-EC) scheme for non-cathartic ultra-low-dose dual-energy CT colonography (DE-CTC).

**METHOD AND MATERIALS**

Twenty-seven patients were prepared for a non-cathartic colorectal examination by oral ingestion of 50 ml of iodinated contrast on the day before and two hours prior to DE-CT scans. DE-CTC images were acquired at a current/voltage of 15 mAs/140 kVp and 40 mAs/80 kVp with sinogram-affirmed iterative image reconstruction. Our novel MUMA-EC performed a water-iodine material decomposition of the DE-CTC images and calculated virtual-monochromatic (VM) images at multiple energies, after which a random forest classifier was used to label the images into the regions of lumen air, soft tissue, fecal tagging, and two types of partial-volume boundaries based on the features of these images. EC was performed by removing materials other than soft tissues from the original CTC image. For pilot evaluation, 280 volumes of interest (VOIs) representing typical EC artifacts (Type I: air-tagging boundary; Type II: three-material layer; Type III: three-material mixture) in current EC schemes were extracted and labeled into a reference standard. The metric of EC accuracy was the mean overlap ratio (OR) between the reference standard labels and the labels generated by the MUMA-EC, a dual-energy EC (DE-EC), and a single-energy EC (SE-EC) schemes. The effective radiation dose of the CTC examination was also assessed.

**RESULTS**

In MUMA-EC, the mean±std of ORs for Types I, II, and III artifacts were 0.981±0.035, 0.919±0.040, and 0.941±0.052, respectively, which were higher than those of SE-EC (0.972±0.040 [p<.01], 0.890±0.046 [p<.01], and 0.915±0.057 [p<.01], respectively), and DE-EC (0.980±0.038 [p=.48], 0.911±0.043 [p<.01], and 0.937±0.048 [p<.05], respectively). Visual assessment confirmed that the MUMA-EC generates less EC artifacts than do DE-EC and SE-EC. The average CTDIvol was 0.95 mGy and the effective dose was 0.75 mSv per CTC scan.

**CONCLUSION**

Our MUMA-EC scheme yielded superior performance over conventional DE-EC and SE-EC schemes in identifying and minimizing subtraction artifacts on non-cathartic ultra-low-dose DE-CTC images.

**CLINICAL RELEVANCE/APPLICATION**

Current electronic cleansing methods for visualization of the colonic surface in CTC produce subtraction artifacts. The proposed method shows potential to minimize these artifacts and to facilitate non-cathartic examination.

**SSG16-02 Deep-Learning-based Bladder Segmentation in CT Urography**

Tuesday, Dec. 1 10:40AM - 10:50AM Location: S502AB

**Participants**

Kenny H. Cha, MSc, Ann Arbor, MI (*Presenter*) Nothing to Disclose  
 Lubomir M. Hadjiiski, PhD, Ann Arbor, MI (*Abstract Co-Author*) Nothing to Disclose  
 Heang-Ping Chan, PhD, Ann Arbor, MI (*Abstract Co-Author*) Institutional research collaboration, General Electric Company  
 Ravi K. Samala, PhD, Ann Arbor, MI (*Abstract Co-Author*) Nothing to Disclose  
 Richard H. Cohan, MD, Ann Arbor, MI (*Abstract Co-Author*) Consultant, General Electric Company; ; ;  
 Elaine M. Caoili, MD, MS, Ann Arbor, MI (*Abstract Co-Author*) Nothing to Disclose

**PURPOSE**

To develop a computerized method for bladder segmentation in CT Urography (CTU) scans for computer-aided diagnosis of bladder cancer and treatment planning.

## METHOD AND MATERIALS

A challenge for computerized bladder segmentation in CTU is that the bladder often contains regions filled with IV contrast and without contrast. We previously developed a Conjoint Level set Analysis and Segmentation System (CLASS) that segments the non-contrast (NC) and the contrast (C) filled regions separately and automatically conjoins the two contours. However, the similar gray levels between the NC region and the adjacent organs often caused errors in the NC contour. We trained a Deep-Learning Convolution Neural Network (DL-CNN) to distinguish between inside and outside of the bladder NC region using 1.18 million ROIs. The trained DL-CNN was used to generate probability maps for slices of a CTU case. Thresholding and hole-filling were applied to the map to generate the initial contour for the NC region. 3D and 2D level set was used to refine the contours. The refined NC contours were conjoined with the cascade-level-set segmented C contour to obtain the full bladder contour. Segmentation performance was evaluated using 159 cases (78 training, 81 testing). Computerized segmentation accuracy compared against 3D hand-segmented contours was evaluated using average volume intersection % (AVI), average % volume error (AVE), and average minimum distance (AMD).

## RESULTS

The AVI, AVE, and AMD for segmentation with DL-CNN were  $87.8 \pm 8.9\%$ ,  $3.5 \pm 16.3\%$ ,  $3.0 \pm 1.5$  mm, respectively, for the training set and  $84.1 \pm 11.7\%$ ,  $8.6 \pm 15.0\%$ ,  $3.1 \pm 1.6$  mm, respectively, for the test set. With CLASS, these values were  $84.2 \pm 11.6\%$ ,  $9.0 \pm 16.6\%$ ,  $3.4 \pm 1.8$  mm, respectively, for the training set and  $79.4 \pm 13.4\%$ ,  $14.6 \pm 15.3\%$ ,  $3.5 \pm 1.5$  mm, respectively, for the test set. Differences in all measures were statistically significant (training:  $p < 0.03$ , testing:  $p < 0.002$ ) except AMD for the training set ( $p = 0.08$ ).

## CONCLUSION

Using the DL-CNN for the NC region performed better than using CLASS alone, demonstrating the feasibility of using DL-CNN with level-set for the segmentation of the NC region of the bladder. Further work is underway to apply the DL-CNN to the entire bladder.

## CLINICAL RELEVANCE/APPLICATION

Bladder segmentation is a crucial step for detection of bladder cancer and wall thickening in CAD and for treatment planning. This study demonstrates a useful method for automatic bladder segmentation.

### SSG16-03 Automated Pancreas Segmentation in CT Using Multi-Level Deep Convolutional Networks

Tuesday, Dec. 1 10:50AM - 11:00AM Location: S502AB

#### Participants

Holger R. Roth, PhD, Bethesda, MD (*Abstract Co-Author*) Nothing to Disclose  
Le Lu, PhD, Bethesda, MD (*Abstract Co-Author*) Nothing to Disclose  
Amal Farag, PhD, Louisville, KY (*Abstract Co-Author*) Nothing to Disclose  
Hoo-Chang Shin, PhD, Bethesda, MD (*Abstract Co-Author*) Nothing to Disclose  
Jiamin Liu, PhD, Bethesda, MD (*Abstract Co-Author*) Nothing to Disclose  
Lauren M. Kim, MD, Bethesda, MD (*Presenter*) Nothing to Disclose  
Ronald M. Summers, MD, PhD, Bethesda, MD (*Abstract Co-Author*) Royalties, iCAD, Inc; Research funded, iCAD, Inc;

## PURPOSE

Automated segmentation is an important yet challenging problem for medical imaging. Segmentation of the pancreas could help assess diabetes and detect pancreatic cancer. While segmentation of other organs in computed tomography (CT) achieves good performances (Dice Similarity Coefficients (DSC)  $> 90\%$  for liver, heart or kidneys), methods for the pancreas achieve only 47% to 69% DSCs due to its greater variation in shape, size and location. In this work, we describe a new "deep learning" method using convolutional neural networks (CNN) for segmentation of the pancreas on CT images.

## METHOD AND MATERIALS

The task is modelled in a bottom-up fashion: from dense labeling of image patches, to regions, and to the entire organ. Given an abdominal CT, superpixel regions are generated by random forest classifiers. These superpixels then serve as candidate regions with high sensitivity (97%) but low precision, achieving an initial DSC of 27%. Next, we propose several CNNs for segmentation refinement (or pruning): 1.) P-CNN labels axial-coronal-sagittal patches, generating a probability response map P. 2.) Regional CNN (R1-CNN) samples a set of bounding boxes covering each image superpixel at multiple scales on the CT intensity. A second stacked regional R2-CNN is also learned to leverage the joint features of CT intensities and probability maps P with structured prediction for post-processing.

## RESULTS

Our methods are evaluated on CT scans of 82 patients in a hard-split of 62 for training and 20 for testing. Results indicate that we advance the current state-of-the-art performance to a DSC of  $75.8 \pm 5.4\%$  in testing. We furthermore provide an extensive evaluation of minimal surface distance between the ground truth and our proposed segmentation, achieving  $0.94 \pm 0.57$  mm on average. The segmentation performance slightly degrades when only the tip of pancreatic head or tail is visible in a CT slice.

## CONCLUSION

We present a bottom-up, coarse-to-fine approach for pancreas segmentation in abdominal CT scans. Multi-level deep CNNs are employed on both image patches and regions. The proposed deep learning based approach advances the state-of-the-art in pancreas segmentation.

## CLINICAL RELEVANCE/APPLICATION

The method could also be applied as multi-organ segmentation since CNNs naturally support this. Segmentation problems with large variations and pathologies (such as in tumors) could be solved by similar deep learning methods.

### SSG16-04 Semi-Automatic Assessment of Carotid Artery Using 3D Magnetic Resonance Imaging

Tuesday, Dec. 1 11:00AM - 11:10AM Location: S502AB

#### Participants

Mariam Afshin, PhD, MENG, Toronto, ON (*Presenter*) Nothing to Disclose  
Tina Binesh Marvasti, Toronto, ON (*Abstract Co-Author*) Nothing to Disclose  
Tishan Maraj, Toronto, ON (*Abstract Co-Author*) Nothing to Disclose  
Navneet Singh, MD, Toronto, ON (*Abstract Co-Author*) Nothing to Disclose  
Alan R. Moody, MD, Toronto, ON (*Abstract Co-Author*) Nothing to Disclose

## PURPOSE

We propose a fast, semi-automatic and accurate framework for 3D assessment of carotid vessel wall based on a 3D segmentation technique for quantification of the Vessel Wall Volume (VWV) with low observer variability.

## METHOD AND MATERIALS

This HIPAA compliant study received IRB approval. Patients with non-surgical carotid artery disease (30-95% stenosis) underwent 3T carotid MRI (Philips). Two image sets were acquired using: 1) a rapid 3D Time of Flight sequence in the axial orientation, and 2) MRIPH sequence (a T1weighted inversion recovery fat suppressed 3D Fast Field Echo technique in the coronal orientation) In this study, we considered a 3.2cm segment of the carotid centered at the bifurcation. User input was required to identify the lumen contour in a single image to be used as initial contour for segmentation. Fast marching level-set technique was used to move the control points in 3D space to minimize an energy function. Next, the 3D lumen segmentation was transferred and registered to the corresponding MRIPH images. Lumen boundary adjustment was applied on the MRIPH images if necessary. Outer wall boundary was delineated using a similar technique.

## RESULTS

We estimated the correlation coefficient,  $R$ , to evaluate the conformity between the manually and automatically computed volumes. The proposed method yielded correlation coefficients of 0.97, 0.95 and 0.85 for the lumen, outer and vessel wall volume respectively, indicating a high conformity between manual and automatic estimations. We used a two-tailed t-test to estimate the conformity between manual and automatic measurements, which yielded a non-significant P-values of 0.98, 0.81 and 0.37 indicating that automatic estimations of volumes are not significantly different from those obtained from manual segmentation.

## CONCLUSION

We developed a framework for vessel wall volume assessment based on the intensity and shape features in MR images estimated from user-provided segmentation of the vessel wall in a single image. The algorithm was tested on 40 carotids and a close correlation was demonstrated between the results and manual segmentation by two expert radiologists.

## CLINICAL RELEVANCE/APPLICATION

The proposed technique can be used for 3D assessment of the carotid MR images to assist radiologists to diagnose abnormality in carotid artery as well as atherosclerosis disease faster and with lower user variability.

## SSG16-05 Automatic Colon Segmentation using Statistical Approach and Global Convexification in CT

Tuesday, Dec. 1 11:10AM - 11:20AM Location: S502AB

### Participants

Amal Farag, PhD, Louisville, KY (*Presenter*) Nothing to Disclose  
Ahmed Shalaby, Louisville, KY (*Abstract Co-Author*) Nothing to Disclose  
Robert L. Falk, MD, Louisville, KY (*Abstract Co-Author*) Founder, 3DR Inc Managing Director, 3DR Inc  
Salwa Elshazly, BS, Louisville, KY (*Abstract Co-Author*) Nothing to Disclose  
Aly A. Farag, MS, PhD, Louisville, KY (*Abstract Co-Author*) Nothing to Disclose  
Albert Seow, MD, Louisville, KY (*Abstract Co-Author*) Nothing to Disclose

## PURPOSE

Accurate segmentation of the colon is an essential part for any computer aided diagnosis colonography system. Colon segmentation is a challenging problem for numerous reasons such as the variability in the topology of the colon and its asymmetrical and twisted shape (i.e. Haustral folds); regions consistent in intensity to that of air, soft tissue and oral contrast agents being similar to high-attenuation structures similar to bones. The presence of residual stool and lesions as well as disconnected colon segments further add to the difficulties of the problem. In this work, we describe a new statistical and variational method for automatic colon segmentation in CT images.

## METHOD AND MATERIALS

The segmentation approach is designed in a multi-tiered information propagation framework using statistical and variational methods. First, an initial segmentation using the intensity histogram volume of a typical CT. The Expectation-Maximization, is used to obtain a threshold intensity that encompasses the colon air regions and soft tissue. The global/convex continuous minimization problem of the active contour model and the active contours model without edges are generalized to the 3D space (GAC in fig.) and mathematically manipulated enhancing reconstruction of topological changes of haustral folds while maintaining polyps on colon walls. Post-processing of 3D connected component and morphological operations provided the final segmented colon volume.

## RESULTS

A subset from the ACRIN study (30 supine oral contrast enhanced abdominal CT scans) is used to assess the accuracy and robustness measures for colon segmentation. The approach shows promise in its ability to obtain both air-filled and fluid-filled colon regions in 2-3 minutes for datasets of size 512x512x400 and slight increase in time as the dataset size increases to over 600 slices. Results of overall Dice 93.8% and Jaccard 90.2% are comparable to current state-of-the-art using less datasets.

## CONCLUSION

We present an automatic multi-tiered statistical and variational approach in abdominal CT for colon segmentation. The proposed method shows promising results with the current state-of-the-art.

## CLINICAL RELEVANCE/APPLICATION

The method can be used as an initialization to computer-aided detection of polyps, 3D virtual navigation of the colon and registration of prone/supine CT scans.

## SSG16-06 Automatic Separation and Classification of Arteries and Veins in Non-Contrast Thoracic CT Scans

Tuesday, Dec. 1 11:20AM - 11:30AM Location: S502AB

### Participants

Jean-Paul Charbonnier, Nijmegen, Netherlands (*Presenter*) Nothing to Disclose  
Monique Brink, MD, PhD, Nijmegen, Netherlands (*Abstract Co-Author*) Speaker, Toshiba Corporation  
Francesco Ciompi, PhD, Nijmegen, Netherlands (*Abstract Co-Author*) Nothing to Disclose  
Ernst T. Scholten, MD, Haarlemmerliede, Netherlands (*Abstract Co-Author*) Nothing to Disclose  
Cornelia M. Schaefer-Prokop, MD, Nijmegen, Netherlands (*Abstract Co-Author*) Advisory Board, Riverain Technologies, LLC  
Eva M. Van Rikxoort, PhD, Nijmegen, Netherlands (*Abstract Co-Author*) Stock holder, Thirona BV Co-founder, Thirona BV

### PURPOSE

Automated classification of pulmonary arteries and veins in thoracic CT scans is an unsolved problem which is important for e.g. CAD of pulmonary embolisms and treatment planning. This study presents and validates a new anatomy-based method to automatically classify arteries and veins in non-contrast chest CT scans.

### METHOD AND MATERIALS

A set of 55 full inspiration non-contrast low dose chest CT scans (16x0.75mm, 120-140kVp, 30mAs) with variable severity of emphysema and interstitial lung diseases, were taken from a lung cancer screening trial. In all state-of-the-art vessel segmentation algorithms, arteries and veins are attached at locations where they cross, since these algorithms are not designed to distinguish between bifurcating and crossing vessels. This method starts with automatic vessel segmentation, followed by pruning the vessel segmentation to detect locations that are inconsistent with the topology of a tree structure. By disconnecting the vessels at these locations, the vessel segmentation is separated into subtrees that fulfill a tree structure and are assumed to be of an arterial or venous label. Next, subtrees are grouped using anatomical knowledge that arterial and venous capillaries meet each other at the alveoli, which implies that the corresponding peripheral arteries and veins go towards similar regions. By analyzing the peripheral vessels in each subtree, subtrees of the same artery-vein label are grouped without knowing the actual label. To extract the final artery-vein labels of the grouped subtrees, classification is performed using the fact that veins have an overall larger volume compared to arteries. For quantitative evaluation, two human observers manually labeled a total of 2750 randomly selected arteries and veins from all 55 scans. The accuracy and Cohen's kappa between the observers and between the method and observers were used for evaluation.

### RESULTS

Inter-observer Cohen's kappa was 0.84 with 93% accuracy. The proposed method achieved a mean accuracy of 88% and a Cohen's kappa of 0.76.

### CONCLUSION

A new concept for artery-vein separation and classification was presented that uses anatomical information from peripheral arteries and veins. The performance of the presented method closely approximated the inter-observer agreement.

### CLINICAL RELEVANCE/APPLICATION

Automatic artery-vein classification is essential for investigating pulmonary hypertension, COPD and for improving CAD systems for pulmonary embolisms.

## SSG16-07 Modeling Breast Compression and Deformation Using Breast Computed Tomography for Multi-view Applications

Tuesday, Dec. 1 11:30AM - 11:40AM Location: S502AB

### Participants

Ravi K. Samala, PhD, Ann Arbor, MI (*Presenter*) Nothing to Disclose  
Heang-Ping Chan, PhD, Ann Arbor, MI (*Abstract Co-Author*) Institutional research collaboration, General Electric Company  
Lubomir M. Hadjiiski, PhD, Ann Arbor, MI (*Abstract Co-Author*) Nothing to Disclose  
Ruola Ning, PhD, Rochester, NY (*Abstract Co-Author*) Board of Directors, Koning Corporation Consultant, Koning Corporation  
Kenny H. Cha, MSc, Ann Arbor, MI (*Abstract Co-Author*) Nothing to Disclose  
Mark A. Helvie, MD, Ann Arbor, MI (*Abstract Co-Author*) Institutional Grant, General Electric Company

### PURPOSE

To model breast compression and target localization using breast computed tomography (BCT) volumes as a step for multi-view correlation studies.

### METHOD AND MATERIALS

We studied breast compression and deformation using biomechanical models and simulated boundary constraints. Breast models were generated from BCT volumes of isotropic resolution assuming homogeneous material properties. A compressed view is simulated from a BCT volume using finite element (FE) method. The FE model uses quadratic tetrahedral elements with 5-parameter Mooney-Rivlin non-linear constitutive material. More than 97% of the elements have aspect ratio of less than 5 with a chosen element size of 9-15 mm depending on the breast size. Because BCT is acquired in prone position without compression, the gravity loading of the BCT volume in the anterior-posterior direction is compensated before the compression model is applied. The compression in the superior-inferior direction is modeled as a contact problem between two parallel plates and the breast using surface displacements. The breast is compressed until the thickness reaches the same thickness as that used for acquiring the corresponding DM view of the same breast. In this pilot study, 10 BCT volumes and the corresponding digital mammograms (DMs) were obtained by inter-institutional collaboration. Four volumes were found to have identifiable landmark (LM) locations and used for validation.

### RESULTS

The root-mean-squared distance error between the LM location of the ray-cast projected compressed BCT volume and that in the DM image is used for evaluation of the model performance. For 9 LMs in 4 BCT volumes compressed in the cranio-caudal (CC) view, the mean error was  $0.61 \pm 0.37$  cm with a range from 0.1 cm to 1.06 cm.

## CONCLUSION

The uncompressed 3D BCT of isotropic resolution offers a unique opportunity to model the breast compression and deformation accurately with an error of less than 1 cm. The result for the modeling in CC view shows the potential for application to other views. The compression model will be further validated with breasts of various sizes and density categories and different compression views using appropriate material properties for fatty, glandular and skin tissues.

## CLINICAL RELEVANCE/APPLICATION

The modeling of the breast compression and deformation process will be useful for automated localization and registration of lesions in multi-view or multimodality image analysis of the breast.

### SSG16-08 A Novel Computational CT Image Analysis Method for Classifying Benign and Malignant Thyroid Nodules: A Preliminary Study

Tuesday, Dec. 1 11:40AM - 11:50AM Location: S502AB

#### Participants

Wenxian Peng, PhD, Hangzhou, China (*Presenter*) Nothing to Disclose  
Shunren Xia, Hangzhou, China (*Abstract Co-Author*) Nothing to Disclose  
Yihong Chen, Hangzhou, China (*Abstract Co-Author*) Nothing to Disclose  
Xiufang Xu, MD, Hangzhou, China (*Abstract Co-Author*) Nothing to Disclose

#### PURPOSE

To investigate the feasibility of utilizing texture features to classify the benign thyroid nodules from malignant ones in Computed Tomography (CT) images.

#### METHOD AND MATERIALS

Ninety-three thyroid nodules of 58 patients undergone thyroid surgery were enrolled in this study from January 2012 to December 2013. Final diagnoses were confirmed histopathologically after surgery. Axial non-contrast CT images in 134 (50 malignant and 84 benign) were chose and we extracted 28 texture features with the gray level co-occurrence matrix (GLCM) (13 features) and the gray level gradient co-occurrence matrix (GLGCM) (15 features). Support Vector Machine (SVM) was used in data classification. Leave one out cross validation (LOOCV) strategy was utilized to take full advantage of the samples.

#### RESULTS

With texture features of GLCM, 66/84 benign (66 goiters, 4 thyroiditis and 14 thyroid adenoma) and 32/50 malignant images (49 papillary thyroid cancer, 1 follicular thyroid cancer) can be classified correctly (the accuracy-rate 0.7313), the sensitivity, specificity, positive predictive value (PPV) and negative predictive value (NPV) of classification is 0.7857, 0.6400, 0.7857 and 0.6400 respectively, which the AUC of ROC is 0.7874; The GLGCM is 0.7612, 0.8810, 0.5600, 0.7708 and 0.7368 respectively, which the AUC is 0.7980; According to relativity (>0.999), Twelve features involved reach the accuracy-rate 0.7612, sensitivity 0.8452, which the AUC is 0.7926.

## CONCLUSION

As the preliminary study in thyroid CT image analysis, texture feature may help classify the benign from the malignant thyroid nodules.

## CLINICAL RELEVANCE/APPLICATION

GLCM and GLGCM texture features can be used in Thyroid nodule CT image analysis to help classify nodule property and is recommended when the diameter of nodule is more than 3 mm.

### SSG16-09 Extracellular Volume Fraction (ECV): A Semi-automatic Method to Map the Myocardium

Tuesday, Dec. 1 11:50AM - 12:00PM Location: S502AB

#### Participants

Nicola Galea, MD, Rome, Italy (*Abstract Co-Author*) Nothing to Disclose  
Luisa Altabella, Rome, Italy (*Abstract Co-Author*) Nothing to Disclose  
Marco Carni, Rome, Italy (*Abstract Co-Author*) Nothing to Disclose  
Andrea Fiorelli, Rome, Italy (*Abstract Co-Author*) Nothing to Disclose  
Marco Franccone, MD, Rome, Italy (*Abstract Co-Author*) Speakers Bureau, Bracco Group  
Elisabetta Di Castro, Rome, Italy (*Abstract Co-Author*) Nothing to Disclose  
Carlo Catalano, MD, Rome, Italy (*Abstract Co-Author*) Nothing to Disclose  
Iacopo Carbone, MD, Montreal, QC (*Presenter*) Nothing to Disclose

#### PURPOSE

Cardiovascular magnetic resonance (CMR) is a useful tool for myocardial tissue characterization representing the only non-invasive methodology to assess fibrosis and edema in vivo. The extracellular volume fraction (ECV) estimation is emerging as accurate biomarkers in many cardiac diseases associated with diffuse myocardial fibrosis. ECV represent the percentage of tissue comprised of extracellular space, which increases in presence of fibrosis, and is reproducible, not affected by field strength. Our aim was to develop an automatic software for ECV map creation.

#### METHOD AND MATERIALS

30 subjects underwent to MOLLI sequence (scheme: 3[3]3[3]5) before and 15-20min after injection of gadobenate dimeglumine (Gd-BOPTA) on a 1.5T MR scanner (Magnetom Avanto). Imaging parameters: matrix 218x256, voxel size 1.41x1.41x8mm<sup>3</sup>, TR/TE 1.44/1.12 ms, minimum TI 120 ms with 80ms increment, FA 35°. First, pre- and post- contrast MOLLI images underwent to non-rigid image registration for motion correction and patient position variations. Then, T1 maps were generated using MRmap. T1 time was calculated with a 3-parameter curve fitting using a Levenberg-Marquardt algorithm and additional T1\* correction. ECV map was finally generated using a home-made program (developed in Matlab, Mathworks Inc.) according to the equation:  $ECV = [1 - \text{hematocrit}] * \Delta R1_{\text{myo}} / \Delta R1_{\text{blood}}$ .  $\Delta R1_{\text{myo}} = (1/T1_{\text{myo-post}}) - (1/T1_{\text{myo-pre}})$  was obtained taking the reciprocal of the T1 maps on a



pixel-by-pixel basis. Blood relaxation rate  $\Delta R_{1\text{blood}} = (1/T_{1\text{blood-post}}) - (1/T_{1\text{blood-pre}})$  were calculated automatically creating a mask on the T1 pre contrast map applying a threshold, then applied on T1 post contrast map to calculate the mean T1<sub>blood-post</sub>.

## **RESULTS**

We compare the ECV myocardium values obtained manually drawing ROI in the myocardium and blood of T1 pre- and post-contrast images with ECV values obtained from the same ROI in ECV map. The mean deviation between manual and automatic ECV values is less than 3% (t-paired Test:  $p=0.9$ ).

## **CONCLUSION**

Our software provide semi-automatically an informative pixel-wise ECV map, enabling the direct visualization of the extent and severity of ECV alterations respect to manual approach.

## **CLINICAL RELEVANCE/APPLICATION**

Ease automatic generation of ECV map may provide further qualitative information about the distribution of fibrosis and the pattern of disease.



**Quality Improvement Symposium: Designing and Running a Successful Practice Quality Improvement Effort**

Tuesday, Dec. 1 10:30AM - 12:00PM Location: S406B

**SQ**AMA PRA Category 1 Credits™: 1.50  
ARRT Category A+ Credits: 1.50**Participants**Olga R. Brook, MD, Boston, MA, (obrook@bidmc.harvard.edu) (*Moderator*) Nothing to Disclose**LEARNING OBJECTIVES**

Attendees scoring 80% or higher on the SAM test may earn a Quality Essentials Certificate in the "Quality Improvement in Your Practice" domain.

**Sub-Events****MSQI32A Project Design: Choosing the Topic and Team****Participants**James R. Duncan, MD, PhD, Saint Louis, MO (*Presenter*) Nothing to Disclose**LEARNING OBJECTIVES**

1) List improvement topics that will resonate with their teams and hospital leadership. 2) Develop operational measures that align with the intent of their improvement projects. 3) Identify the key attributes that lead to high performing teams. Attendees scoring 80% or higher on the SAM test may earn a Quality Essentials Certificate in the "Quality Improvement in Your Practice" domain.

**ABSTRACT**

Quality improvement begins when we acknowledge that our current products or services are less than ideal. In 2001, the Institute of Medicine found that our "health care delivery system does not provide consistent, high-quality medical care to all people .... Indeed, between the health care that we now have and the health care that we could have lies not just a gap, but a chasm." While progress has been made since 2001, numerous opportunities for improvement remain. This session will include strategies for choosing improvement topics in radiology. It will also walk participants through the process of forming an improvement team, creating a project charter and developing quality/safety metrics.

**MSQI32B Using Data to Drive Improvement****Participants**Olga R. Brook, MD, Boston, MA (*Presenter*) Nothing to Disclose**LEARNING OBJECTIVES**

1) Participants will be taught the critical difference between data used for research and data used for improvement. 2) Introduce participants to The Model for Improvement, an applied sciences methodology that is both easy to apply and shown to have manifest utility at solving wicked problems. Attendees scoring 80% or higher on the SAM test may earn a Quality Essentials Certificate in the "Quality Improvement in Your Practice" domain.

**ABSTRACT**

The applied sciences have flourished in every industry in the United States with the key exceptions of both healthcare and education. The pressing demands of the future 'value based economy' will require the American healthcare industry to adopt modern improvement sciences methodology. A great first step for leaders is to understand the key difference between research methodology and improvement methodology. Participants will be introduced to the popular improvement methodology 'The Model for Improvement'. The 'MFI' is a very pragmatic and effective way at testing change that results in real sustainable quality, financial, service or operational improvement.

**MSQI32C QI in Radiology, the Joint Commission Perspective****Participants**David W. Baker, MD, MPH, Oakbrook Terrace, IL (*Presenter*) Nothing to Disclose**LEARNING OBJECTIVES**

1) To gain knowledge about Joint Commission standards for radiation safety. 2) To become familiar with the principles of The Joint Commission's Robust Process Improvement® model for improving quality of care. 3) To understand the Targeted Solutions Tool® approach for identifying key drivers of quality and safety at an institution to target for quality improvement. Attendees scoring 80% or higher on the SAM test may earn a Quality Essentials Certificate in the "Quality Improvement in Your Practice" domain.

**ABSTRACT**

Advances in diagnostic imaging have greatly improved the quality of medical care. However, imaging has substantial risks and is therefore an important target for projects to improve quality and safety. This talk will review diagnostic radiation-related Sentinel Events reported to The Joint Commission, Joint Commission Standards to prevent patient safety events, and ongoing and planned initiatives to improve imaging safety. It will also discuss The Joint Commission's Robust Process Improvement® model for quality improvement projects and The Joint Commission's Center for Healthcare Transformation's step-by-step process to accurately measure an organization's actual performance, identify their barriers to excellent performance, and direct them to proven solutions.

that are customized to address their particular barriers.

**Active Handout:** [David William Baker](#)

[http://abstract.rsna.org/uploads/2015/15003472/Active MSQI32C.pdf](http://abstract.rsna.org/uploads/2015/15003472/Active_MSQI32C.pdf)

MSCC32

## Case-based Review of Nuclear Medicine: PET/CT Workshop-Cancers of the Thorax (In Conjunction with SNMMI) (An Interactive Session)

Tuesday, Dec. 1 10:30AM - 12:00PM Location: S406A



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

### Participants

Janis P. O'Malley, MD, Birmingham, AL (*Director*) Nothing to Disclose

Katherine A. Zukotynski, MD, Toronto, ON (*Presenter*) Nothing to Disclose

### LEARNING OBJECTIVES

1) Apply basic anatomic, pathologic, and physiologic principles to the interpretation of PET/CT with emphasis on cancers of the thorax. 2) Identify artifacts that can influence interpretation of PET/CT studies and analyze factors that can improve image quality while minimizing patient risk. 3) Demonstrate understanding of issues on current and future practice patterns.

### ABSTRACT

SSG15

## Physics (Radiation Dose Control I)

Tuesday, Dec. 1 10:30AM - 12:00PM Location: S404AB

**CT** **PH** **SQ**

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

### Participants

Ioannis Sechopoulos, PhD, Atlanta, GA (*Moderator*) Consultant, FUJIFILM Holdings Corporation; Research agreement, Hologic, Inc;  
Research agreement, Barco nv  
Xiujiang J. Rong, PhD, Houston, TX (*Moderator*) Nothing to Disclose

### Sub-Events

#### SSG15-01 Shielding Gamma-rays from Nuclear Medicine Rooms: Monte Carlo Simulations of Ceiling Scatter in the Diagnostic and Therapeutic Use of Tc-99m, I-131 and F-18

Tuesday, Dec. 1 10:30AM - 10:40AM Location: S404AB

### Participants

Roald S. Schnerr, PhD, Maastricht, Netherlands (*Presenter*) Research Grant, Bayer AG  
Anouk de Jong, MSc, Breda, Netherlands (*Abstract Co-Author*) Nothing to Disclose  
Cecile R. Jeukens, PhD, Utrecht, Netherlands (*Abstract Co-Author*) Nothing to Disclose  
Guillaume Landry, Garching, Germany (*Abstract Co-Author*) Nothing to Disclose  
Roel Wiert, Maastricht, Netherlands (*Abstract Co-Author*) Nothing to Disclose

### PURPOSE

In the design of diagnostic and therapeutic treatment rooms for Nuclear Medicine, an important consideration is the shielding required for blocking the ionizing radiation from the radioactive isotopes. The primary radiation, possibly with build-up correction, can be calculated analytically. However, little data is available to estimate the radiation dose contribution of ionizing radiation that travels over the (typically lead) shielding in the wall and scatters of the ceiling; so-called skyshine. We aim to determine the contribution of this skyshine to the radiation dose received by people outside Nuclear Medicine rooms.

### METHOD AND MATERIALS

Monte-Carlo simulations were performed with Gate/Géant for different heights of lead shielding in the wall, and different ceiling heights. A point source of Tc-99m (141keV), I-131 (365keV) or F-18 (511keV) was placed free in air, 1m above the floor, 3m from the wall. We used lead shielding of 2mm (Tc-99m) and 8mm (I-131, F-18). In total 165 simulations were run; for each isotope we varied the shielding height (between 1.8m and 5.0m) and ceiling height (3.0-5.0m). These simulations allow us to compare the contribution of the direct radiation (through the shielding), and skyshine (over the shielding).

### RESULTS

We find that the skyshine contribution to the total radiation dose varies greatly (from <2% to ~100%), and strongly depends on photon energy. For low photon energies (e.g. Tc-99m) skyshine is often a dominant factor. For higher photon energies (e.g. F-18), shielding the primary radiation is typically the most important concern.

### CONCLUSION

We have performed simulations that allow an estimation of the contribution of skyshine to the radiation dose outside a room, based on room use (occupancy, total radioactivity used), ceiling- and shielding height and the isotope used. For lower photon energies (e.g. Tc-99m) this can be a major contribution, which, if neglected, can result in insufficiently shielded rooms. These results will allow for safer and better optimized shielding designs in Nuclear Medicine departments.

### CLINICAL RELEVANCE/APPLICATION

Our research will aid safer and better optimized shielding designs in Nuclear Medicine departments as the contribution of scattered radiation from the ceiling (skyshine) can be properly accounted for.

#### SSG15-02 Radiation Dose Reduction using Added Beam-shaping Filtration in Lung-Cancer Screening CT

Tuesday, Dec. 1 10:40AM - 10:50AM Location: S404AB

### Participants

Chi Ma, PhD, Rochester, MN (*Presenter*) Nothing to Disclose  
Lifeng Yu, PhD, Rochester, MN (*Abstract Co-Author*) Nothing to Disclose  
Shuai Leng, PhD, Rochester, MN (*Abstract Co-Author*) Nothing to Disclose  
Cynthia H. McCollough, PhD, Rochester, MN (*Abstract Co-Author*) Research Grant, Siemens AG

### PURPOSE

Added beam-shaping filtration such as the use of a tin filter may improve the dose efficiency of an x-ray beam by removing some of the low-energy photons that do not contribute to image quality. The purpose of this study was to evaluate the radiation dose reduction potential of a 100 kV beam with an added tin filter for different patient sizes.

### METHOD AND MATERIALS

An anthropomorphic chest phantom (Lungman, Kyoto Kagaku) with 2 additional attenuation layers was used to simulate small (35 x 20 cm), medium (40 x 26 cm), and large (47 x 31 cm) adult patients. These phantoms were scanned on a 192-slice CT scanner (Force, Siemens) at 100 and 120 kV without tin filtration, and 100 and 150 kV with tin filtration (100Sn and 150Sn), each at 5

different dose levels. The CTDIvol at each kV was matched to that in the 100Sn scan with quality reference mAs (QRM) values of 300, 150, 100, 50, and 25. Images were reconstructed using an iterative reconstruction method (ADMIRE, Siemens) with a kernel of Bv49-2. A 0.6 cc point ion chamber was used to measure radiation dose at 6 locations of each phantom. For each phantom size, dose level, and kV setting, image noise at uniform areas of the central region was measured and averaged across 10 slices. The average dose from the point-chamber measurement, instead of CTDIvol, was used to evaluate the dose efficiency. Radiation dose was calculated for each kV and each phantom size such that the noise was matched to that in the 120 kV images acquired at a dose level specified by 100Sn and 100 QRM, which was deemed clinically acceptable for lung cancer screening. The percent dose reduction of 100Sn relative to 120 kV for each phantom size was estimated.

## RESULTS

100Sn generated images with the lowest noise among all tube voltages for all three phantom sizes at the same radiation dose. At a dose level that is considered clinically acceptable (100Sn, 100 QRM), the noise was reduced by 31%, 30%, and 28% for small, medium, and large phantom sizes compared with 120 kV. The corresponding dose reduction was 52%, 51%, and 49%.

## CONCLUSION

The 100 kV with an added beam filtration can reduce radiation dose by 49-52% compared with the 120 kV in lung cancer screening CT.

## CLINICAL RELEVANCE/APPLICATION

Added beam filtration such as tin filter has the potential to improve dose efficiency in lung cancer screening CT.

### SSG15-03 Radiation Dose Reduction Using Mini-Mobile Digital Imaging System in a Neonatal Intensive Care Unit

Tuesday, Dec. 1 10:50AM - 11:00AM Location: S404AB

#### Participants

Yoogi Cha, Jeonrabukdo Iksan, Korea, Republic Of (*Presenter*) Nothing to Disclose  
Taeyeong Heo, Iksan, Korea, Republic Of (*Abstract Co-Author*) Nothing to Disclose  
Dong Woon Heo, Iksan-City, Korea, Republic Of (*Abstract Co-Author*) Nothing to Disclose  
Jong Hyun Ryu, Iksan, Korea, Republic Of (*Abstract Co-Author*) Nothing to Disclose  
Chang Won Jeong, Iksan, Korea, Republic Of (*Abstract Co-Author*) Nothing to Disclose  
Tae-Hoon Kim, Iksan, Korea, Republic Of (*Abstract Co-Author*) Nothing to Disclose  
Hong Young Jun, PhD, Iksan, Korea, Republic Of (*Abstract Co-Author*) Nothing to Disclose  
Kyong Woo Kim, PhD, Jeonju, Korea, Republic Of (*Abstract Co-Author*) Nothing to Disclose  
Kwon-Ha Yoon, MD, PhD, Iksan, Korea, Republic Of (*Abstract Co-Author*) Nothing to Disclose

## PURPOSE

The aim of this work was to determine the radiation dose received by infants from radiographic exposure and compare to mini-mobile digital imaging system (mini-DI) and conventional mobile digital radiography (DR) for entrance surface dose (ESD) and image quality for neonatal chest imaging

## METHOD AND MATERIALS

The sample consisted of 20 neonatal chest x-rays of 12 neonates admitted and treated in a neonatal intensive care unit (NICU). All the neonates were preterm in the range of 25-35 weeks, with a mean of 31.5 weeks. We used a mini-DI system (Meteor, Nanofocusray Co. Ltd, Korea), which was adapted a flat-panel detector and monoblock X-ray source and conventional mobile DR (EFX vision, Shimadzu medical system, Japan) for comparison. The protocols of neonatal chest imaging were 60kV and 0.15 mAs for mini-DI, and 60kV and 1.2 mAs for mobile DR, respectively. With each protocol and system, ESD was measured using a dosimeter (Piranha, RTI electronics, Sweden). Signal to noise ratio (SNR), contrast to noise ratio (CNR) and modulation transferring function (MTF, 10%) were calculated for image quality using bar phantom (x-ray test pattern type 18, FUNK, Germany).

## RESULTS

The mean ESD for the mini-DI and mobile DR were  $28.3 \pm 0.09 \mu\text{Gy}$  and  $254.6 \pm 1.04 \mu\text{Gy}$ , respectively ( $p < 0.001$ ). Regarding image quality, the mean SNR values for the mini-DI and mobile DR were 626.8 vs 18.4, the CNR value were 30.2 vs 26.8, and 10% MTF were  $131 \mu\text{m}$  vs  $162 \mu\text{m}$ , respectively. The diagnostic performance of mini-DI was better than those of conventional DR.

## CONCLUSION

The results of our study show that neonates received ten-times lower dose from mini-mobile digital imaging system compare to conventional mobile DR. The mini-DI would be useful with dose reduction and good image quality in a NICU considering the sensitivity of the neonates to radiation

## CLINICAL RELEVANCE/APPLICATION

The mini-mobile digital imaging system would be useful in a NICU for dose reduction considering the sensitivity of the neonates to radiation.

### SSG15-04 A Method for Dose Reduction in Dedicated Breast CT Using a Wedge Filter: Theory and Preliminary Validation

Tuesday, Dec. 1 11:00AM - 11:10AM Location: S404AB

#### Participants

Andrew Hernandez, Sacramento, CA (*Presenter*) Nothing to Disclose  
Peymon Gazi, MS, Sacramento, CA (*Abstract Co-Author*) Nothing to Disclose  
John M. Boone, PhD, Sacramento, CA (*Abstract Co-Author*) Research Grant, Siemens AG Research Grant, Hologic, Inc Consultant, Varian Medical Systems, Inc

## PURPOSE

To improve image quality and reduce patient dose in dedicated breast CT (bCT) by means of a wedge filter design that modulates

the x-ray beam in the cone angle direction.

## METHOD AND MATERIALS

Using a large cohort of breast CT images and the known geometry of our prototype bCT scanner, the x-ray path length profile through each breast as a function of position along the z-axis was obtained by ray tracing from the x-ray tube focal spot through the breast CT data and onto the detector panel, with some assumptions. A complete description of the air kerma at scanner isocenter and resulting arbitrary detector units (ADUs) on the projection images were then measured on our system by sweeping through all possible tube current values (up to detector saturation). Our bCT system's modeled x-ray spectra were then mathematically filtered with increasing thicknesses of 20% glandular breast tissue to provide a relationship between changes in air kerma and hence ADU values with varying x-ray path lengths through breast tissue. For several different filter materials (Cu, Ti, and Al) a nonlinear regression algorithm was developed to estimate the wedge filter thickness profiles needed to equalize the ADU values (behind the breast) along the z-axis of the detector.

## RESULTS

Using a 60 kV x-ray spectrum with 0.3 mm Cu pre-filtration, the wedge filter thickness profiles resulting from the proposed algorithm were fit using linear regression and resulted in  $R^2$  values  $> 0.9110$  for all materials analyzed (Cu, Ti, and Al). The resulting wedge-shaped filters increased linearly from 0 mm (posterior edge of detector) to 1.1, 4.3, and 25.1 mm thick (anterior edge of detector) for the Cu, Ti, and Al filter materials, respectively.

## CONCLUSION

A proposed design of a wedge-shaped filter for dedicated bCT has the potential of reducing patient dose by reducing incident air kerma along the thinner anterior regions of the breast where the dose is the highest; and improving image quality by reducing beam attenuation along the thicker posterior regions of the breast where image noise dominates. Furthermore, the proposed design is robust because it makes use of a large number of patient bCT datasets and it would be relatively straightforward to implement on our prototype bCT systems.

## CLINICAL RELEVANCE/APPLICATION

This study is directly related to the improvement of clinical breast imaging because it has the potential of reducing patient dose and improving image quality

### SSG15-05 Five Year Review of Size and Age Specific CT Radiation Exposures in a Research Hospital During Advanced Dose Reduction Initiatives

Tuesday, Dec. 1 11:10AM - 11:20AM Location: S404AB

#### Participants

Les R. Folio, DO, MPH, Bethesda, MD (*Presenter*) Research agreement, Carestream Health, Inc  
William Kovacs, Bethesda, MD (*Abstract Co-Author*) Nothing to Disclose  
Jianhua Yao, PhD, Bethesda, MD (*Abstract Co-Author*) Royalties, iCAD, Inc  
David A. Bluemke, MD, PhD, Bethesda, MD (*Abstract Co-Author*) Research support, Siemens AG

## PURPOSE

To review size and age specific CT exposures during various dose reduction initiatives over five years at a major research center. Our aim was to extract all CT exam exposure, size, age and other data from PACS dating back to 2010. Detailed data extractions allow us to compare across research protocols and ordering physicians demonstrating successful targeted radiation exposure reductions relative to prior and new benchmark exposures. Principal Investigators establishing new research protocols use this data to select optimal scanner settings and dose reductions for their studies.

## METHOD AND MATERIALS

Using an in house extraction tool (Radiation Exposure Extraction Engine), we extracted CT exposure data from DICOM headers over three (as of submission) years (Feb 2012 to March 2015). Parameters included age, anatomic region(s), phases, scan protocol settings, research protocol number and ordering provider. We were also able to obtain body volume segmentation of scanned regions automatically with our extraction tool for accurate size estimation. Dose reduction initiatives included BMI based kVp reduction in 2010, model based iterative reconstruction starting in 2011, kVp modulation and application of Virtual non-contrast in 2013. We compared dose reductions in our most common exams, including chest, abdomen and pelvis routine and triple phase exams and chest CT.

## RESULTS

As of submission, we have successfully extracted exposure data of 38,200 CT exams from eight scanners. We compared age and size specific similar research protocols throughout the last three years with aggressive dose reduction initiatives on 554 research protocols and 87 CT scan protocols. Example CT exams presented showed significant dose reductions over each year ( $p < 0.001$ ).

## CONCLUSION

Collecting size specific CT exposure and other data over several years has allowed us to confirm and compare many types of dose reduction initiatives across several hundred research and scan protocols. We demonstrated significant dose reductions over each year of continued dose reductions on our most common exams.

## CLINICAL RELEVANCE/APPLICATION

Our results demonstrated and compared several successful exposure reduction initiatives during a dynamic time of advanced exposure reduction innovation. This is the largest review of CT exposures available to our knowledge that include parameters such as age, body size, ordering doctor, research protocol number, etc.

## **SSG15-06 Virtual Non-enhanced Images Acquired by Material Suppression Iodine (MSI) in Enhanced Spectral CT Imaging on Chest: In Comparison with Plain Scan**

Tuesday, Dec. 1 11:20AM - 11:30AM Location: S404AB

### **Participants**

Qimeng Quan, MD, PhD, Shanghai, China (*Presenter*) Nothing to Disclose  
Yuanjiong Chen, Shanghai, China (*Abstract Co-Author*) Nothing to Disclose  
Nianyun Li, Shanghai, China (*Abstract Co-Author*) Nothing to Disclose  
Na Gao, Beijing, China (*Abstract Co-Author*) Nothing to Disclose  
Gui-Xiang Zhang, MD, Shanghai, China (*Abstract Co-Author*) Nothing to Disclose

### **PURPOSE**

To evaluate the feasibility of virtual non-enhanced images post-processed by MSI in enhanced spectral CT imaging in comparison with the images of plain scan on chest.

### **METHOD AND MATERIALS**

The chest plain and iodine-enhanced standardized CT scanning was performed sequentially on 11 patients using a 64-row CT scanner (GE healthcare, Discovery CT750 HD). The enhanced images were post-processed into virtual non-enhanced images following the function of material suppression iodine (MSI) on AW4.6 workstation (GE healthcare). The virtual non-enhanced images were compared with the images of plain scan by analyzing the CT values in selected vessels. The statistical analysis was carried on.

### **RESULTS**

The CT values of the region of interest (ROI) in thoracic aorta, ascending aorta, pulmonary artery trunk, and dorsal muscle in enhanced images of chest were  $258.38 \pm 29.21$  HU,  $266.37 \pm 36.02$  HU,  $239.91 \pm 57.63$  HU, and  $45.64 \pm 8.64$  HU. All CT values on MSI images for the vessels mentioned above dropped to  $44.00 \pm 6.23$  HU,  $43.71 \pm 9.41$  HU,  $47.03 \pm 11.93$  HU,  $43.47 \pm 7.81$  HU, respectively. The MSI images demonstrated similar CT values as plain scan ( $40.25 \pm 6.19$  HU,  $39.14 \pm 9.27$  HU,  $40.11 \pm 11.01$  HU, and  $50.41 \pm 9.96$  HU, respectively) ( $P > 0.05$ ). There were no significantly different values of CTD<sub>ivol</sub> between plain scan and enhanced CT scan ( $8.38 \pm 2.77$  mGy vs.  $8.85 \pm 1.83$  mGy) ( $p > 0.05$ ) meanwhile.

### **CONCLUSION**

Virtual non-enhanced images acquired by MSI effectively suppressed iodinate contrast, which was comparable to plain CT images on chest. Successful substitution scans lead to nearly 50% radiation dose reduction and got equal image quality.

### **CLINICAL RELEVANCE/APPLICATION**

None

## **SSG15-07 Quantifying Uncertainties in Absorbed Organ Dose Calculations in Monte Carlo Simulations of Dental Cone Beam CT Applications**

Tuesday, Dec. 1 11:30AM - 11:40AM Location: S404AB

### **Participants**

Andreas Stratis, Leuven, Belgium (*Presenter*) Nothing to Disclose  
Guozhi Zhang, Leuven, Belgium (*Abstract Co-Author*) Nothing to Disclose  
Reinhilde Jacobs, Leuven, Belgium (*Abstract Co-Author*) Nothing to Disclose  
Ria Bogaerts, Herestraat 49, Belgium (*Abstract Co-Author*) Nothing to Disclose  
Hilde Bosmans, PhD, Leuven, Belgium (*Abstract Co-Author*) Co-founder, Qaelum NV Research Grant, Siemens AG

### **PURPOSE**

To estimate the uncertainty of calculated absorbed organ doses in dental Cone Beam CT (CBCT) Monte Carlo (MC) simulations due to uncertainties in the measurement of Half Value Layer (HVL) and in the positioning of the Field of View (FOV).

### **METHOD AND MATERIALS**

X-ray tubes are applied to our EGSnrc MC framework via equivalent source models which consist of an energy spectrum derived from HVL measurements and a filter description specified from air kerma measurements across the radiation field. The HVL of the Promax 3D Max scanner (Planmeca, Finland) was measured at 96 kV with a farmer ion chamber. Source models were generated for the measured HVL and for HVL values corresponding to theoretical deviations of  $\pm 2.5\%$  and  $\pm 5\%$ . In a first study, each spectrum was directed towards the Zubal head phantom to simulate a jaw examination protocol ( $130 \times 90$  mm<sup>2</sup>). The centre of the FOV was initially placed between the upper and the lower jaw and axially positioned such that the entire denture is imaged. In a second study, a fixed source model was directed ten times to the phantom, each time shifting the centre of the FOV by  $\pm 1$  cm and  $\pm 2$  cm in the front-back direction, 1 cm diagonally, 1 cm back and 1 cm down.

### **RESULTS**

The HVL at 96kV was 9.05mmAl. A 5% lower HVL value results in an average 34.4% overestimation in absorbed organ doses, whereas a 5% overestimation results in an average 33.02 % underestimation in calculated organ doses. The more the FOV is shifted frontwards (either on the midline or diagonally) the lower the doses get. Shifting the FOV down, there is a noticeable 35% dose increase in the esophagus, a 28% dose increase in thyroid, a 29% decrease in brain and 29.62 % decrease in eye lens dose.

### **CONCLUSION**

Underestimating HVL in the generation of equivalent source models procedure results in a thinner filter present on the beam path and hence in higher doses. In cases of highly filtered beams, such as CT or CBCT, uncertainties of 5% in HVL and its implementation to source models intended for MC dose calculations lead to 34% over or under estimation of calculated organ doses. Similar uncertainties are obtained for misplacements of the FOV on the model.

### **CLINICAL RELEVANCE/APPLICATION**



Accurate dental CBCT dose calculations in head voxel models via Monte Carlo simulations require accurate HVL measurements and careful FOV positioning.

#### **SSG15-08 A Monte Carlo Dosimetry Comparison Study of Two Different Paediatric Protocols for Teeth Auto Transplantation Planning and Follow-up**

Tuesday, Dec. 1 11:40AM - 11:50AM Location: S404AB

##### **Participants**

Andreas Stratis, Leuven, Belgium (*Presenter*) Nothing to Disclose  
Mostafa Ezeldeen, Leuven, Belgium (*Abstract Co-Author*) Nothing to Disclose  
Guozhi Zhang, Leuven, Belgium (*Abstract Co-Author*) Nothing to Disclose  
Reinhilde Jacobs, Leuven, Belgium (*Abstract Co-Author*) Nothing to Disclose  
Ria Bogaerts, Herestraat 49, Belgium (*Abstract Co-Author*) Nothing to Disclose  
Hilde Bosmans, PhD, Leuven, Belgium (*Abstract Co-Author*) Co-founder, Qaelum NV Research Grant, Siemens AG

##### **PURPOSE**

To investigate via Monte Carlo (MC) simulations whether or not, a newly proposed autotransplantation tooth protocol in a new scanner, yielding images of similar quality with the existing protocol performed in an old scanner, is capable of reducing the dose to paediatric patients (justification).

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

The clinical protocol requires one high resolution treatment planning CBCT scan to guide the segmentation of the tooth to be transplanted and two follow-up scans, one and two years later. The current protocol in Accuitomo 170 (Morita, Japan) employs a 60x60 mm<sup>2</sup> 'High Resolution' planning scan and two follow up 'Standard Resolution' 40x40 mm<sup>2</sup> scans. The newly proposed one is to be carried out in Promax 3D Max (Planmeca, Finland) using a planning scan (90x100 mm<sup>2</sup>), followed by two (50x55 mm<sup>2</sup>) scans (all of them 'Ultra low dose, normal reconstruction'). To compare organ doses, MC simulations in voxel phantoms were implemented. CT scans of three paediatric patients (5 and 8 years old male, 12 years old female) were used to segment internal anatomy and create paediatric head voxel models. Three clinical dental applications (canine, incisor and premolar tooth) were investigated. An EGSnrc based MC framework was calibrated and employed to calculate absorbed organ doses and effective dose (ED) for each paediatric voxel phantom.

##### **RESULTS**

The total EDs of the currently used protocol for the 3 dental applications range from 356 µSv to 390 µSv for the 5 years old, 390 to 402 µSv for the 8 years old and 270 to 288 µSv for the 12 years old phantoms. The new suggested protocol results in ED ranges of 267 to 275 µSv, 242 to 246 µSv and 207 to 208 µSv for 5, 8 and 12 years old respectively. The contribution of the planning scan on the total ED is 70% on average with the current protocol in Accuitomo 170 and 50% with the newly proposed one in Promax 3D Max.

##### **CONCLUSION**

Effective doses for the new protocol are lower and it is therefore dosewise justified. The contribution of the follow up scans to the total ED suggests that the next step towards dose optimisation should investigate the dose reduction of the follow up scans even further.

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

The newly proposed tooth auto transplantation protocol delivers lower doses to children compared to the currently used protocol

#### **SSG15-09 Is Simulation of 3D Tube Current Modulation Needed for Organ Dose Assessment with MC Frameworks?**

Tuesday, Dec. 1 11:50AM - 12:00PM Location: S404AB

##### **Participants**

Xochitl Lopez-Rendon, MSc, Leuven, Belgium (*Presenter*) Nothing to Disclose  
Guozhi Zhang, Leuven, Belgium (*Abstract Co-Author*) Nothing to Disclose  
Walter Coudyzer, Leuven, Belgium (*Abstract Co-Author*) Nothing to Disclose  
Wim Develter, Leuven, Belgium (*Abstract Co-Author*) Nothing to Disclose  
Hilde Bosmans, PhD, Leuven, Belgium (*Abstract Co-Author*) Co-founder, Qaelum NV Research Grant, Siemens AG  
Federica Zanca, PhD, Leuven, Belgium (*Abstract Co-Author*) Nothing to Disclose

##### **PURPOSE**

To estimate the error associated with breast and lung dose calculation when using longitudinal tube current modulation (TCM) only versus the full 3D TCM information for three chest CT protocols.

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

Four cadavers (3 female, 1 male) with different BMI (underweight, normal, overweight and obese) were scanned with a Siemens Definition Flash CT scanner using Standard-, XCare- and Flash-protocols (120 kVp, TCM). CTDIvol was matched to the patient specific CTDIvol of the Standard protocol for comparison purposes. The doses to the lungs and breasts were calculated with a MC simulation framework (EGSnrc) by using the full 3D TCM information obtained from raw data versus the use of longitudinal modulation only, obtained from DICOM headers. For each cadaver a voxel model was generated to be used for the dose calculation.

##### **RESULTS**

Results were analyzed per protocol and BMI. For the Standard protocol, independently of patient habitus, lung and breast dose differences between the two TCM methods were negligible (3.6% at maximum). For the XCare protocol, not accounting for the angular modulation caused a maximum underestimation of the lung dose for the underweight BMI of 1.6%. However, for the breast we found an overestimation for the smaller BMI (7.0%) whereas the tendency reverted to an underestimation which increased with BMI (up to 14.4%). For the Flash protocol we found that the lung dose is underestimated for all BMI, with a maximum of 4.6% for

the underweight, decreasing to 0.7% for overweight, when considering only longitudinal TCM. For the breast, we found an overestimation for the underweight BMI (3.3%), and a tendency to switch to underestimating values of 1.4% and 0.9% for the normal and overweight BMI, respectively.

## **CONCLUSION**

Lung and breast dose estimations with MC frameworks or commercial tools that implement only z-modulation are within 5% of the respective doses when simulating 3D TCM for chest CT scans using a Standard or a Flash CT protocol. For the XCare protocol, the use of 3D TCM is recommended. This can be explained by the larger impact of the patient's anatomy and the particular tube current modulation scheme used for that protocol.

## **CLINICAL RELEVANCE/APPLICATION**

The implementation of longitudinal modulation only is sufficiently accurate for Standard and Flash CT protocols. This facilitates organ dosimetry estimation as 3D TCM is not accessible without the help of the manufacturer.

SSG03

## ISP: Chest (Dual Energy CT of the Chest)

Tuesday, Dec. 1 10:30AM - 12:00PM Location: S404CD



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

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

### Participants

Mannudeep K. Kalra, MD, Boston, MA (*Moderator*) Nothing to Disclose  
Jonathan H. Chung, MD, Denver, CO (*Moderator*) Research Grant, Siemens AG; Royalties, Reed Elsevier

### Sub-Events

#### SSG03-01 Chest Keynote Speaker: Dual Energy of the Chest

Tuesday, Dec. 1 10:30AM - 10:40AM Location: S404CD

### Participants

Myrna C. Godoy, MD, PhD, Houston, TX (*Presenter*) Nothing to Disclose

#### SSG03-02 Are There Radiomic Features Associated with EGFR Mutation Status in Peripheral Lung Adenocarcinomas

Tuesday, Dec. 1 10:40AM - 10:50AM Location: S404CD

### Participants

Ying Liu, Tianjin, China (*Presenter*) Nothing to Disclose  
Jongphil Kim, PhD, Tampa, FL (*Abstract Co-Author*) Nothing to Disclose  
Shichang Liu, Tianjin, China (*Abstract Co-Author*) Nothing to Disclose  
Qian Li, Tianjin, China (*Abstract Co-Author*) Nothing to Disclose  
Fangyuan Qu, Tianjin, China (*Abstract Co-Author*) Nothing to Disclose  
Yoganand Balagurunathan, Tampa, FL (*Abstract Co-Author*) Nothing to Disclose  
Alberto L. Garcia, Tampa, FL (*Abstract Co-Author*) Nothing to Disclose  
Zhao Xiang Ye, Tianjin, China (*Abstract Co-Author*) Nothing to Disclose  
Robert J. Gillies, PhD, Tampa, FL (*Abstract Co-Author*) Nothing to Disclose

### PURPOSE

To retrospectively evaluate the capability of computed-tomography (CT) radiomic features in predicting EGFR mutation status in surgically resected peripheral lung adenocarcinomas in Asian cohort patients.

### METHOD AND MATERIALS

This study was approved by the institutional review board, with waiver of informed consent. 298 patients (167 for training and 131 for validation) with surgically resected peripheral lung adenocarcinomas were enrolled in this study. The EGFR mutations at exons 18 - 21 were determined by amplification refractory mutation system-PCR. We used Definiens Developer XD© (Munich, Germany) as the image analysis platform to perform tumor segmentation and feature extraction.

### RESULTS

Mutant EGFR was significant associated with never smoker status ( $p=0.041$ ), lepidic predominant adenocarcinomas subtype ( $p=0.030$ ), and low or intermediate pathologic grade ( $p=0.041$ ) in peripheral lung adenocarcinomas. Eight radiomic features were significantly associated with the presence of EGFR mutation, including three size base features, four tumor location based features, and one runlength and cooccurrence based feature. The results of a multivariable model showed that the most important predictors of harboring EGFR mutation in Asian patients with peripheral lung adenocarcinoma were histologic subtype (OR 1.99, 95% CI 0.97-4.06), smoking status (OR 0.55, 95% CI 0.29-1.03), and one radiomic feature describing tumor location (OR 0.01, 95% CI <0.001-1.10). The AUC value calculated from the predictive logistic model was 0.650 (95% CI: 0.567 - 0.734), and the AUC value computed by cross-validation method was 0.569 (95% CI: 0.480 - 0.659). The AUC value of this predictive model on the independent validation dataset was 0.696 (95% CI: 0.605 - 0.787).

### CONCLUSION

CT based radiomic features of peripheral lung adenocarcinomas can capture useful information regarding tumor phenotype, and the current model we built could be highly useful to predict the presence of EGFR mutations in peripheral lung adenocarcinoma in Asian patients when mutational profiling is not available or possible.

### CLINICAL RELEVANCE/APPLICATION

The significant association between radiomic features and EGFR mutation status for patients with peripheral lung adenocarcinomas would serve as image biomarker to allow identification of patients with high incidence of harboring EGFR mutations.

#### SSG03-03 Correlations of Iodine Uptake and Perfusion Parameters in Lung Cancer with Dual-Energy CT and First-pass Dual-input Perfusion CT

Tuesday, Dec. 1 10:50AM - 11:00AM Location: S404CD

### Participants

Xiaoliang Chen, Beijing, China (*Abstract Co-Author*) Nothing to Disclose  
Hongliang Sun, MD, Beijing, China (*Presenter*) Nothing to Disclose

Wu Wang, MD, PhD, Beijing, China (*Abstract Co-Author*) Nothing to Disclose  
Shaoyuan Yang, Beijing, China (*Abstract Co-Author*) Nothing to Disclose

## PURPOSE

To investigate the potential relationship between iodine uptake levels estimated from single source dual-energy CT (DE-CT) and perfusion parameters with dual-input perfusion CT in lung cancer.

## METHOD AND MATERIALS

This study was an institutional review board-approved study, and written informed consent was obtained from all patients. Twenty patients with lung cancers (including 12 of adenocarcinoma, 6 of squamous carcinoma and 2 of small cell lung cancer) underwent whole volume perfusion CT and single source DE-CT with 320-row CT in one examination (30S perfusion then DE-CT). The dual-input maximum slope CT perfusion (DI-CT) analysis was employed. Then, the single source DE-CT was applied, and iodine uptake were estimated by the difference ( $\lambda$ ) and the slope ( $\lambda$ HU) between the CT numbers of net enhancement in 40KeV and 70KeV monochromatic images. For the perfusion CT, the pulmonary trunk and the ascending aorta were selected as the input arteries for the pulmonary circulation and the aortic circulation respectively. Pulmonary flow (PF), aortic flow (AF), and a perfusion index (PI,  $=PF/(PF + AF)$ ) were calculated using the maximum slope method. The DI-CT and DE-CT parameters were analyzed by Pearson/Spearman correlation analysis, respectively.

## RESULTS

There are significant correlations between  $\lambda$ ,  $\lambda$ HU and AF, PF. Correlation coefficient between  $\lambda$  and AF, PF are 0.615 ( $P < 0.01$ ) and 0.526 ( $P < 0.05$ ), respectively. Correlation coefficient between  $\lambda$ HU and AF, PF are 0.575 ( $P < 0.01$ ) and 0.538 ( $P < 0.05$ ), respectively. There is a positive correlation between the DI-CT and DE-CT parameters.

## CONCLUSION

Both the single source DE-CT and dual-input CT perfusion analysis method can be used to estimate lung cancer perfusion. This study demonstrates that the iodine uptake of lung cancer estimated from DE-CT is significant correlated with the pulmonary flow and aortic flow supplying the tumors.

## CLINICAL RELEVANCE/APPLICATION

The iodine uptake of lung cancer estimated from single source DE-CT may assess tumor perfusion in consistent with the whole volume perfusion CT. It has potential value to reflect tumor pathophysiology and treatment response.

## SSG03-04 Effect of Energy Level on Texture Analysis in Simultaneously Acquired Dual-Energy Chest CT

Tuesday, Dec. 1 11:00AM - 11:10AM Location: S404CD

### Participants

James Sorensen, MBBS, Houston, TX (*Presenter*) Nothing to Disclose  
Deep Pujara, MBBS, Houston, TX (*Abstract Co-Author*) Nothing to Disclose  
Unnati Shah, BDS, MPH, Houston, TX (*Abstract Co-Author*) Nothing to Disclose  
Girish S. Shroff, MD, Houston, TX (*Abstract Co-Author*) Nothing to Disclose  
Laurence E. Court, PhD, Houston, TX (*Abstract Co-Author*) Nothing to Disclose  
Jeremy J. Erasmus, MD, Houston, TX (*Abstract Co-Author*) Nothing to Disclose  
Myrna C. Godoy, MD, PhD, Houston, TX (*Abstract Co-Author*) Nothing to Disclose  
Cihan Duran, MD, Houston, TX (*Abstract Co-Author*) Nothing to Disclose

## PURPOSE

To characterize the effect of dual-energy CT (DECT) energy levels on some commonly used texture analysis features, and on the ability of these features to differentiate between tissue types.

## METHOD AND MATERIALS

18 consecutive patients underwent chest DECT for investigation of lung nodules. All images were acquired on Siemens Somatom Definition Flash scanners. Various image acquisition and post processed data sets were evaluated, including 70keV monochromatic, 100 and 140 kVp, and a mixed 100/140 kVp (0.6 weighting factor). In each patient, a series of cylindrical ROIs were drawn in 5 different healthy tissues (bone, muscle, lung, fat, and liver), as well as an ROI delineating the lung lesion under investigation. Histogram, GreyLevel Cooccurrence Matrix, and RunLength Matrix -based texture features were then calculated in each ROI from each CT image set. The diagnostic accuracy of the features acquired from each reconstruction was then tested by using them in a machine-learning classifier to identify the tissue type present in each ROI. The diagnostic accuracy of the predictions derived from each reconstruction was then noted.

## RESULTS

All textural features were found to vary considerably with the CT energy level. In nearly all tissues, and for all feature classes, the change in feature values with different image data sets followed a simple linear regression, with  $r^2$  values typically  $> 0.9$ . The exceptions to this were fat, which had a slightly weaker positive relation for most features, and skeletal muscle, in which feature values of all classes were found to change unpredictably with energy. In general, GLCM features were the most predictable in response to changes in kilovoltage (with  $r^2$  usually  $> 0.95$ ), while RLM were the least ( $r^2 > 0.8$ ). The ability of this group of features to identify tissue types varied only slightly across the evaluated CT datasets, ranging from 77% with mixed 100/140kVp, to 84% at 100kVp.

## CONCLUSION

Textural features were accurately able to differentiate between tissue types on DECT, and this accuracy was independent of energy level. All textural features showed variation according to the energy level used, and for most tissue types this followed a simple linear relation.

## CLINICAL RELEVANCE/APPLICATION

By using a simple correction factor, textural feature values in most tissues can be directly compared between CT scans acquired with different energy levels and reconstruction datasets.

## Honored Educators

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

Jeremy J. Erasmus, MD - 2015 Honored Educator

### SSG03-05 Lesion Differentiation with Material Decomposition Images Acquired from Dual Energy CT of the Chest

Tuesday, Dec. 1 11:10AM - 11:20AM Location: S404CD

#### Participants

Alexi Otrakji, MD, Boston, MA (*Presenter*) Nothing to Disclose  
Azadeh Tabari, Boston, MA (*Abstract Co-Author*) Nothing to Disclose  
Andrew Primak, PhD, Malvern, PA (*Abstract Co-Author*) Employee, Siemens AG  
Jo-Anne O. Shepard, MD, Boston, MA (*Abstract Co-Author*) Nothing to Disclose  
Mannudeep K. Kalra, MD, Boston, MA (*Abstract Co-Author*) Nothing to Disclose  
Subba R. Digumarthy, MD, Boston, MA (*Abstract Co-Author*) Nothing to Disclose  
Shaunagh McDermott, FFR(RCSI), Boston, MA (*Abstract Co-Author*) Nothing to Disclose

#### PURPOSE

To assess imaging characteristics of pulmonary abnormalities seen on material decomposition images of dual energy CT of the chest.

#### METHOD AND MATERIALS

In an IRB approved retrospective study, 83 patients (mean age:61±14 years, M:F 45:38, mean weight 77±18 kg) underwent dual-energy chest CT on dual source multidetector CT (Siemens Definition Flash) or a single source 64-row multidetector CT (GE 750HD Discovery). Virtual monochromatic (60 keV) images were reviewed for presence of pulmonary embolism, as well as presence, shape, size, location, and attenuation characteristics of pulmonary abnormalities. Pulmonary blood volume (PBV) images were assessed for presence and size of blood volume abnormalities in the area of pulmonary abnormalities seen on other images. Data were analyzed using Wilcoxon Signed Rank test.

#### RESULTS

In pulmonary embolism with infarction, the size of decreased perfusion on PBV images was greater or equal to the size of pulmonary opacities on 60 keV images (size mismatch between attenuation and decomposition images in 10/83 patients). Decreased PBV ("perfusion defect") was also seen in 6/83 patients with non-occlusive pulmonary embolism without definite pulmonary infarction. The "stripe sign" described in perfusion nuclear scans was negative in all patients with infarctions and perfusion defects. In patients with atelectasis, pneumonia or emphysema the size of perfusion abnormalities on PBV was smaller or equal to the size of pulmonary opacity or lucency seen on 60 keV images (no size mismatch). Areas of heterogeneously increased perfusion on PBV with associated "Swiss cheese" appearance was seen in 17/83 patients with pneumonia. PBV abnormality in 34/83 patients with atelectasis is characterized by homogeneously increased perfusion on PBV. Perfusion abnormality in 15/83 patients with lucent lesions (emphysema, air trapping, cysts) is characterized by homogeneous hypo-perfusion on PBV images.

#### CONCLUSION

Size matching of area of abnormalities seen on attenuation and on PBV images help differentiate pulmonary opacities from pulmonary infarcts, pneumonia and atelectasis. Lessons from nuclear medicine (V:Q) can help the chest radiologists interpret DECT.

#### CLINICAL RELEVANCE/APPLICATION

Simultaneous interpretation of virtual monochromatic and PBV images can increase the diagnostic confidence of differentiating between the lung lesions.

## Honored Educators

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

Subba R. Digumarthy, MD - 2013 Honored Educator

### SSG03-06 Reproducibility and Consistency of Dual Energy Computed Tomography (DECT) Pulmonary Blood Volume (PBV) Measurements in Repeated Examinations

Tuesday, Dec. 1 11:20AM - 11:30AM Location: S404CD

#### Participants

Sam Dumonteil, MBBS, London, United Kingdom (*Presenter*) Nothing to Disclose  
Jaymin H. Patel, MBBS, BSC, London, United Kingdom (*Abstract Co-Author*) Nothing to Disclose  
Charlie Sayer, MBBS, FRCR, London, United Kingdom (*Abstract Co-Author*) Nothing to Disclose  
Ioannis Vlahos, MRCP, FRCR, London, United Kingdom (*Abstract Co-Author*) Research Consultant, Siemens AG Research Consultant, General Electric Company

#### PURPOSE

To evaluate the reproducibility of DECT in the measurement of PBV in patients with and without pulmonary embolism (PE).

#### METHOD AND MATERIALS

122 patients were identified from a 2-yr retrospective review of all patients undergoing more than one DECT for suspected PE

133 patients were identified from a 3yr retrospective review of all patients undergoing more than one DECT for suspected PE (100/Sn140kVp, refmAs 150/128, 100 mls 5ml/s iohexol 300mgI/ml, Definition FLASH, Siemens). Excluding patients with known pulmonary hypertension or technical failures 61 patients (mean age 62, 27 male) had a pair of normal examinations (N-N). 47 patients (mean age 60, 18 male) had one normal and one PE positive examination (N-PE). Mean interval was 6.5 months. On a both lung, individual lung or 6 standardized volumetric region basis automated PBV measurements (SyngoVia) were compared from the first to the second study by paired t-test. N-N paired PBV measurements were tested for reproducibility using Intraclass Correlation (ICC) before and after correction for central pulmonary arterial enhancement. The variance of the standard 6 regions was compared by paired t-test across time in both groups.

## RESULTS

For N-N pairs all regional PBV measures showed no significant difference between the two scans: Both Lungs (25 v 26), Right Lung (25 v 25), Left Lung (25 v 26), 6 Regions (22 v 22, 26 v 26, 28 v 28, 24 v 23, 26 v 27, 27 v 28), all  $p>0.05$ . ICC concordance in all regions was moderate to substantial (Mean 0.66, 0.57-0.73) improving further when corrected for central pulmonary enhancement (Mean 0.75, 0.65-0.82). For the N-PE pairs all regional PBV measures showed significant reduction on the PE positive study: Both Lungs (31 v 25), Right Lung (31 v 25), Left Lung (31 v 27), 6 Regions (28 v 21, 31 v 25, 33 v 28, 28 v 23, 32 v 27, 34 v 29), all  $p<0.01$ . In the N-PE group the PE positive study demonstrated significantly increased variance of the 6 standard region PBVs compared to the normal study (554 v 1062,  $p=0.04$ ), whereas comparable variance comparison in the N-N pairs was not statistically different.

## CONCLUSION

In patients undergoing repeated DECT, PBV measures are reproducible with a high degree of concordance within individual patients when normal, but with significant reduction and variability in all lung regions when PE is present.

## CLINICAL RELEVANCE/APPLICATION

The reproducibility of DECT PBV measures in normality and their predictable absolute value reduction and increased variance in PE raises the possibility of using such measures to assess treatment response.

## Honored Educators

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Ioannis Vlahos, MRCP, FRCR - 2015 Honored Educator

## SSG03-07 Iodine-density Analysis Using Enhanced ssDECT Imaging in Differentiating Benign and Malignant Serous Cavity Effusion

Tuesday, Dec. 1 11:30AM - 11:40AM Location: S404CD

### Participants

Ye Ju, Dalian, China (*Presenter*) Nothing to Disclose  
Ailian Liu, MD, Dalian, China (*Abstract Co-Author*) Nothing to Disclose  
Yijun Liu, Dalian, China (*Abstract Co-Author*) Nothing to Disclose  
Meiyu Sun, Dalian, China (*Abstract Co-Author*) Nothing to Disclose  
Shifeng Tian, Dalian, China (*Abstract Co-Author*) Nothing to Disclose  
Lingxin Kong, Dalian, China (*Abstract Co-Author*) Nothing to Disclose

## PURPOSE

To assess the value of quantitatively iodine concentration measurement of enhanced ssDECT imaging in the differential diagnosis of malignant and benign serous cavity effusion.

## METHOD AND MATERIALS

Approval for this retrospective HIPAA -compliant study was obtained from the institutional review board, and informed consent was waived. From August 2012 to February 2015, totally 51 patients, including 17 cases of benign serous effusion and 34 cases of malignant serous effusion proven by histopathological diagnosis or laboratorial examination, underwent plain and three-phase enhanced ssDECT imaging through fast kVp-switching technique. The iodine-based material density images were reconstructed. The iodine concentration (M-IE) in the effusion was measured at plain and three-phase enhanced iodine-based material density images, and the iodine concentration (M-IA) in the artery was also measured. The normalized iodine concentration (NIC= M-IE /M-IA) was calculated. The difference of normalized iodine concentration (D-I) was also calculated. The difference of these parameters was evaluated statistically by Mann-Whitney Test.

## RESULTS

1)The NIC of benign group in the three-phase enhanced images all lower than those of malignant group (26.13 vs. 36.76, 25.87 vs. 36.90, 23.87 vs. 38.00, respectively) with statistical difference ( $P=0.03$ ,  $P=0.02$ ,  $P=0.00$ ). 2)D-I between arterial phase and plain scan of benign group (21.96) was lower than that of malignant group (39.05) with statistical difference ( $P=0.00$ ). The D-I between venous phase and plain scan of benign group (20.91) was also lower than that of malignant group (39.62) with statistical difference ( $P=0.00$ ). The D-I between delayed phase and plain scan of benign group (19.48) was also lower than that of malignant group (40.40) with statistical difference ( $p=0.00$ ).

## CONCLUSION

The malignant and benign effusion shows different NIC and D-I in the iodine-density images of enhanced ssDECT imaging.

## CLINICAL RELEVANCE/APPLICATION

The iodine-density images of enhanced ssDECT scanning provides a sensitive approach for identifying benign and malignant serous cavity effusion.

## SSG03-08 Xenon Ventilation CTs Using Dual-Energy CT and Subtraction CT Methods versus Krypton Ventilation



## **SPECT/CT: Capability for Regional Ventilation and Pulmonary Functional Loss Assessments in Smokers**

Tuesday, Dec. 1 11:40AM - 11:50AM Location: S404CD

### **Participants**

Daisuke Takenaka, MD, Kobe, Japan (*Abstract Co-Author*) Nothing to Disclose  
Yoshiharu Ohno, MD, PhD, Kobe, Japan (*Presenter*) Research Grant, Toshiba Corporation; Research Grant, Koninklijke Philips NV; Research Grant, Bayer AG; Research Grant, DAIICHI SANKYO Group; Research Grant, Eisai Co, Ltd; Research Grant, Terumo Corporation; Research Grant, Fuji Yakuhin Co, Ltd; Research Grant, FUJIFILM Holdings Corporation; Research Grant, Guerbet SA;  
Yasuko Fujisawa, MS, Otawara, Japan (*Abstract Co-Author*) Employee, Toshiba Corporation  
Noriyuki Negi, RT, Kobe, Japan (*Abstract Co-Author*) Nothing to Disclose  
Tohru Murakami, Kobe, Japan (*Abstract Co-Author*) Nothing to Disclose  
Naoki Sugihara, MENG, Otawara, Japan (*Abstract Co-Author*) Employee, Toshiba Corporation  
Shinichiro Seki, Kobe, Japan (*Abstract Co-Author*) Nothing to Disclose  
Hisanobu Koyama, MD, PhD, Kobe, Japan (*Abstract Co-Author*) Nothing to Disclose  
Takeshi Yoshikawa, MD, Kobe, Japan (*Abstract Co-Author*) Research Grant, Toshiba Corporation  
Sumiaki Matsumoto, MD, PhD, Kobe, Japan (*Abstract Co-Author*) Research Grant, Toshiba Corporation;  
Kazuro Sugimura, MD, PhD, Kobe, Japan (*Abstract Co-Author*) Research Grant, Toshiba Corporation Research Grant, Koninklijke Philips NV Research Grant, Bayer AG Research Grant, Eisai Co, Ltd Research Grant, DAIICHI SANKYO Group

### **PURPOSE**

To compare the capability for regional ventilation and pulmonary functional loss assessments among xenon ventilation CT (Xe-CT) obtained by dual-energy CT (DECT) and subtraction CT (Sub-CT) methods, and krypton ventilation SPECT/CT in smokers.

### **METHOD AND MATERIALS**

Eleven consecutive smokers (7 male and 4 female, mean age: 69 years) prospectively underwent low-dose unenhanced and xenon-enhanced CT as well as xenon-CT by DECT at 320-detector row CT. In addition, all smokers were also performed SPECT/CT and pulmonary function test. In each smoker, unenhanced and xenon-enhanced CT data were subtracted by commercially available software to generate Xe-CT as Sub-CT method. To evaluate the capability of regional ventilation difference on each method, regional ventilation was assessed by consensus of board certified chest radiologists according to previously reported 3-point scoring system on a per segment basis. To determine the functional lung volume on each method, functional lung volume in each subject was calculated based on visual scores according to past literatures. To evaluate qualitative capability for regional ventilation assessment, the inter-method agreements were determined by kappa statistics. To determine quantitative capability for regional ventilation and pulmonary functional loss assessments among three methods, functional lung volume was correlated each other by Pearson's correlation. Finally, functional lung volume on each method was also correlated with FEV1%.

### **RESULTS**

Inter-method agreements were as follows: DECT vs. Sub-CT,  $\kappa=0.90$ , DECT vs. SPECT/CT,  $\kappa=0.82$ , Sub-CT vs. SPECT/CT,  $\kappa=0.79$ . On correlation of functional lung volume among three methods, there were excellent correlations among three methods (DECT vs. Sub-CT:  $r=0.99$ ,  $p<0.0001$ ; DECT vs. SPECT/CT:  $r=0.96$ ,  $p<0.0001$ ; Sub-CT vs. SPECT/CT:  $r=0.96$ ,  $p<0.0001$ ). In addition, FEV1% had excellent correlations with all methods (DECT:  $r=0.93$ ,  $p<0.0001$ ; Sub-CT:  $r=0.93$ ,  $p<0.0001$ ; SPECT/CT:  $r=0.88$ ,  $p<0.0001$ ).

### **CONCLUSION**

Xenon CT can be obtained by DECT and subtraction CT methods, and have similar potentials to evaluate regional ventilation and pulmonary functional loss as well as krypton ventilation SPECT/CT.

### **CLINICAL RELEVANCE/APPLICATION**

Xenon CT can be obtained by DECT and subtraction CT methods, and have similar potentials to evaluate regional ventilation and pulmonary functional loss as well as krypton ventilation SPECT/CT.

## **SSG03-09 Dual-Point Contrast-Enhanced Dual-Energy CT vs. FDG-PET/CT: Capability for Distinguishing Malignant from Benign Pulmonary Nodules**

Tuesday, Dec. 1 11:50AM - 12:00PM Location: S404CD

### **Participants**

Sachiko Miura, MD, Kashihara, Japan (*Presenter*) Nothing to Disclose  
Yoshiharu Ohno, MD, PhD, Kobe, Japan (*Abstract Co-Author*) Research Grant, Toshiba Corporation; Research Grant, Koninklijke Philips NV; Research Grant, Bayer AG; Research Grant, DAIICHI SANKYO Group; Research Grant, Eisai Co, Ltd; Research Grant, Terumo Corporation; Research Grant, Fuji Yakuhin Co, Ltd; Research Grant, FUJIFILM Holdings Corporation; Research Grant, Guerbet SA;  
Takeshi Kawaguchi, Kashihara, Japan (*Abstract Co-Author*) Nothing to Disclose  
Takashi Tojo, Kashihara, Japan (*Abstract Co-Author*) Nothing to Disclose  
Kimihiko Kichikawa, MD, Kashihara, Japan (*Abstract Co-Author*) Nothing to Disclose

### **PURPOSE**

To directly and prospectively compare the capability of dual-point contrast-enhanced (CE-) dual-energy CT (DECT) for distinguishing malignant from benign pulmonary nodules as compared with FDG-PET/CT.

### **METHOD AND MATERIALS**

Fifteen consecutive patients who had 19 lung nodules totally (10 men, 5 women, mean age: 70.5 years) underwent dual-point CE-DECT and FDG-PET/CT, and pathological and/or follow-up examinations. According to the pathological and follow-up examinations, all nodules were divided into two groups as follows: malignant ( $n=15$ ) and benign ( $n=4$ ) nodules. From dual-point CE-DECT data obtained at 80 and 140kV, we generated virtual non-contrast (VNC) images and iodine maps at early and late phases. To determine the capability of dual-point CE-DECT for nodule evaluation in each patient, ROIs were placed over all nodules for measuring values on all generated images at the two phases and difference of values between early and late phases on VNC image ( $\Delta VNC$ ). On FDG-PET/CT in all patients, SUVmax was also assessed by ROI measurement placed over each nodule. To evaluate differences of all CE-



DECT indices and SUVmax between malignant and benign nodule groups, Student's t-test was performed. For distinguishing malignant from benign nodules, ROC-based positive test was performed to determine feasible threshold values of the indices as having significant differences between the two groups. Finally, sensitivity (SE), specificity (SP) and accuracy (AC) were compared each other by means of McNemar's test.

## RESULTS

On comparison between the two groups, there were significant differences between malignant and benign groups on  $\Delta$ VNC (malignant vs. benign:  $0.67 \pm 4.2$  HU vs.  $10.8 \pm 7.6$  HU,  $p=0.002$ ) and SUVmax (malignant vs. benign:  $6.7 \pm 4.6$  vs.  $1.5 \pm 0.58$ ,  $p=0.0007$ ). When applied feasible threshold values, diagnostic performance of  $\Delta$ VNC (SE: 100 [15/15] %, SP: 50 [2/4] %, AC: 89.5 [17/19] %) was slightly better than that of SUVmax (SE: 86.7 [13/15] %, SP: 50 [2/4] %, AC: 78.9 [15/19] %), although there were no significant differences ( $p>0.05$ ).

## CONCLUSION

Dual-point CE-DECT is considered at least as valuable as FDG-PET/CT for distinguishing malignant from benign nodules.

## CLINICAL RELEVANCE/APPLICATION

When applied dual-point CE-DECT technique, CE-DECT is considered at least as valuable as FDG-PET/CT for distinguishing malignant from benign nodules in routine clinical practice.

## Productive Tools and Technology for the Academic Radiologist (Hands-on)

Tuesday, Dec. 1 10:30AM - 12:00PM Location: S401AB



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

### Participants

Mahesh M. Thapa, MD, Seattle, WA (*Moderator*) Nothing to Disclose

Mahesh M. Thapa, MD, Seattle, WA (*Presenter*) Nothing to Disclose

Jonelle M. Petscavage-Thomas, MD, MPH, Hummelstown, PA (*Presenter*) Consultant, Medical Metrics, Inc

Michael L. Richardson, MD, Seattle, WA (*Presenter*) Nothing to Disclose

### LEARNING OBJECTIVES

1) Know some of the latest technology for text processing. 2) Learn some of the latest technology for health in the workplace. 3) Be aware of technology that can make the RSNA meeting more pleasant and productive.

### ABSTRACT

#### Honored Educators

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Michael L. Richardson, MD - 2013 Honored Educator

Michael L. Richardson, MD - 2015 Honored Educator

**Making the Most of Google Docs: Docs, Slides, Forms, and Sheets (Hands-on)**

Tuesday, Dec. 1 10:30AM - 12:00PM Location: S401CD



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

**Participants**

Marc D. Kohli, MD, San Francisco, CA (*Moderator*) Research Grant, Siemens AG  
Marc D. Kohli, MD, San Francisco, CA (*Presenter*) Research Grant, Siemens AG  
Ross W. Filice, MD, Washington, DC, (ross.w.filice@gunet.georgetown.edu) (*Presenter*) Nothing to Disclose  
Aaron P. Kamer, MD, Indianapolis, IN, (apkamer@iupui.edu) (*Presenter*) Nothing to Disclose  
Andrew B. Lemmon, MD, Atlanta, GA (*Presenter*) Nothing to Disclose  
Thomas W. Loehfelm, MD, PhD, Atlanta, GA (*Presenter*) Nothing to Disclose

**LEARNING OBJECTIVES**

1) Describe the benefits and drawbacks of using Google tools for collaborative editing. 2) Explain issues related to storing protected health information in Google Drive. 3) Demonstrate the ability to use the Google productivity applications for collaboration on document, spreadsheet, online form and presentation creation.

**ABSTRACT**

Note: Attendees should have or create a Google account prior to coming to the session. In today's busy environment, we need tools to work smarter, not harder. Google's suite of productivity applications provides a platform for collaboration that can be used across and within institutions to produce documents and presentations and to obtain and work-up data with ease. However, with increased sharing, security concerns need to be addressed. At the end of the session, learners should be able to demonstrate creating, sharing, and editing a document as a group.

SSG05

## Gastrointestinal (CT Dose Reduction)

Tuesday, Dec. 1 10:30AM - 12:00PM Location: E352



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

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

### Participants

William P. Shuman, MD, Seattle, WA (*Moderator*) Research Grant, General Electric Company  
Kathryn J. Fowler, MD, Chesterfield, MO (*Moderator*) Research support, Bracco Group  
Achille Mileto, MD, Durham, NC (*Moderator*) Nothing to Disclose

### Sub-Events

#### **SSG05-01 Automated Tube Voltage Adaptation in Combination with Advanced Modeled Iterative Reconstruction in Thoracoabdominal Oncological Follow-up Third-generation Dual-Source Computed Tomography: Effects on Image Quality and Radiation Dose**

Tuesday, Dec. 1 10:30AM - 10:40AM Location: E352

### Participants

Jan-Erik Scholtz, MD, Frankfurt, Germany (*Presenter*) Nothing to Disclose  
Moritz H. Albrecht, MD, Frankfurt am Main, Germany (*Abstract Co-Author*) Nothing to Disclose  
Kristina Husers, Frankfurt, Germany (*Abstract Co-Author*) Nothing to Disclose  
Martin Beeres, MD, Frankfurt Am Main, Germany (*Abstract Co-Author*) Nothing to Disclose  
Claudia Frellesen, Frankfurt, Germany (*Abstract Co-Author*) Nothing to Disclose  
Julian L. Wichmann, MD, Charleston, SC (*Abstract Co-Author*) Nothing to Disclose  
Thomas Lehnert, MD, Frankfurt Am Main, Germany (*Abstract Co-Author*) Nothing to Disclose  
Ralf W. Bauer, MD, Frankfurt, Germany (*Abstract Co-Author*) Research Consultant, Siemens AG Speakers Bureau, Siemens AG  
Thomas J. Vogl, MD, PhD, Frankfurt, Germany (*Abstract Co-Author*) Nothing to Disclose

### PURPOSE

To evaluate image quality and radiation exposure of portal-venous-phase thoracoabdominal third-generation 192-slice dual-source computed tomography (DSCT) with automated tube voltage adaptation (TVA) in combination with advanced modeled iterative reconstruction (ADMIRE).

### METHOD AND MATERIALS

Fifty-one patients underwent oncological portal-venous-phase thoracoabdominal follow-up CT twice within 7 months. The initial examination was performed on second-generation 128-slice DSCT with a fixed tube voltage of 120 kV in combination with filtered back projection reconstruction (FBP). The second examination was performed on a third-generation 192-slice DSCT using automated TVA in combination with ADMIRE. Attenuation and image noise of liver, spleen, renal cortex, aorta, vena cava inferior, portal vein, psoas muscle and perinephric fat were measured. Signal-to-noise (SNR) and contrast-to-noise ratios (CNR) were calculated. Radiation dose was assessed as size-specific dose estimates (SSDE). Subjective image quality was assessed by 2 observers using five-point Likert scales. Interobserver agreement was calculated using intraclass correlation coefficients (ICC).

### RESULTS

Automated TVA set tube voltage of follow-up CT to 90 kV (n=8), 100 kV (n=31), 110 kV (n=11), or 120 kV (n=1). Average SSDE was decreased by 34.9% with 192-slice DSCT compared to 128-slice 120-kV DSCT (SSDE, 7.8±2.4 mGy vs. 12.1±3.2 mGy; p<0.001). Image noise was substantially lower, SNR and CNR were significantly increased with 192-slice DSCT compared to 128-slice DSCT (all p<0.005). Image quality was voted excellent for both acquisition techniques (5.00 vs. 4.93; p=0.083) without significant differences.

### CONCLUSION

Automated TVA in combination with ADMIRE in third-generation 192-slice portal-venous-phase thoracoabdominal DSCT reduces average radiation dose by 34.9% compared to 128-slice DSCT while providing improved objective image quality.

### CLINICAL RELEVANCE/APPLICATION

Automated TVA in combination with ADMIRE is feasible in routine thoracoabdominal follow-up CT on a third-generation DSCT and results in substantial dose reduction without impairment of image quality.

#### **SSG05-02 Assessment of Sinogram-affirmed Iterative Reconstruction Techniques for Reduced Dose Abdomen CT**

Tuesday, Dec. 1 10:40AM - 10:50AM Location: E352

### Participants

Atul Padole, MD, Boston, MA (*Presenter*) Nothing to Disclose  
Nisha Sainani, MD, Boston, MA (*Abstract Co-Author*) Nothing to Disclose  
Shelly Mishra, Boston, GA (*Abstract Co-Author*) Nothing to Disclose  
Azadeh Tabari, Boston, MA (*Abstract Co-Author*) Nothing to Disclose  
Alexi Otrakji, MD, Boston, MA (*Abstract Co-Author*) Nothing to Disclose  
Mannudeep K. Kalra, MD, Boston, MA (*Abstract Co-Author*) Nothing to Disclose  
Subba R. Digumarthy, MD, Boston, MA (*Abstract Co-Author*) Nothing to Disclose

## PURPOSE

To assess the different settings of Sinogram-affirmed iterative reconstruction (Safire, Siemens Healthcare, Germany) techniques for reduced dose (RD) abdomen CT to the standard dose (SD) CT.

## METHOD AND MATERIALS

In an IRB approved prospective study, 20 patients (age  $68 \pm 6$  years, M:F 11:9) undergoing SD abdominal CT on 128-MDCT (Definition Edge with Stellar detectors) scanner gave informed consent for acquisition of an additional RD CT. The RD series were acquired with reduced tube current but identical scan length compared to the SD CT. The sinogram data of RD CT were reconstructed with three settings of Safire (S1, S3, S5) and SD CT reconstructed with Safire (S3) ( $n = 4 \times 20 = 80$  series). Radiologists performed independent, random, and blinded comparison for lesion detection, lesion conspicuity, and visibility abdominal structures, first for all patients on RD dose images and subsequently for SD images.

## RESULTS

Mean CTDIvol were  $9 \pm 3$  mGy and  $1.4 \pm 0.1$  mGy for SD CT and RD CT, respectively. There were total 70 lesions detected on SD CT. There were five missed lesions (4 liver lesions, 2-4 mm, and a liver mass  $< 1.2$  cm) and a pseudo liver lesion ( $< 4$  mm) on RD images regardless of Safire settings and size of patients. The lesion conspicuity was sufficient for clinical diagnostic performance for 25/45 lesions with RD S1, 27/45 lesions with RD S3, and 24/45 lesions with RD S5 images regardless of patient size. Visibility of normal liver and renal parenchyma was sufficient on 15/20 patients with RD S1, 16/20 patients with RD S3, and 9/20 patients with RD S5. Other abdominal structures such as adrenals, pancreas, gall bladder, and bowels were sufficiently seen in most patients on RD CT.

## CONCLUSION

SubmSv radiation doses for routine abdominal CT are associated with missed lesions and suboptimal image quality despite use of higher strength iterative reconstruction techniques.

## CLINICAL RELEVANCE/APPLICATION

Abdominal CT acquired at CTDIvol of 1.4 mGy is not sufficient for diagnostic confidence.

## Honored Educators

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Subba R. Digumarthy, MD - 2013 Honored Educator

## SSG05-03 Contrast Enhanced CT Exams of the Abdomen Obtained at Low kVp: Impact on Radiation Dose and Image Quality

Tuesday, Dec. 1 10:50AM - 11:00AM Location: E352

### Participants

Yasir Andrabi, MD, MPH, Boston, MA (*Abstract Co-Author*) Nothing to Disclose  
Rani S. Sewatkar, MBBS, Edison, NJ (*Abstract Co-Author*) Nothing to Disclose  
Manuel Patino, MD, Boston, MA (*Abstract Co-Author*) Nothing to Disclose  
Farhad Mehrkhani, MD, Boston, MA (*Abstract Co-Author*) Nothing to Disclose  
Andrea Prochowski Iamurri, MD, Boston, MA (*Abstract Co-Author*) Nothing to Disclose  
Seyed Mahdi Abtahi, MD, Revere, MA (*Abstract Co-Author*) Nothing to Disclose  
Avinash R. Kambadakone, MD, Boston, MA (*Abstract Co-Author*) Nothing to Disclose  
Dushyant V. Sahani, MD, Boston, MA (*Presenter*) Research Grant, General Electric Company; Research Consultant, Allena Pharmaceuticals, Inc

## PURPOSE

Low tube potential (kVp) is increasingly being applied for contrast enhanced (CE) CT exams due to availability of software solutions for automated kVp selection on new generation scanners. Therefore, we studied the impact of low kVp imaging on the radiation dose and image quality of CE abdominal CT exams obtained on new generation scanners with automated kVp selection.

## METHOD AND MATERIALS

In this IRB approved retrospective study, 362 patients (age=55 years, weight=77.6 kg) underwent CE abdominal CT exams on one of our 4 scanners from same vendor (Siemens) during one month period. All of these 4 CT scanners [Stellar Detectors=3 (Definition Force, Flash and Edge) and conventional Solid detector=1 (Force)] have automated kVp selection (80-140) option. Radiation dose information and applied scan parameters (kVp and mA) were retrieved. For 85 randomly sampled patients, contrast-to-noise ratio (CNR) was determined and subjective IQ assessment was done by 2 radiologists.

## RESULTS

Low kVp ( $\leq 110$  kVp) was applied in 78% (281) CT exams [80 kVp=4(1%); 90 kVp=22(6%); 100 kVp=251(70%); 110 kVp=4(1%)] while 22% of exams ( $n=81$ ) were obtained at high kVp [120 kVp=78(21%); 140 kVp=3(1%)]. The radiation doses showed a strong correlation with kVp [CTDI(mGy): 80=6.1; 90=6.3; 100=8.1; 110=10.9; 120=14.1; 140=22.9;  $r^2=0.46$ ,  $p<0.001$ ]. For patients  $\leq 91$  kg, 80% of exams were performed at low kVp corresponding to 49% lower radiation doses (mGy;  $\leq 110$  kVp =6.5, 120 kVp=12.6;  $p<0.001$ ). For  $>91$  kg, 69% of exams were obtained at low kVp (mGy;  $\leq 110$  kVp =9.6,  $\geq 120$  kVp=17.2, 44% reduction;  $p<0.001$ ). The CNR showed a linear decrease with an increase in the kVp with highest values noted for exams obtained at low kVp ( $r^2=0.18$ ,  $p<0.001$ ). All 85 exams received high subjective image quality ratings.

## CONCLUSION

A substantial (78%) of abdominal CT exams are obtained at low kVp [80% ( $\leq 91$  kg) and 69% ( $>91$  kg)]. Regardless of the patient body weight, CT exams obtained on new generation scanners with automated kVp selection option results in a significant reduction

in radiation doses (44-49%) while preserving objective and subjective IQ.

#### CLINICAL RELEVANCE/APPLICATION

The clinical benefits of low kVp imaging are well recognized, however, image quality concerns may limit its implementation in clinical practice. The new generation scanners with automated kVp selection, stellar detectors as well as iterative reconstructions facilitate low kVp exams without degrading image quality, especially, in large sized patients.

#### Honored Educators

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Dushyant V. Sahani, MD - 2012 Honored Educator

Dushyant V. Sahani, MD - 2015 Honored Educator

#### SSG05-04 Personalized Liver CT Examination Protocol Based on BMI: Combination of Optimized kVp and Optimized Iodine Injection Method

Tuesday, Dec. 1 11:00AM - 11:10AM Location: E352

##### Participants

Jian Jiang, MD, Beijing, China (*Presenter*) Research Grant, General Electric Company

Xiaoying Wang, MD, Beijing, China (*Abstract Co-Author*) Nothing to Disclose

Wei Li, Beijing, China (*Abstract Co-Author*) Nothing to Disclose

Ke Wang, MD, Beijing, China (*Abstract Co-Author*) Nothing to Disclose

Mengxi Jiang, Beijing, China (*Abstract Co-Author*) Research Grant, General Electric Company

Xiaochao Guo, MD, Beijing, China (*Abstract Co-Author*) Nothing to Disclose

#### PURPOSE

To investigate whether the personalized liver CT examination protocol based on body mass index (BMI) could obtain the diagnostic image quality.

#### METHOD AND MATERIALS

This prospective study was approved by IRB. Informed patient consent was obtained. From 2014 May to 2015 March, patients with known or suspected HCC were recruited consecutively, who underwent MDCT. Patients were scanned with different tube voltage (80-120 kVp) in combination with different amount of iodine contrast medium (352 to 550 mgI/kg) based on their BMI: BMI 18.0-24.0, 80-kVp, 352mgI/kg; BMI 24.1-28.0, 100-kVp, 440 mgI/kg; BMI 28.1-35.0, 120-kVp, 550 mgI/kg. All the other scanning parameters were set as the same. For each patient, the late arterial phase images were reconstructed into 6 sets of images, filter back projection (FBP) and sonogram-affirmed iterative reconstruction (SAFIRE) 1 to 5 (S1 to S5). The image noise, attenuation, contrast-to-noise ratio (CNR), and figure of merit (FOM) of the liver parenchyma and portal vein and estimated effective dose (ED) were measured and calculated. Radiologists were independently blinded to grade images quality (sharpness, image noise, beam-hardening artifacts and reconstruction artifact).

#### RESULTS

Totally 133 patients were recruited, according to BMI, 37 in 80-kVp group, 50 in 100-kVp group, 47 in 120-kVp group. Image subjective score of S3 was significantly higher than that of the other reconstructions on the 80-kVp. Images of S2 had the highest image subjective score compared with the other reconstructions on the 100-kVp ( $p < 0.05$ ) and 120-kVp ( $p > 0.05$ ). The estimated ED was 49.6%, 56.8% lower at 80-kVp than at 100-kVp and 120-kVp. CNR of the portal vein was 16.3% higher at the 80-kVp S3 images than of 120-kVp S2 images ( $p > 0.05$ ). FOM of liver on the 80-kVp S3 images was higher than on 100-kVp and 120-kVp S2 images ( $p < 0.05$ ). The subjective score of image quality was significantly higher for 120-kVp S2 images than for 80-kVp S3 images and 100-kVp S2 images; however, there was no significant difference among them.

#### CONCLUSION

High quality liver CT images could be obtained by using personalized liver CT protocol based on BMI, with combination of optimized kVp and iodine injection method.

#### CLINICAL RELEVANCE/APPLICATION

This method will be of benefit to the patients with lower BMI, who will receive lower contrast dosage, significantly less radiation dose compared with the conventional uniform method.

#### SSG05-05 Can 3rd Generation Dual-source CT Achieve 70kV-imaging for Routine Contrast-enhanced Body CT?

Tuesday, Dec. 1 11:10AM - 11:20AM Location: E352

##### Participants

Satoru Takahashi, MD, Kobe, Japan (*Presenter*) Nothing to Disclose

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Wakiko Tani, RT, Kobe, Japan (*Abstract Co-Author*) Nothing to Disclose

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Kazuro Sugimura, MD, PhD, Kobe, Japan (*Abstract Co-Author*) Research Grant, Toshiba Corporation Research Grant, Koninklijke

Philips NV Research Grant, Bayer AG Research Grant, Eisai Co, Ltd Research Grant, DAIICHI SANKYO Group

#### PURPOSE

Low-kV CT can dramatically reduce contrast media (CM) volume with maintaining sufficient contrast enhancement thanks to improved iodine absorption of lower kV. Although low-kV CT has been applied to vascular imaging, its application to parenchymal organs is limited due to high image noise or beam hardening artifact. The purpose of this investigation is to compare quantitative and qualitative data in two contrast enhanced CT protocols acquired with 3rd generation dual-source CT scanner; 70 kV CT with 60% dose of CM and 120 kV CT with a standard dose.

## METHOD AND MATERIALS

We retrospectively compared 100 consecutive patients (57±12 kg) who underwent post-contrast body CT (thorax to pelvis) on 192-slice 3rd generation dual-source CT scanner at 70 kV with 60% dose of diluted 270 mgI/Kg CM (50.8±9.6 mL), with 103 historical control patients (59±13 kg) at 120 kV with a standard dose of 450 mgI/Kg CM (84.4±16.4 mL). CT values of the vessels and the visceral organs, as well as contrast to noise ratio (CNR) of hepatic and renal cysts were compared between the groups. Subjective assessment of image quality, severity of beam hardening artifact was scored on a 4-point scale. Radiation dose (CTDIvol) was recorded in each case.

## RESULTS

CT values of the abdominal aorta, portal vein, liver, kidney, pancreas, spleen at 70 kV with 60% CM were statistically significantly greater than those at 120 kV with a standard dose of CM ( $p<0.0001$ ). There were no significant differences in CNR of hepatic or renal cysts between 70 kV and 120 kV techniques ( $p=0.93$ ,  $p=0.11$ , respectively). The beam-hardening artifact at the level of thoracic inlet and the pelvis was stronger at 70 kV (120 kV, 1.1 and 1.0, 70 kV, 1.6 and 1.3, respectively), while streak artifact from intravenous CM was significantly more prominent at 120 kV technique (120 kV, 2.1, 70 kV, 1.5, respectively). Radiation dose was significantly higher in the 120 kV than 70 kV group [CTDIvol;  $9.1\pm1.7$  mGy, and  $8.3\pm 2.0$  mGy, respectively ( $p<0.01$ )].

## CONCLUSION

70kV-CT would be sufficient for routine clinical body CT study with reduced CM and radiation dose. Although beam hardening artifact may be seen in the pelvis and the thoracic inlet, streak artifact from CM could be reduced.

## CLINICAL RELEVANCE/APPLICATION

70kV imaging can provide sufficient image quality not only for the vessels but also for the organs with reduced dose of CM and radiation.

## SSG05-06 Observer Performance at Varying Dose Levels and Reconstruction Methods for Detection of Hepatic Metastases

Tuesday, Dec. 1 11:20AM - 11:30AM Location: E352

### Participants

Joel G. Fletcher, MD, Rochester, MN (*Presenter*) Grant, Siemens AG; ;  
Jeff L. Fidler, MD, Rochester, MN (*Abstract Co-Author*) Research Grant, Beekley Corporation  
Sudhakar K. Venkatesh, MD, FRCR, Rochester, MN (*Abstract Co-Author*) Nothing to Disclose  
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Lifeng Yu, PhD, Rochester, MN (*Abstract Co-Author*) Nothing to Disclose  
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Adam Bartley, Rochester, MN (*Abstract Co-Author*) Nothing to Disclose  
Shuai Leng, PhD, Rochester, MN (*Abstract Co-Author*) Nothing to Disclose  
David R. Holmes III, PhD, Rochester, MN (*Abstract Co-Author*) Nothing to Disclose  
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Rickey Carter, PhD, Rochester, MN (*Abstract Co-Author*) Nothing to Disclose  
Cynthia H. McCollough, PhD, Rochester, MN (*Abstract Co-Author*) Research Grant, Siemens AG

## PURPOSE

To estimate the ability of abdominal radiologists to detect hepatic metastases (HM) at varying dose levels with or without iterative reconstruction (sinogram-affirmed iterative reconstruction; IR) using a two-stage study design.

## METHOD AND MATERIALS

For stage I, CT projection data from 44 CT contrast-enhanced exams were collected (22 with HM). HM was defined by histopathology, progression/regression on CT/MR. Using a validated noise insertion technique, 12 datasets were reconstructed with filtered back projection (FBP) or IR for each patient at 6 dose levels (automatic exposure control settings of 60, 80, 100, 120, 160 and 200 Quality ref. mAs [QRM]; 528 cases). In each reading session, 3 abdominal imagers randomly evaluated each patient's dataset once. Using a dedicated computer workstation, readers circled all liver lesions, selecting diagnosis and confidence score (0 - 100), and then graded image quality. Automated matching of reference and reader lesions was performed using overlapping spheres. A successful reading was defined as  $\geq 2$  readers localizing all "essential" HM (or no non-lesion localizations in negative cases), where an essential HM was identified by the reference standard and  $\geq 2$  readers at 200 QRM FBP. Sample size calculations ( $p_0=0.8$ ,  $p_1=0.9$ ,  $\alpha=0.05$  (one sided)) determined  $\geq 37$  cases to pass through stage I. JAFROC analysis was also performed on a per-lesion basis for HM using a non-inferiority limit of -0.1

## RESULTS

There were 75 HM with a median size of  $1.2 \pm 0.6$  cm. 7 of the 12 configurations passed through stage I screening, corresponding to dose levels of  $\geq 120$  QRM (or at 100 QRM with IR). Using non-inferiority criterion and JAFROC FOM, all but the IR 60 QRM met the a priori definition of having the lower limit of 95% CI  $> -0.1$ . At dose levels  $\leq 120$  QRM, IR improved diagnostic confidence ( $p<0.05$ ).

## CONCLUSION

Lower dose CT images reconstructed at dose levels corresponding to 120 and 160 QRM, or at 100 QRM for IR only, performed similar to 200 QRM FBP in this pilot study for detection of hepatic metastases. IR improved diagnostic image quality but not performance at lower dose levels.

## CLINICAL RELEVANCE/APPLICATION

Pilot data obtained over a range of doses suggests that substantial dose reduction is possible without compromising performance.



IR improved performance only over a narrow range of radiation doses.

#### Honored Educators

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

Naoki Takahashi, MD - 2012 Honored Educator

#### SSG05-07 Single- and Dual-Energy Acquisition with 2nd and 3rd Generation Abdominal Dual-Source CT: Direct Comparison of Scan Modes Regarding Radiation Dose and Image Quality

Tuesday, Dec. 1 11:30AM - 11:40AM Location: E352

##### Participants

Julian L. Wichmann, MD, Charleston, SC (*Presenter*) Nothing to Disclose  
Lloyd Felmlly, Charleston, SC (*Abstract Co-Author*) Nothing to Disclose  
Carlo N. De Cecco, MD, PhD, Charleston, SC (*Abstract Co-Author*) Nothing to Disclose  
Andrew D. Hardie, MD, Charleston, SC (*Abstract Co-Author*) Nothing to Disclose  
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U. Joseph Schoepf, MD, Charleston, SC (*Abstract Co-Author*) Research Grant, Bracco Group; Research Grant, Bayer AG; Research Grant, General Electric Company; Research Grant, Siemens AG; Research support, Bayer AG; ;  
Akos Varga-Szemes, MD, PhD, Charleston, SC (*Abstract Co-Author*) Nothing to Disclose  
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Giuseppe Muscogiuri, MD, Charleston, SC (*Abstract Co-Author*) Nothing to Disclose  
Stephen R. Fuller, Charleston, SC (*Abstract Co-Author*) Nothing to Disclose  
Christian Canstein, Charleston, SC (*Abstract Co-Author*) Employee, Siemens AG

#### PURPOSE

To compare dual-energy (DE) and single-energy (SE) abdominal computed tomography (CT) in matched cohorts of routine clinical patients performed with third-generation dual-source CT (DSCT) and to assess differences in radiation dose and image quality compared to second-generation DSCT.

#### METHOD AND MATERIALS

This retrospective study was approved by the local institutional review board with a waiver of written informed consent. A total of 200 patients divided into four groups of 50 patients matched by gender and body mass index underwent portal-venous-phase abdominal DECT with standard scan protocols on second-generation DSCT (SE 120-kV, group A; DE 80/140-kV, group C) and third-generation (100-kV SE, group C; 90/150-kV DE, group D) DSCT. Radiation dose was normalized for a typical scan length of 40 cm. Dose-independent figure-of-merit (FOM) contrast-to-noise ratios (CNR) were calculated for various organs and vessels. Subjective overall image quality and image artifacts and reader confidence were assessed by three observers using five-point scales. Results were compared with two-way analysis of variance and intra-class-correlation coefficients.

#### RESULTS

Effective dose normalized for 40-cm acquisition was lowest in groups D ( $5.3 \pm 1.9$  mSv) and C ( $6.2 \pm 2.0$  mSv,  $P=0.103$ ), significantly lower (both  $P < 0.0001$ ) compared to groups A ( $8.8 \pm 2.3$  mSv) and B ( $9.7 \pm 2.4$  mSv). Dose-independent FOM CNR peaked for liver, kidney, and portal vein measurements (all  $P \leq 0.0285$ ) in group D. Results for pancreas and aorta did not reach significance compared to group C (both  $P \geq 0.0719$ ), but did compared to groups A and B (all  $P \leq 0.0077$ ). Overall subjective image quality and image artifacts and reader confidence were consistently rated as excellent in all groups (all  $\geq 1.53$  out of 5).

#### CONCLUSION

Both acquisition modes with third-generation abdominal DSCT result in significantly lower radiation dose compared to second-generation DSCT while maintaining image quality. Third-generation abdominal DE DSCT can be routinely performed without any dose penalty compared to SE acquisition.

#### CLINICAL RELEVANCE/APPLICATION

Third-generation DSCT is more dose-efficient than second-generation DSCT; the spectral imaging opportunities of DE acquisition can be utilized without radiation dose penalty.

#### SSG05-08 CT Enterography: Diagnostic Value Of 4th Generation Iterative Reconstruction Algorithm with Low Dose CT-Protocol In Comparison with Standard Dose Protocol for Clinical Follow-Up of Patients with Crohn's Disease

Tuesday, Dec. 1 11:40AM - 11:50AM Location: E352

##### Participants

Sophie Lombardi, Vimercate, Italy (*Presenter*) Nothing to Disclose  
Davide Ippolito, MD, Monza, Italy (*Abstract Co-Author*) Nothing to Disclose  
Alessandra S. Casiraghi, Casatenovo, Italy (*Abstract Co-Author*) Nothing to Disclose  
Pietro A. Bonaffini, MD, Monza, Italy (*Abstract Co-Author*) Nothing to Disclose  
Cammillo R. Talei Franzesi, Milan, Italy (*Abstract Co-Author*) Nothing to Disclose  
Sandro Sironi, MD, Monza, Italy (*Abstract Co-Author*) Nothing to Disclose

#### PURPOSE

To compare radiation dose, image quality and diagnostic performance of low dose CT-enterography protocol (256 MDCT scanner) combined with iterative reconstruction algorithm (iDose4), with standard dose CT-enterography in follow-up of patients with known Crohn's disease.

## METHOD AND MATERIALS

Fifty-one patients (32 male; mean BMI 24.9), with CD underwent low-dose CTE scan in a single venous phase on 256 MDCT scanner (iCT, Philips) with following parameters: 120 kV, automated mAs dose modulation, slice thickness 2mm, with iDose4 iterative reconstruction algorithm. The same patients underwent a standard dose examination on 256-rows CT scan (120kV, 200-400mAs, depending on patient weight, slice thickness 2mm). Two radiologists, blinded to clinical and pathological findings, independently evaluated, in each scan, HU values in bowel wall and presence of CD activity features (mural thickening and enhancement pattern, mesenteric fat stranding, comb sign, lymphadenomegaly and disease's complications). Image noise and diagnostic quality were evaluated using a 4-point scale. Dose-length product (DLP) was calculated and data from both examinations were compared and statistically analyzed.

## RESULTS

Low-dose CTE protocol showed high diagnostic quality in assessment of Crohn's disease features (i.e. mural thickening and enhancement, halo sign, mesenteric fat stranding, lymphadenopathy), which were detected in 43/51 (82%) of our series. Total DLP and CTDI were significantly ( $p<0,001$ ) lower for CTE studies with iDose (607 mGy\*cm and 12 mGy) as compared to standard dose examinations (891 mGy\*cm and 19.13 mGy), allowing an overall dose reduction of 35%. The objective noise measurements were slightly higher in iDose images (DS 12.9) than in standard dose studies (DS 10.37) but not statistically significant difference was achieved ( $p=0,06$ ).

## CONCLUSION

Low dose CTE protocol combined with iDose4 reconstruction algorithm offers high quality images with lower radiation dose, being a useful tool in CD patients management, in regard of their young age and the frequent imaging follow-up required.

## CLINICAL RELEVANCE/APPLICATION

Low-dose CTE protocol combined with iDose4 algorithm allows a significant reduction of radiation dose, while providing an appropriate diagnostic image quality for the evaluation of CD manifestations.

## SSG05-09 Comparison of Model-based Iterative Reconstruction, Adaptive Statistical Iterative Reconstruction and Filtered Back Projection for Detecting Hepatic Metastases on Submillisievert Low-Dose CT

Tuesday, Dec. 1 11:50AM - 12:00PM Location: E352

### Participants

Jung Hee Son, MD, Busan, Korea, Republic Of (*Presenter*) Nothing to Disclose  
Seung Ho Kim, MD, Busan, Korea, Republic Of (*Abstract Co-Author*) Nothing to Disclose  
Jung Hee Yoon, MD, Busan, Korea, Republic Of (*Abstract Co-Author*) Nothing to Disclose  
Yedaun Lee, MD, Busan, Korea, Republic Of (*Abstract Co-Author*) Nothing to Disclose  
Yun-Jung Lim, Seoul, Korea, Republic Of (*Abstract Co-Author*) Nothing to Disclose  
Seon Jeong Kim, Seoul, Korea, Republic Of (*Abstract Co-Author*) Nothing to Disclose

## PURPOSE

To compare the image quality and diagnostic performance of model-based iterative reconstruction (MBIR), adaptive statistical iterative reconstruction (ASIR) and filtered back projection (FBP) on submillisievert low-dose CT (LDCT) for detecting hepatic metastases in patients with gastrointestinal cancer.

## METHOD AND MATERIALS

From February 2014 to September 2014, 38 consecutive patients (mean age 63 years; range 33-87 years) having clinically suspected hepatic metastases underwent abdomen CT. CT protocol consisted of routine standard-dose portal venous phase scan (120 kVp), and investigational 90 second delayed low-dose scan (80 kVp) with an automatic tube current modulation. The LDCT images were reconstructed with FBP, ASIR 70% and MBIR. Two blinded readers independently scored overall image quality of each image set based on a five-point scale and recorded number of hepatic metastases on a per lesion basis (FBP, ASIR, and MBIR in order). The subjective image quality was compared by Wilcoxon signed rank test. The CT image noise was measured for each image data set. The image noise and number of detected hepatic metastases were compared among the three image data sets using the repeated measures analysis of variance.

## RESULTS

105 metastatic lesions (42 lesions  $\geq 1$  cm, 63 lesions  $< 1$  cm) were analyzed. The mean values of CTDIvol and DLP of LDCT were 1.66 mGy and 47.8 mGy\*cm, respectively. The subjective image quality was improved in reading order for both readers ( $P<0.0001$ ). The measured image noise was also decreased in reading order (40.5, 24.6, 14.8;  $P<0.0001$ ). The pooled sensitivity was unchanged after applying ASIR from 49% (51/105) to 52% (55/105) ( $P=0.0697$ ), however, significantly increased to 66% (69/105) after applying MBIR for reader 1 ( $P=0.0035$ ). MBIR applied images showed a higher pooled sensitivity than ASIR applied ones ( $P=0.0311$ ). For reader 2, it was not increased after applying either ASIR from 65% (67/105) to 68% (70/105), or MBIR to 67% (69/105) ( $P=0.4571$ ).

## CONCLUSION

Although MBIR and ASIR might improve the subjective image quality and decrease measured image noise, the reconstructed images showed a limited sensitivity in detecting hepatic metastases on submillisievert LDCT.

## CLINICAL RELEVANCE/APPLICATION

The MBIR or ASIR applied images show a limited sensitivity in detecting hepatic metastases on submillisievert LDCT.

SSG01

## ISP: Breast Imaging (Intervention Path Correlation)

Tuesday, Dec. 1 10:30AM - 12:00PM Location: E451A



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

### Participants

Thomas J. Lawton, MD, Chapel Hill, NC (*Moderator*) Nothing to Disclose  
Dianne Georgian-Smith, MD, Boston, MA (*Moderator*) Nothing to Disclose  
Michael A. Cohen, MD, Atlanta, GA (*Moderator*) Nothing to Disclose

### Sub-Events

#### SSG01-01 Breast Imaging Keynote Speaker: Radiology-Pathology Challenges to Lobular Neoplasia and Radial Scars

Tuesday, Dec. 1 10:30AM - 10:40AM Location: E451A

#### Participants

Dianne Georgian-Smith, MD, Boston, MA (*Presenter*) Nothing to Disclose

#### SSG01-02 Breast Imaging Keynote Speaker: Radiology-Pathology Challenges to Lobular Neoplasia and Radial Scars

Tuesday, Dec. 1 10:40AM - 10:50AM Location: E451A

#### Participants

Thomas J. Lawton, MD, Chapel Hill, NC (*Presenter*) Nothing to Disclose

#### SSG01-03 ACR BI-RADS Assessment Category 4 Subdivisions in Diagnostic Mammography: Utilization and Outcomes in the National Mammography Database

Tuesday, Dec. 1 10:50AM - 11:00AM Location: E451A

#### Participants

Mai A. Elezaby, MD, Madison, WI (*Presenter*) Nothing to Disclose  
Mythreyi Bhargavan-Chatfield, PhD, Reston, VA (*Abstract Co-Author*) Nothing to Disclose  
Elizabeth S. Burnside, MD, MPH, Madison, WI (*Abstract Co-Author*) Stockholder, NeuWave Medical Inc  
Wendy B. Demartini, MD, Madison, WI (*Abstract Co-Author*) Nothing to Disclose

### PURPOSE

Since 2003, the ACR Breast Imaging Reporting and Data System (BI-RADS) Atlas has suggested that mammography category 4 assessments be subdivided by likelihood of malignancy into 4A (> 2% to ≤ 10%), 4B (> 10% to ≤ 50%) and 4C (> 50% to ≤ 95%). This allows a more meaningful practice audit and aids patients, clinicians and pathologists. However, little is known about use and outcomes of category 4 subdivisions in clinical practice. We evaluated utilization of these subdivisions in the National Mammography Database (NMD), a large national registry with approximately 160 participating facilities.

### METHOD AND MATERIALS

This study was NMD Registry Committee approved and HIPAA compliant. We included data for all diagnostic mammograms submitted to the NMD performed from January 2008 to December 2013. We calculated the utilization rate of BI-RADS assessment category 4 subdivisions overall and by year, and determined the positive predictive values of biopsy performed (PPV3) overall and by category 4 subdivision.

### RESULTS

Data from 968,670 diagnostic mammograms were included. Overall, 90,988 (9%) were given BI-RADS assessment category 4, with subdivisions used in 30,163 (33%) and not used in 60,825 (67%) of category 4 exams. Subdivision use by year was 54% (2008), 46% (2009), 35% (2010), 31 % (2011), 30% (2012) and 32 % (2013). Among the 30,163 diagnostic mammograms given category 4 subdivisions, frequencies were 4A in 1, 6900 (56%), 4B in 9,555 (32%) and 4C in 3,708 (12%). PPV3s were: overall category 4 20% (13.925/69,537), category 4A 8% (941/12,460), category 4B 22% (1683/7636) and category 4C 69% (1990/2892).

### CONCLUSION

Despite the ACR BI-RADS Atlas suggestion for use of assessment category 4 subdivisions since 2003, the minority (33%) of NMD category 4 diagnostic mammograms utilized these subdivisions. When category 4 subdivisions were used, positive predictive values for biopsy performed reproduced appropriate BI-RADS specified malignancy ranges. This analysis supports the use of subdivisions in broad practice and should motivate increased utilization given benefits for patient care.

### CLINICAL RELEVANCE/APPLICATION

In the NMD, subdivisions were used in the minority of category 4 diagnostic mammograms, but PPV3s were in BI-RADS-specified malignancy ranges. Increased utilization should be encouraged given benefits for patient care.

## **SSG01-04 Identifying Criteria to Follow Rather than Excise Radial Scar/Complex Sclerosing Lesion: A 10-year Single Institution Study and Literature Review**

Tuesday, Dec. 1 11:00AM - 11:10AM Location: E451A

### **Participants**

Bart B. Singer, Chapel Hill, NC (*Presenter*) Nothing to Disclose  
Sheryl G. Jordan, MD, Chapel Hill, NC (*Abstract Co-Author*) Nothing to Disclose  
Thomas J. Lawton, MD, Chapel Hill, NC (*Abstract Co-Author*) Nothing to Disclose

### **PURPOSE**

Radial scars/complex sclerosing lesions (RS/CSL) are not considered premalignant, yet are routinely excised because of a reported risk of coexistent malignancy. This study's purpose was to determine if pathologic and imaging criteria can identify patients who may not require surgery.

### **METHOD AND MATERIALS**

A literature review identified 21 published studies since 1999, reporting upgrade rates for RS from 0% to 40%. In addition to significant selection bias, each of these retrospective studies had at least one major confounding factor: 1) Admixing upgrade rates of RS plus atypia with benign RS; 2) Not reporting CNB RadPath concordance and/or including discordant cases; 3) Not providing histologic review; 4) Not reporting distance from the biopsy site to upgrade lesion on excision, thereby not confirming association. With IRB approval, we identified all breast biopsies from 2004 to 2014 with RS/CSL, with and without atypia, followed by excision. All above confounding factors were addressed, and pathologic and radiologic features were catalogued for each case. Statistical significance was evaluated using the chi-square test.

### **RESULTS**

The literature review identified 352 cases that met our inclusion criteria, with 1.1% upgrading to DCIS or invasive malignancy at excision. Our study identified 50 concordant RS/CSL without atypia, 11 concordant RS/CSL with atypia, and 2 discordant RS/CSL without atypia; all were excised. Imaging features and CNB techniques used are detailed in Figure 1. Of the 50 cases of RS/CSL without atypia that were concordant, 0% were upgraded to DCIS or invasive malignancy at excision. 16% of these cases had an excisional diagnosis of atypia that was not present on CNB. This occurred more frequently when CNB technique was automated load device (23.5%) vs vacuum assisted device (13.2%). 2/2 discordant cases upgraded to DCIS or invasive carcinoma on excision, and 3/11 cases of RS/CSL with atypia upgraded (27.2%).

### **CONCLUSION**

Our review suggests that concordant RS/CSL without atypia do not warrant excision. The data also suggests CNB for suspected RS should be performed with larger gauge VAD for improved accuracy of risk assessment based on the presence of atypia.

### **CLINICAL RELEVANCE/APPLICATION**

Entering the era of increased detection of RS/CSL by digital breast tomosynthesis, it is relevant to have identified strict pathologic and biopsy technique criteria that may permit patients to forgo unnecessary surgery

## **SSG01-05 Suspicious Breast Calcifications in Women Over Age 70: Are Some Safe to Follow?**

Tuesday, Dec. 1 11:10AM - 11:20AM Location: E451A

### **Participants**

Lars J. Grimm, MD, Durham, NC (*Presenter*) Advisory Board, Medscape, LLC;  
David Y. Johnson, Durham, NC (*Abstract Co-Author*) Nothing to Disclose  
Karen S. Johnson, MD, Durham, NC (*Abstract Co-Author*) Research Consultant, Siemens AG  
Jay A. Baker, MD, Durham, NC (*Abstract Co-Author*) Research Consultant, Siemens AG  
Mary S. Soo, MD, Durham, NC (*Abstract Co-Author*) Nothing to Disclose  
Sujata V. Ghatge, MD, Durham, NC (*Abstract Co-Author*) Nothing to Disclose

### **PURPOSE**

While the incidence of breast cancer increases with age, tumor prognosis in the elderly is often favorable. Our study evaluated the histologic outcomes of stereotactically biopsied breast calcifications in women  $\geq 70$  years of age to determine if specific BI-RADS morphology descriptors may be candidates for active surveillance rather than biopsy.

### **METHOD AND MATERIALS**

In this HIPAA compliant, IRB approved study, digital mammograms from 236 consecutive patients  $\geq 70$  years who underwent stereotactic biopsy of calcifications without associated findings were independently reviewed by three breast radiologist who provided BI-RADS morphology descriptors for each case. The majority opinion was recorded. Stereotactic and surgical excision pathology reports were reviewed and final tumor type, hormone receptor status, and lymph node status were recorded. Surrogate molecular subtypes based on ER, PR and HER2 data were tabulated. The proportion of benign, atypical, in situ, and invasive disease were calculated in total and by morphology.

### **RESULTS**

The 236 biopsies resulted in 131 (56%) benign, 20 (9%) atypical, 57 (24%) in situ, and 28 (12%) invasive diagnoses. There were 30 (53%) low risk (low/intermediate grade) and 27 (47%) high risk (high grade) in situ cases. Of the 28 invasive cases, 24 (86%) were luminal type (ER and/or PR+), 1 (4%) HER2 (ER/PR-, HER2+), and 3 (11%) triple negative cancers; 5 (18%) were node positive. Invasive disease was found in 25% (7/28) of fine linear, 18% (3/17) of round, 15% (16/105) of fine pleomorphic, and 5% (2/40) of amorphous calcifications, with no invasive disease in the coarse heterogeneous calcifications. In situ disease was found in 35% (37/105) of fine pleomorphic, 29% (8/28) of fine linear, 20% (8/40) of amorphous, 12% (2/17) of round, and 5% (2/37) of coarse heterogeneous. There was no malignancy detected in 9 cases of calcifications described as dystrophic.

### **CONCLUSION**

Biopsies of calcifications in women  $\geq 70$  years yielded a greater than 5% likelihood of malignancy, including triple negative and

lymph node positive tumors, for all suspicious calcification morphologies. Active surveillance in this age group is not appropriate.

#### CLINICAL RELEVANCE/APPLICATION

Active surveillance is not appropriate for women  $\geq 70$  years with suspicious calcification morphologies.

#### SSG01-06 Amorphous Calcifications Rarely Represent Aggressive Malignancy

Tuesday, Dec. 1 11:20AM - 11:30AM Location: E451A

##### Participants

Wendie A. Berg, MD, PhD, Pittsburgh, PA (*Presenter*) Consultant, SuperSonic Imagine; Departmental Research Grant, General Electric Company ; Departmental Research Grant, Hologic, Inc; Equipment support, Gamma Medica, Inc; Equipment support, General Electric Company; Equipment support, Hologic Inc; ;  
Sue S. Chen, MD, Pittsburgh, PA (*Abstract Co-Author*) Nothing to Disclose  
Hayley Oligane, DO, Pittsburgh, PA (*Abstract Co-Author*) Nothing to Disclose  
Sahand Sohrabi, MD, San Francisco, CA (*Abstract Co-Author*) Nothing to Disclose  
Margarita L. Zuley, MD, Pittsburgh, PA (*Abstract Co-Author*) Research Grant, Hologic, Inc;  
Maria L. Anello, DO, Jacksonville, FL (*Abstract Co-Author*) Nothing to Disclose

##### PURPOSE

To determine rate and molecular subtypes of malignancy on stereotactic biopsy of amorphous calcifications and to consider implications for overdiagnosis.

##### METHOD AND MATERIALS

From 6727 stereotactic 9-g vacuum-assisted biopsies performed from 1/1/2009 through 9/30/2013 at a single institution, consecutive cases were reviewed under an IRB-approved protocol. Calcification morphology and distribution were recorded. For cases with primarily amorphous calcifications but no more suspicious morphologies, demographic information was recorded together with imaging findings and histopathologic outcomes including excision for any high-risk result or malignancy.

##### RESULTS

Interim analysis of 804 biopsies revealed 233 (29.0%) were for amorphous calcifications in 203 women (median age 53 years, range 30-78). Of 233 biopsies, 25 (10.8%) were ultimately malignant in 24 women (median age 51, range 39-75), including nine invasive ductal carcinomas (IDC) with median size 0.3 cm (range 0.1 to 1.2 cm), all node negative, seven Nottingham grade 2 and two grade 1; seven were luminal A [ER/PR(+) HER2(-), low Ki-67] and two were luminal B [ER(+),HER2(-), Ki-67 20%; one PR(+) and one PR(-)]. Among 16 DCIS lesions, two were nuclear grade 3, 11 grade 2 (two of which were upgraded from ADH on core), and 3 grade 1; three of the DCIS were PR(-). Distribution influenced malignancy rate: 4/11(36%) linear distribution were malignant as were 3/9(33%) segmental, 17/194(8.8%) grouped, and 1/18(5.6%) regional ( $p < 0.001$ ). Of 24 women diagnosed with cancer, 18 (75%) had risk factors other than age or breast density. Another 67/233 (28.8%) biopsies yielded a final result of atypical/high risk results: 45 ADH; 8 LCIS; 7 FEA; 6 ALH; 1 atypical apocrine adenosis.

##### CONCLUSION

Malignancy rate of 10.8% was observed on stereotactic biopsy of amorphous calcifications. All malignancies were DCIS or ER-positive IDC; 4/203 (2.0%) women were diagnosed with luminal B IDC or high nuclear grade DCIS. Among 69 lesions atypical/high risk on core biopsy only 2 (2.9%) (95%CI 0.9 to 4.9%) were upgraded at excision (grade 2 DCIS), both of whom had ipsilateral cancer (one current, one prior).

#### CLINICAL RELEVANCE/APPLICATION

Stereotactic biopsy remains necessary for amorphous calcifications, but an atypical result on vacuum biopsy of amorphous calcifications has a very low (2.9%) rate of upgrade to malignancy at excision. Further study is warranted to determine if excision is necessary in this context.

#### SSG01-07 Pilot Evaluation of Minimally Invasive Needle-biopsy of Sentinel Nodes as Compared to Surgical Removal

Tuesday, Dec. 1 11:30AM - 11:40AM Location: E451A

##### Participants

Stefan Paepke, MD, Munich, Germany (*Abstract Co-Author*) Advisor, SurgicEye GmbH; Advisor, NeoDynamics AB  
Christian H. Pfof, MD, Munich, Germany (*Abstract Co-Author*) Nothing to Disclose  
Ralf Ohlinger, MD, Greifswald, Germany (*Abstract Co-Author*) Nothing to Disclose  
Ines Gruber, MD, Tübingen, Germany (*Abstract Co-Author*) Nothing to Disclose  
Marc Thill, MD, Frankfurt, Germany (*Abstract Co-Author*) Nothing to Disclose  
Jens-Uwe Blohmer, MD, Berlin, Germany (*Abstract Co-Author*) Nothing to Disclose  
Thorsten Kuhn, MD, Esslingen, Germany (*Abstract Co-Author*) Nothing to Disclose  
Markus Hahn, MD, Tübingen, Germany (*Abstract Co-Author*) Nothing to Disclose  
Marion Kiechle, MD, Munich, Germany (*Abstract Co-Author*) Nothing to Disclose  
Klemens Scheidhauer, Munich, Germany (*Abstract Co-Author*) Nothing to Disclose  
Thomas Wendler, Munich, Germany (*Abstract Co-Author*) Former Employee, SurgicEye GmbH  
Joerg Traub, PhD, Garching bei München, Germany (*Presenter*) Shareholder and Managing Director of SurgicEye GmbH

##### PURPOSE

Evaluate within a pilot setup feasibility and safety of minimally invasive needle-biopsy of sentinel nodes guided by SPECT/US as compared to surgical removal while defining optimal needle for follow-up trial.

##### METHOD AND MATERIALS

As pre-trial test phase of the MinimalSNB study, 38 breast cancer patients (6 centers) were taken a needle-biopsy of their sentinel lymph nodes (SLNs) under guidance of SPECT/US (SentiGuide by SurgicEye). All patients were indicated for a surgical SLN biopsy which was performed immediately after the needle-biopsy. For the test phase, 4 different biopsy systems were tested: HistoCore



14G (BIP), elite 10G and 13G (Mammotome) and CASSI II 10G (Scion Medical Technologies). Histopathological examination (HandE, step-sectioning) of needle-biopsies and surgically removed SLNs were compared.

## RESULTS

No single complication was reported. Occasionally, small hematomas could be found close to the SLN during surgery. The needle-biopsies showed lymphatic tissue in 29/38 cases. Within the 29 successful cases both methods matched in 26 cases (24 true negative, 2 true positive). The needle biopsy failed to detect metastases in 2 pN1 SLNs. In 1 case, the surgically resected tissue did not contain lymph nodes and the needle biopsy remained the only information on nodal status (pN0). The success of the biopsies was strongly dependent on training and experience of user making axillary needle biopsies. 5 of the failed needle biopsies were the first attempt of the user. In both false negative cases, the retrieved lymph tissue was minimal (1x 14G sample, 1x 10G sample tangential to node).

## CONCLUSION

SPECT/US showed to be a valid method for percutaneous detection of SLNs and needle-guidance. Sampling SLNs with a needle seems safe and feasible. However it requires proper training and user experienced with axillary needle-biopsies. Retrieving more tissue (more cores and larger lumen needles) improves diagnostic power of needle-biopsy. These considerations will be taken within the upcoming MinimalSNB trial.

## CLINICAL RELEVANCE/APPLICATION

Sentinel lymph biopsy today is a surgical diagnostic procedure with a non-zero morbidity. Moving it out of the operating theatre to a needle-based intervention has a huge impact on the burden of this procedure for the patient as well as relevant improvements in logistics, workflow and radiation burden.

### SSG01-08 Detection of Different Nuclear Grades of Ductal Carcinoma in Situ in Digital Mammography Screening

Tuesday, Dec. 1 11:40AM - 11:50AM Location: E451A

#### Participants

Stefanie B. Weigel, Muenster, Germany (*Presenter*) Nothing to Disclose  
Jan Heidrich, Muenster, Germany (*Abstract Co-Author*) Nothing to Disclose  
Oliver Heidinger, Muenster, Germany (*Abstract Co-Author*) Nothing to Disclose  
Shoma Berkemeyer, Muenster, Germany (*Abstract Co-Author*) Nothing to Disclose  
Walter L. Heindel, MD, Muenster, Germany (*Abstract Co-Author*) Nothing to Disclose  
Hans Werner Hense, Muenster, Germany (*Abstract Co-Author*) Nothing to Disclose

## PURPOSE

To investigate detection rates of ductal carcinoma in situ (DCIS), separately for different nuclear grades of the first subsequent round in relation to the initial round of a population-based digital mammography screening program.

## METHOD AND MATERIALS

We included data from 516,286 subsequent round (SR) examinations (52-69 years, 2007-2010) and 720,778 initial round (IR) examinations (50-69 years, 2005-2008) from 16 screening areas provided by the population-based cancer registry. The total detection rate per 100 women screened (DetR%) for DCIS was dissected into low (SR n= 64, IR n= 181), intermediate (SR n= 220, IR n= 387) and high grades (SR n= 285, IR n= 425). Spearman rank correlations and Wilcoxon test were used. P values less than .05 were considered significant.

## RESULTS

The SR-DetR% of total DCIS correlated significantly with high grade DCIS ( $r = 0.75$ ;  $P < .001$ ) and intermediate grade DCIS ( $r = 0.55$ ;  $P = .028$ ), the association with low grade DCIS was lower ( $r = 0.48$ ;  $P = .057$ ). SR-DetR% of DCIS low grade was lower than for intermediate ( $P < .001$ ) and high grade ( $P < .001$ ). The median SR-DetR% of total DCIS (0.12%) was lower than the median IR-DetR% (0.14%;  $P = .039$ ). In particular, the median SR-DetR% of low grade was significantly lower than in the initial round (0.01% vs. 0.02%;  $P = .01$ ) while the median DetR% of intermediate grade were 0.04% and 0.05%, respectively ( $P = 0.19$ ), and for high grade 0.05% and 0.06%, respectively ( $P = .67$ ).

## CONCLUSION

Only DCIS of low grade decreased significantly from the initial to the first subsequent screening round, it was less common than intermediate and high grade DCIS and it showed only a weak association with total DCIS detection.

## CLINICAL RELEVANCE/APPLICATION

Biennial digital mammography screening of women aged 50 to 69 years showed constantly higher DCIS detection rates of the more progressive grades than of the DCIS low grade.

### SSG01-09 Following Imaging-concordant Benign MRI-guided Vacuum-assisted Breast Biopsy: Is MRI Follow Up Needed?

Tuesday, Dec. 1 11:50AM - 12:00PM Location: E451A

#### Participants

Monica L. Huang, MD, Houston, TX (*Presenter*) Nothing to Disclose  
Megan E. Speer, MD, Houston, TX (*Abstract Co-Author*) Nothing to Disclose  
Basak E. Dogan, MD, Houston, TX (*Abstract Co-Author*) Nothing to Disclose  
Gaiane M. Rauch, MD, PhD, Houston, TX (*Abstract Co-Author*) Nothing to Disclose  
Rosalind P. Candelaria, MD, Houston, TX (*Abstract Co-Author*) Nothing to Disclose  
Wei T. Yang, MD, Houston, TX (*Abstract Co-Author*) Researcher, Hologic, Inc  
Kenneth Hess, PhD, Houston, TX (*Abstract Co-Author*) Nothing to Disclose  
Beatriz E. Adrada, MD, Houston, TX (*Abstract Co-Author*) Nothing to Disclose

## PURPOSE

Follow up of lesions with imaging-concordant benign MRI-guided vacuum-assisted biopsy result is not currently standardized. We aim to investigate the false omission rate of benign breast MRI-guided vacuum-assisted biopsy (MVAB) to assess whether MRI follow up is needed.

## **METHOD AND MATERIALS**

Medical records of patients with 9-gauge breast MRVAB from January 1, 2007 to July 1, 2012 were reviewed retrospectively. Only patients/lesions with imaging-concordant MRVAB benign result and 1) surgical histopathology or 2) minimum of 2-year imaging follow up were included in this study. The false omission rate ( $1 - \text{NPV} = \# \text{ false negative result} / \# \text{ negative calls}$ ) of the MRVAB with imaging-concordant benign result was calculated.

## **RESULTS**

A total of 161 patients (170 lesions) with MRVAB imaging-concordant benign result met the inclusion criteria. The majority, 127/161 (79%) patients [134/170 (79%) lesions] had only imaging follow up; 58/161 (36%) patients [61/170 (36%) lesions] had mammography and > 24 months MRI follow up; and 26/161 (16%) patients [29/170 (17%) lesions] had mammography with < 24 months follow up (MRI follow up range 2 to 20 months, median 11 months). Of the 34/161 (21%) patients [36/170 (21%) lesions] with surgical correlation, none had surgical discordance. Malignancy was later diagnosed in the same breast in 3/161 patients (1.9%): 1 invasive ductal carcinoma (IDC) (0.6%), 1 IDC with ductal carcinoma in situ (DCIS) (0.6%), and 1 DCIS (0.6%). Only 1 of these 3 patients ( $1/127 = 0.8\%$ ) had subsequent malignancy (IDC) near (1 cm from) the site of previous MRVAB, with malignancy discovered on follow up mammography (calcifications) >23 months after MRVAB. The other 2 patients developed cancer in a different site in the same breast: 1(DCIS) found on mammography (calcifications) >11 months post MRVAB and 1(DCIS) found on MRI (mass) >22 months post MRVAB.

## **CONCLUSION**

Our study shows a false omission rate for benign MRVAB of 0.6%, with cancer near the MRVAB site detected by mammography at 24 months post MRVAB in 1/170 lesions (1 false negative result/170 negative calls).

## **CLINICAL RELEVANCE/APPLICATION**

Imaging-concordant benign MRVAB has extremely low false omission rate and may not warrant MRI follow up.



SPCP31

## Mexico Presents: The Challenges of Radiology Education in Mexico and Some Proposals for Mexico and Latin American Countries

Tuesday, Dec. 1 10:30AM - 12:00PM Location: E353C



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



Discussions may include off-label uses.

### Participants

Jose Rene Manuel Anguiano-Martinez, MD, Aguascalientes, Mexico (*Presenter*) Nothing to Disclose

Armando Lopez SR, MD, Mexico, Mexico (*Presenter*) Nothing to Disclose

Guillermo Elizondo-Riojas, MD, PhD, Monterrey, Mexico, (elizondoguillermo@hotmail.com) (*Presenter*) Research Consultant, Caymus Medical, Inc

Luis Felipe Alva Lopez, MD, Mexico City, Mexico (*Presenter*) Nothing to Disclose

Jose L. Ramirez-Arias SR, MD, PhD, Mexico, Mexico, (jramirez.arias@saludangeles.com) (*Presenter*) Nothing to Disclose

### LEARNING OBJECTIVES

1) Explain some of the problems of the 52 university postgraduate programs in radiology ,and also the need of more academic radiologists. 2) To describe the different needs of radiology education through the nation as well as the need of more academic radiologist to teach the present and future generations in the upcoming radiological knowledge. 3)To recognize for this purpose the support of international societies , RSNA, ARRS, ACER, CIR ,ESR ,SERAM.

### ABSTRACT

Mexico has 52 university radiology programs. For a country of one hundred million inhabitants there are no more than six thousand radiologists .More radiologists are needed and for that purpose more academic radiologists are needed .We also consider that there must be a standarization of radiology programs and our radiology institutions ,Federation ,Societies, Board and College of Radiology are working together for this unification .We have had for many years the academic support of many International Radiology Institutions ,specially by RSNA ,we will mention in the presentation what results have been obtained There will be also information of Mexico and the health system.

### URL

**Handout:** Jose Rene Manuel Anguiano-Martinez

<http://abstract.rsna.org/uploads/2015/15000046/Presentacion Dr. Anguiano RSNA 2015.pptx>

### Sub-Events

#### SPCP31A Opening Remarks

Participants

Ronald L. Arenson, MD, San Francisco, CA (*Presenter*) Nothing to Disclose

### LEARNING OBJECTIVES

View learning objectives under main course title.

#### SPCP31B Closing Remarks

Participants

James P. Borgstede, MD, Colorado Springs, CO (*Presenter*) Nothing to Disclose

### LEARNING OBJECTIVES

View learning objectives under main course title.

SSG10

## ISP: Musculoskeletal (Hand and Wrist)

Tuesday, Dec. 1 10:30AM - 12:00PM Location: E450B



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

### Participants

Mary G. Hochman, MD, West Roxbury, MA (*Moderator*) Stockholder, General Electric Company; Stock options, Nomir Medical Technologies, Inc; Author, UpToDate, Inc  
Mary M. Chiavaras, MD, PhD, Ancaster, ON (*Moderator*) Nothing to Disclose

### Sub-Events

#### SSG10-01 Musculoskeletal Keynote Speaker: MR Evaluation of the Hand-Technique and Application

Tuesday, Dec. 1 10:30AM - 10:50AM Location: E450B

### Participants

Jean-Luc Drape, MD, PhD, Paris, France (*Presenter*) Nothing to Disclose

### ABSTRACT

To optimize MRI of fingers nine technical points should be especially checked: (1) the choice of the surface coil according to the clinical findings, (2) the gradient strength and the bandwidth, (3) the positioning and the contention, (4) a dedicated scout view, (5) the spatial resolution, (6) the slice thickness with a special attention to 3D millimetric slices, (7) the choice of a main slice plane according to the suspected lesion, (8) the suppression of motion artifacts and (9) the use of stress images if possible (collateral ligaments, pulleys, extensor tendon).

#### SSG10-03 MR Morphology of Triangular Fibrocartilage Complex: Correlation with Quantitative MR and Biomechanical Properties

Tuesday, Dec. 1 10:50AM - 11:00AM Location: E450B

### Participants

Thumanoon Ruangchaijatuporn, MD, Bangkoknoi, Thailand (*Presenter*) Nothing to Disclose  
Eric Y. Chang, MD, San Diego, CA (*Abstract Co-Author*) Nothing to Disclose  
Reni Biswas, San Diego, CA (*Abstract Co-Author*) Nothing to Disclose  
Sheronda Statum, San Diego, CA (*Abstract Co-Author*) Nothing to Disclose  
Betty Tran, San Diego, CA (*Abstract Co-Author*) Nothing to Disclose  
Won C. Bae, PhD, San Diego, CA (*Abstract Co-Author*) Nothing to Disclose  
Christine B. Chung, MD, San Diego, CA (*Abstract Co-Author*) Nothing to Disclose

### PURPOSE

Wrist pain may involve the triangular fibrocartilage complex (TFCC; Fig.A). The purpose of this study was to evaluate MR morphology of TFCC tissues, and relate it to regional quantitative MR (qMR) and biomechanical properties.

### METHOD AND MATERIALS

Five cadaveric wrists (22 to 70 yrs) were imaged at 3T using morphologic (PD SE, Fig.AC; 3D SPGR, Fig.B) and quantitative (ME SE T2; UTE T2\*; 2D SCMP T1rho; 3D MAPSS T1rho; UTE T1rho) MR sequences. In 8 geographic regions (Fig.B), morphology of TFCCdisc and the laminae were evaluated for pathology (Fig.BDE) and quantitative MR (qMR) values (Fig.F). Four of the samples were disarticulated, and biomechanical indentation testing was performed on the distal surface of the discs (Fig.C). Instantaneous (Indentation) modulus, taking into account tissue thickness, was determined.

### RESULTS

On PD SE images, pathology of TFCC disc included degeneration (Fig.BE) and tears (Fig.E), while that of the lamina included degeneration, degeneration with superimposed tear, and mucinous transformation (Fig.E). Calcifications were highly visible on 3D SPGR images (Fig.D). Calcifications were found only among pathologic regions, and disc pathology was found more frequently in the proximal than distal regions. In the disc (Fig.G), most qMR values were the lowest in normal samples, and increased significantly with degeneration or tear. Indentation modulus (Fig.G) showed an inverse trend, being the highest in normal samples and decreasing with pathologic changes. qMR properties also correlated moderately with indentation modulus. Laminae samples (Fig.H) were mostly pathologic, and requires additional normal samples to discern qMR changes.

### CONCLUSION

These results show potential utility of morphologic, qMR, and biomechanical techniques to characterize pathology of the TFCC.

### CLINICAL RELEVANCE/APPLICATION

Quantitative MR techniques provide novel and sensitive means of evaluating tissues of TFCC, which compliment conventional techniques.

#### SSG10-04 Accessory Tendon Slips of the Extensor Carpi Ulnaris: MRI Findings and Association with Tendon Abnormalities

Tuesday, Dec. 1 11:00AM - 11:10AM Location: E450B

### Participants

Fabio Becce, MD, Lausanne, Switzerland (*Presenter*) Nothing to Disclose  
Antoine Rochette, MD, Quebec, QC (*Abstract Co-Author*) Nothing to Disclose  
Eric G. Pessis, MD, St Denis, France (*Abstract Co-Author*) Nothing to Disclose  
Patrick Omoumi, MD, Lausanne, Switzerland (*Abstract Co-Author*) Nothing to Disclose  
Henri Guerini, MD, Paris, France (*Abstract Co-Author*) Nothing to Disclose  
Dominique Le Viet, MD, Paris, France (*Abstract Co-Author*) Nothing to Disclose  
Jean-Luc Drape, MD, PhD, Paris, France (*Abstract Co-Author*) Nothing to Disclose

## PURPOSE

Anatomic variants are common in the wrist and hand, and some of them may be the triggering factor of tendon disorders. The purpose of this study was to report the MRI findings of accessory tendon slips arising from the extensor carpi ulnaris (ECU), and evaluate their association with ECU tendon abnormalities.

## METHOD AND MATERIALS

All wrist MRI scans performed over a 1-year period in two university hospitals were retrospectively reviewed. Patients with prior ulnar-sided wrist surgery and MRI scans without at least axial T1-weighted and T2-weighted sequences were excluded. Two musculoskeletal radiologists independently assessed the presence of accessory tendon slips arising from the ECU, as well as ECU tendinosis, partial or complete tears, and tenosynovitis. The origin and insertion of the accessory tendon slips were noted, and their diameter and the cross-sectional area of the ECU tendons were measured.

## RESULTS

A total of 254 wrist MRI scans from 257 patients (139 men, 115 women; mean age, 46 years) were included. The prevalence of accessory tendon slips arising from the ECU was 23% (58/254). Surgical correlation was available in 12% (7/58) of cases. Their mean long-axis diameter was  $1.1 \pm 0.2$  mm. Their origin was always visible, while their insertion on the fifth metacarpal or extensor digiti minimi tendon was seen in 33% (19/58) of cases. Patients with accessory tendon slips had statistically significantly more ECU tendon abnormalities and tenosynovitis than patients without the anatomic variant (14% vs. 6%, and 46% vs. 11%, respectively;  $p \leq 0.02$ ). The prevalence of accessory tendon slips was statistically significantly higher in patients with ulnar-sided wrist pain (23% vs. 14%,  $p = 0.01$ ).

## CONCLUSION

Accessory tendon slips arising from the ECU are common and frequently associated with ECU tendon abnormalities. They are frequently found in patients with ulnar-sided wrist pain.

## CLINICAL RELEVANCE/APPLICATION

Accessory tendon slips arising from the ECU are important to recognize because they represent a diagnostic pitfall and may also play a role in the pathogenesis of ECU tendon abnormalities.

## SSG10-05 Computer-Based Temporal Subtraction Analysis of Joint Space Narrowing in Rheumatoid Patients: Validation Study in Carpal Joints

Tuesday, Dec. 1 11:10AM - 11:20AM Location: E450B

### Participants

Shota Ichikawa, Sapporo, Japan (*Presenter*) Nothing to Disclose  
Tamotsu Kamishima, MD, Sapporo, Japan (*Abstract Co-Author*) Nothing to Disclose  
Kenneth Sutherland, Hokkaido, Japan (*Abstract Co-Author*) Nothing to Disclose  
Takanobu Okubo, Asahikawa, Japan (*Abstract Co-Author*) Nothing to Disclose  
Kou Katayama, Asahikawa, Japan (*Abstract Co-Author*) Nothing to Disclose

## PURPOSE

To evaluate the computer-based method using temporal subtraction in carpal joints of rheumatoid arthritis (RA) patients, which can detect the difference in joint space between two images as the joint space difference index (JSDI).

## METHOD AND MATERIALS

Twenty-seven rheumatoid arthritis patients (24 females and 3 males, mean age 60 years) on Tocilizumab were enrolled. Radiographs were obtained at baseline and at 1 year. The joint space narrowing (JSN) of a total of 229 carpal (3rd carpometacarpal, 5th carpometacarpal, scaphoid-trapezium, scaphoid-capitate, and radius-scaphoid) joints on bilateral hand radiographs was assessed by our computer-based method, setting the Sharp/van der Heijde method as the gold standard. We performed three examinations to confirm that the JSDI reflects the chronological change in joint space width. We compared the JSDI of joints with JSN progression (increase in Sharp/van der Heijde score) in the follow-up period with those without JSN progression. In addition, we examined whether there is a significant difference in JSDI in terms of laterality or topology of the joint.

## RESULTS

The JSDI of joints with JSN progression was significantly higher than those without JSN progression (Mann-Whitney U test,  $p < 0.001$ ). There was no statistically significant difference in the JSDI between left and right carpal joints, which was analyzed for 5 different joints altogether and each joint separately (Mann-Whitney U test,  $p > 0.05$  respectively). There was no statistically significant difference in JSDI among different joints (Kruskal-Wallis test,  $p = 0.155$ ). In all examinations, the results of the computer-based method were consistent with those of the Sharp/van der Heijde method as the gold standard.

## CONCLUSION

These results suggest that our computer-based method may be useful to recognize the joint space narrowing progression on radiographs in carpal joints.

## CLINICAL RELEVANCE/APPLICATION

The computer-based temporal subtraction method can detect the joint space narrowing progression in the wrist, which is the single most predilection site for rheumatic diseases.

## SSG10-06 Cracking the Case on "Knuckle Cracking": The Sonographic Evidence

Tuesday, Dec. 1 11:20AM - 11:30AM Location: E450B

### Participants

Robert D. Boutin, MD, Sacramento, CA (*Presenter*) Nothing to Disclose  
Anuj Netto, MD, MPH, Sacramento, CA (*Abstract Co-Author*) Nothing to Disclose  
David Nakamura, MD, Orange, CA (*Abstract Co-Author*) Nothing to Disclose  
Cyrus Bateni, MD, Sacramento, CA (*Abstract Co-Author*) Nothing to Disclose  
Michael S. Cronan, RT, Sacramento, CA (*Abstract Co-Author*) Nothing to Disclose  
Robert Szabo, MD, MPH, Sacramento, CA (*Abstract Co-Author*) Nothing to Disclose  
Abhijit J. Chaudhari, PhD, Davis, CA (*Abstract Co-Author*) Nothing to Disclose

### PURPOSE

1] Report the static and dynamic appearance of knuckle cracking (KC) with sonography (US) and 2] analyze the performance of US for the diagnosis of KC.

### METHOD AND MATERIALS

A prospective, IRB-approved study was performed on healthy adult subjects with and without a history of habitual KC. Exclusion criteria were a history of pain or arthritis in the hands. Recorded clinical history included KC events per day multiplied by the number of KC years (allowing the calculation of "crack-years") and a QuickDASH questionnaire. Physical examination, including grip strength and Beighton scoring, was performed by two subspecialty orthopaedists blinded to subject KC history. US (with temporal resolution of 87 frames/sec) was conducted by a single sonographer, with static and cine images recorded before, during, and after metacarpophalangeal joint (MPJ) distraction was performed by the subjects. Two blinded musculoskeletal radiologists interpreted the images for a definite hyperechoic focus during and after MPJ distraction (not present prior to distraction); this was compared against the reference standard of an audible "crack" during joint distraction.

### RESULTS

We studied 400 MPJs of 40 subjects (17 women, 23 men), with mean age of 33 years (range, 18-63). In comparing 10 non-KC subjects (with 0 "crack-years") versus 30 KC subjects (with "crack-years" ranging from 16 to 800), there was no significant difference in sex, age, QuickDASH score, grip strength, or Beighton score. In 62 of the 400 MPJs, there was an audible "crack" during manual distraction. Range of motion was noted to significantly increase in these 62 MPJs with respect to active and passive flexion, and passive extension between pre and post KC ( $p < 0.05$ ). With US, blinded readers had a good sensitivity (R1, 75%; R2, 80%) and excellent specificity (R1, 94%; R2, 95%), with a very good inter-observer reliability of 0.87 ( $p < 0.0005$ ). A brilliant hyperechoic flash that was simultaneous with the KC event and arose over approximately 115 msec was highly characteristic.

### CONCLUSION

US examination during movement of the MPJs can show distinctive findings of KC with relatively high specificity and inter-observer reliability. US features corroborate the theory of cavitation as the etiology for sound generation in voluntary KC.

### CLINICAL RELEVANCE/APPLICATION

Audible emissions may be associated with a broad array of (intraarticular and extraarticular) clinical conditions, but KC has a characteristic US appearance.

## SSG10-07 Hand MRI: Quality of Fat Signal Suppression with Dixon versus CHESS and STIR Imaging

Tuesday, Dec. 1 11:30AM - 11:40AM Location: E450B

### Participants

Thomas P. Kirchgesner, MD, Brussels, Belgium (*Presenter*) Nothing to Disclose  
Vasiliki Perlepe, MD, Brussels, Belgium (*Abstract Co-Author*) Nothing to Disclose  
Nicolas Michoux, Brussels, Belgium (*Abstract Co-Author*) Nothing to Disclose  
Ahmed Larbi, MD, Nimes, France (*Abstract Co-Author*) Nothing to Disclose  
Frederic E. Lecouvet, MD, Brussels, Belgium (*Abstract Co-Author*) Nothing to Disclose  
Bruno C. Vande Berg, MD, PhD, Brussels, Belgium (*Abstract Co-Author*) Consultant, Bone Therapeutics SA

### PURPOSE

To compare the quality of fat signal suppression and signal to noise ratio (SNR) obtained by the Dixon method in comparison to the CHESS (CHEMical Shift Selective) and STIR (Short Tau Inversion Recovery) sequences at hand MRI of healthy subjects.

### METHOD AND MATERIALS

Both hands of 14 healthy volunteers were imaged with IDEAL T1 SE (Spin Echo), IDEAL T2 SE, FS (Fat Saturated) T1 SE, FS T2 SE and STIR on a 1.5T MR scanner. Slice thickness, slice spacing and imaging plans were kept constant between sequences. Water pure IDEAL T1 SE, water pure IDEAL T2 SE, FS T1 SE, FS T2 SE and STIR images were anonymized and archived by an independent operator in the picture archiving communication system. Three radiologists blindly and independently scored the quality of the fat signal suppression (1: absent; 2: partial; 3: complete) in bone marrow and adjacent soft tissues of 20 articulations. One radiologist calculated the SNR in 5 locations for each hand.

### RESULTS

Scores for fat signal suppression were significantly higher in water pure IDEAL T1 SE than in FS T1 SE for the 3 readers ( $p < 0.001$ ). Scores for fat signal suppression were significantly higher in water pure IDEAL T2 SE than in FS T2 SE for the 3 readers ( $p < 0.017$ ). Scores for fat signal suppression were statistically and significantly higher in water pure IDEAL T2 SE than in STIR for 2 readers ( $p < 0.022$ ), and not statistically different for the third reader ( $p = 0.109$ ). SNR in water pure IDEAL T1 SE was significantly higher than SNR in FS T1 SE ( $p < 0.001$ ). SNR in water pure IDEAL T2 SE was statistically and significantly higher than SNR in STIR ( $p < 0.001$ ), but statistically and significantly lower than SNR in FS T2 SE ( $p < 0.001$ ).

### CONCLUSION

Quality of fat signal suppression at hand MRI achieved with the Dixon method is superior to that obtained with fat selective

quality of fat signal suppression at hand and achieved with the Dixon method is superior to that obtained with fat selective presaturation and STIR. SNR is higher on IDEAL T1 but not on IDEAL T2 in comparison with the corresponding CHESS sequences.

#### CLINICAL RELEVANCE/APPLICATION

Dixon sequences should be further investigated in patients with inflammatory hand diseases as they yield better quality for fat suppression than currently validated sequences.

#### SSG10-08 Value of Tomosynthesis for Lesion Evaluation in Osteoarthritic Hands Using the OARSI Score

Tuesday, Dec. 1 11:40AM - 11:50AM Location: E450B

##### Participants

Katharina Martini, Zurich, Switzerland (*Presenter*) Nothing to Disclose  
Anton S. Becker, Zurich, Switzerland (*Abstract Co-Author*) Nothing to Disclose  
Joerg Mueller, Dusseldorf, Germany (*Abstract Co-Author*) Employee, FUJIFILM Holdings Corporation  
Roman Guggenberger, Zurich, Switzerland (*Abstract Co-Author*) Nothing to Disclose  
Gustav Andreisek, MD, Zurich, Switzerland (*Abstract Co-Author*) Grant, Holcim Ltd; Grant, Siemens AG; Speaker, Mepha Pharma AG; Speaker, Guerbet SA; Travel support, Guerbet SA; Consultant, Otsuka Holdings Co, Ltd; Travel support, Otsuka Holdings Co, Ltd; Institutional Research Grant, Bayer AG; Institutional Research Grant, Guerbet AG; Institutional research collaboration, Siemens AG; Institutional research collaboration, Koninklijke Philips NV; Speaker, General Electric Company; Speaker, Koninklijke Philips NV; Speaker, Siemens AG; ;  
Thomas Frauenfelder, MD, Zurich, Switzerland (*Abstract Co-Author*) Nothing to Disclose

#### PURPOSE

To investigate the value of Tomosynthesis in depicting osteoarthritic lesions in comparison to conv. X-ray, with use of computed tomography (CT) as standard-of-reference.

#### METHOD AND MATERIALS

Imaging of 12 cadaver wrists was performed with Tomosynthesis in anteriorposterior (ap) projection (50 kV at 40 mA; tube angle: 40°), conventional X-ray and multi-detector CT (70kV at 16mAs ref). Distal interphalangeal joint (DIP) II, DIP III, proximal interphalangeal joint (PIP) II, PIP III, first carpometacarpal (CMC) and scaphotrapezotrapezoidal joint (STT) were individually graded using the Osteoarthritis Research Society International (OARSI) score by two independent readers for the presence of osteophytes (0-3), joint space narrowing (0-3), subchondral sclerosis (0-1), lateral deformity (0-1), subchondral cysts (0-1) and erosion (0-1). Total scores range from 0-60. Inter-reader agreement (Cohen's k) was calculated. CT served as standard of reference.

#### RESULTS

Comparing Tomosynthesis and conventional X-ray to CT, the agreement was of 69.64% vs. 63.89% for the presence of osteophytes; 80.56% vs. 56.94% for joint space narrowing; 69.44% vs. 68.1% for subchondral sclerosis; 94.44% vs. 91.67% for lateral deformity; 97.22% vs. 80.56% for subchondral cysts; and 100% vs. 97.22% for erosion. While Tomosynthesis showed no significant difference ( $p=0.846$ ) in OARSI score grading to CT (mean OARSI-score CT: 16.8, SD=10.64 vs. mean OARSI-score Tomosynthesis: 16.25, SD=9.56), conventional X-ray had significant lower mean OASIS scores (mean OARSI-score X-ray: 11, SD=8.33;  $p=0.037$ ). Inter-reader agreement for OARSI scoring was excellent ( $k=0.83$ ).

#### CONCLUSION

Tomosynthesis depicts more lesions than conventional X-ray compared to CT.

#### CLINICAL RELEVANCE/APPLICATION

The mean OARSI score of Tomosynthesis is not significantly different from CT.

#### SSG10-09 Assessment of Pisotriquetral Instability with 3D Dual Echo Steady State (DESS): Is It Associated with Trauma or not?

Tuesday, Dec. 1 11:50AM - 12:00PM Location: E450B

##### Participants

Hee-Dong Chae, MD, Seoul, Korea, Republic Of (*Presenter*) Nothing to Disclose  
Hye Jin Yoo, MD, Seoul, Korea, Republic Of (*Abstract Co-Author*) Nothing to Disclose  
Ja-Young Choi, MD, San Diego, CA (*Abstract Co-Author*) Nothing to Disclose  
Sung Hwan Hong, MD, Seoul, Korea, Republic Of (*Abstract Co-Author*) Nothing to Disclose

#### PURPOSE

To determine if there is an association between pisotriquetral (PT) instability and trauma history or internal derangements of the carpal joint by using three-dimensional (3D) dual echo steady state (DESS)

#### METHOD AND MATERIALS

We evaluated 44 patients with distal radius fracture (patient) and other 44 patients without previous trauma history (control), who underwent 3T magnetic resonance (MR) imaging including 3D DESS sequence. To analyze PT instability, three parameters were measured on axial and sagittal images by two blinded-readers, independently: PT interval, PT angle and pisiform translation relative to triquetrum. The MR appearances of PT joint and ulnar-sided structures were also evaluated. The associations between PT instability and distal radius fracture, abnormality of ulnar-sided structures or osteoarthritic features of PT joint were calculated.

#### RESULTS

PT instability parameters measured by two radiologists showed good or excellent agreement (ICC=0.628-0.965). Proximal translation of pisiform in relation to triquetrum was reduced in the patients with distal radius fracture ( $P=0.028$ ). However, there was no difference of other instability parameters between the two groups. ECU tendinopathy was associated with larger PT interval ( $P=0.01$ ) and with wider opening of sagittal PT angle ( $P=0.021$ ). Triangular ligament tear was also related to reduced proximal translation of pisiform ( $P=0.031$ ). Osteoarthritic features of PT joint and triangular fibrocartilage tear were not associated with PT instability.

## **CONCLUSION**

Only pisiform translation was associated with distal radius fracture. Other instability parameters were not affected by distal radius fracture. ECU tendinopathy and triangular ligament tear were associated with PT instability.

## **CLINICAL RELEVANCE/APPLICATION**

Knowledge of PT instability and its relation to other carpal abnormality and traumatic disorder will facilitate early diagnosis of PT instability preventing symptomatic degenerative change of PT joint.

SSG04

## Gastrointestinal (Liver Masses)

Tuesday, Dec. 1 10:30AM - 12:00PM Location: E350

**GI** **CT** **MR** **OI**

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

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

### Participants

Ernst J. Rummeny, MD, Munich, Germany (*Moderator*) Nothing to Disclose  
Sudhakar K. Venkatesh, MD, FRCR, Rochester, MN (*Moderator*) Nothing to Disclose

### Sub-Events

#### SSG04-01 Predictive Value of MRI Combined with MR Cholangiography in the Preoperative Assessment of Perihilar Cholangiocarcinoma

Tuesday, Dec. 1 10:30AM - 10:40AM Location: E350

### Participants

Claudio Sallemi, MD, Milan, Italy (*Presenter*) Nothing to Disclose  
Francesca Ratti, Milan, Italy (*Abstract Co-Author*) Nothing to Disclose  
Paolo Marra, Milan, Italy (*Abstract Co-Author*) Nothing to Disclose  
Luca Aldrighetti, MD, Milano, Italy (*Abstract Co-Author*) Nothing to Disclose  
Alessandro Del Maschio, MD, Milan, Italy (*Abstract Co-Author*) Nothing to Disclose  
Francesco A. De Cobelli, MD, Milan, Italy (*Abstract Co-Author*) Nothing to Disclose

### PURPOSE

To evaluate the predictive value of contrast enhanced MR images with MR cholangiography (MRC) in the preoperative evaluation of perihilar cholangiocarcinoma.

### METHOD AND MATERIALS

twenty-five patients that underwent MRI/MRC and surgical treatment were included. Two radiologists evaluated the biliary MR images, including 3D-MRC and gadolinium-enhanced dynamic images, regarding the tumor resectability (including longitudinal tumor extent, vascular involvement of the bile duct cancer, and lymph node metastasis) and the surgical radicality, intended as tumor-free\ tumor-involved margins (R0\R1) of biliary ducts and portal vein. The results of preoperative and retrospective (blinded) assessment of diagnostic data were compared with the surgical and pathology findings used as the reference standards.

### RESULTS

The prospective assessment of the resection to be performed was correct in 80% of cases. For determining the assessment of tumor margins (R0\R1) of biliary ducts and portal vein, the overall accuracy was, respectively, 84% and 88% for each reviewer. The area under the receiver operating characteristic curve (Az) of the 2 reviewers for evaluation of tumor margins (R0\R1) was 0.83 and 0.78 for biliary ducts, and 0.68 and 0.97 for portal vein. In the assessment of lymph node metastasis, the overall accuracy was 0.75 for each reviewer.

### CONCLUSION

MR imaging combined with MRC showed excellent diagnostic capability for assessing the tumor resectability of bile duct cancer, although it generally underestimated the tumor involvement of lymph nodes, and predicted with good diagnostic accuracy surgical radicality.

### CLINICAL RELEVANCE/APPLICATION

MRI combined with MRC can predict in advance R0\R1 resection in perihilar cholangiocarcinoma . In case of R1, it can lead to a focused neo adjuvant therapy or change of the treatment strategy.

#### SSG04-02 Correlation between Standardized Uptake Value and Apparent Diffusion Coefficient in Focal FDG-PET Positive Hepatic Metastasis

Tuesday, Dec. 1 10:40AM - 10:50AM Location: E350

### Participants

Vaseemali J. Mulla, MBBS, DMRD, Gokak, India (*Presenter*) Nothing to Disclose  
Vishal Agrawal, Bangalore, India (*Abstract Co-Author*) Nothing to Disclose  
Kapil K. Shirodkar, DMRD, MBBS, Mapusa, India (*Abstract Co-Author*) Nothing to Disclose  
Govindarajan J. Mallarajapatna, MBBS, MD, Bangalore, India (*Abstract Co-Author*) Nothing to Disclose  
Aruna R. Patil, MD, FRCR, Bangalore, India (*Abstract Co-Author*) Nothing to Disclose

### PURPOSE

1)To evaluate a potential correlation of the maximum standard uptake value (SUVmax) and the minimum apparent diffusion coefficient (ADCmin) in FDG-PET positive hepatic metastasis2) To study the role of Diffusion Weighted MR Imaging in patients with FDG-PET positive hepatic metastasis

### METHOD AND MATERIALS

Twenty patients with a known and histopathologically proven extrahepatic primary lesion, who were referred for FDG PET and found



to have FDG avid hepatic lesion were enrolled. Regions of interest were drawn on the PET images and SUV mean was calculated. Patients with a SUVmean more than 4 were further imaged with MRI within 30-60 min of acquisition of PET images. Diffusion-weighted imaging was performed with free breathing and with b values of 0, 500, and 800. ADC map was generated using the above raw diffusion data. Regions of interest were manually drawn along the contours of neoplastic lesions, which were identified on PET and diffusion-weighted images. Maximum SUV (SUVmax) and mean SUV (SUVmean) were recorded from PET-CT fusion images using fusion viewer (Philips medical systems). Minimum ADC (ADCmin), and mean (ADCmean) were recorded on MRI workstation for each FDG-avid lesion. Pearson correlation coefficient was used to assess the following relations: SUVmax versus ADCmin and SUVmean versus ADCmean. A total of 33 lesions were studied.

## RESULTS

Thirty three lesions were evaluated in a total of 20 patients. The mean SUVmax was 13.5 with standard deviation of 5.1; SUVmean, 8.3 with standard deviation of 3.1; mean ADCmin, 491 with standard deviation of 235; and mean ADCmean, 809 with standard deviation of 263. Pearson correlation coefficient of 0.026 was found between SUVmean and ADCmean. Pearson correlation coefficient of 0.002 was found between SUVmax and ADCmin.

## CONCLUSION

There was no correlation between SUVmax and ADCmin or SUVmean and ADCmean. Focal hepatic lesions visualized on PET/CT were visualized clearly with a high contrast in the background of reduced signal from normal liver on b 0,500 and 800 maps of DWI

## CLINICAL RELEVANCE/APPLICATION

Liver metastases are the most frequently encountered malignant liver lesions. DWI is a non-contrast technique that is easy to perform, fast, has the potential to provide tissue characterization, and gives qualitative and quantitative information that can be helpful for tumor assessment. DWI gives visually comparable imaging which can be approximated to PET CT

### SSG04-03 Improving Detection of Vascular Structure and Intratumoral Hemorrhage in Primary Hepatic Carcinoma with a Multi-breath-hold Susceptibility-weighted Imaging Technique

Tuesday, Dec. 1 10:50AM - 11:00AM Location: E350

#### Participants

Ling Zhang, MD, Nanning, China (*Presenter*) Nothing to Disclose  
Zhongkui Huang, Nanning, China (*Abstract Co-Author*) Nothing to Disclose  
Yongming Dai, Shanghai, China (*Abstract Co-Author*) Nothing to Disclose  
Wenmei Li, Nanning, China (*Abstract Co-Author*) Nothing to Disclose

## PURPOSE

The purpose is to evaluate the role of abdominal susceptibility-weighted imaging (SWI) in the detection of vascular structure and intratumoral hemorrhage of primary hepatic carcinoma.

## METHOD AND MATERIALS

Nineteen patients with pathologically identified primary hepatic carcinoma were imaged at 3T (MAGNETOM Verio, A Tim System, Siemens, Germany) using a standard body matrix-coil. Imaging included precontrast transverse T1-weighted GRE (fiip angle 70°, TR/TE 140/2.46 msec), transverse T2-weighted fat-suppressed 2D turbo-spin-echo (TSE, fiip angle 122°, TR/TE 3700/84 msec, ETL 9) and transverse abdominal 2D SWI (fiip 20°, TR/TE 150/2.5 msec). For all sequences, the following parameters were used: field of view (FOV) 380×285 mm<sup>2</sup>; matrix 320-384×250, slice thickness 5 mm with a gap of 1 mm. Two to three 15-20 second breath-hold acquisitions were acquired to cover the liver. Two radiologists prospectively analyzed all magnetic resonance imaging (MRI) studies. Vascular structure and hemorrhage detected by each imaging technique were evaluated for comparison.

## RESULTS

Nineteen lesions were found in nineteen patients. 2D SWI showed the evidence of hemorrhage in 12 of all 19 cases. SWI displayed vasculature of tumors in 11 cases. Only 5 cases found vasculature in conventional sequences. On 2D SWI, the hemorrhage or vasculature in the lesions manifested dot-like, streak, circular areas with hypointensity signal. In the evaluation of blood products, SWI is superior to the conventional T1WI and T2WI for visualizing the intra vascular structure and hemorrhage (X<sup>2</sup>= 4.17, P < 0.05). There was close correlation between pathological results and SWI in depicting internal architecture of lesions.

## CONCLUSION

SWI surpassed conventional MRI sequences in discovering vascular structure in tumor and intratumoral hemorrhage. SWI offers a new way to show the internal structures of primary hepatic carcinoma. It is more useful than conventional MRI in showing blood products and details of tumor related veins.

## CLINICAL RELEVANCE/APPLICATION

SWI offers a new way to show the internal structures of primary hepatic carcinoma. It is more useful than conventional MRI in showing blood products and details of tumor related veins.

### SSG04-04 Subtraction Images of Gadoteric Acid-enhanced MR: The Impact on Image Interpretation of Focal Hepatic Lesions in Patients at Risk for HCC

Tuesday, Dec. 1 11:00AM - 11:10AM Location: E350

#### Participants

Sang Hyun Choi, Seoul, Korea, Republic Of (*Presenter*) Nothing to Disclose  
So Yeon Kim, MD, Seoul, Korea, Republic Of (*Abstract Co-Author*) Nothing to Disclose  
Seung Soo Lee, MD, Seoul, Korea, Republic Of (*Abstract Co-Author*) Nothing to Disclose  
Seong Ho Park, MD, Seoul, Korea, Republic Of (*Abstract Co-Author*) Nothing to Disclose  
Jae Ho Byun, MD, Seoul, Korea, Republic Of (*Abstract Co-Author*) Nothing to Disclose  
Yong Moon Shin, Seoul, Korea, Republic Of (*Abstract Co-Author*) Nothing to Disclose  
Moon-Gyu Lee, MD, Seoul, Korea, Republic Of (*Abstract Co-Author*) Nothing to Disclose

## PURPOSE

To evaluate the impact of subtraction images of gadoxetic acid-enhance on image interpretation of hepatic lesions in patients at risk for hepatocellular carcinomas (HCC)

## METHOD AND MATERIALS

We retrospectively identified 228 patients (181 men, 47 women; mean age, 55.2 years) with chronic viral hepatitis or liver cirrhosis who underwent gadoxetic acid-enhanced liver MR for the evaluation of focal hepatic lesions and then hepatic resection. The patients were confirmed to have 243 focal hepatic lesions including 227 HCCs, and 16 cholangiocarcinomas. We compared the detection rate of arterial hypervascularity on subtraction images and that on visual assessment of arterial phase images. Subgroup analysis was performed according to the pathology and the size of the lesions ( $\leq 3$  cm vs.  $> 3$  cm). We assessed the impact of subtraction images in diagnosing HCC according to the American Association for the Study of Liver Diseases (AASLD) guidelines in comparison with that of visual assessment.

## RESULTS

Subtraction images (92.6%, 225/243) detected arterial hypervascularity of all the focal hepatic lesions more sensitively than visual assessment (85.6%, 208/243;  $P = .001$ ). On the subgroup analysis according to the pathology, the same trend was also observed in HCC (96.0% vs. 90.3%,  $P = .011$ ), and in cholangiocarcinomas (43.8% vs. 18.8%,  $P = .125$ ). In the 113 lesions  $\leq 3$  cm, subtraction images (91.2%, 103/113) depicted arterial hypervascularity significantly better than visual assessment (81.4%, 92/113;  $P = .013$ ), while they did not significantly differ in detecting arterial hypervascularity in the 130 large lesions ( $> 3$  cm,  $P = .109$ ). When we included arterial hypervascularity detected on subtraction images, it increased the sensitivity from 86.3% to 92.5% in diagnosing HCCs with the increased false positive rate from 0.8% to 2.5%.

## CONCLUSION

Subtraction images can enhance the sensitivity of the non-invasive diagnosis of HCC by detecting arterial hypervascularity more sensitively especially in small focal hepatic lesions, with minimal increase in a false positive rate.

## CLINICAL RELEVANCE/APPLICATION

Subtraction images may be considered as an option to enhance the diagnostic performance of the noninvasive diagnosis for HCC.

### SSG04-05 Is Contrast-Enhanced Ultrasound Comparable to MRI with Liver-Specific Contrast Agent for Diagnosis of Focal Nodular Hyperplasia and Hepatocellular Adenoma?

Tuesday, Dec. 1 11:10AM - 11:20AM Location: E350

#### Participants

Krishan Ramsaransing, MD, Rotterdam, Netherlands (*Abstract Co-Author*) Nothing to Disclose

Roy S. Dwarkasing, MD, Rotterdam, Netherlands (*Abstract Co-Author*) Nothing to Disclose

Francois Willemsen, MD, Hoogstraten, Belgium (*Presenter*) Nothing to Disclose

Marianne De Vries, MD, Maastricht, Netherlands (*Abstract Co-Author*) Nothing to Disclose

## PURPOSE

To compare the diagnostic performance of contrast-enhanced ultrasonography (CEUS) with MRI with gadobenate dimeglumine (CEMRI) for the diagnosis of focal nodular hyperplasia (FNH) and hepatocellular adenoma (HCA) in a tertiary referral center for hepatobiliary diseases.

## METHOD AND MATERIALS

One hundred-nineteen patients (111 female and 8 male, mean age 39 years) referred to a tertiary center for hepatobiliary diseases were included. Patients had undergone standard diagnostic work-up with CEUS and CEMRI for the diagnosis of FNH or HCA. Final diagnosis was considered correct when outcome of CEUS and CEMRI were concordant. Histopathologic assessment (PA) followed in case of discrepancy between outcome of CEUS and CEMRI. CEMRI was considered as the reference method for final diagnosis when lesion biopsy for PA was considered undesirable or contra-indicated. Agreement between CEUS and CEMRI was calculated with Cohen's kappa and sensitivity, specificity, predictive values and likelihood ratios were calculated for CEUS and CEMRI.

## RESULTS

Outcomes of CEUS and CEMRI were concordant in the majority of patients ( $n=80$ , 67%) ( $p<0.001$ ) with an unweighted kappa of 0.34 (95% CI 0.20-0.49). In case of discrepancy between CEUS and CEMRI ( $n=39$ , 33%), PA followed in fourteen cases (12% of total), where CEMRI was correct in thirteen cases (93%) and CEUS in one case (7%) ( $p=0.002$ ). In the remaining twenty-five cases (21% of total), CEMRI was considered as reference for final diagnosis. For HCA, sensitivity was 64% (95% CI 48% - 78%) with CEUS and 100% (95% CI 92% - 100%) with CEMRI. For FNH, sensitivity was 67% (95% CI 55% - 77%) with CEUS, and 99% (95% CI 93% - 100%) with CEMRI.

## CONCLUSION

In our study, agreement between CEUS and CEMRI was fair and the diagnostic performance of CEUS was inferior to CEMRI for diagnosis of FNH and HCA, especially with emphasis on PA proven cases.

## CLINICAL RELEVANCE/APPLICATION

In case of discordance between CEUS and CEMRI, it may be justifiable to be prudent with liver biopsy and prefer CEMRI-outcome as final diagnosis, especially when the diagnosis on CEMRI is firm.

### SSG04-06 Hypoenhancement on Delayed Phase Contrast-enhanced MRI is a More Sensitive Sign of Malignancy in Colorectal Cancer Patients with Intravascular Contrast Agent, Gadofosveset, Than with Extracellular Contrast Agent, Gadobutrol

Tuesday, Dec. 1 11:20AM - 11:30AM Location: E350

#### Participants

Helen Cheung, MD, Toronto, ON (*Presenter*) Nothing to Disclose  
Natalie Coburn, Toronto, ON (*Abstract Co-Author*) Nothing to Disclose  
Chirag Patel, MBBS, MRCP, Toronto, ON (*Abstract Co-Author*) Nothing to Disclose  
Paul Karanickolas, Toronto, ON (*Abstract Co-Author*) Nothing to Disclose  
Masoom A. Haider, MD, Toronto, ON (*Abstract Co-Author*) Consultant, Bayer AG  
Laurent Milot, MD, MSc, Toronto, ON (*Abstract Co-Author*) Nothing to Disclose  
Calvin Law, MD, FRCPC, Toronto, ON (*Abstract Co-Author*) Nothing to Disclose

## PURPOSE

Hypoenhancement on delayed phase contrast-enhanced MRI using extracellular contrast agents, such as gadobutrol, is often used as a sign to diagnose colorectal liver metastases. Some studies have suggested that MRI with intravascular contrast agent, gadofosveset, may be useful in diagnosing focal liver lesions. The goal of this study is to determine the diagnostic accuracy of this sign using gadofosveset versus gadobutrol.

## METHOD AND MATERIALS

This is an interim analysis on an institutional REB-approved, prospective study. Patients with known colorectal cancer referred for a clinical gadobutrol-enhanced MRI at our institution met inclusion criteria for our study. Patients with known contraindication to MRI or MR contrast agents were excluded. Patients received both gadobutrol- and gadofosveset-enhanced liver MRI's, performed within 4 weeks of each other. Lesion-liver contrast-to-noise ratios (CNR) of all solid focal liver lesions (cysts were excluded) were measured on 10-minute delayed phase imaging for both contrast agents. Lesions with CNR<0 were considered hypoenhancing and lesions with CNR≥0 were considered hyperenhancing. We calculated the sensitivity, specificity, and likelihood ratio's of the ability of hypoenhancement to predict malignancy. Weighting was performed to account for the effects of clustering. The generalized estimating equation (GEE) was used to determine the effect of the contrast agent on the ability of the sign to predict malignancy.

## RESULTS

There were a total of 265 lesions from 14 patients. The weighted sensitivity and specificity of gadofosveset was 89.2% (SD: 25.0%) and 81.3% (SD: 37.2%) respectively, which corresponds to positive and negative likelihood ratio's of 4.76 and 0.13, respectively. The weighted sensitivity and specificity of gadobutrol 41.6% (SD: 40.9%) and 98.1% (5.6%), which corresponds to positive and negative likelihood ratios of 22.5 and 0.59. In the GEE model, hypoenhancement on delayed phase significantly predicted malignancy ( $p=0.005$ ) as did the interaction of hypoenhancement and contrast agent ( $p=0.006$ ).

## CONCLUSION

Hypoenhancement on delayed phase contrast-enhanced MRI with gadofosveset is a more sensitive sign of malignancy in colorectal cancer patients than with gadobutrol.

## CLINICAL RELEVANCE/APPLICATION

Delayed phase gadofosveset-enhanced MRI may be a helpful problem-solving tool for excluding malignancy in colorectal cancer patients.

### SSG04-07 Accuracy of the Extended Washout of Gadoteric-Acid for Distinguishing Hypervascular Hepatic Metastases from Hemangiomas on MRI

Tuesday, Dec. 1 11:30AM - 11:40AM Location: E350

#### Participants

Sheela Agarwal, MD, MS, Boston, MA (*Presenter*) Subsequent to the conduct of this research, speaker has become an employee of Bayer HC.  
Cinthia Cruz, MD, Boston, MA (*Abstract Co-Author*) Nothing to Disclose  
Joseph R. Grajo, MD, Boston, MA (*Abstract Co-Author*) Nothing to Disclose  
Mukesh G. Harisinghani, MD, Boston, MA (*Abstract Co-Author*) Nothing to Disclose  
Sanjay Saini, MD, Boston, MA (*Abstract Co-Author*) Nothing to Disclose  
Peter F. Hahn, MD, PhD, Belmont, MA (*Abstract Co-Author*) Stockholder, Abbott Laboratories Stockholder, Medtronic, Inc  
Stockholder, CVS Caremark Corporation Stockholder, Kimberly-Clark Corporation Stockholder, Landauer, Inc

## PURPOSE

The extended washout sign, slow de-enhancement of liver lesions in early hepatobiliary phase, has been proposed to help distinguish hemangiomas from conventional metastases. The intent of this study was to test this sign for hypervascular metastases.

## METHOD AND MATERIALS

This IRB approved retrospective study performed quantitative and qualitative image analysis of 24 patients with proven neuroendocrine liver metastases, together with data on 45 hemangioma patients and 39 with hypovascular metastases already reported. Gadoteric-acid MR imaging was obtained during arterial and portal-venous phase, and delays of 3, 8, and 20 minutes. During each phase, signal intensities were measured for the lesion, liver, and aorta, and were normalized by paraspinal musculature. Quantitatively, extended washout was defined as a 10% change in signal intensity from 8 to 20 minutes. Statistical analysis was performed using paired Student's t-test. Qualitative analysis was performed by one reader, who assessed the appearance of all lesions on T2-weighted images alone, dynamic images alone, and combined early (8 min) and late (20 min) hepatobiliary phases. Extended washout was defined as a perceptible change in signal from 8 to 20 minutes.

## RESULTS

On quantitative analysis, 84% (n=38) of hemangiomas demonstrated a positive extended washout sign while only 8% (n=2) of hypervascular metastases, and 4% (n=7) of hypovascular metastases did. Hemangiomas demonstrated a mean change in signal intensity of 18.4% as compared to 5.5% for hypervascular metastases ( $p<0.05$ ). Qualitatively, 78% of hemangiomas demonstrated a perceptible change in signal from 8 to 20 minutes, but only 4.1% of metastases did. 67% of hemangiomas demonstrated peripheral nodular enhancement during dynamic phases and 87% demonstrated classic T2 hyperintensity. Arterial enhancement of the metastases was appreciated with gadoteric acid in 83% of the cases. When extended washout was used in combination with T2 hyperintensity, specificity increased to 98%, with a sensitivity of 96%.

## CONCLUSION

The extended washout sign on gadoteric acid-enhanced MRI can be applied to hypervascular as well as to non-hypervascular liver metastases to help in distinguishing them from hemangiomas.

## CLINICAL RELEVANCE/APPLICATION

Extended washout sign, particularly when used in conjunction with T2 signal intensity, can be used to increase accuracy of differentiating hemangiomas from metastases on gadoterate-enhanced MRI.

## SSG04-09 Fully Integrated PET/MRI for the Colorectal Cancer Liver Metastases: Diagnostic Performance and Prognostic Value

Tuesday, Dec. 1 11:50AM - 12:00PM Location: E350

### Participants

Dong Ho Lee, MD, Seoul, Korea, Republic Of (*Presenter*) Nothing to Disclose  
Jeong Min Lee, MD, Seoul, Korea, Republic Of (*Abstract Co-Author*) Grant, Guerbet SA; Support, Siemens AG; Support, Koninklijke Philips NV ; Grant, Bayer AG; Consultant, Bayer AG; Grant, General Electric Company; Support General Electric Company; Grant, STARmed Co, Ltd; Grant, RF Medical Co, Ltd; Grant, Toshiba Corporation; Grant, Dong-Seo Medical Industrial Co, Ltd  
Ijin Joo, MD, Seoul, Korea, Republic Of (*Abstract Co-Author*) Nothing to Disclose  
Bo Yun Hur, 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 diagnostic performance and prognostic value of fully integrated PET/MRI in patients with colorectal cancer liver metastases (CRLMs)

## METHOD AND MATERIALS

between January 2013 and June 2014, 55 patients with 98 CRLMs who underwent fully integrated PET/MRI and MDCT were included in this study. Among these CRLMs, 66 CRLMs in 34 patients were diagnosed by histopathology after hepatic resection, and 32 CRLMs in 21 patients were diagnosed by follow-up imaging. Among the 34 patients who underwent hepatic resection for CRLMs, 17 patients received neoadjuvant chemotherapy (NAC) and then followed by surgery. Two board-certificated radiologists independently and randomly assessed both MDCT and fully integrated PET/MRI for detection of CRLMs. In order to compare the diagnostic performance of PET/MRI for detecting CRLMs to MDCT, jackknife alternative free-response receiver-operating characteristic (JAFROC) and generalized estimating equations (GEE) were used. For the evaluation of prognostic value of PET, we analyzed recurrence-free survival in 17 patients who underwent NAC and followed by hepatic resection for CRLMs.

## RESULTS

reader average figure-of-merit of PET/MRI was significantly higher than that of MDCT for detecting CRLMs (0.842 for MDCT vs. 0.932 for PET/MRI,  $P=0.004$ ). Sensitivity per tumor as well as per patients of PET/MRI was also significantly higher than those of MDCT in both two readers. Especially, PET/MRI showed significantly higher sensitivities for CRLMs  $\leq 1$ cm and CRLMs treated by NAC in both two readers. According to the PET imaging findings of PET/MRI, six of 17 patients who underwent NAC were classified as having iso-metabolic CRLMs on PET, while 11 patients as having hyper-metabolic CRLMs. 1-year recurrence-free survival rate was 80.0% in 6 patients with iso-metabolic CRLMs, compared to 15.2% in 11 patients with hyper-metabolic CRLMs: this difference was statistically significant ( $P=0.034$ ).

## CONCLUSION

fully integrated PET/MRI can provide significantly higher diagnostic performance for detecting CRLMs compared to MDCT, especially for small CRLMs and CRLMs treated by NAC. PET imaging findings of PET/MRI after NAC was a significant affecting factor for recurrence-free survival after hepatic resection.

## CLINICAL RELEVANCE/APPLICATION

fully integrated PET/MRI can be helpful for patients with CRLMs.

**Physics (CT IV-New Development 1)**

Tuesday, Dec. 1 10:30AM - 12:00PM Location: S403B



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

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

**Participants**

Willi A. Kalender, PhD, Erlangen, Germany (*Moderator*) Consultant, Siemens AG Consultant, Bayer AG Founder, CT Imaging GmbH Scientific Advisor, CT Imaging GmbH CEO, CT Imaging GmbH  
Guang-Hong Chen, PhD, Madison, WI (*Moderator*) Research funded, General Electric Company; Research funded, Siemens AG

**Sub-Events****SSG14-01 Lung Cancer Screening (LCS) in Ultra-low-dose CT (U-LDCT) by Means of Massive-Training Artificial Neural Network (MTANN) Image-Quality Improvement: An Initial Clinical Trial**

Tuesday, Dec. 1 10:30AM - 10:40AM Location: S403B

**Participants**

Wataru Fukumoto, Hiroshima, Japan (*Presenter*) Nothing to Disclose  
Kenji Suzuki, PhD, Chicago, IL (*Abstract Co-Author*) Royalties, General Electric Company; Royalties, Hologic, Inc; Royalties, MEDIAN Technologies; Royalties, Riverain Technologies; Royalties, Toshiba Corporation; Royalties, Mitsubishi Corporation; Research Consultant, Alara Systems; Stockholder, Alara Systems; Research Consultant, AlgoMedica; Stockholder, AlgoMedica; ; ; ; ; ;  
Toru Higaki, PhD, Hiroshima, Japan (*Abstract Co-Author*) Nothing to Disclose  
Yoshikazu Awaya, MD, Miyoshi, Japan (*Abstract Co-Author*) Nothing to Disclose  
Masayo Fujita, Hiroshima, Japan (*Abstract Co-Author*) Nothing to Disclose  
Kazuo Awai, MD, Hiroshima, Japan (*Abstract Co-Author*) Research Grant, Toshiba Corporation; Research Grant, Hitachi, Ltd; Research Grant, Bayer AG; Research Grant, DAIICHI SANKYO Group; Medical Advisor, DAIICHI SANKYO Group; Research Grant, Eisai Co, Ltd; Research Grant, Nemoto-Kyourindo; ; ; ; ;

**PURPOSE**

We developed a method for improving the image quality of U-LDCT by means of a supervised patch/pixel-based machine-learning technique called an MTANN. The MTANN can create the virtual higher-dose CT (v-HDCT) from U-LDCT by learning the relationship between U-LDCT and higher-dose CT. The purpose of this study was to investigate the clinical feasibility of U-LDCT with the MTANN technology for LCS.

**METHOD AND MATERIALS**

Thirty subjects (median age: 66 y.o.; range: 55-74) underwent CT LCS with both low-dose CT (LDCT) and U-LDCT using a 320-detector-row CT scanner (Aquilion One, Toshiba, Japan). LDCT were performed under our LCS protocol (120 kVp, automatic tube-current control with 22 noise index, 0.5 mm x 80 detector row, 1.39 pitch factor, 2 mm reconstruction slice thickness and interval), while U-LDCT were done with the same parameters except a tube-current-time-product of 5 mAs. Effective radiation doses for LDCT and U-LDCT were approximately 2.0 and 0.2 mSv, respectively. Both LDCT and U-LDCT were reconstructed with the filtered-back-projection algorithm. Our MTANN converted U-LDCT images to v-HDCT images. Two radiologists reviewed LDCT images, and "gold-standard" pulmonary nodules 4 mm or larger in diameter were determined in consensus. We evaluated v-HDCT in comparison to the "gold-standard" by using a 3-point subjective scale, i.e., Grade 3: a nodule and its type (solid nodule [SN] or ground-glass nodule [GGN]) were accurately identified on v-HDCT; Grade 2: a nodule but not its type was identified confidently; Grade 1: a nodule could not be identified.

**RESULTS**

We identified 18 nodules (16 SN; 2 GGN) on LDCT images in the 30 subjects. All 16 SNs on v-HDCT were classified as Grade 3, whereas the 2 GGNs were Grade 2.

**CONCLUSION**

All SNs and GGNs could be identified on MTANN v-HDCT, but a nodule type for 2 GGNs was difficult to be determined confidently.

**CLINICAL RELEVANCE/APPLICATION**

MTANN may be useful for further reduction of radiation dose in LDCT for lung cancer screening.

**SSG14-02 Motion Compensation from Short-Scan Data in Cardiac CT**

Tuesday, Dec. 1 10:40AM - 10:50AM Location: S403B

**Participants**

Juliane Hahn, Heidelberg, Germany (*Presenter*) Nothing to Disclose  
Thomas Allmendinger, Forchheim, Germany (*Abstract Co-Author*) Nothing to Disclose  
Herbert Bruder, Forchheim, Germany (*Abstract Co-Author*) Nothing to Disclose  
Marc Kachelriess, PhD, Heidelberg, Germany (*Abstract Co-Author*) Nothing to Disclose

**PURPOSE**

To reduce motion artifacts of the coronary arteries (CAs) and to increase the temporal resolution (TR) while utilizing only the minimal amount of rawdata needed for a short-scan reconstruction.



## METHOD AND MATERIALS

The TR in diagnostic single source cardiac CT lies in the order of 0.15 s. In cases with higher heart rates, however, motion artifacts remain in the region of the CAs. Motion compensation (MoCo) algorithms estimate and apply motion vector fields (MVFs) and can, potentially, reduce such artifacts by effectively improving the TR. Most of the MoCo algorithms described so far require scan data significantly larger than the short scan interval to estimate the motion parameters. We propose a new approach to increase the TR in the region of the CAs. It consists of three steps: a) performing an initial reconstruction and segmenting the CAs, b) estimating the motion from the short scan interval ( $180^\circ + \text{fan angle}$ ) and c) performing the MoCo. The last two steps are based on the decomposition of the initial volume into N overlapping limited angle reconstructions. As an initial MVF guess the barycenters of the CAs are determined slice-wise in the limited angle image volumes. The MVFs are iteratively refined using a cost function maximizing the image sharpness. To validate the algorithm a dynamic CA simulation study is employed. Furthermore the algorithm is applied to clinical patient data with heart rates between 60 bpm and 90 bpm. Motion-compensated reconstruction is performed in several heart phases.

## RESULTS

In the simulated and measured cases the value  $N = 30$ , yielding limited angle images covering a  $12^\circ$  projection range each, turned out to be sufficient. The TR could be increased which was found by comparison with simulations at faster rotation speeds. Regarding the patient data we found that 10 coronary segments showed motion artifacts and with our MoCo method we were able to remove the artifacts in all but two cases.

## CONCLUSION

We presented a cardiac MoCo algorithm providing an improved delineation of the coronary arteries. The findings have been evaluated based on a simulation study and on patient data, where the visibility of the coronary arteries increased due to an increased temporal resolution.

## CLINICAL RELEVANCE/APPLICATION

Increasing the temporal resolution in cardiac CT imaging and thereby reducing motion artifacts improves the accuracy in the diagnosis of coronary artery disease.

### SSG14-03 XACT: A New Imaging Modality Based on Ultrasonic Detection of X-ray Absorption

Tuesday, Dec. 1 10:50AM - 11:00AM Location: S403B

#### Awards

##### Trainee Research Prize - Fellow

#### Participants

Shanshan Tang, PhD, Norman, OK (*Presenter*) Nothing to Disclose  
Hong Liu, PhD, Norman, OK (*Abstract Co-Author*) Nothing to Disclose  
Liangzhong Xiang, PhD, Norman, OK (*Abstract Co-Author*) Nothing to Disclose

## PURPOSE

Absorption based X-ray imaging including CT is an invaluable tool in medical diagnostics. However, the use of conventional CT is limited by two factors; one is the limited spatial resolution, and the other is the relatively high radiation dose. The purpose of this study is to explore X-ray induced acoustic computed tomography (XACT), a new imaging modality, which take advantages of the X-ray absorption contrast at low radiation dose and high ultrasonic resolution in a single modality.

## METHOD AND MATERIALS

First, a theoretical model was built to analyze the sensitivity to X-ray absorption by comparing with XACT and conventional X-ray imaging. Second, an XACT imaging system was developed to evaluate the X-ray induced acoustic signal generation. 60-nanosecond x-ray pulses were generated from an X-ray source operated at the energy of 150 kVp with a 25-Hz repetition rate. The X-ray induced acoustic signals were captured by a commercial ultrasonic transducer (2.25 MHz in central frequency).

## RESULTS

Theoretical analysis shows that X-ray induced acoustic signal has 100% relative sensitivity to the X-ray absorption. It naturally filters out the X-ray scattering. Less background from the ultrasonic detection of X-ray absorption will increase the imaging sensitivity. In the experiment, a lead wire and a piece of bone were irradiated to demonstrate the X-ray induced acoustic signals generation, respectively. A major peak is readily observed in the signals. We found that the pulse width of the acoustic signal was about 0.66  $\mu$ s; which correspond with the target size of 1 mm. The radiation dose of a single pulse is 0.03 mGy. It is only 1/100 less radiation dose of the normal X-ray CT.

## CONCLUSION

In XACT imaging, we detect the acoustic signal generated by X-rays instead of detecting X-rays themselves. The acoustic signal is sensitive only to the X-ray absorption, and not to X-ray scattering. Using this principle, we improve the imaging sensitivity of X-ray absorption. Taking advantage of the high ultrasonic resolution, we can also perform 3-D imaging with a single x-ray pulse and without any mechanical motion of the imaging system. We can thus reduce the radiation dose by a factor of 100, and image 100 times faster when compared to the conventional X-ray CT. This new modality has the potential to revolutionize x-ray imaging applications in medicine and biology.

## CLINICAL RELEVANCE/APPLICATION

Dedicated breast XACT for breast cancer screening.

### SSG14-04 Assessment of Dose Performance of a New Technique for Single Source Dual Energy Acquisition

Tuesday, Dec. 1 11:00AM - 11:10AM Location: S403B

#### Participants

Christian Hofmann, Erlangen, Germany (*Abstract Co-Author*) Employee, Siemens AG

Thomas G. Flohr, PhD, Forchheim, Germany (*Abstract Co-Author*) Employee, Siemens AG  
Katharine Grant, PhD, Rochester, MN (*Presenter*) Employee, Siemens AG  
Bernhard Schmidt, PhD, Forchheim, Germany (*Abstract Co-Author*) Employee, Siemens AG

## PURPOSE

Dual Energy (DE) scanning has skyrocketed in scientific relevance and diagnostic importance. The goal of this research is to determine if a novel, yet simple technique for DE utilizing a single x-ray tube by applying a split filtration to the x-ray beam in scan direction enabling simultaneous acquisition of different spectra, allows for dose efficient CT acquisitions compared to other single source DE approaches and standard single energy scanning.

## METHOD AND MATERIALS

Two water equivalent phantoms, an anthropomorphic phantom (20cmx30cm) and a circular phantom (30cm), both equipped with an iodine insert (15mg I/cm<sup>3</sup>) in the center, were used for measurements. Four different scan acquisitions at matched dose (CTDIvol) were utilized for comparison; split filter DE (SFDE) utilizing 120kV, Dual Scan DE (optimized mA between kVs. DSDEopt), Dual Scan DE (fixed mA between kVs, DSDEfix), and 120kV single energy (SE). Each phantom was scanned 5 times for each acquisition to gather statistical meaning. All measurements were performed on systems with highly integrated circuit detectors (Stellar, Siemens AG, Forchheim, Germany). Image noise and iodine contrast-to-noise ratio (CNR) were measured in mixed images generated by linear combination of the high and low kV images resulting in minimal image noise.

## RESULTS

At equal CTDIvol the image noise in SFDE approach tends to be lower than in the other approaches. For the anthropomorphic phantom:  $\sigma_{SFDE} = 11.6 < \sigma_{SE} = 13.9 < \sigma_{DSDEfix} = 14.4 < \sigma_{DSDEopt} = 14.5$  HU. For the circular phantom:  $\sigma_{SFDE} = 17.7 < \sigma_{SE} = 21.5 < \sigma_{DSDEfix} = 22.4 < \sigma_{DSDEopt} = 23.1$  HU. At equal CTDIvol the iodine CNR tends to be highest for DSDEopt followed by SFDE. For the anthropomorphic phantom:  $CNR_{DSDEopt} = 27.9 > CNR_{SFDE} = 24.9 > CNR_{SE} = 24.2 > CNR_{DSDEfix} = 22.4$ . For the circular phantom:  $CNR_{DSDEopt} = 15.4 > CNR_{SFDE} = 14.9 > CNR_{SE} = 14.0 > CNR_{DSDEfix} = 12.7$ .

## CONCLUSION

SFDE provides an effective solution to simultaneously acquire high and low energy data without dose penalties compared to standard single scanning, thus enabling routine Dual Energy scanning.

## CLINICAL RELEVANCE/APPLICATION

Dose efficient dual energy scanning has been limited to dual source systems. SFDE allows for dose efficient scans on a single source systems, further enabling routine Dual Energy in clinical practice.

## SSG14-05 Value of Scout-View Based Personalized Scan Protocol Selection of Spectral CT Imaging Individual Contrast Medium Protocol

Tuesday, Dec. 1 11:10AM - 11:20AM Location: S403B

### Participants

Shiyu Wang, Dalian, China (*Presenter*) Nothing to Disclose  
Yijun Liu, Dalian, China (*Abstract Co-Author*) Nothing to Disclose  
Ailian Liu, MD, Dalian, China (*Abstract Co-Author*) Nothing to Disclose  
Renwang Pu JR, MBBCh, FRCPC, Dalian, China (*Abstract Co-Author*) Nothing to Disclose  
Xin Fang, Dalian, China (*Abstract Co-Author*) Nothing to Disclose

## PURPOSE

To investigate the value of scout-view based personalized scan protocol selection of gemstone spectral imaging and personalized contrast medium protocol (400mgI/kg) in enhanced abdomen CT, comparison the image quality with routine 120 kV and contrast medium protocol.

## METHOD AND MATERIALS

83 patients suggested with abdomen enhanced CT scan were enrolled and all were divided into two groups randomly. Group A (n=49) used tube voltage of 120kV and automatic exposure control (AEC), according to the body mass index (BMI), the noise index (NI) of AEC were setted as 10 (BMI<23), 12(23≤BMI≤26) and 14(BMI>26) respectively. The contrast medium concentration was 350mgI/ml, the injection volume and speed was 100ml and 5ml/s respectively. Group B (n=34) underwent plain CT scanning using AEC with BMI based NI setting (BMI<23, NI=10; 23≤BMI≤26, NI=12; BMI>26, NI=14). According the maximum mA and average mA, choosing corresponding GSI protocols with approximate CTDIvol. The maximum mA corresponded CTDIvol approximate GSI protocol was used for arterial phase and vein phase. The average mA corresponded CTDIvol approximate GSI protocol was used for parenchyma phase. Monochromatic images at 60keV blending with 40% adaptative statistical iterative reconstruction (ASiR) were reconstructed. The CT value and SD value of abdomen aorta and erector spinae were measured and the contrast-noise-ratio was calculated. Data was compared with student T-test.

## RESULTS

The image noise and the CT value of aorta and erector spinae showed no significant difference between two groups (both P>0.05). The CNR of two groups have no significant difference (43.89±19.08 vs 38.29±9.44, P>0.05). The DLP of group B was lower than that of group A (460.91±225.18 vs 390.69±129.03, P<0.05). The total contrast volume of group B had an average 25.29% decrease than that of group A (74.71±11.04 vs 100ml±0.00, P<0.05).

## CONCLUSION

Personalized scan and contrast medium protocol in spectral CT imaging significant reduce radiation dose and contrast medium dose without compromising image quality.

## CLINICAL RELEVANCE/APPLICATION

Spectral CT imaging provides a high-quality angiographic technique, which allows use of a lower contrast agent compared with conventional 120-kVp SECT.



## **SSG14-06 Fluence Field Modulation for Low-dose X-ray Computed Tomography using Compact Multiple Aperture Devices**

Tuesday, Dec. 1 11:20AM - 11:30AM Location: S403B

### **Participants**

Joseph W. Stayman, PhD, Baltimore, MD (*Presenter*) Research Grant, Elekta AB; Research Grant, Varian Medical Systems, Inc  
Aswin J. Mathews, Saint Louis, MO (*Abstract Co-Author*) Nothing to Disclose  
Wojciech Zbijewski, PhD, Baltimore, MD (*Abstract Co-Author*) Research Grant, Carestream Health, Inc  
Jeffrey H. Siewerdsen, PhD, Baltimore, MD (*Abstract Co-Author*) Research Grant, Siemens AG; Consultant, Siemens AG; Research Grant, Carestream Health, Inc; License agreement, Carestream Health, Inc; License agreement, Elekta AB; ;  
Ira Blevis, Haifa, Israel (*Abstract Co-Author*) Employee, Koninklijke Philips NV  
Reuven Levinson, MSc, Haifa, Israel (*Abstract Co-Author*) Employee, Koninklijke Philips NV  
Hao Dang, Baltimore, MD (*Abstract Co-Author*) Research Grant, Carestream Health, Inc  
Satomi Kawamoto, MD, Baltimore, MD (*Abstract Co-Author*) Research Grant, Siemens AG; ;

### **PURPOSE**

CT scanning at low doses is limited by the scanner's ability to adapt to specific patients and imaging tasks. Current clinical CT permit exposure reductions via x-ray technique selection and current modulation. While dynamic fluence field modulation (FFM) has been proposed to greatly expand the capability of CT systems to customize acquisitions and minimize dose, design constraints including actuation speed, g-forces, and available space make practical solutions difficult. In this work, we propose a novel, compact FFM system based on multiple aperture devices (MADs) that can meet these practical requirements to provide patient-specific low-dose acquisitions.

### **METHOD AND MATERIALS**

We develop a theoretical framework for design and simulation of MADs and construct prototype devices for initial characterization. MADs are essentially binary filters (entirely blocking or transmitting the x-ray beam on a fine scale). Spatial modulation is established through appropriately sized, space-variant aperture design. Dynamic FFM is possible when two devices are placed in series, and translated relative to one another. Various design options are explored - especially those that minimize undesirable high-frequency field modulations while enforcing the desired low-frequency modulations. Prototype devices were constructed using tungsten sintering and characterized on a CT test bench.

### **RESULTS**

Various multiple apertures devices were studied including designs meant to yield flat fluence patterns for circular and elliptical objects of various sizes. In testbench studies using prototype devices, flattened fields are demonstrated in physical phantoms, minimized high-frequency aperture patterns are observed, and artifact-free tomographic reconstructions are produced and shown to have similar image quality as compared to traditional (static) bow-tie filters.

### **CONCLUSION**

With relative motion requirements of less than a millimeter/quarter rotation, minimum thicknesses of several millimeters, and a rigid filter material, practical device placement within a clinical CT gantry is achievable. Combined with good image quality in initial reconstruction results, multiple aperture devices are a potential solution to practical FFM in CT.

### **CLINICAL RELEVANCE/APPLICATION**

The proposed dynamic FFM system is practical for clinical CT scanners and will facilitate customized patient scans, maximizing diagnostic imaging performance at minimum radiation exposures.

## **SSG14-07 Quantitative Assessment of Coronary Artery CT Images with Full Iterative Reconstruction Performed on a 320 Detector-row Scanner**

Tuesday, Dec. 1 11:30AM - 11:40AM Location: S403B

### **Participants**

Masao Kiguchi, RT, Hiroshima, Japan (*Presenter*) Nothing to Disclose  
Chikako Fujioka, RT, Hiroshima, Japan (*Abstract Co-Author*) Nothing to Disclose  
Eiji Nishimaru, RT, Hiroshima, Japan (*Abstract Co-Author*) Nothing to Disclose  
Kazushi Yokomachi, RT, Hiroshima, Japan (*Abstract Co-Author*) Nothing to Disclose  
Toru Higaki, PhD, Hiroshima, Japan (*Abstract Co-Author*) Nothing to Disclose  
Kazuo Awai, MD, Hiroshima, Japan (*Abstract Co-Author*) Research Grant, Toshiba Corporation; Research Grant, Hitachi, Ltd; Research Grant, Bayer AG; Research Grant, DAIICHI SANKYO Group; Medical Advisor, DAIICHI SANKYO Group; Research Grant, Eisai Co, Ltd; Research Grant, Nemoto-Kyourindo; ; ; ;  
Akira Taniguchi, RT, Otawara, Japan (*Abstract Co-Author*) Employee, Toshiba Corporation  
So Tsushima, Otawara, Japan (*Abstract Co-Author*) Employee, Toshiba Corporation

### **PURPOSE**

To compare the spatial resolution, image noise, and image quality of volume scans performed on a 320 detector-row CT scanner with filtered back projection (FBP), hybrid iterative reconstruction (IR), and a new full IR algorithm.

### **METHOD AND MATERIALS**

Using a 320-detector scanner (Aquilion One Vision, Toshiba) we scanned Catphan- and pulsating coronary artery (CA) phantoms (diameter 4 mm) with plaque-, calcium plaque-, and Cypher stent stenosis. The phantoms contained an iodine solution (CT number 350 HU at 120 kV) and were scanned in the volume scan mode, non-gated. Scanning was at 50-, 100-, and 150 mAs. Reconstruction was with filtered back projection (FBP) and quantum denoising filters, hybrid IR (Adaptive Iterative Dose Reduction-3D: AIDR 3D), and full IR (FIRST). We recorded the image noise (standard deviation [SD] of the CT number and the noise power spectrum), image resolution (contrast of the ladder pattern and the modulation transfer factor [MTF]), and the full width at half maximum (FWHM) of the inner diameter of the simulated CAs and performed Tukey's multiple comparisons among the different scan parameters.

## RESULTS

The image noise on images acquired at 150 mAs was 7.9 (FBP), 10.0 (AIDR 3D), and 8.1 (FIRST) and the [WU1] 50% MTF was 0.45, 0.49, and 0.78. The mean absolute percentage error of the FWHM was 4.2, 4.7, and 6.6% (50% plaque stenosis model), 4.4, 3.7, and 2.1% (50% CA stenosis model), and 26.2, 25.8, and 14.4% (stent model). The FWHM [k2] of the stent model [WU3] on images reconstructed with FIRST was significantly larger than with FBP or AIDR 3D ( $p < 0.01$ ). On images reconstructed with FIRST, the image quality was improved by 15-20% compared with FBP or AIDR 3D.

## CONCLUSION

On scans of the simulated pulsating CA, FIRST yielded better image noise and spatial resolution than FBP or AIDR 3D.

## CLINICAL RELEVANCE/APPLICATION

Full iterative reconstruction (FIRST) yields better image noise and spatial resolution than FBP or AIDR 3D and facilitates the accurate quantitative analysis of CT images of the coronary artery.

### SSG14-08 Phase Retrieval and De-wrapping in Grating-based X-ray Differential Phase Contrast CT with Twin-peaks in Phase-stepping Curves

Tuesday, Dec. 1 11:40AM - 11:50AM Location: S403B

#### Participants

Yi Yang, PhD, Atlanta, GA (*Presenter*) Nothing to Disclose  
Huiqiao Xie, PhD, Atlanta, GA (*Abstract Co-Author*) Nothing to Disclose  
Weixing Cai, PhD, Rochester, NY (*Abstract Co-Author*) Nothing to Disclose  
Hui Mao, PhD, Atlanta, GA (*Abstract Co-Author*) Nothing to Disclose  
Xiangyang Tang, PhD, Atlanta, GA (*Abstract Co-Author*) Research Grant, Sinovision Technologies Co Ltd

## PURPOSE

In x-ray differential phase contrast (DPC) CT implemented with Talbot interferometry, phase-stepping procedure is widely employed to extract the phase signal for imaging. Since the fabrication process may cause defects in analyzer grating G2, the actual period of G2 may double the nominal period of G2, and the experimental determined phase-stepping curve (PSC) exhibits two distinct peaks within an actual period  $2g_2$ . For such a DPC-CT system with twin-peak PSCs, we develop an approach to retrieve and unwrap the phase signal.

## METHOD AND MATERIALS

Based on the paraxial Fresnel-Kirchhoff theory, we derive an analytical formula to characterize the PSCs of an x-ray Talbot interferometry with flawed analyzer grating. We also conduct an experimental investigation into the phase retrieval and de-wrapping in x-ray DPC-CT with twin-peak PSCs. An x-ray Talbot interferometry with 4.6 micron of  $g_2$  is utilized to scan a mouse and a phantom that consists of tubes filled with water, cotton, sugar and air.

## RESULTS

Fourier analysis of the PSC demonstrates that its first-order Fourier component with spatial frequency  $1/2g_2$  is non-negligible, although it is smaller in magnitude than the second-order Fourier component with spatial frequency  $1/g_2$ . Consequently, experimental results show that in comparison with scanning G2 over its nominal period  $g_2$ , stepping G2 over its actual period  $2g_2$  can provide data to enable a significantly improved reconstruction of the phase-contrast CT images. Furthermore, with the use of the phase signal retrieved from the first-order Fourier component, the possible phase wraps in the phase signal retrieved from the second-order Fourier component can be removed.

## CONCLUSION

Our theoretical analysis and experimental investigation show that for an x-ray DPC-CT imaging system with twin-peak PSCs, the PSCs should be determined by scanning G2 over the double of its nominal period  $g_2$ ; and then the PSCs can be utilized to retrieve and unwrap the phase signal for imaging.

## CLINICAL RELEVANCE/APPLICATION

The preliminary results reported in this study may be of relevance to the preclinical and eventually clinical applications of grating-based x-ray phase contrast CT.

### SSG14-09 Third-generation Dual-source CT of the Neck Using Automated Tube Voltage Adaptation in Combination with Advanced Modeled Iterative Reconstruction: Evaluation of Image Quality and Radiation Dose

Tuesday, Dec. 1 11:50AM - 12:00PM Location: S403B

#### Participants

Jan-Erik Scholtz, MD, Frankfurt, Germany (*Presenter*) Nothing to Disclose  
Moritz H. Albrecht, MD, Frankfurt am Main, Germany (*Abstract Co-Author*) Nothing to Disclose  
Kristina Husers, Frankfurt, Germany (*Abstract Co-Author*) Nothing to Disclose  
Sebastian Fischer, MD, Frankfurt, Germany (*Abstract Co-Author*) Nothing to Disclose  
Martin Beeres, MD, Frankfurt Am Main, Germany (*Abstract Co-Author*) Nothing to Disclose  
Julian L. Wichmann, MD, Charleston, SC (*Abstract Co-Author*) Nothing to Disclose  
Thomas J. Vogl, MD, PhD, Frankfurt, Germany (*Abstract Co-Author*) Nothing to Disclose  
Boris Bodelle, MD, Frankfurt Am Main, Germany (*Abstract Co-Author*) Nothing to Disclose

## PURPOSE

To evaluate image quality and radiation dose in third-generation 192-slice dual-source computed tomography (DSCT) of the neck using automated tube voltage adaptation (TVA) with an advanced modeled iterative reconstruction (ADMIRE) algorithm.

## METHOD AND MATERIALS

CT studies of the neck in 116 patients were retrospectively evaluated. Group A (n=59) was examined on a second-generation DSCT with automated TVA and standard filtered back projection (FBP). Group B (n=57) was examined on a third-generation DSCT with automated TVA and ADMIRE. Age, neck diameter, and attenuation and noise of sternocleidomastoid muscle, internal jugular vein (IJV), submandibular gland, tongue, subscapularis muscle, and cervical fat were measured. Signal-to-noise ratio (SNR) and contrast-to-noise ratio (CNR) were calculated. Size-specific dose estimates (SSDE) were assessed. Diagnostic acceptability was rated by three readers on a five-point scale.

## **RESULTS**

Age (Group A, 57.9±18.1 years; Group B, 57.4±17.7 years; p=0.87) and effective body diameter (Group A, 15.1±1.6 cm; Group B, 15.8±1.9; p=0.075) did not differ significantly. Tube voltage in Group A was automatically set by TVA to 100 kV for all patients in group A (n=59), and to 70 kV (n=2), 80kV (n=5), and 90kV (n=50) in Group B. Average image noise was reduced and CNR was increased significantly (both p<0.001) in group B compared to group A. Diagnostic acceptability was rated consistently high in both groups with significantly better ratings for Group B than for Group A (4.83 vs. 4.56; p<0.001). Average SSDE was reduced by 34% in Group B compared to Group A (20.38±1.63 mGy vs. 13.04±1.50 mGy, p<0.001).

## **CONCLUSION**

Combination of automated TVA and ADMIRE reconstruction in neck CT using third-generation DSCT results in a 34% radiation dose reduction compared to second-generation DSCT with automated TVA and FBP reconstruction with substantially lower image noise and significantly increased CNR and subjective image quality.

## **CLINICAL RELEVANCE/APPLICATION**

Automated TVA in combination with ADMIRE should be routinely applied to neck DSCT in clinical routine to reduce radiation exposure and image noise, and to increase image quality.

SSG08

## Informatics (Results and Reporting)

Tuesday, Dec. 1 10:30AM - 12:00PM Location: S402AB



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

### Participants

David S. Hirschorn, MD, Staten Island, NY (*Moderator*) Nothing to Disclose  
Amon Makori, MD, Chicago, IL (*Moderator*) Medical Advisory Board, Carestream Health, Inc

### Sub-Events

#### SSG08-01 Follow that Patient! Follow-up of Patients with Abdominal Imaging Findings of Possible Cancer

Tuesday, Dec. 1 10:30AM - 10:40AM Location: S402AB

### Participants

Hanna M. Zafar, MD, Philadelphia, PA (*Presenter*) Nothing to Disclose  
Philipose G. Mulugeta, MD, Philadelphia, PA (*Abstract Co-Author*) Nothing to Disclose  
Caroline Sloan, Philadelphia, PA (*Abstract Co-Author*) Nothing to Disclose  
Denise Petersen, BSN, Philadelphia, PA (*Abstract Co-Author*) Nothing to Disclose  
Darco Lalevic, Philadelphia, PA (*Abstract Co-Author*) Nothing to Disclose  
Tessa S. Cook, MD, PhD, Philadelphia, PA (*Abstract Co-Author*) Nothing to Disclose

### Background

Focal masses potentially representing cancer are commonly discovered in patients referred for abdominal imaging. Failure to properly follow-up patients with imaging findings of possible cancer can result in missed or delayed cancer diagnoses. Yet the proportion of patients in whom follow-up is not completed, but clinically appropriate, is poorly understood

### Evaluation

In July 2013 our radiology department implemented a mandatory coding scheme for reporting the malignant likelihood of focal masses in the adrenals, kidneys, pancreas and liver on all CT, MRI and ultrasound examinations. Focal masses with codes correlating to imaging findings of possible cancer were detected in 675 unique patients between 7/1/13 and 9/31/13 of whom 24% (164/675) expired within 30 days. Chart review within 15 months revealed that 40% of patients (268/675) received imaging follow-up, 7% (50/675) pathology follow up, 5% (35/675) other methods of follow-up (e.g. specialist referral, change in therapy), 5% (37/675) had documented reasons for the lack of follow-up, and 17% (118/675) had no reason for lack of follow-up documented in the chart.

### Discussion

Over half of patients with abdominal imaging findings possibly representing cancer receive imaging, pathology or clinical follow-up within 15 months of initial detection; most commonly through imaging (40%). Yet, nearly one fifth of patients receive no follow-up and have no reason for the lack of follow-up documented in the medical record. These patients are at risk for missed or delayed cancer diagnoses.

### Conclusion

Reliable methods of monitoring patients with abdominal imaging findings of possible cancer are needed to identify the nearly one fifth of patients with no documented reason for lack of follow-up in the clinical chart. Providers caring for these patients should be contacted to determine the reason for no follow-up in order to improve the quality and safety of patient care.

#### SSG08-03 Lexical Disparities between Reports Authored by Residents and Reports Authored by Attending Radiologists Using Natural Language Processing

Tuesday, Dec. 1 10:50AM - 11:00AM Location: S402AB

### Participants

Brian E. Chapman, PhD, Salt Lake City, UT (*Presenter*) Nothing to Disclose  
Amilcare Gentili, MD, San Diego, CA (*Abstract Co-Author*) Nothing to Disclose  
Stuart L. Schulthies, Salt Lake City, UT (*Abstract Co-Author*) Nothing to Disclose  
Marta E. Heilbrun, MD, Salt Lake City, UT (*Abstract Co-Author*) Nothing to Disclose

### Background

We explored using simple natural language processing tools to characterize radiology reports and identify lexical features that differed between reports generated by residents and reports generated by attending radiologists. In this initial exploration, we limited ourselves to the Impression section (IS) of the reports. Reports generated from October through December 2013 were analyzed. From the IS we extracted the following features: 1) the number of words in the IS, 2) the number of RadLex concepts in the IS divided by the number of words, 3) the number of uncertainty phrases in the IS divided by the number of words in the IS, 4) the polarity of the IS (whether the concepts were expressed in a negative, neutral, or positive manner), and 5) the subjectivity of the IS. RadLex concepts consisted of all preferred names and synonyms defined in the RadLex ontology. Uncertainty terms were identified using pyConTextNLP using a lexical knowledge base defined previously. Polarity and subjectivity were measured using the textblob Python package. A logistic regression model determined the statistical relationships between lexical features and report authorship.

### Evaluation

61705 impression sections were analyzed, of these 35352 were generated by an attending without a resident and 26353 were

generated by a resident supervised by an attending. On average, resident impression sections were longer, more subjective, less positive, used fewer RadLex terms and used fewer uncertainty terms. All features were significant in the logistic regression model ( $p < 0.000$ ).

## Discussion

Our results indicate that there are measurable lexical differences between resident and attending reports. Attending reports are shorter, use more standard terms, express more positive sentiment, as well as use more uncertain expressions. It is somewhat surprising that the residents expressed less uncertainty and warrants further investigation.

## Conclusion

Our study has several limitations. We have not analyzed the results by service or experience level of the residents. Also, the distribution of authorship was not uniform across services. Mammography and nuclear medicine had significantly fewer resident reports than other services.

### SSG08-04 Structured Reporting vs. Free Text Reporting of MRI Examinations of the Shoulder: Potential Impact on Durgical Planning

Tuesday, Dec. 1 11:00AM - 11:10AM Location: S402AB

#### Participants

Marco Armbruster, Munich, Germany (*Presenter*) Co-Founder of medical software company.  
Sebastian Gassenmaier, Munich, Germany (*Abstract Co-Author*) Nothing to Disclose  
Florian Haasters, MD, Munich, Germany (*Abstract Co-Author*) Nothing to Disclose  
Tobias Helfen, MD, Munich, Germany (*Abstract Co-Author*) Nothing to Disclose  
Thomas Henzler, MD, Mannheim, Germany (*Abstract Co-Author*) Nothing to Disclose  
Maximilian F. Reiser, MD, Munich, Germany (*Abstract Co-Author*) Nothing to Disclose  
Wieland H. Sommer, MD, Munich, Germany (*Abstract Co-Author*) Founder, QMedify GmbH  
Nora N. Kammer, MD, Munich, Germany (*Abstract Co-Author*) Nothing to Disclose

#### PURPOSE

To compare structured reports vs. standard free text reports of MRI examinations of the shoulder and to evaluate quality of reports, satisfaction of referring physicians and potential effects for surgical planning.

#### METHOD AND MATERIALS

We included 30 patients who underwent MRI of the shoulder for one of the following reasons: trauma, luxation or a possible tendon tear. Exclusion criteria were known tumors, previous shoulder operations or inflammatory diseases. We acquired both standard free text reports and structured reports, which were performed with an online software with dedicated templates and clickable decision trees with concomitant generation of semantic structured reports. The template was specific for MRI of the shoulder after trauma and/or degenerative lesions and included specific information relevant for surgical planning. All reports were evaluated with regard to their impact on clinical decision making, sufficiency for surgical planning, convenience of information extraction, linguistic quality, and referring physicians' satisfaction.

#### RESULTS

Overall 30 structured and 30 free-text reports were reviewed by two orthopedic surgeons with long lasting experience in surgery of the shoulder (9 yrs, 6 yrs respectively). Decision making regarding surgery vs. conservative therapy was possible without further consultations in 87% of structured and 73% of free text reports. In case of surgery the provided information was considered to be sufficient for surgical planning in 87% of structured and 60% of non-structured reports. Overall, 17% of structured and 47% of free text reports were considered to be incomplete. The effort of information extraction from the reports was considered to be time-consuming in 17% of structured and 54% of free text reports ( $p < 0.001$ ). The linguistic quality was not rated different between structured and non-structured reports ( $p = 0.1745$ ).

#### CONCLUSION

Structured reporting of MRI of the shoulder facilitates clinical decision making and surgical planning and potentially leads to a higher satisfaction of referring physicians.

#### CLINICAL RELEVANCE/APPLICATION

Structured reporting of musculoskeletal MRI examinations with dedicated and specific templates is a valuable tool to provide standardized information to referring physicians.

### SSG08-05 Pilot Study of a Global Radiology Report Categorization (RADCAT) System in the Emergency Department

Tuesday, Dec. 1 11:10AM - 11:20AM Location: S402AB

#### Participants

David W. Swenson, MD, Brooklyn, CT (*Presenter*) Nothing to Disclose  
Martha B. Mainiero, MD, Providence, RI (*Abstract Co-Author*) Nothing to Disclose  
Grayson L. Baird, MS, Providence, RI (*Abstract Co-Author*) Nothing to Disclose  
David C. Portelli, MD, Providence, RI (*Abstract Co-Author*) Nothing to Disclose  
Jonathan S. Movson, MBChB, Providence, RI (*Abstract Co-Author*) Nothing to Disclose

#### PURPOSE

To develop a global categorization system for radiology reports in the emergency department, and to evaluate the inter-observer variation of the system as a first step in establishing its clinical utility.

#### METHOD AND MATERIALS

In collaboration, members from the departments of diagnostic imaging and emergency medicine developed a report categorization

system with 5 grades for characterizing the urgency of findings: RADCAT 1=Normal, 2=Routine, 3=Non-Urgent imaging follow-up recommended, 4=Priority (likely to affect treatment during the ongoing care episode), and 5=Critical (requiring immediate direct physician-to-physician communication). Four radiologists interpreted a minimum of 400 studies in the ED setting, assigning each report a RADCAT designation. 58 of these 1600 reports (without images) were selected as a representative sample, and re-categorized by 6 radiologists and 6 emergency medicine physicians, all blinded to the original RADCAT designation. Inter-observer agreement was assessed using Cohen's Kappa statistic.

## RESULTS

Inter-observer agreement was interpreted according to the guidelines of Landis and Koch. Among radiologists, agreement was excellent for RADCAT 1 ( $k=0.83$ ), substantial for RADCATs 2, 3, and 5 ( $k=0.73$ ,  $k=0.68$ , and  $k=0.71$ , respectively), and moderate for RADCAT 4 ( $k=0.54$ ). Among emergency physicians, agreement was excellent for RADCAT 1 ( $k=0.85$ ), substantial for RADCATs 2 and 5 ( $k=0.70$ ,  $k=0.77$ , respectively), and moderate for RADCATs 3 and 4 ( $k=0.51$ ,  $k=0.52$ , respectively). Among both groups combined, agreement was excellent for RADCAT 1 ( $k=0.85$ ), substantial for RADCATs 2, 3, and 5 ( $k=0.74$ ,  $k=0.61$ , and  $k=0.74$ , respectively), and moderate for RADCAT 4 ( $k=0.54$ ). Overall agreement for RADCAT designations of all physicians was substantial ( $k=0.65$ ).

## CONCLUSION

The RADCAT system for globally characterizing radiology reports may provide a valuable shorthand for communication between radiologists and emergency medicine physicians interacting through the electronic medical record, with substantial interobserver agreement demonstrated on this initial pilot study.

## CLINICAL RELEVANCE/APPLICATION

We demonstrate a system for improving efficiency and fidelity of communicating information through radiology reports.

### SSG08-06 Use of Conditional Statements in Radiology Follow-Recommendation Sentences: Relationship to Follow Up Compliance

Tuesday, Dec. 1 11:20AM - 11:30AM Location: S402AB

#### Participants

Martin L. Gunn, MBChB, Seattle, WA (*Presenter*) Research support, Koninklijke Philips NV; Spouse, Consultant, Wolters Kluwer NV; Medical Advisor, TransformativeMed, Inc;

Bruce E. Lehnert, MD, Seattle, WA (*Abstract Co-Author*) Research support, Koninklijke Philips NV

Christopher Hall, PhD, Briarcliff Manor, NY (*Abstract Co-Author*) Employee, Koninklijke Philips NV

Meliha Yetisgen, PhD, Seattle, WA (*Abstract Co-Author*) Nothing to Disclose

Norman J. Beauchamp JR, MD, Seattle, WA (*Abstract Co-Author*) Research Grant, Koninklijke Philips NV

Karen Trovato, PhD, Briarcliff Manor, NY (*Abstract Co-Author*) Employee, Koninklijke Philips NV

Sandeep Dalal, Briarcliff Manor, NY (*Abstract Co-Author*) Employee, Koninklijke Philips NV

## PURPOSE

A significant proportion of patients do not receive timely follow-up (F/U) investigations that are recommended in radiology reports. Automated tools to detect, flag, and communicate F/U recommendations may increase the rate of follow-up, but risk alert-fatigue or over-reliance. The purpose of this study is to determine the correlation between conditional statements (CS) (hedge statements) in follow-up recommendation sentences (FURS) of radiology reports and the rate of F/U.

## METHOD AND MATERIALS

A regular expression automated natural language processing (NLP) technique was developed to detect FURS in all radiology reports (1.6m) from 2010 to 2014 at a large multi-hospital academic radiology department. The NLP algorithm was validated using a sample of radiology reports. A representative cohort ( $n=355$ ) of records containing FURS was extracted and a single expert reader (blinded to whether F/U occurred) evaluated full reports for the presence of CS; F/U timeframe, modality, and expectation of whether F/U was necessary/probable based on the entire text of the report ( $E=0,1,2$  where 0=little, 1=moderate, and 2=high/definite). In a second phase, the expert reader determined whether the F/U occurred. A Chi-squared test was used with  $p < 0.05$  considered statistically significant.

## RESULTS

In the sample, CS's occurred in 125/355 reports with FURS (35.2%). Appropriate F/U rate was 55.5%. CS's occurred more in ED patients (46.3%) vs inpatient (43.1%,  $p<0.02$ ) and outpatient settings (26.2%,  $p<0.001$ ). FURS containing CS had lower follow-up compliance than FURS without CS (36% vs. 66%,  $p<0.001$ ). The rate of CS dropped with expectation of follow up (59.4, 36.7, 16.7% with  $E=0, 1, 2$ ;  $p<0.001$ ). However, in cases with high/definite expectation of follow-up ( $E=2$ ), the rate dropped from 78.8% for no CS to 43.8% where CS's were present ( $p<0.001$ ).

## CONCLUSION

This study confirms low follow-up compliance. Conditional statements in FURS are associated with a significantly lower rate of follow-up than FURS without CS.

## CLINICAL RELEVANCE/APPLICATION

Radiologists may use conditional statements in recommendation sentences for less clinically important F/U recommendations. However, these CS are associated with a lower overall rate of F/U. When developing automated tools for to detect F/U compliance, the presence of CS could be incorporated into an NLP algorithm, potentially improving specificity of the system for the detection of important failures to F/U.

### SSG08-07 Enabling Real-time Epidemiological Statistics Through Structured Reporting: Single-center Experience for the Incidence of Pulmonary Embolism

Tuesday, Dec. 1 11:30AM - 11:40AM Location: S402AB

#### Participants

Daniel Pinto dos Santos, MD, Mainz, Germany (*Presenter*) Nothing to Disclose

Gordon Klos, Mainz, Germany (*Abstract Co-Author*) Nothing to Disclose



Sonja Scheibl, Mainz, Germany (*Abstract Co-Author*) Nothing to Disclose  
Roman Kloeckner, MD, Mainz, Germany (*Abstract Co-Author*) Nothing to Disclose  
Peter Mildenberger, MD, Mainz, Germany (*Abstract Co-Author*) Stockholder, GeSIT GmbH

#### PURPOSE

To explore the possibilities for real-time epidemiological metrics using data from a database of structured reports created using IHE MRRT-compliant templates.

#### METHOD AND MATERIALS

After the implementation of a browser-based tool for structured reporting we analyzed all patients from 2013 to 2015 referred from the emergency department to our department for CT because of clinically suspected pulmonary embolism. Radiological reports were read and reformatted using a dedicated MRRT-compliant template for structured reporting. All structured reports were stored in a dedicated MySQL database and various epidemiological metrics were calculated.

#### RESULTS

All relevant data was easily accessible from the MySQL database and was automatically recalculated when more patients were added to the database. After evaluating 521 cases, the calculated incidence of pulmonary embolism was 0.24 for this collective. Mean age for patients with pulmonary embolism was 61.6 and for those without 62.4. Patients with pulmonary embolism had a mean D-Dimer of 13.25 mg/l FEU whereas those without had 2.5 mg/l FEU.

#### CONCLUSION

This proof-of-concept demonstrates that when using structured reporting with meaningful templates and storing results in an accessible database any desired metric can be easily calculated in real time.

#### CLINICAL RELEVANCE/APPLICATION

We demonstrate the benefits of structured reporting. If radiologists adopt structured reporting, analyses can be easily performed in real-time for any desired metric that is included in a respective reporting template.

#### SSG08-08 Support-Vector Machine Classification of Indexed Keyword Search Results: Providing Context to Keywords

Tuesday, Dec. 1 11:40AM - 11:50AM Location: S402AB

##### Participants

Jaron Chong, MD, Montreal, QC (*Presenter*) Nothing to Disclose  
Benoit P. Gallix, MD, PhD, Montpellier, France (*Abstract Co-Author*) Nothing to Disclose

#### PURPOSE

Keyword-indexed based retrospective searches of full-text radiology reports provide a powerful tool for the interactive identification of case series and population cohorts from large databases. While keyword searches are effective for rare terms, diseases, or keywords, keywords alone prove particularly limited in circumstances where a condition is used very frequently with heterogeneous meanings and contexts. We propose a support-vector machine learning workflow to improve the specificity of full-text keyword searches.

#### METHOD AND MATERIALS

This proposal outlines and explores an approach drawn from natural-language processing research used in informatics and linguistics by utilizing a statistically-based machine learning technique to infer associations in words frequencies from labeled examples. In our specific, we attempt to classify sentences containing the word 'appendicitis' into multiple contexts of meaning, specifically: 1-Positive, 2-Negative, 3-Clinical History, 4-Atypical and report upon both the classification performance characteristics of such a system, potential pitfalls and limitations to the technique, as well as the relationship between performance and a progressively expanded training set.

#### RESULTS

1000 CT Abdomen/Pelvis full-text reports narrative reports were parsed and analyzed. Classification performance began 86.5% and steadily rose to 95.3% after 500 examples of tagged reports were provided at which point classification performance ranged between 93.8 - 96.8% successful classification. Classifications of both 1-Positive or 2-Negative appendicitis were generally highly reliable as were classification of 3-Clinical History. Classifications of 4-Atypical sentences had the greatest relative unreliability with only 13 re-classifications out of 1000 reports. Performance and generation of the SVM models were instantaneous on standard commodity computer hardware.

#### CONCLUSION

The application of support-vector machines is a reliable and successful method for narrative text classification and paired with a full-text indexed search engine allows for powerful contextual language analysis.

#### CLINICAL RELEVANCE/APPLICATION

Support-vector machines provide a novel and practical method of labeling and inferring context of keywords which can be used to increase the specificity of full-text indexed searches.

#### SSG08-09 Initial Experience with Multi-Media and Quantitative Tumor Reporting Appears to Improve Oncologist Efficiency in Assessing Tumor Burden

Tuesday, Dec. 1 11:50AM - 12:00PM Location: S402AB

##### Participants

Les R. Folio, DO, MPH, Bethesda, MD (*Presenter*) Research agreement, Carestream Health, Inc  
Alireza Asary Yazdi, MD, MPH, Bethesda, MD (*Abstract Co-Author*) Research agreement, Carestream Health, Inc  
Melinda Merchant, Bethesda, MD (*Abstract Co-Author*) Nothing to Disclose



## PURPOSE

Tumor assessment by Computed Tomography (CT) has become essential to oncologists in determining the therapeutic response of the metastatic tumor burden in cancer patients on therapeutic trials. This is done by measurement of a subset of "target" metastatic lesions on baseline and follow-up CTs. From these measurements a quantitative assessment of the change in tumor burden over time is calculated. Traditionally, radiologists' CT reports do not consistently include these measurements. One major reason is the time and effort needed to identify target tumors on follow-up scans and making measurements. Instead, the measurements are commonly obtained from images by the oncologists themselves or with the radiologist in a tumor measurement session/consultation. A recent survey we performed at our institution demonstrated that 1) oncologists spend an excessive amount of time making measurements or searching for measurements buried in our reports and matching them to the images in PACS, and 2) oncologists and radiologists prefer measurements in reports be hyperlinked to annotated images. In an effort to improve the content and utility of CT reports for oncologists, we embarked on a collaboration with our PACS vendor (Carestream Health, Rochester, NY) to explore the addition of capacities to PACS that would facilitate the generation of tumor measurement data by the radiologist and presentation in a Multi-media (MM) report with hyperlinks to images that would enable efficient use by oncologists. The recent PACS upgrade we helped develop (v 12.0 Vue PACS) includes the hyperlink capacity and tables and graphs as part of the report, and tools that facilitate lesion identification and quantification (temporal image registration, lesion segmentation and serial 3D localization of measurements; measurement on current exam is automatically related to measurements on prior exams). In this pilot study, we assessed the impact of the PACS upgrade on the timing of radiologists in generating and of oncologists in using MM reports on cancer patients.

## RESULTS

Radiologists' average dictation times were 11.9 ( $\pm 5.6$ ) and 12.6 ( $\pm 4$ ) minutes, before and after PACS upgrade, respectively. Although the reporting time has increased after PACS upgrade, the observed difference was not statistically significant in our study (P value = 0.53). This timing is on par with an average day on CT service in that it takes about 6 hours to dictate and measure 25 complex cancer follow up cases at our institution. Average time for an oncologist to assess tumor burden initially (text-only reports) was 15.4 ( $\pm 5.9$ ) minutes. Average time for oncologist to assess tumor burden using the multimedia reports was 6.2 ( $\pm 2.9$ ) minutes for a mean time savings of 8.9 minutes (Range 5 - 14 minutes per study) when used the MM report to enter data into study forms (P<0.001).

## CONCLUSION

Our pilot study results demonstrate that multimedia reports with data tables and hyperlinks to measurements on key images of target lesions facilitate analysis of tumor response by oncologists resulting in a significant time savings. These MM reports may be generated by radiologists without significant increase in reporting times. We anticipate in our facility alone up to 6-10 hours work by each team of oncologists and research staff could be saved using MM presentation. Although we measured time to complete the work by radiologists and oncologists, time is not the only domain that will be impacted by this innovation. With time saved and more straightforward presentation of data through quantitative MM reports, further studies in larger, more controlled settings can further test if MM reports are a more effective provision of care by improving oncologist's decisions and patient outcomes. Leveraging technology that provides professional-appearing content and media-rich reporting including links to images, reports, and the images may also become increasingly important to patients with the more widespread use of patient portals.

## METHODS

Two radiologists recorded the times it took them to dictate CT exams (of the Chest, Abdomen and Pelvis) in which they measured target lesions on 20 consecutive cancer patients on therapeutic trials before and after the PACS upgrade. The difference between the average times was tested using permutation test. Additionally, an oncologist recorded the times to extract and tabulate target lesion measurements on 10 CT studies of five synovial sarcoma patients that had been reported prior to the PACS upgrade. The timing was also recorded for the same process on the MM reports of the same patients after these reports became available. The permutation test of paired samples was used to compare the mean time differences between extracting the needed data from traditional text only and MM reports by the oncologist.

SSG06

## ISP: Genitourinary (Imaging Gynecological Malignancy)

Tuesday, Dec. 1 10:30AM - 12:00PM Location: N229



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

### Participants

Susanna I. Lee, MD, PhD, Boston, MA (*Moderator*) Nothing to Disclose  
Andrea G. Rockall, MRCP, FRCR, London, United Kingdom (*Moderator*) Nothing to Disclose

### Sub-Events

#### SSG06-01 Genitourinary Keynote Speaker: Gynecologic Cancer Imaging-Present and Future

Tuesday, Dec. 1 10:30AM - 10:40AM Location: N229

### Participants

Susanna I. Lee, MD, PhD, Boston, MA (*Presenter*) Nothing to Disclose

### ABSTRACT

The past decade has seen the development of MRI and FDG PET-CT, both of which now play central and complementary roles in treatment planning and followup of women with uterine, ovarian and vulvar cancer. Ongoing investigations of novel techniques such as diffusion and perfusion imaging, and of PET tracers capable of targeting hypoxia and hormone receptors, will push cancer radiology firmly into the realm of the molecular, quantitative and predictive in the coming decade. PET-MRI, capable of concurrent multi-modality functional imaging, will likely prove to be a mainstay in personalized gynecologic cancer care.

### Honored Educators

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

Susanna I. Lee, MD, PhD - 2013 Honored Educator

#### SSG06-02 High Grade Serous Ovarian Cancer: BRCA Mutation Status and CT Imaging Phenotypes

Tuesday, Dec. 1 10:40AM - 10:50AM Location: N229

### Participants

Stephanie Nougaret, MD, New York, NY (*Presenter*) Nothing to Disclose  
Yuliya Lakhman, MD, New York, NY (*Abstract Co-Author*) Nothing to Disclose  
Hebert Alberto Vargas, MD, New York, NY (*Abstract Co-Author*) Nothing to Disclose  
Maura Micco, MD, Rome, Italy (*Abstract Co-Author*) Nothing to Disclose  
Melvin D'Anastasi, MD, New York, NY (*Abstract Co-Author*) Nothing to Disclose  
Sarah A. Johnson, MD, Toronto, ON (*Abstract Co-Author*) Nothing to Disclose  
Ramon E. Sosa, BA, New York, NY (*Abstract Co-Author*) Nothing to Disclose  
Krishna Juluru, MD, New York, NY (*Abstract Co-Author*) Nothing to Disclose  
Noah Kauff, New York, NY (*Abstract Co-Author*) Nothing to Disclose  
Hedvig Hricak, MD, PhD, New York, NY (*Abstract Co-Author*) Nothing to Disclose  
Evis Sala, MD, PhD, New York, NY (*Abstract Co-Author*) Nothing to Disclose

### PURPOSE

To investigate the associations between BRCA mutation status and preoperative CT imaging phenotypes in women with high-grade serous ovarian cancer (HGSOC).

### METHOD AND MATERIALS

115 patients with HGSOC (76 BRCA mutation-positive and 39 BRCA mutation-negative) and CT scans prior to the primary cytoreductive surgery were included in this retrospective HIPAA-compliant study. Two radiologists (R1 and R2) independently reviewed all CT scans and R1 determined total measurable peritoneal tumor volume (TPTV) for each patient. Associations between BRCA mutation status, CT imaging features, and TPTV were analyzed using Fisher exact test and Mann Whitney test. Inter-reader agreement was assessed with the Cohen's kappa. Kaplan-Meier and Cox proportional hazards regression survival analyses were performed.

### RESULTS

BRCA mutation-positive HGSOC had less frequent peritoneal disease, mesenteric infiltration, and lymphadenopathy at CT ( $p = 0.0002$ ,  $< 0.0001$ - $0.03$ ,  $0.03$  for both readers, respectively). Furthermore, the pattern of peritoneal implants was correlated with the BRCA mutation status: nodular pattern was more common in BRCA-associated tumors whereas infiltrative pattern was more frequent in sporadic tumors ( $p = 0.0009$  and  $p = 0.0005$  for R1 and R2, respectively). BRCA mutation-positive HGSOC had higher mean TPTV ( $125 \text{ cm}^3 \pm 171$ ) than sporadic tumors ( $56 \text{ cm}^3 \pm 95$ ) ( $p < 0.001$ ). Irrespective of BRCA mutation status, mesenteric involvement by tumor was associated with shorter progression-free survival ( $p < 0.0001$  for both readers) and overall survival ( $p < 0.0002$  and  $p < 0.0001$  for R1 and R2, respectively).

### CONCLUSION

BRCA mutation status in HGSOC was linked to the distinct CT imaging phenotypes. Mesenteric disease at CT was an independent

predictor of reduced survival in both BRCA mutation-positive and sporadic tumors.

#### CLINICAL RELEVANCE/APPLICATION

BRCA-associated HGSOc have characteristic prognostically significant morphology on CT.

#### Honored Educators

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

Stephanie Nougaret, MD - 2013 Honored Educator

Evis Sala, MD, PhD - 2013 Honored Educator

#### SSG06-03 Advanced Cervical Cancer: Quantitative Assessment of Early Response to Neoadjuvant Chemotherapy with Intravoxel Incoherent Motion Diffusion-weighted Magnetic Resonance Imaging

Tuesday, Dec. 1 10:50AM - 11:00AM Location: N229

##### Participants

Yanchun Wang, Wuhan, China (*Presenter*) Nothing to Disclose

Dao Y. Hu, MD, PhD, Wuhan, China (*Abstract Co-Author*) Nothing to Disclose

#### PURPOSE

To investigate the utility of intravoxel incoherent motion (IVIM) diffusion-weighted magnetic resonance imaging (MRI) for predicting and monitoring the response of cervical cancer to neoadjuvant chemotherapy (NACT).

#### METHOD AND MATERIALS

This prospective study was approved by an institutional review board, and informed consent was obtained from all patients. A total of 42 patients with primary cervical cancer were recruited into this study. IVIM diffusion-weighted MRI was performed on all patients at three time points (prior to NACT, 3 weeks after the first NACT, and 3 weeks after the second NACT). The response to treatment was determined according to the Responded Evaluation Criteria in Solid Tumors (RECIST) three weeks after the second NACT treatment, and the subjects were categorized into responders and non-responders. The standard ADC, true diffusion coefficient (D), perfusion-related pseudo-diffusion coefficient (D\*), and perfusion fraction (f) values were determined.

#### RESULTS

Patients were divided into responders (n=24) and non-responders (n=18) according to the RECIST guidelines. Before treatment, the D and standard ADC values were significantly higher in responders than in non-responders (both  $p < 0.01$ ). No significant differences were observed in D\* and f. Analysis of the receiver operating characteristic (ROC) curves indicated that the threshold of  $D < 0.93 \times 10^{-3} \text{ mm}^2/\text{s}$  and the standard ADC  $< 1.11 \times 10^{-3} \text{ mm}^2/\text{s}$  could be used to differentiate responders from non-responders, yielding area under curve (AUC) values of 0.804 and 0.768, respectively. Three weeks after both the first and second NACT treatments, the D and standard ADC values in the responders were still significantly higher than those in the non-responders. D\* and f values still showed no significant differences. The ROC curve analysis indicated that the AUC values for D and standard ADC were 0.823 and 0.763 for the second time point and 0.787 and 0.794 for the last time point.

#### CONCLUSION

IVIM may be useful for predicting and monitoring the efficacy of NACT in cervical cancer. D and standard ADC values could represent reliable early predictors of the NACT response prior to treatment. Furthermore, these parameters can be used to monitor NACT responses during and after therapy.

#### CLINICAL RELEVANCE/APPLICATION

These results should be useful for both patients and clinical doctors. Patients who are unsuitable for NACT could be given radiation or surgical treatment in a more timely manner.

#### SSG06-04 Prognostic Value of Diffusion-weighted MRI and PET/CT During Concurrent Chemoradiotherapy in Uterine Cervical Cancer

Tuesday, Dec. 1 11:00AM - 11:10AM Location: N229

##### Participants

Jung Jae Park, MD, Seoul, Korea, Republic Of (*Presenter*) Nothing to Disclose

Chan Kyo Kim, MD, PhD, Seoul, Korea, Republic Of (*Abstract Co-Author*) Nothing to Disclose

Byung Kwan Park, MD, Seoul, Korea, Republic Of (*Abstract Co-Author*) Nothing to Disclose

#### PURPOSE

To evaluate the prognostic value of diffusion-weighted MRI (DWI) and PET/CT during concurrent chemoradiotherapy (CCRT) of cervical cancer for predicting disease progression.

#### METHOD AND MATERIALS

This retrospective study included 67 consecutive patients (median age, 55 years; range, 28-78 years) who received CCRT for locally advanced cervical cancer. All patients underwent both 3T-DWI and PET/CT before and during (at 4 weeks) treatment. The mean apparent diffusion coefficient (ADC) and maximum standardized uptake value (SUVmax) were measured on the tumors and the percentage changes of each parameter between the two time points ( $\Delta\text{ADC}$  and  $\Delta\text{SUVmax}$ ) were calculated. In the prediction of disease progression, the diagnostic performance of tumor  $\Delta\text{ADC}$  and  $\Delta\text{SUVmax}$  was evaluated using the time-dependent receiver operating characteristics (ROC) curve analysis. The relationship between disease progression and clinical and imaging parameters was investigated using univariate and multivariate Cox regression analyses.

#### RESULTS

During a mean follow-up of 2.7 years, disease progression was identified in 16 patients (23.9%): local recurrence (n= 7), distant metastasis (n= 8) and both local recurrence and distance metastasis (n= 1). During treatment, the mean ADC and SUVmax significantly increased and decreased, respectively (both  $P < 0.001$ ). The mean  $\Delta ADC$  and  $\Delta SUV_{max}$  were  $42.6 \pm 17\%$  and  $67.6 \pm 16.5\%$ , respectively. In the prediction of disease progression, the integrated area under the curve of  $\Delta ADC$  (0.791) and  $\Delta SUV_{max}$  (0.781) were not significantly different ( $P = 0.88$ ) and the optimal cut-offs of  $\Delta ADC$  and  $\Delta SUV_{max}$  were 35.1% and 60.7%, respectively. On multivariate Cox regression analysis, the  $\Delta ADC$  ( $< 35.1\%$ ) and  $\Delta SUV_{max}$  ( $< 60.7\%$ ) were the only independent predictors of disease progression after treatment (hazard ratio, 4.1 and 4.5;  $P$ , 0.04 and 0.03, respectively).

## CONCLUSION

The percentage changes of DWI and PET/CT parameters during CCRT offer similar prognostic value for the prediction of post-treatment disease progression in patients with cervical cancer.

## CLINICAL RELEVANCE/APPLICATION

DWI, as a noninvasive tool, can be used in the prediction of therapeutic outcomes following concurrent chemoradiotherapy in patients with cervical cancer, instead of PET/CT with the risk of ionizing radiation exposure.

### SSG06-05 Application of Non-Gaussian Water Diffusional Kurtosis Imaging in the Assessment of Uterine Tumors: A Preliminary Study

Tuesday, Dec. 1 11:10AM - 11:20AM Location: N229

#### Participants

Aliou A. Dia, MD, Suita, Japan (*Presenter*) Nothing to Disclose  
Masatoshi Hori, MD, Suita, Japan (*Abstract Co-Author*) Nothing to Disclose  
Hiromitsu Onishi, MD, Suita, Japan (*Abstract Co-Author*) Nothing to Disclose  
Makoto Sakane, MD, Suita, Japan (*Abstract Co-Author*) Nothing to Disclose  
Takahiro Tsuboyama, MD, Suita, Japan (*Abstract Co-Author*) Nothing to Disclose  
Noriyuki Tomiyama, MD, PhD, Suita, Japan (*Abstract Co-Author*) Nothing to Disclose  
Mitsuaki Tatsumi, MD, PhD, Suita, Japan (*Abstract Co-Author*) Nothing to Disclose  
Tomoyuki Okuaki, RT, Chuo-Ku, Japan (*Abstract Co-Author*) Employee, Koninklijke Philips NV

## PURPOSE

To retrospectively evaluate the feasibility and the value of diffusional kurtosis imaging (DKI) in the assessment of uterine tumors compared with that of conventional diffusion weighted imaging (DWI) and with pathological findings as gold-standard.

## METHOD AND MATERIALS

Sixty-one women (mean age: 54.85 years  $\pm 14.09$ , range 26-89 years) with histopathologically proven uterine cancers (51 cervical cancers and 10 corpus cancers) underwent 3-T MR imaging using DKI with high b values ( $b=700, 1000, 1700$  and  $2500$  s/mm<sup>2</sup>) and DWI ( $b=0$  s/mm<sup>2</sup>,  $b=700$  s/mm<sup>2</sup>). Thirteen of the 61 patients (21.3 %) had coexisting leiomyomas. ROI-based measurements of diffusivity (D), kurtosis (K) and ADC of the uterine cancers, leiomyomas, healthy myometrium and endometrium were performed. The areas under the ROC curve (AUC) in differentiating malignant from benign lesions were also compared.

## RESULTS

Mean D of uterine cancers ( $0.879$  mm/s<sup>2</sup>  $\pm 0.30$ ) was significantly lower than that of the leiomyomas ( $1.174$  mm/s<sup>2</sup>  $\pm 0.43$ ) ( $P=0.006$ ), the healthy myometrium ( $1.178$  mm/s<sup>2</sup>  $\pm 0.27$ ) ( $P=0.000$ ) and the healthy endometrium ( $1.308$  mm/s<sup>2</sup>  $\pm 0.5$ ) ( $P=0.013$ ). Mean K of uterine cancers ( $0.754$  mm/s<sup>2</sup>  $\pm 0.22$ ) was moderately higher than that of leiomyomas ( $0.686$  mm/s<sup>2</sup>  $\pm 0.24$ ), the healthy myometrium ( $0.708$  mm/s<sup>2</sup>  $\pm 0.19$ ) and the healthy endometrium ( $0.568$  mm/s<sup>2</sup>  $\pm 0.25$ ). No significant difference was found between the mean K of the uterine cancers, the leiomyomas, the healthy myometrium and endometrium ( $P=0.33, 0.27$  and  $0.23$ ). There was no significant difference in AUC between D and ADC.

## CONCLUSION

D is not superior or inferior to the conventional ADC in the differentiation between benign and malignant uterine lesions. The K that is related to the microstructural complexity was higher in uterine cancers than that of leiomyomas but without any significant difference, opposite to K values in white matter tissue of the brain, in breast or prostate cancers where the mean K of malignant lesions was significantly higher than of the benign lesions.

## CLINICAL RELEVANCE/APPLICATION

The D, in non-Gaussian DKI, is equal to the conventional ADC in differentiating benign from malignant uterine lesions. The K of uterine malignant tumors was not significantly higher than that of the benign lesions, unlike in breast or prostate cancers.

### SSG06-06 Clinical Value of Proton (1H-) Magnetic Resonance Spectroscopy (MRS) Using Body-phased Array Coil at 3.0 T in Pretreatment Assessment for Cervical Cancer Patients

Tuesday, Dec. 1 11:20AM - 11:30AM Location: N229

#### Participants

Gigin Lin, MD, Guishan, Taiwan (*Presenter*) Nothing to Disclose  
Yu-Ting Huang, Guishan, Taiwan (*Abstract Co-Author*) Nothing to Disclose  
Koon-Kwan Ng, Guishan, Taiwan (*Abstract Co-Author*) Nothing to Disclose  
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Tzu-Chen Yen, MD, PHD, Taoyuan, Taiwan (*Abstract Co-Author*) Nothing to Disclose  
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Angel Chao, MD, Taoyuan, Taiwan (*Abstract Co-Author*) Nothing to Disclose  
Chiun-Chieh Wang, Guishan, Taiwan (*Abstract Co-Author*) Nothing to Disclose  
Chyong-Huey Lai, Guishan, Taiwan (*Abstract Co-Author*) Nothing to Disclose  
Pen-An Liao, MD, Taipei City, Taiwan (*Abstract Co-Author*) Nothing to Disclose

## PURPOSE

To determine the clinical value of proton (1H-) magnetic resonance spectroscopy (MRS) using body-phased array coil at 3.0 T, in pretreatment assessment for cervical cancer patients.

## METHOD AND MATERIALS

We prospectively enrolled 52 histology proven cervical cancer patients (age 27-80 years) and 30 age-matched surgical candidates for benign uterine myoma without evidence of cervical cancer. Pretreatment MR study plus MRS and diffusion weighted imaging (DWI) sequences were carried out at a 3.0 T system using body-phased array coil for the pelvis. PRESS localized 1H-MRS was applied to cervical tumor or normal tissue, with resonances analyzed by using the LC-Model algorithm. Cramer-Rao lower bound (CRLB) threshold of 20% was used as quality control. We compared resonances based on: (1) tumor vs normal cervical tissue, (2) histopathology type (squamous vs adenocarcinoma) (3) T stage = IIb (4) nodal metastasis (5) distant metastasis using Mann-Whitney test.

## RESULTS

Cervical tumor showed a lower 1.3-ppm lipid level (0.30 vs 1.01 $\mu$ M,  $P < .05$ ), as compared with normal cervical tissue. Squamous cell carcinoma demonstrated lower levels in 1.3-ppm lipid (0.17 $\mu$ M vs 0.59 $\mu$ M,  $P < .05$ ) and 0.9-ppm lipid (0.04 $\mu$ M vs 0.16 $\mu$ M,  $P < .05$ ), as compared with adenocarcinoma. Tumor with T stage  $\geq$  IIb had lower levels in 1.3-ppm lipid (0.15 $\mu$ M vs 0.53 $\mu$ M,  $P < .05$ ), 0.9-ppm lipid (0.04 $\mu$ M vs 0.15 $\mu$ M,  $P < .05$ ) and total choline (0.04 $\mu$ M vs 0.16 $\mu$ M,  $P < .05$ ). Tumors with nodal metastasis contained lower levels of 1.3-ppm lipid (0.16 $\mu$ M vs 0.44 $\mu$ M,  $P < .05$ ) and glutamine (0.01 $\mu$ M vs 0.02 $\mu$ M,  $P < .005$ ), whereas tumors with distant metastasis contained a lower level of 1.3-ppm lipid (0.12 $\mu$ M vs 0.50 $\mu$ M,  $P < .05$ ). However, resonances from cervical tumor were independent to maximal tumor size or ADC value on MRI.

## CONCLUSION

1H-MRS using body-phased array coil at 3.0 T in cervical cancer patients is useful in differentiating tumor, histopathology type, T stage  $\geq$  IIb, nodal or distant metastasis, and is independent to maximal tumor size or ADC value on MRI.

## CLINICAL RELEVANCE/APPLICATION

1H-MRS using body-phased array coil at 3.0 T added additional dimensions for pretreatment assessment in cervical cancer patients.

### SSG06-07 Impact of Multiparametric MRI (mMRI) on the Therapeutic Management of Suspicious Adnexal Masses Detected by Transvaginal Ultrasound (TVUS)

Tuesday, Dec. 1 11:30AM - 11:40AM Location: N229

#### Participants

Simone Schradig, MD, Aachen, Germany (*Presenter*) Nothing to Disclose  
Sabine M. Detering, Aachen, Germany (*Abstract Co-Author*) Nothing to Disclose  
Dirk Bauerschlag, Aachen, Germany (*Abstract Co-Author*) Nothing to Disclose  
Christiane K. Kuhl, MD, Bonn, Germany (*Abstract Co-Author*) Nothing to Disclose

## PURPOSE

Incidental adnexal masses at TVUS are common and diagnostically challenging. The primary goal of imaging is accurate tissue characterization to guide further management, i.e. the choice between plain follow-up vs laparoscopic surgery vs. open surgery. Aim of this study was to evaluate the diagnostic utility of mMRI for further management stratification in patients with such adnexal masses

## METHOD AND MATERIALS

Prospective IRB-approved trial on 126 women (mean age 54.6 years) with inconclusive adnexal masses at TVUS. All women underwent conventional work up, including pelvic examination, TVUS, and CA-125 levels. In addition, all women underwent mMRI at 3T with high resolution T2-TSE in three planes, DWI (max. b=800) and DCE. Likelihood of malignancy and appropriate management (i.e. follow-up vs. laparoscopic vs. open surgery) was first determined based on results of conventional methods, and then, independently, based on mMRI. Then, all methods were reviewed in synopsis. Final surgical pathology served as standard-of-reference or clinical and imaging follow-up of at least 24 months

## RESULTS

In 65% (82/126) of patients the adnexal mass finally classified as benign, in 29% (36/126) as malignant and in 6% (8/126) as borderline. The diagnostic indices for TVUS+CA-125 alone vs. MRI alone vs. all methods combined were as follows: Sensitivity: 86% (31/36) vs. 97% (35/36) vs. 100% (36/36); Specificity: 32% (29/90) vs. 83% (75/90) vs. 80% (68/90); PPV: 34% (31/91) vs. 70% (35/50) vs. 74% (40/54); NPV: 65% (29/44) vs. 98% (75/76) vs. 100% (72/72). After mMRI, the therapeutic management was changed in 41/126 (34%) of patients. In 30 patients in whom surgery had been recommended based on conventional assessment, mMRI correctly diagnosed typical benign findings; these patients underwent follow-up instead of surgery. None of these women developed malignancy during follow-up. In another 11 patients, mMRI results correctly suggested malignancy such that open surgery was performed instead of laparoscopic surgery

## CONCLUSION

Compared with conventional assessment (pelvic exam, TVUS, CA-125), mMRI correctly changed the management in one-third of women with incidental adnexal masses. It helps avoid unnecessary surgery, or unnecessary surgical steps (conversion from laparoscopic to open surgery)

## CLINICAL RELEVANCE/APPLICATION

Pelvic mMRI helps to significantly improve clinical management of asymptomatic women with incidental adnexal masses identified on TVUS

### SSG06-08 Preoperative Tumor Texture Analysis from MRI Predicts Deep Myometrial Invasion and High Risk Histology in Endometrial Carcinomas

Tuesday, Dec. 1 11:40AM - 11:50AM Location: N229

#### Participants



Sigmund Ytre-Hauge, MD, Bergen, Norway (*Presenter*) Nothing to Disclose  
Erik Hanson, PhD, Bergen, Norway (*Abstract Co-Author*) Nothing to Disclose  
Arvid Lundervold, MD, PhD, Bergen, Norway (*Abstract Co-Author*) Nothing to Disclose  
Jone Trovik, MD, Bergen, Norway (*Abstract Co-Author*) Nothing to Disclose  
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Ingrid S. Haldorsen, MD, PhD, Bergen, Norway (*Abstract Co-Author*) Nothing to Disclose

## PURPOSE

Tumor heterogeneity is a key feature of malignant disease. Heterogeneity in MR images can be quantified by texture analysis. We aimed to explore whether high risk histological features are reflected in texture parameters derived from preoperative MRI in endometrial carcinomas.

## METHOD AND MATERIALS

Preoperative pelvic contrast-enhanced MRI (1.5T) including diffusion-weighted imaging (DWI) was prospectively performed in 99 patients with histologically confirmed endometrial carcinomas. Tumor region of interest (ROI) was manually drawn encircling the uterine tumor on axial T1-weighted contrast-enhanced (CE) series on the slice displaying the largest cross-section tumor area. Histogram based texture features (standard deviation, skewness and kurtosis) were calculated from these tumor ROIs. Texture parameters were analyzed in relation to established histological subtype and grade, surgicopathological staging parameters (deep myometrial and cervical stroma invasion and lymph node metastases) and MRI based tumor volume and tumor apparent diffusion coefficient (ADC) value using Mann-Whitney U test, Jonckheere-Terpstra trend test and Pearson's bivariate correlation test.

## RESULTS

Large standard deviation (SD) in the tumor ROIs was significantly associated with presence of deep myometrial invasion ( $p=0.009$ ). Lower values for skewness were observed in the tumor ROIs from endometrioid high grade tumors ( $p=0.012$ ) and from non-endometrioid tumors (by definition always high grade lesions,  $p=0.020$ ). Kurtosis was positively correlated to tumor volume ( $r=0.27$ ;  $p=0.006$ ) and negatively correlated to tumor ADC value ( $r=-0.28$ ;  $p=0.006$ ).

## CONCLUSION

MRI derived tumor texture features reflecting tumor heterogeneity are significantly related to high risk histology and predict deep myometrial invasion in endometrial carcinomas. Thus, tumor texture features based on MRI represent promising biomarkers to aid preoperative tumor characterization for risk stratified surgical treatment.

## CLINICAL RELEVANCE/APPLICATION

Tumor texture features derived from MRI reflect high risk endometrial carcinoma and may aid preoperative risk classification for stratified surgery.

## SSG06-09 Endometrial Cancer MR Staging Accuracy in a Large Multi-site UK Cancer Network Over Three Years: Can the Reported Single Centre Staging Accuracies be Met in Clinical Practice?

Tuesday, Dec. 1 11:50AM - 12:00PM Location: N229

### Participants

Neil Soneji, BSC, MBBS, London, United Kingdom (*Abstract Co-Author*) Nothing to Disclose  
Annarita Ferri, MD, Chieti, Italy (*Presenter*) Nothing to Disclose  
Victoria Stewart, London, United Kingdom (*Abstract Co-Author*) Nothing to Disclose  
Roberto Dina, MD, London, United Kingdom (*Abstract Co-Author*) Nothing to Disclose  
Nishat Bharwani, MBBS, FRCR, London, United Kingdom (*Abstract Co-Author*) Nothing to Disclose  
Andrea G. Rockall, MRCP, FRCR, London, United Kingdom (*Abstract Co-Author*) Nothing to Disclose

## PURPOSE

To determine the radiological staging accuracy of endometrial cancer (EC) from images acquired from multiple MR scanners across a 10 centre UK cancer network over three years.

## METHOD AND MATERIALS

Retrospective study of 382 consecutive patients with EC imaged in 9 external hospitals and 3 internal hospital sites discussed at our tertiary gynaecology centre between October 2011-October 2014. All patients with tertiary centre reports for both final histology and MRI were included ( $n=270$ ). The radiological stage provided at MDT discussion was compared to the 'gold standard' histological report. Parameters assessed included depth of myometrial invasion, cervical and nodal stage. The use of DWI or DCE and the site for incorrect staging were recorded. MedCalc statistical software version 15.2.2 was used.

## RESULTS

242 of 270 MRI reports (90%) included a final FIGO stage; of these 147 scans were performed internally and 95 at an external hospital. Accuracy of the reported depth of invasion was 72.7% for all cases (72.8% for internal and 72.6% for external scans). Sensitivity, specificity, positive and negative predictive values & accuracy with DWI ( $n=204$ ) were 67%, 77%, 64%, 79%, 73% and without DWI ( $n=38$ ) were 75%, 69%, 53%, 86%, 71% ( $p>0.05$ ). Accuracy with DCE ( $n=109$ ) was 72% and without ( $n=130$ ) was 73%. For cervical stromal invasion, sensitivity, specificity, PPV, NPV and accuracy for all scans were 59%, 94%, 64%, 93% and 89%. As a percentage of all causes of staging error, depth of invasion accounted for 41-52%, cervix stromal invasion 20-32% and nodal stage 8-16% depending on whether the patient was scanned internally or externally, or whether DWI or DCE were included ( $p>0.05$ ).

## CONCLUSION

Staging accuracy in a large multi-site cancer network over three years does not meet the reported staging accuracies in meta-analyses of smaller single centre published research (pooled sensitivity/specificity of 86-90%). DWI and DCE did not affect staging accuracy, although only a small number of cases did not have these. The underlying causes for the reduction in sensitivity and specificity need to be evaluated in order to translate the highest achievable MR staging accuracy to long term routine practice.

## CLINICAL RELEVANCE/APPLICATION

Accuracy of MR staging of endometrial cancer in a multi-site cancer network over three years does not reach single centre study results. The causes for staging inaccuracies need to be understood.



## Neuroradiology (Imaging of White Matter and Demyelinating Disease)

Tuesday, Dec. 1 10:30AM - 12:00PM Location: N227



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

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

### Participants

Aaron S. Field, MD, PhD, Madison, WI (*Moderator*) Nothing to Disclose  
Ashok Srinivasan, MD, Ann Arbor, MI (*Moderator*) Author, Reed Elsevier

### Sub-Events

#### SSG13-01 Subcortical White Matter Hyperintensity Burden in Astronauts

Tuesday, Dec. 1 10:30AM - 10:40AM Location: N227

### Participants

Jeremy Bernot, MD, Joint Base San Antonio Lackland, TX (*Presenter*) Nothing to Disclose  
Paul M. Sherman, MD, Lackland Air Force Base, TX (*Abstract Co-Author*) Nothing to Disclose  
Stephen McGuire, MD, Joint Base San Antonio Lackland, TX (*Abstract Co-Author*) Nothing to Disclose

### PURPOSE

We postulated that subcortical white matter hyperintensities (WMH) without clinical symptoms might be occurring in astronauts exposed to hypobaric conditions. We previously demonstrated the presence of increased WMH burden in high altitude U-2 pilots (U2P) and altitude chamber aerospace physiology personnel (AOP) occurring in the absence of clinical symptoms.

### METHOD AND MATERIALS

In our prior study evaluating WMH burden in high altitude U-2 pilots (U2P) and aerospace physiology personnel (AOP) we obtained 2-dimensional 5mm clinical MRI sequences, both T2 FSE and FLAIR. Brain exams were conducted on the two Siemens 3T magnets with either a 12-channel or 32-channel phased array head coil. The National Aeronautics and Space Administration (NASA) has previously obtained similar 3T brain MRI scans on 42 astronauts after international space station (ISS) mission completion. These scans were conducted on 3 different 3T magnets, two Siemens scanners and one Philips scanner, with 12-channel head coils. WMH burden was evaluated by 1 neuroradiologist and 1 neurologist for lesion count. Assessment of lesion volume is in progress. Nonparametric Wilcoxon statistics were used to compare the astronauts to our normative, advanced degree (DOC) population (n=162) data as well as our AOP group (n=83) and U2P group (n=105). Age range of our prior study populations was 26-50; average DOC 34.6; average AOP 36.5; and average U2P 37.7. NASA age range 35-55, average 45.

### RESULTS

The average number of WMHs for U2P was 8.1; AOP 6.3; DOC 2.8; and for the NASA astronauts 9.4. Wilcoxon rank sum test with continuity correction data demonstrates a significant difference for WMH burden between the NASA group and DOC (p value = 0.0211). There was no significant difference between the NASA group and AOP (p = 0.4762) or U2P (p = 0.725) groups.

### CONCLUSION

Astronauts demonstrate a similar WMH burden to our high altitude U2 pilots and aerospace physiology personnel, significantly higher than the normal population.

### CLINICAL RELEVANCE/APPLICATION

This study suggests the potential for similar pathophysiology in astronauts as seen in personnel exposed to the hypobaric environment in military operations, which has direct relevance to future deep space operations. Understanding the association between WMHs and hypobaric exposure may provide insight into the pathophysiology of other white matter disease processes.

#### SSG13-02 FLAIR<sup>2</sup> for Improved MS Lesion Detection

Tuesday, Dec. 1 10:40AM - 10:50AM Location: N227

### Participants

Alexander Rauscher, PhD, MSc, Vancouver, BC (*Presenter*) Advisory Board, F. Hoffmann-La Roche Ltd  
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Eneidino Hernandez Torres, PhD, Vancouver, BC (*Abstract Co-Author*) Nothing to Disclose  
Anthony Traboulsee, MD, Vancouver, BC (*Abstract Co-Author*) Researcher, Angiotech Pharmaceuticals, Inc; Researcher, Bayer AG; Researcher, BioMS Medical; Researcher, Johnson & Johnson; Researcher, DAIICHI SANKYO Group; Researcher, F. Hoffmann-La Roche Ltd; Researcher, Merck KGaA; Researcher, Schering-Plough Corporation; Researcher, Teva Pharmaceutical Industries Ltd; Researcher, sanofi-aventis Group; Researcher, Transition Therapeutics Inc; Consultant, sanofi-aventis Group; Research Grant, F. Hoffmann-La Roche Ltd; Research Grant, sanofi-aventis Group;  
David K. Li, MD, Vancouver, BC (*Abstract Co-Author*) Researcher, sanofi-aventis Group Researcher, F. Hoffmann-La Roche Ltd Researcher, Merck KGaA Researcher, Novartis AG Researcher, Nuron Biotech, Inc Researcher, PAREXEL International Corporation Consultant, sanofi-aventis Group Consultant, F. Hoffmann-La Roche Ltd Scientific Advisory Board, Novartis AG Scientific Advisory Board, Nuron Biotech, Inc Scientific Advisory Board, Opexa Therapeutics, Inc

### PURPOSE

To improve the spatial resolution and contrast-to-noise ratio (CNR) of fluid attenuated inversion recovery (FLAIR) MRI.

## METHOD AND MATERIALS

Data from 5 healthy controls and 29 patients with relapsing-remitting and progressive multiple sclerosis (MS) were acquired on a Philips 3T using sagittal 3D sequences. Signal-to-noise ratio and CNR were estimated by assessing the noise between repeated acquisitions of the same scan. Various spatial resolutions ranging from 0.2 mm<sup>3</sup> to 1 mm<sup>3</sup> were tested.

## RESULTS

Gray matter (GM)- white matter (WM) CNR was by 55% and 74.5% higher in FLAIR<sup>2</sup> than in FLAIR and double inversion recovery (DIR) and improved between lesions and WM by 59% and 29.6%, respectively. The figure shows a 3D T2 (A), a conventional 3D FLAIR (B), 3D FLAIR<sup>2</sup> (C) and 3D DIR of a person with relapsing-remitting MS. In agreement with the quantitative CNR measurements, lesion conspicuity and contrast between GM and WM appear improved on FLAIR<sup>2</sup>. Here, FLAIR<sup>2</sup> was acquired at 0.6×0.75×1.35 mm<sup>3</sup> and reconstructed to 0.3 mm<sup>3</sup> voxels, while DIR was acquired and reconstructed to 1 mm<sup>3</sup>. The 3D-nature of FLAIR<sup>2</sup> allowed the visualization of callosal and infratentorial MS lesions. Cortical and juxtacortical MS lesions were more conspicuous in FLAIR<sup>2</sup> than in the other scans.

## CONCLUSION

We present a simple approach for obtaining CSF suppression with improved CNR compared to conventional FLAIR and DIR. Lesions in the entire brain are captured, including infratentorial regions, the corpus callosum and most of the cervical cord as well as cortical lesions, at high spatial resolution. With its DIR-like contrast, FLAIR<sup>2</sup> may elegantly resolve the debate whether or not to include DIR into the standard imaging protocol of MS.

## CLINICAL RELEVANCE/APPLICATION

FLAIR<sup>2</sup> is very easy to acquire on most MR scanners. Apart from MS, the improved detection of WM hyperintensities will benefit research and diagnosis in Alzheimer's disease, neurotrauma, stroke and other applications. The isotropic 3D-acquisition allows for excellent image registration in serial studies, which may improve automated detection of lesions. Dedicated head-neck coils will allow to assess abnormalities in the entire cervical cord and parts of the thoracic cord.

## SSG13-03 Clinical Feasibility of Synthetic MRI in Multiple Sclerosis: A Diagnostic and Volumetric Validation Study

Tuesday, Dec. 1 10:50AM - 11:00AM Location: N227

### Participants

Tobias Granberg, Stockholm, Sweden (*Presenter*) Nothing to Disclose  
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Farouk Hashim, MD, Stockholm, Sweden (*Abstract Co-Author*) Nothing to Disclose  
Carmen Cananau, MD, Bucharest, Romania (*Abstract Co-Author*) Nothing to Disclose  
Love Engstrom-Nordin, MSc, Stockholm, Sweden (*Abstract Co-Author*) Nothing to Disclose  
Sara Shams, Stockholm, Sweden (*Abstract Co-Author*) Nothing to Disclose  
Johan Berglund, MSc, PhD, Stockholm, Sweden (*Abstract Co-Author*) Nothing to Disclose  
Yngve Forslin, Stockholm, Sweden (*Abstract Co-Author*) Nothing to Disclose  
Peter Aspelin, MD, PhD, Stockholm, Sweden (*Abstract Co-Author*) Nothing to Disclose  
Sten Fredrikson, MD, PhD, Stockholm, Sweden (*Abstract Co-Author*) Speaker, Actavis, Inc; Speaker, Bayer AG; Speaker, Biogen Idec Inc; Speaker, Merck KGaA; Speaker, Novartis AG; Speaker, sanofi-aventis Group; Speaker, Teva Pharmaceutical Industries Ltd  
Maria Kristoffersen Wiberg, Stockholm, Sweden (*Abstract Co-Author*) Nothing to Disclose

## PURPOSE

To implement synthetic magnetic resonance imaging (syMRI) on a new scanner type and to compare its diagnostic accuracy with conventional MRI in multiple sclerosis (MS). Secondary aims were to study the repeatability of syMRI volumetry and compare its feasibility with commonly used volumetric methods.

## METHOD AND MATERIALS

This prospective study was approved by the ethical review board and written informed consent was obtained. In October 2014, 20 MS patients were consecutively recruited along with 20 healthy controls. SyMRI was implemented on a Siemens 3T scanner. Comparable conventional (11:00 minutes) and synthetic (6:50 minutes) T1, PD, T2 and FLAIR images were acquired. Diagnostic accuracy, lesion detection and artifacts were assessed by blinded neuroradiological evaluation and contrast-to-noise ratios by manual tracing. Volumetry was performed with SyMRI, Freesurfer, FSL and SPM. Ordinal data was analyzed using Wilcoxon signed ranks test and categorical data using McNemar test. Repeatability was quantified using the inter-measurement coefficient of variance (CoV).

## RESULTS

Synthetic images were of good to sufficient quality, except FLAIR images that were degraded by artifacts. All participants were correctly classified as patients/controls and incidental findings were identical with both MRI techniques. There were no differences in lesion number ( $P = 0.78$ ) or location ( $P = 0.50-0.77$ ). SyMRI provided the fastest segmentations with the lowest CoV for brain volume (0.14%) and brain parenchymal fraction (0.14%).

## CONCLUSION

SyMRI provides diagnostic T1-, PD- and T2-weighted images in MS patients and controls. Synthetic brain tissue segmentations are fast and precise quantitative biomarkers suitable for longitudinal MS studies.

## CLINICAL RELEVANCE/APPLICATION

Synthetic MRI can lower the threshold of implementing radiological quantitative biomarkers into clinical practice in MS by providing fast and precise brain tissue segmentations. Conventional T1, PD and T2 sequences could possibly be replaced by synthetic images with the additional benefits of being able to arbitrarily adjust the weightings post-hoc and a slight reduction in acquisition times, meanwhile providing abovementioned quantitative biomarkers.

## SSG13-04 Grey/white Matter Ratio at Diagnosis, and the Risk of 10-year Multiple Sclerosis Progression

Tuesday, Dec. 1 11:00AM - 11:10AM Location: N227

## Participants

Marcello Moccia, MD, Napoli, Italy (*Presenter*) Nothing to Disclose  
Mario Quarantelli, MD, Napoli, Italy (*Abstract Co-Author*) Nothing to Disclose  
Roberta Lanzillo, Naples, Italy (*Abstract Co-Author*) Nothing to Disclose  
Sirio Cocozza, MD, Napoli, Italy (*Abstract Co-Author*) Nothing to Disclose  
Antonio Carotenuto, Naples, Italy (*Abstract Co-Author*) Nothing to Disclose  
Barbara Carotenuto, Naples, Italy (*Abstract Co-Author*) Nothing to Disclose  
Bruno Alfano, PhD, Napoli, Italy (*Abstract Co-Author*) Nothing to Disclose  
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Maria Triassi, Naples, Italy (*Abstract Co-Author*) Nothing to Disclose  
Raffaele Palladino, London, United Kingdom (*Abstract Co-Author*) Nothing to Disclose  
Arturo Brunetti, MD, Naples, Italy (*Abstract Co-Author*) Nothing to Disclose  
Vincenzo Brescia Morra, Naples, Italy (*Abstract Co-Author*) Nothing to Disclose

## PURPOSE

Grey and white matters are both affected in multiple sclerosis (MS), but poorly correlate among each other. This is possibly due to the heterogeneous pathological substrates of the disease, with preponderance of white matter demyelinating inflammation in relapsing-remitting (RR), and of grey matter neurodegeneration in secondary progressive (SP). Aim of the study is to investigate the relationship between grey and white matter in a population of newly diagnosed RRMS subjects, with long-term MS-related outcomes.

## METHOD AND MATERIALS

The present 10-year retrospective longitudinal study included 134 RRMS subjects that performed MRI at the time of diagnosis with acquisition of T1-weighted volumes for segmentation purposes. In particular, the ratio between grey and white matter was subsequently calculated. The occurrence of clinical relapses, the reaching of Expanded Disability Status Scale (EDSS) 4.0, and the SP conversion were recorded during a mean follow-up period of  $10.1 \pm 1.8$  years (from 7.1 to 13.2).

## RESULTS

During the study period, 54 subjects (40.3%) reached EDSS 4.0, and presented reduced grey/white matter ratio, as compared to subjects not reaching EDSS 4.0 ( $1.270 \pm 0.156$  and  $1.343 \pm 0.185$ , respectively) ( $p=0.017$ ). At the same time, 29 subjects (21.6%) converted to SP, and presented reduced grey/white matter ratio, as compared to subjects not converting to SP ( $1.241 \pm 0.149$  and  $1.334 \pm 0.179$ , respectively) ( $p=0.012$ ). In particular, subjects with higher grey/white matter ratio at diagnosis had a 80% reduced rate of reaching EDSS 4.0 ( $p=0.040$ ; hazard ratio=0.195; 95% confidence interval=0.041-0.829), and a 90% reduced rate of SP conversion, as compared to subjects with lower grey/white matter ratio ( $p=0.043$ ; hazard ratio=0.105; 95% confidence interval=0.011-0.831).

## CONCLUSION

The ratio of grey/white matter is a predictor of disability progression and of SP conversion in newly diagnosed RRMS subjects, suggesting that different pathological substrates are present from the early phases of MS, and highlighting the importance of appropriate MRI techniques at MS diagnosis.

## CLINICAL RELEVANCE/APPLICATION

The present study evaluated for the first time the ratio between grey and white matter in MS, suggesting a novel MRI method to predict MS progression from the diagnosis.

## SSG13-05 Substages of Acute Multiple Sclerosis Lesions Demonstrated on Quantitative Susceptibility Mapping and R2\* from Gradient Echo MRI

Tuesday, Dec. 1 11:10AM - 11:20AM Location: N227

## Participants

Yan Zhang, Wuhan, China (*Presenter*) Nothing to Disclose  
Susan Gauthier, New York, NY (*Abstract Co-Author*) Nothing to Disclose  
Lijie Tu, New York, NY (*Abstract Co-Author*) Nothing to Disclose  
Ajay Gupta, MD, New York, NY (*Abstract Co-Author*) Research Consultant, Biomedical Systems; Research support, General Electric Company  
Joseph P. Comunale JR, MD, New York, NY (*Abstract Co-Author*) Nothing to Disclose  
Dong Zhou, New York, NY (*Abstract Co-Author*) Nothing to Disclose  
Weiwei Chen, Wuhan, China (*Abstract Co-Author*) Nothing to Disclose  
Wenzhen Zhu, MD, PhD, Wuhan, China (*Abstract Co-Author*) Nothing to Disclose  
Yi Wang, PhD, New York, NY (*Abstract Co-Author*) Nothing to Disclose

## PURPOSE

Multiple sclerosis (MS) lesions at early stages are highly dynamic and pathologically heterogeneous, and therefore not well delineated in standard MRI. Quantitative susceptibility mapping (QSM) and R2\* may offer new insight into the rapid changes in myelin and iron content within new lesions. The goal of this study was to characterize changes in QSM and R2\* at various stages of lesions gadolinium enhancement.

## METHOD AND MATERIALS

This retrospective study included 43 MS patients with newly identified T2w white matter lesions that first appeared on the current T2w image compared to the former scans. All patients underwent a 3D gradient multiple echoes sequence to generate QSM and R2\* maps. These new lesions were subtyped according to enhancing patterns: nodular, shell and non-enhancing. Lesions susceptibilities and R2\* values were quantified and compared using analysis of variance (ANOVA) among three patterns. A paired t test was used to analyze susceptibility and R2\* between the enhancing rim and the non-enhancing core of shell lesions.

## RESULTS

Of the total 116 new T2w WM lesions, 65 were nodular with 62 (95.4%) isointense on QSM, 17 were shell with 15 (88.23%)

hyperintense on QSM and 34 were non-enhancing hyperintense on QSM lesions. The susceptibilities relative to contralateral mirror side normal appearing WM (NAWM) were  $0.66 \text{ ppb} \pm 4.64$  for nodular,  $10.21 \text{ ppb} \pm 6.92$  for shell, and  $19.94 \text{ ppb} \pm 7.39$  for non-enhancing ( $P < .01$ ).  $R2^*$  values relative to NAWM were  $-5.60 \text{ Hz} \pm 7.39$ ,  $-7.80 \text{ Hz} \pm 2.40$  and  $-3.10 \text{ Hz} \pm 2.48$  ( $P < 0.001$ ) respectively. Of the 17 shell enhancing lesions, the differences of susceptibilities and  $R2^*$  between the enhancing rim and non-enhancing core were significant ( $7.65 \text{ ppb} \pm 6.92$  vs  $15.51 \text{ ppb} \pm 7.30$ ,  $P < .05$ ;  $-6.13 \text{ Hz} \pm 2.31$  vs  $-9.13 \text{ Hz} \pm 2.95$ ,  $P < .05$ ).

## CONCLUSION

Gadolinium enhancement of acute MS lesions only reflects breakdown of blood-brain barrier. New T2 MS lesions may be sub staged into acute, sub-acute, and early chronic according to GRE data: no change in QSM but rapid decrease in  $R2^*$  during acute stage, rapid increase in QSM and further decrease in  $R2^*$  during sub-acute, and increase in both QSM and  $R2^*$  during early chronic.

## CLINICAL RELEVANCE/APPLICATION

QSM and  $R2^*$  can be used to capture different stages of early multiple sclerosis (MS) lesions.

### SSG13-06 Decreased GABA Concentrations in Patients with Relapsing-remitting Multiple Sclerosis Demonstrated by Edited Magnetic Resonance Spectroscopy

Tuesday, Dec. 1 11:20AM - 11:30AM Location: N227

#### Participants

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Bin Zhao, MD, Jinan, China (*Abstract Co-Author*) Nothing to Disclose  
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Guanmei Cao, Jinan, China (*Abstract Co-Author*) Nothing to Disclose

## PURPOSE

Gamma-aminobutyric acid (GABA) is the main inhibitory neurotransmitter in the central nervous system. Previous studies have demonstrated that there is a dysfunctional GABAergic neurotransmission in animal models of multiple sclerosis (MS). Edited magnetic resonance spectroscopy (MRS), using the MEGA-PRESS sequence, is the most widely used technique for detecting GABA in the human brain. However, to date there has been a paucity of studies exploring changes in GABA concentration in patients with MS. In this study, therefore, J-difference edited MRS was used to investigate GABA concentrations in patients with relapsing-remitting MS (RRMS) and healthy controls.

## METHOD AND MATERIALS

Fifteen patients with RRMS (7 males/8 females, mean age  $41.7 \pm 3.6$  years) and fifteen healthy controls (6 males/9 females, mean age  $43.3 \pm 4.7$  years) were examined on a 3T scanner and T1-weighted three-dimensional TFE images were used as a localizer. The MEGA-PRESS sequence (TR 2000 ms; TE 68 ms; 256 averages) was used to measure GABA concentrations in the posterior cingulate cortex (PCC), left dorsolateral prefrontal cortex (DLPFC) and left hippocampus (LHC). For quantification, a shorter measurement (8 averages) of the unsuppressed water signal was obtained. The MRS data were analyzed using 'Gannet' (GABA-MRS Analysis Tool) in Matlab with Gaussian curve fitting to the GABA peaks. 3 Hz exponential line broadening was applied. The ratios of the integrals of the GABA and water signals, making corrections for T1 and T2 relaxation times and partial volume effects, were used to calculate water-scaled GABA concentration in mmol/L (mM) using a formula.

## RESULTS

GABA concentrations in the PCC and LHC regions were significantly lower in RRMS patients compared to healthy controls (PCC region:  $0.95 \pm 0.09 \text{ mM}$  vs.  $1.06 \pm 0.13 \text{ mM}$ ,  $p = 0.01$ ; LHC region:  $1.04 \pm 0.20 \text{ mM}$  vs.  $1.23 \pm 0.22 \text{ mM}$ ,  $p = 0.02$ ). No statistical difference in GABA concentrations in the DLPFC region was seen between groups ( $0.91 \pm 0.10 \text{ mM}$  vs.  $0.95 \pm 0.13 \text{ mM}$ ,  $p = 0.32$ ).

## CONCLUSION

These results are consistent with a hypothesis of dysfunctional GABAergic neurotransmission in the central nervous system in patients with MS, and suggest a potential treatment target for MS.

## CLINICAL RELEVANCE/APPLICATION

MRS study suggests dysfunctional GABAergic neurotransmission in the central nervous system in patients with MS, as well as a potential treatment target for MS.

### SSG13-07 Temporal Assessment of Injury and Repair in Multiple Sclerosis Lesions Using Structure Tensor Analysis

Tuesday, Dec. 1 11:30AM - 11:40AM Location: N227

#### Participants

Laura Chin, Edmonton, AB (*Abstract Co-Author*) Nothing to Disclose  
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Yunyan Zhang, MD, PhD, Calgary, AB (*Abstract Co-Author*) Nothing to Disclose

## PURPOSE

Multi-focal plaques remain to be the hallmark of multiple sclerosis (MS). Subtle changes in lesion structure are ongoing but not detectable with standard measures. Here we aimed to determine how lesions evolve in brain MRI of MS patients using a new measure of tissue alignment, structure tensor analysis.

## METHOD AND MATERIALS

19 untreated MS patients were scanned bimonthly for 14 months at 1.5T. All images were non-uniformity corrected and sequential images were co-registered to baseline MRI (month 0). T2 lesions were segmented with reference to other MRI contrasts and followed over time. For lesions appeared during study, we mapped their onset time to baseline for consistency. Structure tensor analysis was applied to the corrected T2 images that resulted in 2 index maps: coherency and energy, which represent tissue

anisotropy and total strength of directions respectively. Lesion outcomes were then extracted from corresponding index maps and averaged per MRI slice, timepoint, and patient. Lesion size was also computed for comparison. Outcome significance was assessed using multi-effect modeling ( $p \leq 0.05$ ).

## RESULTS

We identified 156 white matter lesions; 145 visible throughout the study; 15 lesions appeared post baseline and were adjusted. Overall, there is a trend to increase for lesion coherency, prominently from month 10. Lesion energy appeared stable except a remarkable decrease at month 8, as also seen in lesion coherency. These results are not affected by lesion adjustment. Lesion size tended to decrease over 14 months.

## CONCLUSION

Abrupt increase in lesion coherency from month 10 suggests tissue repair including remyelination in these patients. While being a similar measure to diffusion anisotropy, structure tensor coherency has the advantage of using standard MRI, no extra scan time needed. Stable energy and lesion size may indicate lack of sensitivity of these measures. Further confirmation is warranted.

## CLINICAL RELEVANCE/APPLICATION

Structure tensor coherency may become a new measure of nerve repair in MS lesions after demyelination. As it is embeddable to clinical MRI, this measure may improve routine patient care.

### SSG13-08 Lack of Correlation between Neck Venous Drainage and Multiple Sclerosis

Tuesday, Dec. 1 11:40AM - 11:50AM Location: N227

#### Participants

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#### PURPOSE

Presence of flow abnormalities in neck veins of Multiple Sclerosis (MS) patients is still controversial, and the best imaging technique to evaluate them is not well defined yet. Aim of this study is to evaluate, using a quantitative MRI analysis, blood flow and venous stenosis in neck vessels, and investigate if there are differences between MS patients and healthy controls (HC), along with possible correlation with clinical scores.

#### METHOD AND MATERIALS

A group of 61 Relapsing-Remitting MS patients (mean age  $38 \pm 11$  years; F/M=27/34) and 18 HC (mean age  $38 \pm 13.6$  years; F/M=8/10) underwent MR scan of the neck. Acquisition included a 2D dynamic Phase-Contrast sequence (TR=66.8ms; TE=5.3ms; slice thickness=3mm; 30 time points), with peripheral retrospective triggering, acquired as a single slice at two different levels (C2 and C6). Quantitative measures, obtained with a semi-automated method through a dedicated software (Signal Processing In NMR - SPIN, Detroit, USA), were: left and right internal jugular vein (IJV) flow rates, and their cross-sectional areas, total IJV flow rate, total arterial and venous blood flow rates and the corresponding arteriovenous mismatch. Clinical variables included: number of relapses, disease duration, Expanded Disability Status Scale, Annualized Relapsing Rate and Multiple Sclerosis Severity Score. All statistical analyses were performed using SPSS (SPSS Inc, 2008, V.17.0. Chicago, SPSS Inc.).

## RESULTS

Only 13/61 (21.3%) MS patients, with 7/18 HC (38.9%), showed a reduction in IJV cross sectional area. An independent samples t-test between MS patients and HC showed no significant differences for any flow measure. Furthermore, no correlations were found between any MR measure and clinical variables.

## CONCLUSION

Quantitative MR evaluation of blood flow in neck vessels found no difference between MS patients and HC in any of the tested flow measures, confirming that the neurovascular hypothesis of MS is, in our sample, not suitable. Also, MS patients and HC showed no difference in terms of IJV area, suggesting that IJV stenosis is not related to the disease. Further studies, with a larger HC group, need to be performed to confirm our results.

## CLINICAL RELEVANCE/APPLICATION

Neck venous drainage abnormalities have been claimed to be associated with Multiple Sclerosis. Conversely, our quantitative MR analysis seems to exclude that venous patterns are related to the disease

### SSG13-09 fMRI and Multiple Sclerosis: Cognitive Function Assessment Using Verbal Fluency Paradigm

Tuesday, Dec. 1 11:50AM - 12:00PM Location: N227

#### Participants

Bernardo C. Bizzo, MD, Rio De Janeiro, Brazil (*Presenter*) Nothing to Disclose  
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Tania M. Netto, PhD, Rio de Janeiro, Brazil (*Abstract Co-Author*) Nothing to Disclose  
Lucas Ramos, Rio de Janeiro, Brazil (*Abstract Co-Author*) Nothing to Disclose  
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## **PURPOSE**

Multiple Sclerosis (MS) is an autoimmune disease of Central Nervous System, characterized by chronic inflammatory demyelination of both white and grey matter pathology. Individuals with MS suffer from a range of physical, psychiatric and cognitive symptoms. Cognitive impairments have been reported in 40-60% of these patients and verbal fluency tests such as semantic and phonemic have consistently been reported as more sensitive to executive functions impairments in MS than other measures. The aim of this study was to evaluate MS patients by functional magnetic resonance imaging (fMRI) with a verbal fluency paradigm and cognitive neuropsychological scores.

## **METHOD AND MATERIALS**

Nineteen patients with MS (14 women; mean age 35.47 years, SD +/- 9.01) underwent a neuropsychological assessment including: Mini Mental State Examination for exclusion criteria; Semantic and Phonemic Verbal Fluency to measure verbal initiation and inhibition, memory, phonological and semantic language; and Hayling test to evaluate verbal initiation and inhibition, search strategies, syntactic-semantic and processing speed. This was followed by one fMRI session within a period of no more than one month and no less than 1 week. All MRI studies were performed on a 3T Siemens Trio, using fMRI EPI sequences while the patients responded to a verbal fluency task. Image processing and analysis were done using BrainVoyager software using GLM.

## **RESULTS**

During Whole brain analysis (qFDR<0.05) we found an increased BOLD response to verbal fluency task of Wernicke and Brocas areas and Inferior Frontal Gyrus (Brodmann Area 9) in left hemisphere. In a ROI analysis, this activation had an inverse correlation ( $r = -0.61$ ,  $p < 0.01$ ) between Hayling test scores and Wernicke area fMRI responses during Verbal Fluency task. In this situation, subjects that scored higher in Hayling test exhibited lower Wernicke responses to verbal fluency task.

## **CONCLUSION**

This results revealed that those patients that had reduced processing speed to evoke words had higher scores in Hayling test and lower brain responses in Wernicke area, reflecting on executive functions difficulties in initiation and inhibition of phonological and semantic language.

## **CLINICAL RELEVANCE/APPLICATION**

Cognitive impairments are important causes to functional disability on ME patients, and knowing its functional relationships in the brain can affect treatment decisions and improve patients life quality.

## Neuroradiology (The Aging Brain and Neurodegenerative Disease)

Tuesday, Dec. 1 10:30AM - 12:00PM Location: N226



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

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

### Participants

Jeffrey R. Petrella, MD, Durham, NC (*Moderator*) Advisory Board, Johnson & Johnson Speakers Bureau, Quintiles Inc Advisory Board, Piramal Enterprises Limited  
Mykol Larvie, MD, PhD, Boston, MA (*Moderator*) Nothing to Disclose

### Sub-Events

#### SSG12-01 Tract-specific Degeneration of White Matter Microstructure is Related to Worse Cognitive Performance

Tuesday, Dec. 1 10:30AM - 10:40AM Location: N226

### Participants

Lotte G. Cremers, MD, Rotterdam, Netherlands (*Presenter*) Nothing to Disclose  
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Gabriel P. Krestin, MD, PhD, Rotterdam, Netherlands (*Abstract Co-Author*) Consultant, General Electric Company; Research Grant, General Electric Company; Research Grant, Bayer AG; Research Grant, Siemens AG; Speakers Bureau, Siemens AG  
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Mohammad A. Ikram, Rotterdam, Netherlands (*Abstract Co-Author*) Nothing to Disclose

### PURPOSE

Organization of white matter microstructure has been related to cognition. Yet, it remains unclear whether it is a brain-wide loss or localized loss of microstructure that leads to worse cognition. We investigated the role of tract-specific white matter microstructure in global cognitive function and specific cognitive domains.

### METHOD AND MATERIALS

In 4516 non-demented middle-aged and elderly (mean age 63.8 ±11.1 years, 55.4% female) we obtained diffusion magnetic resonance imaging parameters (fractional anisotropy (FA) and mean diffusivity (MD)) in 25 white matter tracts using probabilistic tractography. In general, lower values of FA and higher values of MD are reflecting loss of white matter microstructural organization. With a cognitive test battery we assessed memory, information processing speed, executive function, and motor speed. We studied the association of tract-specific white matter microstructural organization and cognition using multivariable linear regression models, adjusting for macrostructural pathology, cardiovascular risk factors and APOE-ε4 allele carriership.

### RESULTS

Loss of tract-specific white matter microstructure in all tracts, except for the brain stem tracts, was associated with worse global cognition. Lower FA in the association and callosal tracts and higher MD in the projection and association tracts most strongly related to poorer cognition. Loss of white matter microstructure associated with worse information processing speed, executive functioning, and motor speed, but not with memory.

### CONCLUSION

Loss of white matter microstructure mainly in projection, association and callosal tracts is related to worse cognition, especially to worse information processing speed, executive function and motor speed, but not to memory.

### CLINICAL RELEVANCE/APPLICATION

Tract-specific microstructural changes may aid in identifying early biomarkers to predict which persons will suffer from neurodegenerative diseases.

#### SSG12-02 Stripe Sign of Precentral Gyri in Amyotrophic Lateral Sclerosis: A Novel Finding on Phase Difference Enhanced Images-initial Results

Tuesday, Dec. 1 10:40AM - 10:50AM Location: N226

### Participants

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### PURPOSE

Recently, we have developed new phase-weighted MR imaging, "Phase Difference Enhanced Imaging (PADRE)", in which phase difference between objective and surrounding tissue is selected in order to enhance the contrast of objective tissue. We compared the precentral gyri (PG) of patients with amyotrophic lateral sclerosis (ALS) and healthy subjects on PADRE images to determine whether the visualization of changes makes it possible to discriminate between ALS patients and healthy subjects on an individual



basis.

## METHOD AND MATERIALS

At first, with a nonblinded manner, two radiologists reviewed the normal and ALS appearances of the PG on PADRE images, and deviations from the normal PG appearance were recorded. Next, the observer performance study based on the PG abnormalities on PADRE image was performed by two reviewers, and both diagnostic accuracy and inter-observer agreement for the diagnosis of ALS on PADRE images were calculated.

## RESULTS

At the nonblinded evaluations, the two radiologists consensually defined the PG as abnormal when the following finding was present; a low signal intensity layer was seen in the middle gray matter in the PG. By the low signal intensity layer, we found that the four-layer organization could be characterized in the PG (Figure). The observer performance study demonstrated that the sensitivity, specificity, and accuracy of PG abnormalities on PADRE images for discriminating ALS patients from healthy subjects were 100% for reviewer 1 and 90%, 100%, and 96% for reviewer 2. The  $k$  values for inter-observer agreement were excellent ( $k = 0.932$ ).

## CONCLUSION

We propose the term "stripe sign" to describe the characteristically abnormal appearance (four-layer organization) of the PG in the ALS patients. Based on novel PADRE finding on the PG it was possible to discriminate between ALS patients and healthy subjects. The PADRE finding in ALS patients may reflect pathologic changes due to the degeneration of upper motor neurons.

## CLINICAL RELEVANCE/APPLICATION

PADRE in ALS patients showed a stripe sign on precentral gyri, which may be the useful finding for diagnosis of ALS on an individual basis.

### SSG12-03 Systolic Cerebrospinal Fluid Flow Distinguishes Patients with Normal Pressure Hydrocephalus from Age-Matched Controls

Tuesday, Dec. 1 10:50AM - 11:00AM Location: N226

#### Participants

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## PURPOSE

Patients with idiopathic normal pressure hydrocephalus (iNPH) suffer from a potentially treatable cause of dementia, and therefore benefit from fast and precise diagnosis. However, MR-based imaging signs are often ambiguous, and obscured by concomitant age-related changes such as generalized atrophy and microangiopathy. The aim of this study was to find an MR-based flow measure that can help discriminate iNPH patients from age-matched controls.

## METHOD AND MATERIALS

10 patients with NPH (mean age=74.4, STD=6.2, 8 female), 18 age-matched healthy control subjects (mean age=71.1, STD=5.2, 11 female), and 14 young control subjects (mean age=21.6, STD=1.7, 8 female) were studied using a 3.0 T MR scanner (Siemens Healthcare, Erlangen, Germany). Cine phase-contrast images of blood and CSF flow to and from the cranium were used to quantify systolic CSF flow rate and arterial blood flow rates.

## RESULTS

Maximal systolic CSF flow rate was significantly decreased in iNPH patients as compared to age-matched healthy controls ( $p < 0.01$ ). Maximal systolic arterial blood flow, however, did not differ significantly between patients and their age-matched controls ( $p > 0.05$ ). Both maximal arterial blood flow and CSF flow were reduced in healthy adult subjects and iNPH patients as compared to the young control group ( $p < 0.0001$  respectively).

## CONCLUSION

While both vascular and CSF flow rates showed age-related decline, only reduction of CSF flow exceeded age-related changes in iNPH patients.

## CLINICAL RELEVANCE/APPLICATION

Reduced systolic CSF flow rates are a robust and easily obtainable MR-based measure that may support the diagnosis of iNPH.

### SSG12-04 Enlarged Perivascular Spaces on MRI - Pathological or Normal Finding in Cognitive Impairment?

Tuesday, Dec. 1 11:00AM - 11:10AM Location: N226

#### Participants

Sara Shams, Stockholm, Sweden (*Presenter*) Nothing to Disclose  
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Lars-Olof Wahlund, Stockholm, Sweden (*Abstract Co-Author*) Nothing to Disclose  
Lena Cavallin, MD, PhD, Stockholm, Sweden (*Abstract Co-Author*) Nothing to Disclose

## PURPOSE

Enlarged perivascular spaces (EPVS) are seen as a normal finding in the brain. However, increased amounts of EPVS have shown associations with high age and impaired cognitive function, and are thought to be a marker of cerebral small vessel disease. In this study we sought to investigate EPVS in a continuum of cognitive impairment, and the associations with clinical and radiological parameters.

## METHOD AND MATERIALS

989 patients undergoing memory investigation (mean age 63 ±10) were recruited and scanned on 1.5T MRI scanners. Routine clinical cerebrospinal fluid (CSF) biomarkers, amyloid B42 (AB42), total-tau (T-tau), tau phosphorylated at threonine 18 (P-tau), and CSF/ serum albumin ratios were analyzed in 761 patients. Rating of EPVS was made on T2-weighted sequences according to the EPVS rating scale. Associations between EPVS and clinical and radiological parameters were analyzed with multivariate linear and logistic regression models, controlling for appropriate variables.

## RESULTS

Increasing number of EPVS had increased odds ratio for white matter hyperintensities (WMH) (OR: 3.7, 95CI: 2.5-5.4), cerebral microbleeds (OR: 2.3, 95CI: 1.6-3.3) and lacunar infarctions (OR: 3.2, 95CI: 2.2-4.8). Odds ratios for EPVS further increased with high age (OR: 2.5, 95CI: 1.8-3.5), mild cognitive impairment (OR: 1.1, 95CI: 1.0-1.1), and vascular dementia (OR: 2.5, 95CI: 1.1-5.8), but not in Alzheimer's disease. No association between low cognition, measured by the MMSE test, and increased EPVS was seen. AB42 levels decreased with increasing EPVS (Beta: -0.131, P<0.01). T-tau (Beta: 0.10, P<0.01) and P-tau (Beta: 0.08, P<0.05) levels increased with increasing EPVS. No difference was seen in CSF/serum albumin ratios.

## CONCLUSION

Our results suggest that increased EPVS may be a marker of cerebral small vessel disease, and associated with cognitive impairment. Increased EPVS with vascular dementia, but not with Alzheimer's disease suggests that EPVS may be more associated with vessel damage caused by hypertensive arteriopathy.

## CLINICAL RELEVANCE/APPLICATION

Increased enlarged perivascular spaces may be a marker of cerebral small vessel disease, and associated with cognitive impairment.

## SSG12-05 Diffusion Tensor Imaging of the Corticospinal Tract in Patients with Amyotrophic Lateral Sclerosis, Primary Lateral Sclerosis, and Mimic Syndromes

Tuesday, Dec. 1 11:10AM - 11:20AM Location: N226

### Participants

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Sumit N. Niogi, MD, PhD, New York, NY (*Abstract Co-Author*) Institutional license agreement, Athlemetrics ; Potential royalties, Athlemetrics  
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Apostolos J. Tsiouris, MD, New York, NY (*Abstract Co-Author*) Research Consultant, BioClinica, Inc

## PURPOSE

Diffusion tensor imaging (DTI) of the corticospinal tract (CST) has been proposed as an objective method to aid in diagnosis of amyotrophic lateral sclerosis (ALS) and primary lateral sclerosis (PLS). Clinical diagnosis of ALS and PLS is difficult as early symptoms are indistinguishable from those of other neurologic disorders. We test whether CST changes measured by DTI are different in patients with ALS and PLS compared with other motor symptom-predominant neurologic disorders.

## METHOD AND MATERIALS

3 Tesla 33-direction DTI data were retrospectively reviewed in patients with suspected ALS. 6 regions of interest (ROI) were selected along each CST bilaterally using a semi-automated technique operating on native space. Subjects were categorized by diagnosis (definite ALS, probable ALS, PLS, and disease mimics ultimately diagnosed with a non-upper motor neuron condition). Fractional anisotropy (FA) and mean diffusivity (MD) values from the ROIs were analyzed by diagnostic group using Mann-Whitney U-tests and non-parametric ANOVA.

## RESULTS

DTI sequences for 27 patients including 13 patients with definite ALS, 3 probable ALS, 3 definite PLS, and 8 other suspected upper motor neuron diseases ultimately not diagnosed as ALS or PLS were analyzed. Average CST FA was lower in patients with definite or probable ALS and PLS vs other diagnosis (0.56 vs 0.61, p=0.009). MD was higher in definite or probable ALS and PLS vs other diagnosis (0.00076 vs 0.00071, p= 0.03). By ROI, FA in definite ALS and PLS groups was significantly lower than other diagnosis group at the level of the left pons, left cerebral peduncle, and left pyramid (p<0.05). MD was higher in the ALS and PLS groups than other diagnosis group in the left cerebral peduncle (p=0.01)

## CONCLUSION

We have demonstrated significant differences in FA and MD in patients with ALS and PLS compared to mimic syndromes, which may be of clinical utility in differentiating these disorders. This is the first study to our knowledge to compare DTI measures in patients with known ALS, PLS, and other motor symptom-predominant neurologic disease. Further evaluation with additional patients and comparison with controls is warranted.

## CLINICAL RELEVANCE/APPLICATION

DTI may provide an objective method to distinguish ALS and PLS from mimic syndromes.

## **SSG12-06 Fluid Dynamics Study of CSF in Idiopathic Normal Pressure Hydrocephalus**

Tuesday, Dec. 1 11:20AM - 11:30AM Location: N226

### **Participants**

Lekang Yin, Shanghai, China (*Presenter*) Nothing to Disclose  
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Xiaozhu Hao, Shanghai, China (*Abstract Co-Author*) Nothing to Disclose  
Xiaoxue Zhang, Shanghai, China (*Abstract Co-Author*) Nothing to Disclose

### **PURPOSE**

To study the difference of CSF fluid dynamics at the aqueduct between idiopathic normal pressure hydrocephalus (iNPH) patients and normal elderly.

### **METHOD AND MATERIALS**

A total of 15 iNPH patients (iNPH group) and 20 healthy volunteers as normal control (NC group) were included in this study. The flow data of CSF through the aqueduct were collected with phase-contrast cine method in 3T MR unit (MR PC-cine). The CSF fluid dynamics parameters including peak cranio-caudal velocity, peak caudo-cranial velocity, net flow volume, stroke volume, minute flow volume, as well as the direction of net flow were measured and compared statistically between the two groups.

### **RESULTS**

The flow curve of iNPH group was similar to the NC, both presented a sinusoidal flow pattern and caused a net flow per cardiac cycle. All fluid dynamics parameters except for peak cranio-caudal velocity (iNPH vs NC:  $6.50 \pm 1.63$  vs  $5.76 \pm 1.32$ ,  $P=0.20$ ) were significantly increased in patients with iNPH. The net flow of 13 iNPH patients (13/15) were in the caudo-cranial direction, while 15 volunteers (15/20) were in the opposite direction, which was statistically significant differences ( $P=0.002$ ).

### **CONCLUSION**

iNPH patients present a hyperdynamic flow with increased velocity and volume during a cardiac cycle. The degree of rising in caudo-cranial direction exceeds that in cranio-caudal direction. The resulting reversal of net flow direction may play a key role in the occurrence of hydrocephalus in iNPH patients.

### **CLINICAL RELEVANCE/APPLICATION**

This finding about the reversal of net flow direction in iNPH patients helps to understanding the development of the disease.

## **SSG12-07 Quantitative Susceptibility Mapping of the Motor Cortex in ALS and PLS Patients: A Biomarker for Upper Motor Neuron Dysfunction**

Tuesday, Dec. 1 11:30AM - 11:40AM Location: N226

### **Participants**

Santanu Chakraborty, FRCR, DMRD, Ottawa, ON (*Presenter*) Grant, Bayer AG; Grant, General Electric Company  
Gerd Melkus, PhD, Ottawa, ON (*Abstract Co-Author*) Nothing to Disclose  
Pierre Bourque, Ottawa, ON (*Abstract Co-Author*) Nothing to Disclose

### **PURPOSE**

Motor Neuron Disease is a progressive neurodegenerative disease characterized by lower- (LMN) and upper motor neuron (UMN) dysfunction in ALS (Amyotrophic Lateral Sclerosis) and mostly UMN dysfunction in PLS (Primary Lateral Sclerosis). The diagnosis is currently based on clinical assessment, electrodiagnostic studies and exclusion of other diseases. Electromyography effectively detects LMN degeneration but there is no definite technique for demonstrating UMN involvement and UMN findings on clinical examination may not occur until late in the disease course. A method that detects early UMN involvement and accurately monitors disease progression is highly desirable especially for future clinical trials and strategies for early intervention.

### **METHOD AND MATERIALS**

Ten ALS and three PLS patients were included in the study. The QSM processing was performed with a software package developed in-house using Matlab. To evaluate the susceptibility changes, ROIs were drawn into the right (RMC) and the left motor cortex (LMC). For control, susceptibility values were calculated from ROIs in the anterior border of precentral gyrus on the right (RCT) and left (LCT). We correlated the susceptibility values between the primary motor cortex (in the hand knob area) and the anterior border of precentral gyrus with presence of UMN signs (spasticity and hyperreflexia) and also most affected side of symptoms.

### **RESULTS**

Patients with spasticity symptoms have significant higher susceptibility values in the motor cortex area than those who do not ( $p<0.043$ ). In the patient group showing symptoms of spasticity the susceptibility in the control cortex area is significant lower than in the motor cortex area ( $p<0.001$ ).

### **CONCLUSION**

Our results suggest QSM could be a quantitative tool to detect changes in the UMN changes in ALS and PLS. Larger prospective studies will be needed to find the incidence, sensitivity and specificity of this sign in ALS patients and to establish its prognostic value.

### **CLINICAL RELEVANCE/APPLICATION**

QSM could be a quantitative tool to detect changes in the motor cortex in ALS and PLS patients as an objective marker of UMN involvement. However, larger prospective studies will be needed to find the incidence, sensitivity and specificity of this sign and its

prognostic value.

## **SSG12-08 A Preliminary Study of the Relationship between the Volume of Hippocampal Subfields and Memory Deficits in Patients with Thalamus Infarction**

Tuesday, Dec. 1 11:40AM - 11:50AM Location: N226

### **Participants**

Tianyou Luo, Chongqing, China (*Abstract Co-Author*) Nothing to Disclose  
Li Chen, Chongqing, China (*Presenter*) Nothing to Disclose

### **PURPOSE**

Although Clinical and animal studies show the memory function is affected in thalamus infarction (TI), and thalamic nucleus have prominent direct and indirect connections with the hippocampal system, there is no study on the effects of the diagnosis of memory dysfunction of TI on hippocampal subfields volume with in vivo magnetic resonance (MR) imaging. To investigate the influence of thalamus infarction on the memory and hippocampal subfields volume, we measured the volume of each hippocampal subfield of patients with TI using structural MR imaging and tested their association with the performance of the memory.

### **METHOD AND MATERIALS**

A total of thirty-seven TI patients and thirty-eight age, education matched healthy elderly controls were enrolled in the present study. MR imaging were performed at a 3.0T MR scanner. Volumes of hippocampal subfields on MR images were automatically estimated using FreeSurfer software. Clinical examinations (verbal recall, recall of the complex graphics and digit span backward task) were performed for all subjects. Two sample t-test was conducted to explore differences in hippocampal subfield volumes, with intracranial volume and age as covariate variables. Partial correlation analyses were used to examine the relationship between volumes of hippocampal subfields and the memory function in patients, when controlling age, gender and years of education.

### **RESULTS**

TI group had smaller volume in presubiculum (left,  $p < 0.001$ ; right,  $p < 0.001$ ) and subiculum (left,  $p = 0.029$ ; right,  $p = 0.006$ ) when compared with healthy control. In addition, smaller presubiculum volumes were related with poorer long delayed recall ( $r = 0.403$ ,  $p = 0.020$ ) and complex graphics recall ( $r = 0.410$ ,  $p = 0.018$ ) in TI patients. Moreover, smaller subiculum volumes were associated with poorer short delayed recall ( $r = 0.397$ ,  $p = 0.022$ ).

### **CONCLUSION**

Our findings indicated that thalamus infarction lead to hippocampal abnormality and memory deficits. These preliminary results suggested that information might not be passed between hippocampal subfield regions and thalamus, and aberrant hippocampus could not be responsible for memory function in patients with thalamus infarction.

### **CLINICAL RELEVANCE/APPLICATION**

As far as we know, this is the first study exploring the pattern of volume reductions in specific hippocampal subfields in TI patients and investigating association between hippocampal subfield volume and memory function.

## **SSG12-09 Alzheimer's Disease: Diagnostic Potential of Phase Difference Enhanced MR Imaging at 3T**

Tuesday, Dec. 1 11:50AM - 12:00PM Location: N226

### **Participants**

Machiko Tateishi, Kumamoto, Japan (*Presenter*) Nothing to Disclose  
Toshinori Hirai, MD, PhD, Miyazaki, Japan (*Abstract Co-Author*) Nothing to Disclose  
Minako Azuma, Kumamoto, Japan (*Abstract Co-Author*) Nothing to Disclose  
Manabu Ikeda, Kumamoto, Japan (*Abstract Co-Author*) Nothing to Disclose  
Mamoru Hashimoto, Kumamoto, Japan (*Abstract Co-Author*) Nothing to Disclose  
Tetsuya Yoneda, PhD, Kumamoto, Japan (*Abstract Co-Author*) Nothing to Disclose  
Mika Kitajima, MD, Kumamoto, Japan (*Abstract Co-Author*) Nothing to Disclose  
Yasuyuki Yamashita, MD, Kumamoto, Japan (*Abstract Co-Author*) Consultant, DAIICHI SANKYO Group

### **PURPOSE**

Phase difference enhanced imaging (PADRE) technique can selectively enhanced the phase difference between the target and surrounding tissue and might visualize amyloid-related brain changes in Alzheimer's disease (AD). We aimed to determine whether it is possible to diagnose patients with AD on an individual basis using 3T MR images with PADRE.

### **METHOD AND MATERIALS**

All MRI studies were performed with a 2-mm 2D fast-field echo sequence on a 3-T Philips scanner. We studied 10 AD patients (7 females, 3 males; age range 53-82 years, mean age 64 years) and 10 age-matched healthy controls. Two radiologists independently graded the signal of the cerebral cortices in the superior frontal gyrus (SFG), superior temporal gyrus (STG), precuneus (PrCn) and cuneus (Cun) on MR images with PADRE using a 4-point scale: grade 0, no delineation of low signal area (LSA); grade 1, subtle delineation of LSA; grade 2, partial delineation of LSA; and grade 3, diffuse delineation of LSA. Contrast ratio (CR) between the cortices and adjacent white matter was measured. Mann-Whitney U test was used for qualitative and quantitative assessments.

### **RESULTS**

For the cortices other than the SFG, the mean grade of the cerebral cortex was significantly higher for AD patients than control subjects (STG,  $p = 0.027$ ; PrCn,  $p = 0.0002$ ; Cun,  $p = 0.013$ ). Mean CR of the cerebral cortices other than the SFG was significantly higher for AD patients than control subjects (STG,  $p = 0.0052$ ; PrCn,  $p = 0.023$ ; Cun,  $p = 0.002$ ).

### **CONCLUSION**

Our MR study using PADRE suggests that the signal in the specific cerebral cortices in AD patients is different from that in healthy subjects.

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

3T MR images with PADRE may provide useful information for the diagnosis of AD.

MSRP31

## RSNA Resident and Fellow Symposium: Career 101: Essentials for Every New Attending Radiologist (An Interactive Session)

Tuesday, Dec. 1 10:30AM - 12:00PM Location: E451B



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

### Participants

#### LEARNING OBJECTIVES

Please bring your charged mobile wireless device (phone, tablet or laptop) to participate.

### Sub-Events

#### MSRP31A 8 Reasons to Be Optimistic about the Future of Radiology

##### Participants

Amelia Wnorowski, MD, Philadelphia, PA (*Presenter*) Nothing to Disclose

Jonathan W. Berlin, MD, Evanston, IL (*Presenter*) Nothing to Disclose

#### LEARNING OBJECTIVES

1) Articulate some of the key reasons radiologists will be essential in new payment systems. 2) Understand the importance of radiology data in tracking disease management with regards to population health. 3) Consider ways radiologists can increase their outreach.

#### ABSTRACT

With the changing healthcare economic environment it is tempting for radiologists to feel pessimistic about their uncertain future role in healthcare systems. However, there is significant cause for optimism. Radiology utilization management, data mining, and screening in selected high risk populations will likely be important for new payment systems including accountable care organizations and bundled payments. Putting the job of the radiologist in perspective with other occupations is also helpful when considering a radiology career. This lecture will assess the opportunities for radiologists in new payment systems and also provide some comparative analysis of radiology and other occupations.

#### MSRP31B Medical Malpractice: Common Pitfalls New Attending Radiologists Should Avoid

##### Participants

Gelareh Sadigh, MD, Atlanta, GA, (gsadigh@emory.edu) (*Presenter*) Nothing to Disclose

Leonard Berlin, MD, Skokie, IL (*Presenter*) Nothing to Disclose

#### LEARNING OBJECTIVES

1) Identify situations that can contribute to professional liability losses for radiologists. 2) Apply risk management strategies to enhance patient care and reduce potential professional liability exposures created by missed diagnoses, failure to adequately communicate significant and unexpected radiologic findings to referring physicians and in certain situations to the patient, improperly performed interventional radiologic procedures, and improperly administering radiation oncology treatment. 3) Implement processes that will maximize the chances of successfully defending a medical malpractice lawsuit if it is incurred.

#### ABSTRACT

This Course will explore and focus on the subject of medical malpractice litigation: what constitutes a violation of the standard of care, what are the common and uncommon events that lead to, and what is the role of expert witnesses in, a malpractice lawsuit, and how can the likelihood of being accused of malpractice be minimized.



## Creating and Delivering Online and Mobile Education Content: From Online Courses to Interactive iBooks (Hands-on)

Tuesday, Dec. 1 12:30PM - 2:00PM Location: S401CD



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

### Participants

George L. Shih, MD, MS, New York, NY, (george@cornellradiology.org) (*Moderator*) Consultant, Image Safely, Inc; Stockholder, Image Safely, Inc; Consultant, Angular Health, Inc; Stockholder, Angular Health, Inc;

### LEARNING OBJECTIVES

1) Assess the potential of online and mobile e-learning innovations to augment your residents', medical students', and staff's educational curricula. 2) Acquire the domain knowledge to use already available content (eg, PowerPoint presentations) to both create video content and deploy e-learning courses on modern web-based and mobile platforms. 3) Acquire the domain knowledge to create an interactive Apple iBook (electronic books) with text, images, video, and interactive questions.

### ABSTRACT

1. From OpenCourseWare to the Khan Academy, and now to Coursera and edX, e-learning has been dramatically improved over the last decade, changing education from the normal classroom into learning done at convenience, and also allows for more creative and engaging content during the typical lecture. Stanford Med published positive initial findings in utilizing video-based lectures in an interactive class setting. Leveraging this new way of learning, requires knowledge about the types of technology and platforms for these courses. 2. The workflow required to host an e-learning course can be summarized in 3 steps: (a) creating the educational content, (b) hosting the materials, and (c) making the materials available to the intended audience. E-content today typically consists of lecture slides along with video recordings captured by technology like TechSmith Camtasia (non-free) and Apple Quicktime (free). Once the materials are created and edited, one must choose a suitable hosting platform realistic to the skills and goals of the instructor with options that include coursesites.com, iTunes U, and YouTube / Google Hangouts. Students can then be invited to view the material or the content can be made available to the public. 3. Creating and publishing e-books is a great way to share your teaching material as an engaging interactive tool. Publishing in e-book format solves many logistical problems of conventional publishing and the e-book format has interactive features that paper books can't match. We will review the process of creating your own e-book from assembling material to layout design to submitting for e-publication. Specifically Apple iBooks Author software will be used to demonstrate converting an existing Powerpoint presentation or journal publication into an e-book. In addition, the course will go over how to publish with or without DRM (copy-protection) and ways to obtain an ISBN for publishing for sale. Online resources will also be reviewed.

### Sub-Events

#### RCB33A Screencasting Basics on the Desktop and on the iPad

### Participants

Ian R. Drexler, MD, MBA, New York, NY (*Presenter*) Nothing to Disclose

### LEARNING OBJECTIVES

View learning objectives under main course title.

#### RCB33B Massive Open Online Course (MOOC) Creation and Hosting

### Participants

Kurt T. Teichman, BSc, MEng, New York, NY (*Presenter*) Nothing to Disclose

### LEARNING OBJECTIVES

View learning objectives under main course title.

#### RCB33C Interactive iBooks to Supplement your Online Course

### Participants

Alan C. Legasto, MD, New York, NY (*Presenter*) Nothing to Disclose

### LEARNING OBJECTIVES

View learning objectives under main course title.

**3D Printing (Hands-on)**

Tuesday, Dec. 1 12:30PM - 2:00PM Location: S401AB



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

**Participants**

Frank J. Rybicki III, MD, PhD, Ottawa, ON (*Moderator*) Research Grant, Toshiba Corporation;  
 Frank J. Rybicki III, MD, PhD, Ottawa, ON (*Presenter*) Research Grant, Toshiba Corporation;  
 Jane S. Matsumoto, MD, Rochester, MN (*Presenter*) Nothing to Disclose  
 Jonathan M. Morris, MD, Rochester, MN (*Presenter*) Nothing to Disclose  
 Dimitris Mitsouras, PhD, Boston, MA (*Presenter*) Research Grant, Toshiba Corporation; Speakers Bureau, Toshiba Corporation  
 Andreas Giannopoulos, MD, Boston, MA (*Presenter*) Nothing to Disclose  
 Nicole Wake, MS, New York, NY (*Presenter*) Nothing to Disclose  
 Peter C. Liacouras, PhD, Bethesda, MD (*Presenter*) Nothing to Disclose  
 Thomas A. Foley, MD, Rochester, MN (*Presenter*) Nothing to Disclose  
 Kiaran P. McGee, PhD, Rochester, MN (*Presenter*) Nothing to Disclose  
 Michael W. Itagaki, MD, MBA, Seattle, WA (*Presenter*) Owner, Embodi3D, LLC  
 Shannon N. Zingula, MD, Rochester, MN (*Presenter*) Nothing to Disclose  
 Leonid Chepelev, MD, PhD, Ottawa, ON (*Presenter*) Nothing to Disclose  
 Adnan M. Sheikh, MD, Ottawa, ON (*Presenter*) Nothing to Disclose  
 AiLi Wang, Ottawa, ON (*Presenter*) Nothing to Disclose  
 Wilfred Dang, BS, Ottawa, ON (*Presenter*) Nothing to Disclose  
 Ekin P. Akyuz, BSc, Ottawa, ON (*Presenter*) Nothing to Disclose  
 Taryn Hodgdon, MD, Ottawa, ON (*Presenter*) Nothing to Disclose  
 Carlos H. Torres, MD, Ottawa, ON (*Presenter*) Nothing to Disclose  
 Anji Tang, Boston, MA (*Presenter*) Nothing to Disclose

**LEARNING OBJECTIVES**

1) Learn the Standard Tessellation Language (STL) file format that is used in 3D printing. 2) Be exposed to a software package to enable segmentation of DICOM images using semi-automated and manual segmentation algorithms, allowing the user to demarcate desired parts. The most commonly used tools are thresholding, region growing, and manual sculpting. 3) Learn refinement of an output STL output so that it can be optimized for accurate printing of the desired anatomy and pathology. This step uses Computer Aided Design (CAD) software is used to perform steps such as "wrapping" and "smoothing" to make the model more homogeneous.

**ABSTRACT**

"3D printing" refers to fabrication of a tangible object from a digital file by a 3D printer. Materials are deposited layer-by-layer and then fused to form the final object. There are several 3D printing technologies that share similarities but differ in speed, cost, and resolution of the product. Digital Imaging and Communications in Medicine (DICOM) image files cannot be used directly for 3D printing; further steps are necessary to make them readable by 3D printers. The purpose of this hands-on course is to convert a set of DICOM files into a 3D printed model through a series of simple steps. Some of the initial post-processing steps may be familiar to the radiologist, as they share common features with 3D visualization tools that are used for image post-processing tasks such as 3D volume rendering. However, some are relatively or completely new to radiologists, including the manipulation of files in Standard Tessellation Language (STL). It is the STL format that is read by the 3D printer and used to output the hand held part of the patient's anatomy. This 90 minute session will begin with a DICOM file and will proceed through the steps to create a printable STL file. An extensive training manual will be provided before the meeting. It is highly recommended that participants review the training manual to optimize the experience at the workstation.

**URL**

**Active Handout:** Frank John Rybicki

[http://abstract.rsna.org/uploads/2015/14003457/Active RCA13.pdf](http://abstract.rsna.org/uploads/2015/14003457/Active_RCA13.pdf)

## Imaging 3.0: Informatics Tools to Improve Radiologists' Productivity, Quality and Value

Tuesday, Dec. 1 12:30PM - 2:00PM Location: S501ABC



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



Discussions may include off-label uses.

### Participants

J. R. Geis, MD, Fort Collins, CO (*Moderator*) Advisor, Nuance Communications, Inc; Investor, Montage Healthcare Solutions; Vice Chair, ACR IT Informatics Commission

### Sub-Events

#### RCC33A ACRSelect - Using Informatics to Complying with PAMA: CDS Image Ordering Legislation

### Participants

Keith J. Dreyer, MD, PhD, Boston, MA (*Presenter*) Co-Chairman, Medical Advisory Board, Merge/IBM

### LEARNING OBJECTIVES

1) Be informed of the new federal legislation requiring the use of Clinical Decision Support (CDS) for the ordering of medical imaging required by CMS in 2017. 2) Understand the challenges of implementing CDS in the hospital and imaging center environments. 3) Learn the value of embedding CDS into the EHR and CPOE ordering process. 4) Learn methods to use CDS to manage the utilization of medical image appropriateness. 5) Become familiar with methods to implement CDS in an ACO environment.

#### RCC33B Radiology Assist: Informatics Tools to Produce a More Valuable Report and Still Report Fast

### Participants

Tarik K. Alkasab, MD, PhD, Boston, MA, (talkasab@mgh.harvard.edu) (*Presenter*) Nothing to Disclose

### LEARNING OBJECTIVES

1) Understand the motivations for integrating clinical decision support (CDS) into the clinical practice of radiologists. 2) Understand how CDS modules can be defined for use in radiologist reporting. 3) Understand what it looks like for a CDS system to be integrated with radiologist reporting. 4) Understand the challenges associated with deploying CDS for radiologists.

### ABSTRACT

### URL

#### RCC33C Use Your Data to Reduce Costs and Demonstrate Your Value to the Hospital

### Participants

Woojin Kim, MD, Philadelphia, PA, (woojinrad@gmail.com) (*Presenter*) Co-founder, Montage Healthcare Solutions, Inc; Shareholder, Montage Healthcare Solutions, Inc; Board of Directors, Montage Healthcare Solutions, Inc; Advisory Board, Zebra Medical Vision Ltd

### LEARNING OBJECTIVES

1) Understand the role of business intelligence (BI) tools in providing value-based care. 2) Understand how BI can provide effective monitoring of various components of the imaging value chain, including imaging appropriateness, modality operations, image interpretation and reporting, and report communication. 3) Learn how data mining can improve report quality by ensuring proper documentation and reducing errors. 4) Learn how one should implement a BI system and learn about potential problems to consider.

### ABSTRACT

The goals of improving population health at a lower cost and higher quality are placing increased emphasis on value-based care over volume-based approach. Imaging 3.0™ is ACR's call to action for radiologists to take a leadership role in shaping America's future healthcare system through 5 key pillars, which are imaging appropriateness, quality, safety, efficiency and satisfaction. With the aims of delivering better value to patients, Imaging 3.0 has outlined what it calls "imaging value chain" where each link of this chain represents a discrete number of unique value opportunity activities. The imaging value chain includes following components: imaging appropriateness and patient scheduling, imaging protocols, modality operations, image interpretation and reporting, and report communication and referring physician interaction. In the center of the imaging value chain, inter-connected with every link, lie data mining and business intelligence (BI). Timely analysis and appropriate modification using data mining and BI tools are critical to the effective monitoring of all components of the imaging value chain. As a result, it is a critical component of your Imaging 3.0 informatics toolkit. Effective use of BI will allow access to right information at the right time for right decision. This presentation will discuss the basics of BI and its benefits. Specifically, attendees will learn how data mining and BI can monitor adherence to imaging appropriateness guidelines, modality capacity, patient throughput, radiation dose exposure, report standardization and quality including detection of errors and compliance with various reporting requirements including documentation of proper report communication. In addition, attendees will learn how one should implement a BI system, what are some potential problems to consider, and various tips for getting BI right.

### Honored Educators

Presenters or authors on this event have been recognized as RSNA Honored Educators for participating in multiple qualifying educational activities. Honored Educators are invested in furthering the profession of radiology by delivering high-quality educational content in their field of study. Learn how you can become an honored educator by visiting the website at:

<https://www.rsna.org/Honored-Educator-Award/>

Woojin Kim, MD - 2012 Honored Educator

## **RCC33D      Using Workflow Software to Improve Efficiency and Profitability**

### **Participants**

Bradley J. Erickson, MD, PhD, Rochester, MN (*Presenter*) Stockholder, Evidentia Health, Inc; Stockholder, OneMedNet Corporation; Stockholder, VoiceIt Technologies, LLC

### **LEARNING OBJECTIVES**

1) Become familiar with workflow technologies that are available and being used in other industries. 2) See how workflow terminologies can be applied in practice. 3) See how workflow engines have been applied in radiology.

### **ABSTRACT**

Workflow is a critical element of safe and efficient practices. Workflow is usually supported by using relational databases, which tends to force a linear workflow into practice. SQL queries are also not optimal for detecting and handling error conditions. Workflow engines are used in other industries for exactly those reasons--they help enforce an agreed upon optimal pathway of events, and make it easy and clear how to deal with error and exception conditions. While they have been applied in healthcare, those experiments have usually failed because the implementation did not handle error conditions well, and did not completely model the richness and complexity of healthcare. Radiology tends to be more straightforward, and may be a good area to use workflow engines. In this session, we will describe one implementation in a clinical practice, as well as use in research and clinical trials. As we have begun to use workflow engines, it became apparent that agreeing on the names for key steps in the workflow would be helpful. Such a common lexicon would help us to assure that workflow was done in the same way in different locations. It could also allow us to measure the efficiency of workflows. This latter aspect was perceived to be of great value to practices across the world, and led to the creation of the SIIM Workflow Initiative in Medicine (SWIM) lexicon, which is now a part of RadLEX. The basic concepts of SWIM and its connection to IHE and the practice will be described.

## Quality Improvement Symposium: Common Mistakes in Practice Quality Improvement

Tuesday, Dec. 1 1:30PM - 3:00PM Location: S406B

**SQ**

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

### Participants

David B. Larson, MD, MBA, Los Altos, CA, (david.larson@stanford.edu) (*Moderator*) Intellectual property license agreement, Bayer AG; Potential royalties, Bayer AG

### LEARNING OBJECTIVES

1) Understand common reasons why practice quality improvement projects tend to fail. 2) Understand strategies to anticipate and overcome pitfalls to successfully complete practice quality improvement projects. Attendees scoring 80% or higher on the SAM test may earn a Quality Essentials Certificate in the "Quality Improvement in Your Practice" domain.

### ABSTRACT

Meaningful quality improvement requires meaningful organizational change. Change efforts can fail for a variety of reasons. In this session, authors will discuss common reasons why improvement efforts tend to be unsuccessful, and provide strategies for increasing the likelihood of success.

### Sub-Events

#### MSQI33A Pitfalls to Avoid with Project Design

### Participants

David B. Larson, MD, MBA, Los Altos, CA (*Presenter*) Intellectual property license agreement, Bayer AG; Potential royalties, Bayer AG

### LEARNING OBJECTIVES

1) Understand common pitfalls associated with Practice Quality Improvement design and how they can derail a project. 2) Understand strategies to anticipate and successfully overcome these pitfalls. Attendees scoring 80% or higher on the SAM test may earn a Quality Essentials Certificate in the "Quality Improvement in Your Practice" domain.

### ABSTRACT

Like with any meaningful project, the success of a PQI project depends to a large extent on project preparation and design. The author will discuss common pitfalls associated with PQI project design and strategies for anticipating and overcoming them to increase the likelihood of project success.

### Honored Educators

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

David B. Larson, MD, MBA - 2014 Honored Educator

#### MSQI33B Pitfalls to Avoid with Project Execution

### Participants

James V. Rawson, MD, Augusta, GA (*Presenter*) Nothing to Disclose

### LEARNING OBJECTIVES

1) Review reasons projects fail. 2) Review tools to avoid projects not meeting goals. Attendees scoring 80% or higher on the SAM test may earn a Quality Essentials Certificate in the "Quality Improvement in Your Practice" domain.

### ABSTRACT

Performance improvement projects can be well conceived but fail at the implementation or execution stage. Such failures often occur for predictable and hence avoidable reasons. The author will discuss reasons for failed executions and potential tools to help projects meet goals.

#### MSQI33C How to Meet and Pass the American Board of Radiology Practice Quality Improvement (PQI) Requirements and Audit

### Participants

David Laszakovits, MBA, Tucson, AZ (*Presenter*) Nothing to Disclose

### LEARNING OBJECTIVES

1) Understand the Essential Elements of a PQI project. 2) Understand the participation options for fulfilling the PQI requirements. 3) Understand what documentation needs to be provided to the ABR in the event of an audit. Attendees scoring 80% or higher on the SAM test may earn a Quality Essentials Certificate in the "Quality Improvement in Your Practice" domain.

## **ABSTRACT**

The ABR requirements specify that each diplomate complete at least one PQI project every three years. The author will discuss the essential elements of a PQI project, the various options for participation and what documentation should be retained for audit purposes.



**Interventional Oncology Series: Lung and Musculoskeletal**

Tuesday, Dec. 1 1:30PM - 6:00PM Location: S405AB



AMA PRA Category 1 Credits™: 4.25  
ARRT Category A+ Credits: 5.00

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

**Participants**

Matthew R. Callstrom, MD, PhD, Rochester, MN (*Moderator*) Research Grant, Thermedical, Inc Research Grant, General Electric Company Research Grant, Siemens AG Research Grant, Galil Medical Ltd

**Sub-Events****VSIO31-01 How to Approach Lung Ablation**

Tuesday, Dec. 1 1:30PM - 1:50PM Location: S405AB

**Participants**

Constantinos T. Sofocleous, MD, PhD, New York, NY (*Presenter*) Consultant, Sirtex Medical Ltd

**VSIO31-02 Role for SBRT in the Treatment of Primary Lung Tumors**

Tuesday, Dec. 1 1:50PM - 2:10PM Location: S405AB

**Participants**

Kenneth R. Olivier, MD, Rochester, MN (*Presenter*) Nothing to Disclose

**LEARNING OBJECTIVES**

1) Review role of SBRT in the primary management of early stage NSCLC. 2) Review updates to the literature on SBRT including: a. Dose and schedule of SBRT. b. Comparison of SBRT to surgery.

**ABSTRACT**

Stereotactic Body Radiotherapy (SBRT) is an important treatment modality for patients with inoperable Non-Small Cell Lung Cancer. It provides effective local control of early stage Lung Cancers and is associated with minimal toxicity. In this presentation I will review this role and discuss the current literature comparing SBRT to observation and surgery.

**VSIO31-03 Statistically Significant Higher Risk of Local Recurrence after Ablation in KRAS Mutant Lung Adenocarcinomas Compared with Wild Type**

Tuesday, Dec. 1 2:10PM - 2:20PM Location: S405AB

**Participants**

Etay Ziv, MD, PhD, New York, NY (*Presenter*) Nothing to Disclose  
Song Gao, New York, NY (*Abstract Co-Author*) Nothing to Disclose  
Joseph P. Erinjeri, MD, PhD, New York, NY (*Abstract Co-Author*) Nothing to Disclose  
Elena N. Petre, MD, New York, NY (*Abstract Co-Author*) Nothing to Disclose  
Carole A. Ridge, MD, New York, NY (*Abstract Co-Author*) Nothing to Disclose  
Jeremy C. Durack, MD, New York, NY (*Abstract Co-Author*) Scientific Advisory Board, Adient Medical Inc Investor, Adient Medical Inc  
Constantinos T. Sofocleous, MD, PhD, New York, NY (*Abstract Co-Author*) Consultant, Sirtex Medical Ltd  
Stephen B. Solomon, MD, New York, NY (*Abstract Co-Author*) Research Grant, General Electric Company

**PURPOSE**

To evaluate the association between mutation status of lung adenocarcinoma patients and local recurrence after ablation.

**METHOD AND MATERIALS**

We performed a retrospective review to identify patients treated with ablation for lung adenocarcinoma and that had available genetic testing for both EGFR and KRAS mutations. Surgical or biopsy specimens were considered only if they were from the same site as the ablation (either pre- or post-ablation). A subset of the EGFR mutants were also tested for T790M mutation. Local recurrence was either biopsy proven or based on a combination of clinical and imaging parameters. Chi-square test was used to identify statistically significant association with local recurrence.

**RESULTS**

We identified a total of 53 lung adenocarcinomas treated with lung ablation and which had genetic testing to identify both EGFR and KRAS mutations. Overall stage of tumor ranged from stage 1A to stage IV. Median tumor size was 1.6 cm (range: 0.8-3.3 cm). Of the 53 lung ablations, 53% (28) were on wild type (WT) lung adenocarcinomas, 34% (18) were on KRAS mutants and 13% (7) were on EGFR mutants. EGFR and KRAS mutants were mutually exclusive. Local recurrence rates were 29% (8/28) for WT, 67% (12/18) for KRAS, and 29% (2/7) for EGFR mutants. Local recurrence in the KRAS group was statistically significant ( $p=0.01$ ) compared with WT. There was no difference in the local recurrence rate of EGFR mutants compared with WT. Of note, the two local recurrences identified in the EGFR group also harbored a T790M mutation, associated with acquired resistance to tyrosine kinase inhibitors.

**CONCLUSION**

KRAS mutations are associated with statistically significant increased risk of local recurrence compared to WT. The local recurrence

KRAS mutations are associated with statistically significant increased risk of local recurrence compared to WT. The local recurrence rate of EGFR mutations are equivalent to WT. In our study EGFR local recurrences only occurred in the setting of T790M acquired resistance.

#### CLINICAL RELEVANCE/APPLICATION

KRAS mutation status of lung adenocarcinoma patients may be used as a prognostic tool to better stratify patients prior to lung ablation.

#### VSIO31-04 Minimally Invasive Surgery for Limited Lung Metastases

Tuesday, Dec. 1 2:20PM - 2:40PM Location: S405AB

##### Participants

Shanda Blackmon, MD, MPH, Rochester, MN (*Presenter*) Nothing to Disclose

#### LEARNING OBJECTIVES

1) Define the role of surgical pulmonary metastasectomy. 2) Review the literature regarding surgical pulmonary metastasectomy. 3) Review advantages to minimally invasive surgical pulmonary metastasectomy. 4) Define future goals of a novel approach to combined multi-specialty approach to lung metastasectomy.

#### ABSTRACT

Care of the patient with pulmonary metastases (PM) has evolved through the years to now include a larger group of patients who may benefit from metastasectomy. The two most consistent prognostic factors for overall survival remain disease free interval (DFI) and number of pulmonary nodules. The one consistent factor in all series is that only patients achieving a complete (R0) resection have a longer survival. Many series find the # of nodules is no longer a factor determining survival if R0 resection can be obtained, even repeated metastasectomy. We no longer view extra-PM as a disqualifier for resection, as long as the dz can be completely resected and controlled. Patients are typically referred for immediate surgery if they present with a single PM or have a limited # of mets and a long DFI. Those who develop metastatic dz early are treated initially with chemotherapy to determine the pace of dz progression, if any, on treatment. Patients responding to chemotherapy, those with stable dz, and those with slow progression are referred for resection while those with rapidly progressive metastatic dz receive alternative chemotherapy treatment. Adjuvant chemotherapy is continued only if there is evidence of clinical benefit from preoperative chemotherapy. CT scanning is routinely performed to monitor dz progression. The surgical approach should be individualized. As imaging improves our ability to localize smaller nodules, less invasive options become more appealing and may facilitate less difficult repeat metastasectomy. Ablation (SABR/SBRT or lung CT-guided ablation by cryoablation, radiofrequency ablation or microwave ablation) has been used to treat patients with PM, and our institution uses a lung ablation tumor board to review which lesions are best treated with each modality, focusing on R0 treatment, lung preservation, and location of the tumor. Lung preservation achieved by ablation is important in patients who have had previous resections or who have compromised pulmonary function or in whom a lobectomy would be required for nodule removal. More prospective studies are needed and are underway. Better understanding of the biology of the tumor and more developed histologic-specific nomograms may ultimately improve our ability to better select patients. As systemic therapy improves, treatment of local residual oligometastatic dz will become an increasingly important consideration.

#### VSIO31-05 Percutaneous Ablation of Lung Metastases

Tuesday, Dec. 1 2:40PM - 3:00PM Location: S405AB

##### Participants

Alison R. Gillams, MBChB, London, United Kingdom, (alliesorting@gmail.com) (*Presenter*) Advisory Board, Covidien AG

#### LEARNING OBJECTIVES

1) To define the patients most suitable for percutaneous image guided ablation of their metastases. 2) To present clinical outcomes of percutaneous ablation in the common metastatic groups - colorectal, sarcoma, renal, head and neck etc. 3) To understand the role of ablation in conjunction with other therapeutic modalities - surgery, SBRT or chemotherapy.

#### ABSTRACT

Ablation is a very effective tool for the local control of small volume lung tumours. It is the optimal technique for bilateral or small volume but multifocal disease. Although any metastatic deposit can be treated, the most common tumour groups to be referred for ablation are colorectal, sarcoma, head and neck and renal tumours. Colorectal metastases form the largest single cohort of patients. Results from metastasectomy suggest a survival advantage. Number, distribution and speed of development i.e. disease free interval between primary resection and the development of lung metastases, are considered when deciding whether a patient is operable. Surgical preference is given to fit patients with fewer than 3 metachronous metastases, preferably unilateral, a longer disease free interval and no extra-pulmonic disease. Ablation is currently considered in inoperable patients. Our analysis of 122 patients who were not operable candidates but who had small volume colorectal lung metastases showed a median survival of 41 months and a 3 year survival of 57%. Survival was better in patients with smaller tumours; median 51 months, 3-year 64% for

#### VSIO31-06 Complications and Management after Lung Ablation

Tuesday, Dec. 1 3:00PM - 3:20PM Location: S405AB

##### Participants

Damian E. Dupuy, MD, Providence, RI, (ddupuy@lifespan.org) (*Presenter*) Research Grant, NeuWave Medical Inc Board of Directors, BSD Medical Corporation Stockholder, BSD Medical Corporation Speaker, Educational Symposia

#### LEARNING OBJECTIVES

1) Understand the most common adverse events related to lung ablation. 2) Learn how to prevent and treat some of these adverse events. 3) Illustrate some of the more severe adverse events ( grade 3-5) with clinical examples.

#### Honored Educators

Presenters or authors on this event have been recognized as RSNA Honored Educators for participating in multiple qualifying

educational activities. Honored Educators are invested in furthering the profession of radiology by delivering high-quality educational content in their field of study. Learn how you can become an honored educator by visiting the website at: <https://www.rsna.org/Honored-Educator-Award/>

Damian E. Dupuy, MD - 2012 Honored Educator

### **VSIO31-07 Morphological Appearance of Radiofrequency Ablated Stage I NSCLC in Medically Inoperable Patients as Related to Recurrence: Results from the ACOSOG Z4033 (Alliance Trial)**

Tuesday, Dec. 1 3:20PM - 3:30PM Location: S405AB

#### **Participants**

Lillian Xiong, MD, Providence, RI (*Presenter*) Nothing to Disclose

Erica S. Alexander, BS, Providence, RI (*Abstract Co-Author*) Nothing to Disclose

Shauna Hillman, MS, Rochester, MN (*Abstract Co-Author*) Nothing to Disclose

Angelina D. Tan, BS,BA, Rochester, MN (*Abstract Co-Author*) Nothing to Disclose

Grayson L. Baird, MS, Providence, RI (*Abstract Co-Author*) Nothing to Disclose

Hiran Fernando, MD, Boston, MA (*Abstract Co-Author*) Consultant, CSA Medical, Inc Research Consultant, Galil Medical Ltd Research Grant, Deep Breeze Ltd

Damian E. Dupuy, MD, Providence, RI (*Abstract Co-Author*) Research Grant, NeuWave Medical Inc Board of Directors, BSD Medical Corporation Stockholder, BSD Medical Corporation Speaker, Educational Symposia

#### **PURPOSE**

This study evaluates tumor and ablation zone morphology as related to recurrence in medically inoperable patients with stage I NSCLC undergoing CT-guided RFA in a prospective multi-center trial.

#### **METHOD AND MATERIALS**

This prospective, multicenter group trial was approved by each institutional review board. 54 patients from 16 US sites were enrolled, of these, 50 patients (23 Men, 27 Women; mean age 75.3±7.5 years) met eligibility requirements. Patients were followed using CT; evidence of CT recurrence and pre- and post-ablation imaging characteristics were recorded. Characteristics evaluated included tumor/ablation zone shape (round, ovoid, bilobed, irregular), size, borders (smooth, speculated, lobulated), distance to large vessels/airway and distance to pleura.

#### **RESULTS**

A difference was observed for months to recurrence between those with ablation zones greater than 3cm and less than 3cm ( $p=.0023$ ). The median time of recurrence for those with ablation zones less than 3cm was 8.16 months, while the median recurrence time for those with zones greater than 3cm could not be determined. Recurrence free probability was 30% for those with ablation zones less than 3cm and 75% for those with zones greater than 3cm. No significant differences were found between those with and without recurrence for age ( $p=.47$ ), performance score ( $p=.43$ ), histology ( $p=.34$ ), baseline tumor SUV ( $p=.91$ ), tumor size ( $p=.59$ ), peak power ( $p=.92$ ), peak current ( $p=.63$ ), max temp ( $p=.65$ ), total time ( $p=.28$ ), shape ( $p=.30$ ), cavitation ( $p=.29$ ), sphericity ( $p=.45$ ), distance from tumor edge to large vessel ( $p=.62$ ), and distance to pleura ( $p=.25$ ).

#### **CONCLUSION**

Of those morphological characteristics considered, size of ablation zone appears to be most predictive of recurrence-free survival for those patients treated with RFA for early stage lung cancers.

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

Post-radiofrequency ablation zones greater than 3-cm were significantly less likely to be associated with recurrent disease, in a multi-institutional prospective study of 50 stage I NSCLC patients.

#### **Honored Educators**

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Damian E. Dupuy, MD - 2012 Honored Educator

### **VSIO31-08 Lung Tumor Board**

Tuesday, Dec. 1 3:30PM - 3:50PM Location: S405AB

#### **Participants**

Matthew R. Callstrom, MD, PhD, Rochester, MN (*Moderator*) Research Grant, Thermedical, Inc Research Grant, General Electric Company Research Grant, Siemens AG Research Grant, Galil Medical Ltd

### **VSIO31-09 Percutaneous Hardware for Bone Metastases-Where and When**

Tuesday, Dec. 1 4:00PM - 4:20PM Location: S405AB

#### **Participants**

Frederic Deschamps, Villejuif, France (*Presenter*) Research Consultant, Medtronic, Inc

#### **LEARNING OBJECTIVES**

- 1) To understand why cementoplasty alone is not always appropriate for bone fracture management (palliation and/or prevention).
- 2) To introduce the percutaneous screw fixation technique.
- 3) To present clinical outcomes of percutaneous screw fixation in bone cancer patients.

#### **ABSTRACT**

Bone fractures can result in significant pain and loss of function in cancer patients. Percutaneous screw fixation is a very new technique that consists in the insertion of screws in bone structures through a very small skin incision under imaging guidance. The indications are twofold for bone fracture: palliative and preventive. 1/ For patients suffering from pathological or non-pathological fracture the goal of the screw fixation is to achieve a stabilization of the fracture fragments that will result in pain palliation. Typically, the fractures that can be fixed are located in the sacrum, the iliac crest, the acetabulum roof, the pubic ramus and the proximal femur. Cementoplasty can be performed in association (augmented screw fixation) in order to improve the screw's tip anchorage. 2/ For patients with impending osteolytic metastases, the decision to perform percutaneous augmented screw fixation instead of cementoplasty alone is driven by the fact the strength properties of the cement are strong in compression but weak for tensile or shear stresses. Typically, the impending osteolytic metastases that can be consolidated using percutaneous augmented screw fixation are located in the iliac crest, the acetabulum and in the proximal femur. Percutaneous screw fixation is a very effective tool that must be considered as a part of the therapeutic arsenal of the interventional radiologists. Firstly, because it is a minimally invasive procedure that avoids extensive surgical exposure and secondly because the accuracy provided by CT- or Flat panel- guidances results in high technical success and very low complication rate for the screw placement.

#### **VSIO31-10 Patient Selection and Outcomes with MRgFUS**

Tuesday, Dec. 1 4:20PM - 4:40PM Location: S405AB

##### **Participants**

Alessandro Napoli, MD, Rome, Italy, (alessandro.napoli@uniroma1.it) (*Presenter*) Nothing to Disclose

##### **LEARNING OBJECTIVES**

1) To become familiar with the basic principles of HIFU and the potential of MR guidance. 2) To approach selection criteria in MRI screening examinations for accurate indications and identify contraindications and non-suitable patients. 3) To appreciate current results and potential therapy regimens. 4) To understand recent technical developments and their potential.

##### **ABSTRACT**

Bone metastases are common in patients with advanced cancer and are the greatest contributor to cancer-related pain, often severely affecting quality of life. Many patients with advanced cancer are undertreated for pain. Radiation therapy (RT), together with systemic therapies and analgesics, is the standard of care for localized metastatic bone pain, although up to two-thirds of patients have residual pain after RT, leaving them with limited treatment options. These include reirradiation, which results in temporary pain reduction in some patients, surgical intervention, and percutaneous cryoablation. More effective systemic therapies are prolonging survival of cancer patients with metastatic disease, resulting in an increased need for alternative therapies for painful bone metastases. Focused ultrasound is a noninvasive technique that delivers acoustic energy to heat lesions focally to ablative temperatures of more than 65°C. The combination of focused ultrasound with magnetic resonance (MR) imaging enables physicians to perform precise localized tumor tissue ablation, while using MR thermometry for real-time temperature monitoring. Clinical studies on the use of MR-guided focused ultrasound surgery (MRgFUS) for palliation of painful bone metastases demonstrated excellent response rates and safety. Results of a randomized controlled trial will be reviewed to discuss safety and efficacy of MRgFUS for treating bone metastases in patients with persistent or recurrent pain after RT, or who were otherwise not candidates for RT, or who declined RT. MRgFUS has several advantages that may positively influence safety and effectiveness compared with other ablative therapies. These include high-resolution imaging of the targeted tumor and nontargeted normal anatomy, intraprocedural MR thermometry accurate within approximately 2° to verify adequate temperatures to achieve ablation while respecting normal tissue tolerances, and immediate post-treatment validation of the extent of ablation.

#### **VSIO31-11 Minimally Invasive Treatment of Osteoid Osteoma: Experience of a Single Center Using MR Guided Focused Ultrasound Surgery (MRgFUS) or Radiofrequency Ablation (RFA)**

Tuesday, Dec. 1 4:40PM - 4:50PM Location: S405AB

##### **Participants**

Francesco Arrigoni, Coppito, Italy (*Presenter*) Nothing to Disclose  
Alice La Marra, MD, L'Aquila, Italy (*Abstract Co-Author*) Nothing to Disclose  
Silvia Mariani, MD, L'Aquila, Italy (*Abstract Co-Author*) Nothing to Disclose  
Luigi Zugaro, L'Aquila, Italy (*Abstract Co-Author*) Nothing to Disclose  
Antonio Barile, MD, L'Aquila, Italy (*Abstract Co-Author*) Nothing to Disclose  
Carlo Masciocchi, MD, L'Aquila, Italy (*Abstract Co-Author*) Nothing to Disclose

##### **PURPOSE**

To evaluate effectiveness and safety of minimally invasive treatment of Osteoid Osteoma (OO) with ablation techniques: Magnetic Resonance guided Focused Ultrasound Surgery (MRgFUS) and Radiofrequency Ablation (RFA).

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

From March 2011 to March 2014 we treated 40 OO, 18 with MRgFUS (ExAblate InSightech, Israel) and 22 with RFA (Needle Electrode, Boston Scientific-USA). For each patient we chose the less invasive treatment, when applicable. When the lesion could be easily reached with the US beam, the patient was treated with MRgFUS; otherwise, the patient was treated with RFA. Sixteen OO were treated with MRgFUS in the lower arm and 2 in the uppers. The treatments lasted a mean time of 110 minutes. The lesions treated with RFA were 18 in the lower extremities, 2 in the upper ones and 2 in the vertebral body. They were treated in less than 100 min. The follow-up was performed by MRI and CT up to a maximum of two years; the clinical evaluation was performed using the visual analogue scale (VAS).

##### **RESULTS**

All patients, except one treated with MRgFUS and subsequently re-treated with RFA, showed a regression of painful symptomatology. After treatment, they no longer needed any pain medication. The mean hospitalization time was 2 days for patients treated with MRgFUS and 2.4 days for those submitted to RFA. The mean VAS value, 2 years after treatment, showed an overall improvement of 100% (from 8.2 to 0). At the first control at one week after the procedure, patients treated with MRgFUS showed a lower mean VAS value (0.5) as compared with that of RFA (0.8). The results of MRI and CT, 2 years after the treatment, showed in all cases the disappearance of both bone edema (MRI) and nidus with central calcification and peripheral osteosclerosis (CT), that are typical findings of the osteoid osteoma. In no case, major complications were observed.

## CONCLUSION

Though based on a limited group of patients, our study demonstrates the safety and effectiveness of both techniques in the treatment of OO, by which it was possible to obtain an optimal clinical and imaging outcome. Compared with RFA, MRgFUS is less invasive, but to be successful, it is mandatory that the US beams properly reach the region of interest.

## CLINICAL RELEVANCE/APPLICATION

To evaluate safety and efficacy of an innovative technique of ablation, MRgFUS, which promises to be even less invasive than RFA, which is currently the gold standard in the treatment of OO.

### VSIO31-12 Spine Metastases Palliation-Ablation Stabilization

Tuesday, Dec. 1 4:50PM - 5:10PM Location: S405AB

#### Participants

Jonathan M. Morris, MD, Rochester, MN (*Presenter*) Nothing to Disclose

## LEARNING OBJECTIVES

1. Learn the basics of ablative technologies available for use in the spine and sacrum. 2. Define current indications for percutaneous ablation in the Spine and Sacrum. 3. How we do it. Lessons learned and resources needed. 4. Define local control rates for the varied tumors treated. 5. Discuss our experience with palliative outcomes for pain relief. 6. Limitations of ablation in the neuroaxis. 7. Postablative kyphoplasty/vertebroplasty. 8. Discuss unique considerations for cervical, thoracic, lumbar spine and sacrum.

## ABSTRACT

Oligometastatic disease involving the spine and sacrum is growing due to an aging population as well as improved survival rates of varied primary malignancies. 70% of all cancer patients will have metastatic disease with 40% involvement of the neuroaxis and 20% with epidural disease. While radiation therapy continues to be the primary treatment a subset of tumors are not radiosensitive and of those which are there are non responders. Starting in 2009 this clinical need led us to develop an ablation service dedicated to the spine and sacrum to aid in the treatment of oligometastatic disease. This talk will enable the attendee to learn the basics of ablative technologies in the spine and sacrum. Learn current indications for this technologies. Learn "how we do it" including lessons learned and resources need to perform this type of treatment. We will discuss the role of post ablative kyphoplasty/vertebroplasty. Finally we will review our palliative pain relief results as well as local control rates in the increasing types of tumors treated.

### VSIO31-13 Ablation is Front-line Therapy for Desmoid Tumors

Tuesday, Dec. 1 5:10PM - 5:30PM Location: S405AB

#### Participants

Afshin Gangi, MD, PhD, Strasbourg, France (*Presenter*) Nothing to Disclose

#### Handout: Afshin Gangi

<http://abstract.rsna.org/uploads/2015/15003113/desmoid.pptx>

### VSIO31-14 CT-guided Cryoablation as Single Treatment or Combined with Radiotherapy in the Management of Bone and Soft Tissue Lesions

Tuesday, Dec. 1 5:30PM - 5:40PM Location: S405AB

#### Participants

Francesco Arrigoni, Coppito, Italy (*Presenter*) Nothing to Disclose  
Silvia Mariani, MD, L'Aquila, Italy (*Abstract Co-Author*) Nothing to Disclose  
Alice La Marra, MD, L'Aquila, Italy (*Abstract Co-Author*) Nothing to Disclose  
Luigi Zugaro, L'Aquila, Italy (*Abstract Co-Author*) Nothing to Disclose  
Antonio Barile, MD, L'Aquila, Italy (*Abstract Co-Author*) Nothing to Disclose  
Carlo Masciocchi, MD, L'Aquila, Italy (*Abstract Co-Author*) Nothing to Disclose

## PURPOSE

To evaluate safety and efficacy of percutaneous CT-guided cryoablation, performed with multiple cryoprobes (also in combination with Radiotherapy) in the treatment of bone and soft tissue lesions.

## METHOD AND MATERIALS

Up to April 2015, we treated 27 patients with percutaneous CT-guided cryoablation. All patients but one had osteolytic bone metastases; one patient had a recurrence of aggressive fibromatosis of the shoulder. Prior to treatment, the patients were evaluated with the VAS questionnaire for pain which resulted in a mean value of 7.6. For a faster and more comfortable procedure, we employed three to six cryoprobes for each lesion under fluoroscopic guide. The area of cryoablation (iceball) and the position of the cryoprobes were controlled during the procedure with a wide-volume acquisition, employing 3D and MPR reconstruction. Follow-up studies at 3 and 6 months were performed with CT and VAS questionnaire. No major complications occurred during the procedures.

## RESULTS

We observed a reduction of pain in all patients. The mean VAS value dropped from 7.6 to 1.6 one week after treatment and remained substantially unchanged until the end of follow-up (6 months). CT follow-up showed progression of the disease in no case. Only size reduction or stationary CT findings were observed.

## CONCLUSION

Our results show the effectiveness of cryoablation, particularly in combination with RT, in terms of tumoral mass control and particularly of pain relief. Through thermoablation in fact it is possible to obtain a prompt relief of pain, and enhancement of the

quality of life immediately after the treatment. The main advantages are the possibility to treat the whole lesion at the same time with the use of multiple cryoprobes and to check in real time the treated volume; the main limitations are represented by the low number of patients recruited and by the length of the follow-up.

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

To evaluate safety and effectiveness of cryoablation also in combination with RT in the management of painful bone and soft tissue lesions, with the aim of reducing tumoral mass and pain.

#### **VSIO31-15 Bone Metastases Tumor Board**

Tuesday, Dec. 1 5:40PM - 6:00PM Location: S405AB

##### **Participants**

Matthew R. Callstrom, MD, PhD, Rochester, MN (*Moderator*) Research Grant, Thermedical, Inc Research Grant, General Electric Company Research Grant, Siemens AG Research Grant, Galil Medical Ltd

MSCC33

## Case-based Review of Nuclear Medicine: PET/CT Workshop-Cancers of the Abdomen and Pelvis (In Conjunction with SNMMI) (An Interactive Session)

Tuesday, Dec. 1 1:30PM - 3:00PM Location: S406A



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

### Participants

Janis P. O'Malley, MD, Birmingham, AL (*Director*) Nothing to Disclose

Ciaran J. Johnston, MD, Dublin, Ireland (*Presenter*) Nothing to Disclose

### LEARNING OBJECTIVES

1) Identify the utility of PET CT in staging a wide variety of primary and recurrent GI, GU and gynecological cancers. 2) Differentiate patterns of physiological FDG uptake from pathologic processes. 3) Explain the importance of CT correlation for selected cancer subgroups. 4) Describe the role of PET CT in assessing patient response to radiation therapy and chemotherapy, including early assessment and PET influenced treatment strategies.



MSES33

## Essentials of Musculoskeletal Imaging

Tuesday, Dec. 1 1:30PM - 3:00PM Location: S100AB



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

### Participants

#### Sub-Events

#### **MSES33A Introduction to Musculoskeletal Ultrasound**

##### Participants

Maha Torabi, MD, Winston Salem, NC, (mtorabi@wakehealth.edu) (*Presenter*) Nothing to Disclose

##### LEARNING OBJECTIVES

1) List the indications, benefits, and limitations of musculoskeletal ultrasound. 2) Demonstrate proper transducer manipulation and system optimization to produce diagnostic images. 3) Recognize common pathology of the musculoskeletal system as seen at ultrasound.

##### ABSTRACT

**Active Handout:**Maha Torabi

[http://abstract.rsna.org/uploads/2015/15001838/Active\\_MSES33A.pdf](http://abstract.rsna.org/uploads/2015/15001838/Active_MSES33A.pdf)

#### **MSES33B MRI of Injuries in the High Performance Athlete**

##### Participants

William B. Morrison, MD, Philadelphia, PA (*Presenter*) Consultant, General Electric Company Consultant, AprioMed AB Patent agreement, AprioMed AB Consultant, Zimmer Holdings, Inc

##### LEARNING OBJECTIVES

1) Recognize patterns of injury in high performance athletes using MRI. 2) Be able to relate pathology to common injuries in the general population. 3) Realize implications of injury in females and adolescent athletes.

#### **MSES33C Return to Play: Imaging the Athlete**

##### Participants

Bethany U. Casagrande, DO, Pittsburgh, PA (*Presenter*) Nothing to Disclose

##### LEARNING OBJECTIVES

1) Define Return to Play. 2) Discuss social pressures and controversial dogma surrounding Return to Play. 3) Recognize imaging findings of common sports related injuries. 4) Discuss the radiologist's role in diagnosis of pathology and communication with referring physicians.

##### ABSTRACT

Athletes of all levels are encumbered by injury and the social stresses of returning to play (RTP). RTP is a broad topic describing the time it takes an athlete to return to their sport after sustaining an injury. This discussion will encompass various levels of play, several sports and position-specific injuries. The focus will be on common injuries as well as controversial topics. Overall, emphasis is on imaging and the role of the radiologist caring for athletes.

MSRP32

## **RSNA Resident and Fellow Symposium: Career 102: Essentials for Residency and Job Success (An Interactive Session)**

Tuesday, Dec. 1 1:30PM - 3:00PM Location: E451B



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

### **Participants**

#### **LEARNING OBJECTIVES**

Please bring your charged mobile wireless device (phone, tablet or laptop) to participate.

### **Sub-Events**

#### **MSRP32A    How to Convert an Interview into a Job Offer**

##### **Participants**

Candice Bookwalter, MD, PhD, Rochester, MN (*Presenter*) Nothing to Disclose

Fred T. Lee JR, MD, Madison, WI (*Presenter*) Stockholder, NeuWave Medical, Inc; Patent holder, NeuWave Medical, Inc; Board of Directors, NeuWave Medical, Inc ; Patent holder, Medtronic, Inc; Inventor, Medtronic, Inc; Royalties, Medtronic, Inc

#### **LEARNING OBJECTIVES**

1) At the conclusion of this lecture, attendees should understand the different parts of the interview process, how to prepare for an interview, and strategies to maximize success during the interview day.

#### **MSRP32B    Six Must Know Strategies for Success Every Radiology Trainee Should Master**

##### **Participants**

Richard E. Sharpe JR, MD, MBA, Denver, CO, (RichSharpeJr@gmail.com) (*Presenter*) Nothing to Disclose

#### **LEARNING OBJECTIVES**

1) This presentation will allow participants at every stage of radiology training and practice to identify several key skills and strategies they can adopt to be more successful, and better accomplish their goals.

### **ABSTRACT**

#### **MSRP32C    Candid, Frank and Personal Job Advice from Recent Grads**

##### **Participants**

Nancy J. Benedetti, MD, Greenwood Village, CO (*Presenter*) Nothing to Disclose

Candice Bookwalter, MD, PhD, Rochester, MN (*Presenter*) Nothing to Disclose

Richard E. Sharpe JR, MD, MBA, Denver, CO, (RichSharpeJr@gmail.com) (*Presenter*) Nothing to Disclose

Andrew K. Moriarity, MD, Grand Rapids, MI (*Presenter*) Nothing to Disclose

Joseph H. Yacoub, MD, Maywood, IL (*Presenter*) Nothing to Disclose

PS30

## Tuesday Plenary Session

Tuesday, Dec. 1 1:30PM - 2:45PM Location: Arie Crown Theater

OT

AMA PRA Category 1 Credits™: 1.25  
ARRT Category A+ Credit: 1.00

### Participants

Ronald L. Arenson, MD, San Francisco, CA (*Presenter*) Nothing to Disclose

### Sub-Events

#### **PS30A Presentation of the Gold Medal of the Radiological Society of North America**

### Participants

Hedvig Hricak, MD, PhD, New York, NY (*Presenter*) Nothing to Disclose

Robert A. Novelline, MD, Boston, MA (*Presenter*) Nothing to Disclose

Steven E. Seltzer, MD, Boston, MA (*Presenter*) Nothing to Disclose

#### **PS30B Dedication of the Annual Oration in Diagnostic Radiology to the Memory of Byron Gilliam Brogdon, MD (1925-2014)**

### Participants

#### **PS30C Annual Oration in Diagnostic Radiology: Trends and Developments Shaping the Future of Radiology**

### Participants

James H. Thrall, MD, Boston, MA (*Presenter*) Board Member, Mobile Aspects, Inc; Board Member, WorldCare International Inc; Consultant, WorldCare International Inc; Shareholder, Antares Pharma, Inc; Shareholder, iBio, Inc; Shareholder, Peregrine Pharmaceuticals, Inc

Jon A. Jacobson, MD, Ann Arbor, MI (*Presenter*) Consultant, BioClinica, Inc; Royalties, Reed Elsevier; ;

### Abstract

Three categories of innovation will shape future directions in radiology: continued development of imaging technologies, parallel developments in infrastructure, most importantly in computer analytics, and information and communications systems and the development and application of the imaging correlates of precision medicine. Continued substantial improvements in the spatial and temporal resolution of existing imaging methods coupled with more efficient detector technologies and analytical capabilities will support the increased use of parametric imaging-the imaging of function, the use of imaging to detect and portray physiology and cellular and molecular events. These attributes will result in new applications and in wider use of imaging methods clinically. They will also make imaging methods more valuable and relevant in basic research and imaging methods will be ever more widely adopted by scientists outside of traditional radiology research domains. Improvements in x-ray based imaging will result in reductions in radiation exposure to the point that radiation dose will no longer be a topic of concern or controversy. Phase contrast imaging with x-rays is likely to be the next entirely new imaging method in clinical practice and has the potential to reduce radiation doses by 10-to-100 fold or more. In the era of "big data," no discipline in medicine will have opportunities that rival or surpass those we will have in radiology. We will use computer data mining and analysis techniques to turn "dumb" data into knowledge that can be delivered in real time at the point of care-just-in-time - for both radiologists and referring physicians. Data will inform development of better appropriateness criteria which will be immediately available to ordering providers and their patients. Borders will blur between concepts of information and communications systems and strong analytic and image processing capabilities will be incorporated directly into diagnostic work stations for key stroke access to advanced functions. The term "teleradiology" will become obsolete because of ubiquitous wide area networking capabilities worldwide. Advances in the foregoing areas will underpin radiology's participation in the era of precision medicine, also called personalized medicine. The fundamental principle of precision medicine is definition of ever smaller more precise sub groups of patients with similar characteristics who are likely to benefit from the same therapies and have similar prognoses. Imaging phenotypes-i.e. systems for scoring, categorizing or classifying disease presence and severity-based on imaging biomarkers will help define these "precise" subpopulations. Linkages between patient genotype and imaging phenotypes will also be important for surveillance of disease manifestation, assessment of disease extent and discovery of genetic polymorphisms. Positive consequences of future developments in imaging include new applications with higher medical value, reduced radiation doses, more appropriate utilization and more efficient use of health care resources. Challenging consequences of future developments include vastly increased complexity in radiology practice with associated increased educational requirements especially in parametric imaging. There will be unremitting competition for "ownership" of imaging methods between specialties in clinical practice and in research.

### Honored Educators

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Jon A. Jacobson, MD - 2012 Honored Educator

## Radiation Safety and Dose Optimization (Sponsored by the Associated Sciences Consortium) (An Interactive Session)

Tuesday, Dec. 1 1:30PM - 3:00PM Location: S105AB



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

### Participants

Richard Evans, London, United Kingdom (*Moderator*) Nothing to Disclose  
Louise Coleman, London, United Kingdom (*Moderator*) Nothing to Disclose

### Sub-Events

#### MSAS33A Dose Optimization in Pediatric Cardiology

### Participants

Sonya L. McFadden, MD, Antrim, United Kingdom, (s.mcfadden@ulster.ac.uk) (*Presenter*) Nothing to Disclose

### LEARNING OBJECTIVES

1) Comprehend current levels and risks of radiation exposure in Paediatric Interventional Cardiology (PIC). 2) Be able to calculate Local Diagnostic Reference Levels (LDRL). 3) Identify the different Interventional cardiology (IC) protocols currently used across the UK/Ireland and their impact on radiation dose/image quality. 4) Apply best practice in PIC.

### ABSTRACT

**PURPOSE**The number of pediatric interventional cardiology (PIC) procedures being performed has increased rapidly in recent years due to their reliability and cost effectiveness. However, interventional cardiology procedures have been reported to contribute to the highest doses of radiation to patients from medical examinations. Previous authors have estimated DRL for PIC and identified a wide variation of radiation exposure to the patient. **METHOD AND MATERIALS**A questionnaire study was used to investigate the PIC protocols currently used in clinical departments. Experimental studies were performed on anthropomorphic phantoms investigating these different variations in practice and the subsequent effect on image quality and radiation dose. A subsequent randomised controlled trial investigating these different protocols and their effect on image quality and dose is currently ongoing in the clinical environment. The effect of different scatter removal techniques on radiation dose and associated DNA damage was also investigated by quantifying  $\gamma$ H2AX-foci as a biomarker of radiation-induced effect. **RESULTS**Wide variations in imaging protocols are currently being used across different hospitals. These variations in practice are having a significant impact on the resultant radiation dose to the patient. Results of experimental studies on anthropomorphic phantoms showed that radiation dose reductions of 30% to 50% could be achieved by removing the anti-scatter grid, introducing an air gap and decreasing the frame rate with minimal impact on image quality. Radiation induced DNA damage is evident in patients undergoing PIC procedures and mean  $\gamma$ H2AX-foci can be significantly greater in different hospitals depending on the protocol used. **CONCLUSION**Great variation in radiation exposure exists across hospitals performing similar examinations on similar sized patients. There is a clear need for standardised protocols and guidelines. The anti-scatter grid should be removed routinely for newborn and infant patients undergoing PIC. The air gap should be introduced when possible. **CLINICAL RELEVANCE/APPLICATIONS**Simple modifications to clinical protocols will ensure the radiation dose to pediatric patients is kept ALARA without affecting image quality or diagnostic efficacy.

#### MSAS33B Learning from Errors and Near-Misses

### Participants

Sarah Peters, Didcot, United Kingdom, (sarah.peters@phe.gov.uk) (*Presenter*) Nothing to Disclose

### LEARNING OBJECTIVES

1) Identify common causes of errors and near-misses in the UK. 2) Describe the way errors and near-misses are investigated and reported in the UK. 3) Compare several approaches to disseminating learning from errors and near-misses.

### ABSTRACT

Healthcare professionals have a duty to inform their employer when things go wrong, regardless of whether it leads to actual harm. In turn employers should create an environment where staff members are supported and encouraged to report errors and near-misses. The World Health Organization (WHO) defines an error as "the failure of a planned action to be completed as intended or the use of a wrong plan to achieve an aim. Errors may be errors of commission or omission, and usually reflect deficiencies in the systems of care". The first stage in learning from an error is to investigate not just the 'who was involved, what happened and when?' but more importantly the 'why did it happen?' These investigations should seek to establish the facts surrounding the error rather than apportion blame, unless there was obvious malicious intent. Error investigations should also include recommendations and changes to systems of work and procedures that will lead to improvements in patient safety and prevent recurrence. For every error or incident, many more near misses will occur. The reporting and subsequent investigation of near misses can reduce the chances of an actual error occurring. No system is perfect, especially when human beings play an integral part in the process. The key point is that when errors and near-misses occur, organisations and individuals must learn from them and also ensure that this learning is shared. This could be on a local, regional or even national level to avoid the same mistake happening over and over again, at multiple locations and impacting the lives of numerous patients. This presentation will look at common errors and near-misses from a UK perspective as well as a number of approaches that are used both locally and nationally to ensure that learning is shared amongst the Radiology community.

**Using RSNA Clinical Trial Processing (CTP) Software for De-identification and Data Sharing (Hands-on)**

Tuesday, Dec. 1 2:30PM - 4:00PM Location: S401AB



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

**Participants**

Justin Kirby, Bethesda, MD (*Presenter*) Stockholder, Myriad Genetics, Inc  
Bradley J. Erickson, MD, PhD, Rochester, MN (*Presenter*) Stockholder, Evidentia Health, Inc; Stockholder, OneMedNet Corporation;  
Stockholder, VoiceIt Technologies, LLC  
Kirk E. Smith, BS, Saint Louis, MO (*Presenter*) Nothing to Disclose

**LEARNING OBJECTIVES**

1) Learn about CTP's capabilities and the unique challenges associated with de-identifying DICOM images 2) Learn how to install the CTP software 3) Learn how to use Pipelines to quickly configure CTP for data sharing and clinical trial use cases 4) Learn how to customize de-identification scripts for advanced use cases

**ABSTRACT**

The RSNA Clinical Trials Processor (CTP) is free software that enables researchers to share data for imaging clinical trials and research projects. CTP provides a secure end-to-end solution for efficiently de-identifying and moving images and related data between clinical trial sites or research teams. CTP is designed to support industry-standard Digital Imaging and Communications in Medicine (DICOM) transport protocols, so it is easy to configure CTP to work with commercial PACS systems as well as research databases such as DCM4CHEE, NBIA, MIDAS or XNAT. Built-in compliance with DICOM de-identification standards enables easy and effective removal of protected health information while preserving key attributes necessary to maintain usability of the data. In this course participants will be provided with an overview of CTP's functionality and the unique challenges associated with de-identifying DICOM images. They will then perform hands-on image processing of sample data based on common research and clinical trial scenarios.

**URL**

RCC34

### 3D Printing with Viable Tissues - Bioprinting

Tuesday, Dec. 1 2:30PM - 4:00PM Location: S501ABC



AMA PRA Category 1 Credits <sup>™</sup>: 1.50  
ARRT Category A+ Credit: 0

#### Participants

Dimitris Mitsouras, PhD, Boston, MA (*Moderator*) Research Grant, Toshiba Corporation; Speakers Bureau, Toshiba Corporation  
Roger R. Markwald, PhD, Charleston, SC (*Moderator*) Nothing to Disclose

#### Sub-Events

##### **RCC34A**      3D Printing of Viable Tissues

#### Participants

Roger R. Markwald, PhD, Charleston, SC (*Presenter*) Nothing to Disclose

##### **RCC34B**      3D Printing and Regenerative Medicine in Congenital Heart Disease

#### Participants

Richard G. Ohye, MD, Ann Arbor, MI (*Presenter*) Nothing to Disclose

#### LEARNING OBJECTIVES

1) To understand the current role for 3-D printing and regenerative medicine in congenital heart disease.

##### **RCC34C**      Intellectual Property

#### Participants

Bruce Kline, BS, Rochester, MN (*Presenter*) Nothing to Disclose

##### **RCC34D**      Quality Control

#### Participants

Shuai Leng, PhD, Rochester, MN (*Presenter*) Nothing to Disclose

## Nuclear Medicine (Quantitative Imaging and Image Processing)

Tuesday, Dec. 1 3:00PM - 4:00PM Location: S505AB



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

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

### Participants

Chadwick L. Wright, MD, PhD, Lewis Center, OH (*Moderator*) Nothing to Disclose  
Andrew C. Homb, MD, Louisville, KY (*Moderator*) Nothing to Disclose

### Sub-Events

#### SSJ17-01 The Prognostic Value of Volumetric FDG PET/CT Parameters and Partial Volume Effect Correction in Patients with Locally Advanced Non-Small Cell Lung Cancer: A Secondary Analysis of ACRIN 6668/RTOG 0235 Trial

Tuesday, Dec. 1 3:00PM - 3:10PM Location: S505AB

### Awards

#### Trainee Research Prize - Resident

### Participants

Ali Salavati, MD, MPH, Philadelphia, PA (*Presenter*) Nothing to Disclose  
Fenghai Duan, PhD, Providence, RI (*Abstract Co-Author*) Nothing to Disclose  
Sina Houshmand, MD, Philadelphia, PA (*Abstract Co-Author*) Nothing to Disclose  
Benjapa Khiewvan, MD, Philadelphia, PA (*Abstract Co-Author*) Nothing to Disclose  
Adam Opanowski, Philadelphia, PA (*Abstract Co-Author*) Nothing to Disclose  
Bradley S. Snyder, MS, Providence, RI (*Abstract Co-Author*) Nothing to Disclose  
Bo Wei, Providence, RI (*Abstract Co-Author*) Nothing to Disclose  
Murat Sadic, Ankara, Turkey (*Abstract Co-Author*) Nothing to Disclose  
Barry A. Siegel, MD, Saint Louis, MO (*Abstract Co-Author*) Consultant, Merrimack Pharmaceuticals, Inc Consultant, Siemens AG Advisory Board, General Electric Company Stockholder, Radiology Corporation of America Spouse, Speaker, Siemens AG  
Mitchell Machtay, MD, Cleveland, OH (*Abstract Co-Author*) Consultant, Bristol-Myers Squibb Company; Consultant, Eli Lilly and Company; Consultant, AbbVie Inc; Speaker, Bristol-Myers Squibb Company; Speaker, Eli Lilly and Company; Speaker, AbbVie Inc  
Abass Alavi, MD, Philadelphia, PA (*Abstract Co-Author*) Nothing to Disclose

### PURPOSE

There is a growing body of evidence supporting the application of volumetric PET/CT parameters and partial volume effect correction (PVC) in the prognostication of patients with non-small cell lung cancer (NSCLC). The aim of this secondary analysis was to assess the ability of pretreatment volumetric PET/CT measures, along with PVC, to predict locoregional control (LRC) and overall survival (OS) in patients enrolled in ACRIN 6668/RTOG 0235.

### METHOD AND MATERIALS

Patients with inoperable stage IIB/III NSCLC and evaluable pretreatment FDG-PET/CT scans were included. Pretreatment Metabolic Tumor Volume(MTV),SUVmax,SUVmean,Total Lesion Glycolysis (TLG=SUVmean\*MTV), pvcSUVmean and pvcTLG(pvcSUVmean\*MTV) were quantified using semiautomatic adaptive contrast-oriented thresholding and local background PVC algorithms.The relationship between PET/CT indices and patient outcomes was assessed using Cox proportional hazards regression and time-varying models.

### RESULTS

Of 234 eligible patients,38 were excluded mainly due to inadequate image quality, leaving 196-151 depending on the measured PET indices. PVC parameters were very highly correlated with their non-corrected counterparts (median correlation 0.98,range 0.96 to 0.997). Pretreatment MTV, TLG and pvcTLG (both primary tumor(PT) and whole body(WB)) were independent predictors of OS, while SUVmax, SUVmean and pvcSUVmean were not prognostic using either PT or WB measures.PVC and non-PVC indices yielded similar hazard ratios of 1.17(95%CI 1.05-1.31 p=0.004),1.20(95%CI1.06-1.34 p=0.003), 1.24(95%CI1.06-1.44 p=0.007), 1.27(95%CI1.08-1.50 p=0.004) for PT TLG, PT pvcTLG, WB TLG and WB pvcTLG,respectively.Similar results were observed after subsetting the entire cohort based on tumor size.Similar to OS, MTV and TLG were independent predictors of LRC, although their prognostic ability decreased during long-term follow-up.

### CONCLUSION

Pretreatment volumetric PET/CT parameters including MTV and TLG are strong predictors of OS and LRC for NSCLC;however, the association with LRC appears to diminish over time. For this particular cohort,PVC did not appear to enhance the prognostic ability of PET/CT indices.The significance of PVC in treatment monitoring remains to be clarified.

### CLINICAL RELEVANCE/APPLICATION

Pretreatment volumetric FDG-PET/CT parameters are strong independent predictors of overall survival and locoregional control in patients with locally advanced NSCLC treated with chemoradiation therapy.

#### SSJ17-02 Impact of Point-spread Function Reconstruction on Quantitative FDG-PET/CT Imaging Parameters and Inter Reader Reproducibility in Solid Tumors

Tuesday, Dec. 1 3:10PM - 3:20PM Location: S505AB

### Awards



## Trainee Research Prize - Fellow

### Participants

Sara Sheikhabaei, MD, MPH, Baltimore, MD (*Presenter*) Nothing to Disclose  
Charles Marcus, MD, Baltimore, MD (*Abstract Co-Author*) Nothing to Disclose  
Rick Wray, MD, Baltimore, MD (*Abstract Co-Author*) Nothing to Disclose  
Arman Rahmim, PhD, Baltimore, MD (*Abstract Co-Author*) Nothing to Disclose  
Martin A. Lodge, PhD, Baltimore, MD (*Abstract Co-Author*) Nothing to Disclose  
Rathan M. Subramaniam, MD, PhD, Baltimore, MD (*Abstract Co-Author*) Travel support, Koninklijke Philips NV

### PURPOSE

Recent studies suggest that implementation of the point spread function (PSF) in the reconstruction algorithm of positron emission tomography (PET) improves the spatial resolution of PET images. However, there is little known about the influence of PSF reconstruction on volumetric measurements in PET/CT. This study aims to determine the impact of PSF reconstruction on quantitative PET/CT indices and the inter-reader reproducibility of these measurements.

### METHOD AND MATERIALS

Study was approved by the Institutional Review Board under a waiver of informed consent. A total of 42 oncology patients with 89 lesions (all  $\geq 2$ cm) were included. The PET/CT images were reconstructed with PSF (OSEM+TOF, 2i, 21s, all pass filter) and without PSF (OSEM+TOF, 2i, 21s, 5 mm Gaussian). For each lesion, the maximum, mean and peak standardized uptake values (SUV), total lesion glycolysis (TLG), and metabolic tumor volume (MTV) were measured by two readers (R1, R2) using a semi-automatic gradient segmentation method. Intra-class correlation coefficient (ICC) and Bland-Altman analyses were performed.

### RESULTS

There was excellent correlation between non-PSF and PSF reconstruction PET/CT values [ICC $\geq$ 0.950 for all parameters,  $P<0.0001$ ]. Bland-Altman analyses comparing PSF with non-PSF images showed the average biases (%) of +11.14 (R1) and +11.1 (R2) for SUVmax, +7.04 (R1) and +7.54 (R2) for SUVmean, +7.03 (R1) and +7.06 (R2) for SUVpeak, -2.62 (R1) and -3.17 (R2) for TLG, and -9.61 (R1) and -10.43 (R2) for MTV. Percentage changes in PSF versus non-PSF indices were not related to the site of the lesions ( $P>0.05$ ). Close agreement was observed between two readers [ICC ranged between 0.908-0.997,  $P<0.0001$ ].

### CONCLUSION

The PSF reconstruction increases the SUVmax, SUVmean and SUVpeak, as expected, while it tends to produce lower values for MTV and has variable effect on TLG. This can be attributed to the ability of PSF reconstruction to better discern tumor uptake from activity spill-out.

### CLINICAL RELEVANCE/APPLICATION

Reconstruction method of PET/CT should be carefully considered in reporting quantitative parameters, subsequent lesion classifications and comparisons for therapy assessment.

## SSJ17-03 Early Prediction of Chemotherapeutic Response with Volumetric FDG PET Parameters in Recurrent Gynecological Malignancies

Tuesday, Dec. 1 3:20PM - 3:30PM Location: S505AB

### Participants

Mitsuaki Tatsumi, MD, PhD, Suita, Japan (*Presenter*) Nothing to Disclose  
Kayako Isohashi, Suita, Japan (*Abstract Co-Author*) Nothing to Disclose  
Hiroki Kato, Suita, Japan (*Abstract Co-Author*) Nothing to Disclose  
Masatoshi Hori, MD, Suita, Japan (*Abstract Co-Author*) Nothing to Disclose  
Noriyuki Tomiyama, MD, PhD, Suita, Japan (*Abstract Co-Author*) Nothing to Disclose  
Jun Hatazawa, MD, PhD, Osaka, Japan (*Abstract Co-Author*) Nothing to Disclose

### PURPOSE

To evaluate if volumetric parameters (VPs) of FDG PET were useful in predicting treatment response early after chemotherapy in recurrent gynecological malignancies.

### METHOD AND MATERIALS

This study included 35 patients with recurrent gynecological malignancies (19 uterine, 12 ovarian, 2 peritoneal, and 2 others). FDG PET/CT exam was performed before (pre) and after 1 cycle of chemotherapy (post1c). Metabolic tumor volume (MTV, SUV threshold 2.5) and total lesion glycolysis (TLG) were obtained as VPs in addition to SUVmax at the hottest lesion in each exam. MTV and TLG were also obtained for whole-body (wb) lesions. Pre, post1c, and changes (expressed as  $\Delta$ ) of VPs as well as SUVmax were compared each other and to the treatment response after last cycle of chemotherapy, which was decided with all clinical information available including imaging data.

### RESULTS

PreSUVmax ranged from 1.9 to 22.4 (median: 7.0) and preMTV from 0 to 161 (median: 8.8). All preVPs exhibited a strong correlation with preSUVmax ( $Rho=0.78-0.88$ ,  $p<0.001$ ). Similar results were observed between post1cVPs and post1cSUVmax and between  $\Delta$ VPs and  $\Delta$ SUVmax. Post1cVPs and post1cSUVmax showed a strong ( $Rho=0.63-0.76$ ) and moderate ( $Rho=0.40-0.57$ ) correlation with  $\Delta$ VPs and  $\Delta$ SUVmax, respectively. Treatment response was observed in 14 of 35 pts and it correlated moderately with post1cVPs,  $\Delta$ VPs, and  $\Delta$ SUVmax. Among them,  $\Delta$ wbMTV or  $\Delta$ wbTLG was considered the best parameter to predict response from ROC analysis (AUC: 0.79). A cutoff of  $\Delta$ wbMTV 121% from ROC curve yielded the sensitivity, specificity, positive-, and negative predictive value of 57%, 100%, 100%, and 61%, respectively, if non-response was defined as positive. Mean  $\Delta$ wbMTV was 31% and 287% respectively in response and non-response groups ( $p<0.05$ ). No significant findings were noted between preVPs or preSUVmax and treatment response.

### CONCLUSION

This study demonstrated early changes of VPs in FDG PET after 1 cycle of chemotherapy were more useful than changes of

SUVmax in predicting treatment response after the last cycle in pts with recurrent gynecological malignancies. Potential of MTV and TLG dealing with whole-body lesions was also demonstrated in this study.

#### CLINICAL RELEVANCE/APPLICATION

Early changes of volumetric FDG PET parameters after 1 cycle of chemotherapy were useful in predicting final treatment response in pts with recurrent gynecological malignancies.

#### SSJ17-04 Assessment of Whole-body Metabolic Tumor Burden of Nerve Sheath Tumors in Neurofibromatosis Type 1 Using 18F-FDG PET/CT

Tuesday, Dec. 1 3:30PM - 3:40PM Location: S505AB

##### Participants

Johannes M. Salamon, MD, Hamburg, Germany (*Presenter*) Nothing to Disclose  
Azien Laqmani, Hamburg, Germany (*Abstract Co-Author*) Nothing to Disclose  
Ivayla I. Apostolova, MD, Magdeburg, Germany (*Abstract Co-Author*) Nothing to Disclose  
Gerhard B. Adam, MD, Hamburg, Germany (*Abstract Co-Author*) Nothing to Disclose  
Victor F. Mautner, MD, Hamburg, Germany (*Abstract Co-Author*) Nothing to Disclose  
Thorsten Derlin, MD, Hannover, Germany (*Abstract Co-Author*) Nothing to Disclose

##### PURPOSE

To determine the metabolically active whole-body tumor volume and whole body total lesion glycolysis on 18F-fluorodeoxyglucose positron emission tomography/computed tomography (18F-FDG PET/CT) in individuals with neurofibromatosis type 1 (NF1) using a three-dimensional (3D) segmentation and computerized volumetry technique. And to compare these parameters in NF1 patients with benign (BPNSTs) and malignant peripheral nerve sheath tumors (MPNSTs).

##### METHOD AND MATERIALS

Eighteen NF1 patients with malignant PNSTs and 18 age- and sex-matched NF1 controls with benign PNSTs examined by 18F-FDG PET/CT were included (20 men; 16 women; age,  $36.6 \pm 12.3$  years; range 16.5 to 68.7 years). Whole-body metabolic tumor burden (mTB), whole-body total lesion glycolysis (TLG) and a set of semi-quantitative imaging-based parameters were analyzed on a per-patient and a per-lesion basis. The Mann-Whitney U test, the Spearman correlation coefficient and ROC analysis were used for statistical analyses. Histopathological evaluation and clinical / radiological follow-up examinations served as the reference standards.

##### RESULTS

Whole-body mTB and whole-body TLG were significantly higher in NF1 patients with MPNSTs compared to patients with BPNSTs at different SUVmax cut-offs (2.0, 2.5, 3.5 and 4.0,  $p < 0.0001$ ). MPNST demonstrated both a significantly higher metabolic tumor volume and TLG than BPNSTs ( $p < 0.0001$ ). ROC analysis showed that metabolic tumor volume and TLG could be used to differentiate between benign and malignant tumors. Neither age nor gender were significantly correlated with whole-body mTB and whole-body TLG.

##### CONCLUSION

Whole-body mTB and whole-body TLG are different between NF1 patients with BPNST and MPNST. Moreover, malignant tumors have higher metabolic tumor volume and TLG than benign tumors. Further evaluation in prospective studies is required to determine the potential clinical impact and prognostic significance of these novel PET parameters in the context of NF1.

#### CLINICAL RELEVANCE/APPLICATION

New volumetric imaging parameters of peripheral nerve sheath tumors in NF1 such as mTB and TLG provide the basis for investigating biomarkers for early detection of MPNST and may help reducing unnecessary biopsies or surgery.

#### SSJ17-05 Determination of the Degree of Colorectal Carcinoma differentiation by Characterizing Tumor Heterogeneity with Textural Features on 18F-FDG PET/CT

Tuesday, Dec. 1 3:40PM - 3:50PM Location: S505AB

##### Participants

Wei Mu, Beijing, China (*Abstract Co-Author*) Nothing to Disclose  
Zhe Chen, Beijing, China (*Abstract Co-Author*) Nothing to Disclose  
Ying Liang, Beijing, China (*Abstract Co-Author*) Nothing to Disclose  
Ning Wu, MD, Beijing, China (*Abstract Co-Author*) Nothing to Disclose  
Jie Tian, PhD, Beijing, China (*Presenter*) Nothing to Disclose

##### PURPOSE

The aim of the study is to assess the usefulness of the tumor heterogeneity characterized by texture features and other commonly used semi-quantitative indices extracted from 18F-FDG PET images to determinate the differentiated degree of cancer cells in colorectal adenocarcinoma (CA) patients.

##### METHOD AND MATERIALS

We retrospectively studied the PET/CT images of 42 patients with pathologically proven CA (26 male and 15 female; mean age,  $60 \pm 13$  years), and the differentiation was graded on a scale of poor, moderate, or well differentiated. Firstly, the primary tumor was segmented with an improved level set method. Based on the traditional Chan-Vese (CV) model, we imposed gradient field constraint to exclude the effect of the adjacent bladder for some rectal tumors. Secondly, fifty-four 3D texture features (based on histogram analysis, concurrence matrix (CM), gray level size zone matrix (GLSZM), run length matrix (RLM), neighbourhood gray level difference matrix (NGLD) and texture spectrum (TS)) were studied besides of SUVs (SUVmax, SUVmean, SUVpeak) and metabolic tumor volume (MTV). A 64-gray-level quantization was used, and local features (features based on CM and RLM) were computed over 13 directions. Then one-way analysis of variance (ANOVA) followed by multiple comparisons was employed to test the features for the statistical significance of group differences. In addition, the robustness of the features with respect to the segmentation methods was validated.

## RESULTS

Three of the forty-eight features, difference variance (DV) and information correlation<sup>1</sup> (IC1) based on CM and low gray level run emphasis (LGRE) based on GLSZM showed significant differences between any two groups ( $P < 0.05$ ). Through Student's test, there were no significant differences of the features between the manual segmentation and the proposed method ( $p > 0.05$ ).

## CONCLUSION

Texture analysis of FDG PET could determinate the degree of colorectal carcinoma differentiation potentially, which also means the texture features may be another prognostic factors and can provide supplementary information for developing treatment plan.

## CLINICAL RELEVANCE/APPLICATION

The texture features could determine the differentiated degree of cancer cells in colorectal adenocarcinoma (CA) patients, and could be another prognostic factors for personalized medicine.

### SSJ17-06 Automatic PET Image Segmentation: A Cross-Platform and Cross-Method Evaluation

Tuesday, Dec. 1 3:50PM - 4:00PM Location: S505AB

#### Participants

Tram Nguyen, Odense, Denmark (*Presenter*) Nothing to Disclose

Poul-Erik Braad, Odense C, Denmark (*Abstract Co-Author*) Nothing to Disclose

Poul Flemming Hoiland-Carlsen, Odense, Denmark (*Abstract Co-Author*) Nothing to Disclose

#### PURPOSE

Quantitative PET relies on reproducible and accurate target delineation. This study investigated the unassessed variation between different commercial software packages that generally use threshold approaches. Method variability was also tested against in-house implemented methods.

#### METHOD AND MATERIALS

PET scans of the NEMA/IEC phantom with different target-to-background ratios (TBRs) (5:1, 10:1, 20:1, infinite) and human <sup>18</sup>F-NaF PET images (6 vertebrae of various shapes and inhomogeneity with/without bone abnormalities) were used. Region-of-interest (ROI) analysis with the ROVER (ABX, Radeberg, Germany) and PETVCAR (GE Healthcare) software was performed along with in-house implementations. Cross-platform reproducibility was assessed by applying the same common 40% of peak value threshold method on all platforms. Cross-method variability was tested among the adaptive threshold (AT) method of ROVER, the estimated threshold (ET) by PETVCAR, and in-house implemented region growing with non-peak-based threshold (RG) and non-threshold level set (LS) methods.

## RESULTS

Overall, consistent cross-platform results were obtained with some estimated mean activity deviations ( $\sim 0.1$ - $0.3$  kBq/mL) and volume variations ( $\sim 0.02$ - $0.4$  mL) at TBR5 and target size  $< 15$  mm. At higher levels, ROVER deviated slightly from the other platforms with their near identical estimates. The peak-based method failed to segment inhomogeneous vertebrae well. Different methods yielded variations in estimated phantom activity ( $p \sim 0.6$ - $0.9$ ) and volumes ( $p \sim 0.8$ - $0.95$ ) that became marked at low contrast and targets  $< 35$  mm. LS generally gave the best estimates, especially at high contrast and targets  $> 20$  mm. Above TBR10, ET captured volumes the best, but overall underestimated activity levels the most. For vertebrae delineation, ET measurements, especially target volumes, deviated the most due to segmentation limitations.

## CONCLUSION

Non-threshold or locally adaptive threshold methods had better performance range than peak-based thresholding across contrast, target size, and inhomogeneity. The cross-platform and cross-method variations introduced bias that has to be accounted for in any quantitative analysis design.

## CLINICAL RELEVANCE/APPLICATION

Work like this is essential to elucidate critical aspects of quantification that will have decisive clinical impact along with the growing role of PET for prediction and therapy planning/evaluation.

SSJ12

## ISP: Health Service, Policy and Research (Quality)

Tuesday, Dec. 1 3:00PM - 4:00PM Location: S102D



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

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

### Participants

Jonathan James, BMBS, Nottingham, United Kingdom (*Moderator*) Nothing to Disclose  
Edward Y. Lee, MD, MPH, Boston, MA (*Moderator*) Nothing to Disclose

### Sub-Events

#### SSJ12-01 Health Service, Policy and Research Keynote Speaker: Assessing Individual Performance in Radiology

Tuesday, Dec. 1 3:00PM - 3:10PM Location: S102D

### Participants

Jonathan James, BMBS, Nottingham, United Kingdom (*Presenter*) Nothing to Disclose

#### SSJ12-02 Framing Bias Effects on Retrospective Reviews of Radiological Reports

Tuesday, Dec. 1 3:10PM - 3:20PM Location: S102D

### Participants

Jeffrey D. Robinson, MD, MBA, Seattle, WA (*Presenter*) Consultant, HealthHelp, LLC; President, Clear Review, Inc;  
Daniel S. Hippe, MS, Seattle, WA (*Abstract Co-Author*) Research Grant, Koninklijke Philips NV; Research Grant, General Electric Company

### PURPOSE

When reviewing difficult exams, radiologists often disagree on the severity of a potential error. In the legal setting, this is often attributed to retrospective or framing bias. This study examines the effect of framing bias on radiologists' perceptions when evaluating potential errors.

### METHOD AND MATERIALS

This study was IRB approved. Eleven de-identified exams that had been subject of malpractice litigation and four uncontested control exams were divided into four review sets each containing three litigation (L) exams and one control (C) and their accompanying reports. Volunteers solicited from the ACR directory were randomly assigned to one of four groups (P,D,Q,N). Group P was told that they had been retained by a malpractice plaintiff's attorney; D that they had been retained by a defense attorney; Q that a neighboring hospital requested an outside QA review and N was given no context. Subjects were also randomly assigned to one of the four review sets, and asked for each exam if the radiology report failed to meet the standard of care (failure). The rates at which each group judged each type of exam to be a failure were compared using a multivariate, mixed-effect, logistic regression model.

### RESULTS

The study was completed by 102 radiologists, yielding 368 reviews (276 L, 92 C). Together, all four groups rated L exams as failures in 57% of assessments, and C exams in 27% ( $p = 0.006$ ). The difference in ratings between L and C exams was most pronounced in Group P (62% vs. 26%,  $p = 0.013$ ) and Group N (66% vs. 18%,  $p = 0.003$ ). Within the subgroup of L exams, Group P was significantly more likely to judge an exam a failure than the Group D (62% vs 48%,  $p = 0.032$ ). The Q and N groups were not significantly different than the other groups.

### CONCLUSION

Framing bias plays a significant role in retrospective review. Told that the exams they were reviewing were problematic, reviewers rated 27% of control exams below the standard of care. Simulated plaintiff's experts rated litigation exams below the standard of care significantly more frequently than simulated defense experts rated the same exams. These differences in performance highlight the effect such bias plays in actual expert witness review.

### CLINICAL RELEVANCE/APPLICATION

Since framing bias can significantly affect reviewers' impressions, blinding a reviewer to the nature of the exam being reviewed should increase the objectivity of the reviewer's judgment.

#### SSJ12-03 Performance Testing for Radiologists Interpreting Chest Radiographs

Tuesday, Dec. 1 3:20PM - 3:30PM Location: S102D

### Participants

Yan Chen, Loughborough, United Kingdom (*Presenter*) Nothing to Disclose  
Jonathan James, BMBS, Nottingham, United Kingdom (*Abstract Co-Author*) Nothing to Disclose  
Leng Dong, Loughborough, United Kingdom (*Abstract Co-Author*) Nothing to Disclose  
Alastair G. Gale, PhD, Loughborough, United Kingdom (*Abstract Co-Author*) Nothing to Disclose

### PURPOSE

The aim was to develop a system to assess the image interpretation performance of radiologists in identifying signs of malignancy

on chest radiographs.

## METHOD AND MATERIALS

A test set of 30 digital chest radiographs was chosen by an experienced radiologist consisting of 11 normal and 19 challenging abnormal cases. The abnormal cases all had biopsy proven pathology; the normal cases had at least 2 years of imaging follow up. 14 radiologists with a range of experiences were recruited. Participants individually read the test set displayed on a standard reporting workstation, with their findings entered directly onto a laptop running specially designed reporting software. For each case they were given the relevant clinical information and were asked to mark any perceived abnormality and rate their level of suspicion on a 5-points scale (normal, benign, indeterminate, suspicious or malignant). On completion of the test, participants were given instant feedback and had the opportunity to review cases where there was disagreement with the expert opinion and pathology. The time taken for the participants to complete the test was recorded. Differences between the participants' performance were assessed using ROC analysis.

## RESULTS

The experience of the participants in reporting chest radiographs ranged from 1 to 26 years (Mean=9 yrs, Mdn=5 yrs). Participants' performance (ROC score) varied significantly between 2 groups (6 post-fellowship consultants, and 8 radiology residents). Radiology residents' performance as measured by ROC score was significantly poorer compared to post-fellowship consultants (Mean-RS=0.76, Mean-PFC=0.93,  $p=.003$ ). There was a positive correlation between image interpretation performance (ROC Mean=0.85, SD=0.11) and years of reading experience (Mean=9, SD=8.58),  $r=.573$ ,  $p<.05$ ,  $n=14$ . There was a trend for radiology residents to take longer to complete the task (Mean=26.51s) compared to post-fellowship consultant radiologists (Mean=19.65s), but this did not quite reach statistical significance ( $p=.07$ ).

## CONCLUSION

This pilot study demonstrates that it is possible to devise a method for performance testing the reporting of chest radiographs.

## CLINICAL RELEVANCE/APPLICATION

Chest radiographs are the first line imaging test for patients with chest symptoms suspicious of malignancy, this pilot study demonstrates that it is possible to devise methods to test performance of the reporting radiologist.

### SSJ12-04 Do Socioeconomic Disparities Exist in Radiology? Multivariate Analysis of Socioeconomic Factors Impacting Access to Imaging Services

Tuesday, Dec. 1 3:30PM - 3:40PM Location: S102D

#### Participants

Omid Khalilzadeh, MD, MPH, Boston, MA (*Abstract Co-Author*) Nothing to Disclose  
Alvin Y. Yu, MD, Boston, MA (*Abstract Co-Author*) Nothing to Disclose  
Emmanuel Carrodegua, BS, Boston, MA (*Abstract Co-Author*) Nothing to Disclose  
Anand M. Prabhakar, MD, Somerville, MA (*Abstract Co-Author*) Nothing to Disclose  
Synho Do, PhD, Boston, MA (*Abstract Co-Author*) Nothing to Disclose  
Garry Choy, MD, MS, Boston, MA (*Abstract Co-Author*) Nothing to Disclose  
James A. Brink, MD, Boston, MA (*Abstract Co-Author*) Nothing to Disclose  
Efren J. Flores, MD, Boston, MA (*Presenter*) Nothing to Disclose

## PURPOSE

Racial disparities are known to exist in medicine, but little has been studied in radiology. One way to examine this is to look at missed radiology appointments or missed care opportunities (MCO) which result in delayed diagnoses and negatively impact patient care. Moreover, MCO in radiology may be a symptom of missed appointments in other specialties. The reason for missing appointments is multifactorial, and socioeconomic factors may play an important role. In this study, we investigated the demographic factors associated with radiology missed appointments.

## METHOD AND MATERIALS

Demographic data of 975,539 ordered radiologic imaging exams at our institution in the calendar year 2014 was collected. The dataset included: ethnicity/race, primary language, insurance status, and reasons for cancellation of the appointment. The association of different factors with radiology MCOs was evaluated. Multivariate logistic regression models were implemented to evaluate the independent relationship between radiology MCOs and various factors.

## RESULTS

MCO was the most common reason for not completing a radiologic exam (41.5%). Overall, there was about 5% MCO (42,854) in radiology appointments during the calendar year 2014. A primary language other than English (OR: 1.2), Black ethnicity (OR: 1.8, relative to White) and Hispanic ethnicity (OR: 1.5, relative to White) were significantly associated with higher odds of MCO on a radiology appointment. Among different scan type, the odds of MCO was significantly higher for CT angiograms (OR: 2.8,  $P<0.001$ ). These associations remained significant after multiple adjustments for potential confounding variables.

## CONCLUSION

There was a high number (42,854) of radiology MCO in the past year at our institution. Non-English primary language and Hispanic ethnicity significantly correlate with likelihood of missing a radiology appointment. Our results identify patients who are at risk for MCO and provide opportunities for intervention that will improve the patient's experience and address healthcare disparities. Possible interventions to bridge the gap include telephone reminders in the patient's native language, scheduling radiology procedures with radiologists that come from similar background, assistance in coordination of transportation, among others.

## CLINICAL RELEVANCE/APPLICATION

Socioeconomic disparities exist in radiology. Further research in this area is paramount to examine the impact to healthcare access.

### SSJ12-05 Prevalence of Unanticipated Events Associated with MRI Examinations: A Benchmark for MRI Quality, Safety, and Patient Experience



## Awards

### Trainee Research Prize - Resident

#### Participants

Gelareh Sadigh, MD, Atlanta, GA (*Presenter*) Nothing to Disclose

Amit M. Saindane, MD, Atlanta, GA (*Abstract Co-Author*) Nothing to Disclose

Kimberly E. Applegate, MD, MS, Zionsville, IN (*Abstract Co-Author*) Nothing to Disclose

## PURPOSE

To determine the prevalence of unanticipated events (UE) associated with MRI examinations in a multi-center academic radiology department.

## METHOD AND MATERIALS

UE reported by MRI technologists for examinations performed between June 2013 and November 2014 on 17 scanners in a university- (UH) and community-affiliated (CH) hospitals of single health system were retrospectively reviewed. Events were categorized into: (1) orders and scheduling (no/improper order, insurance problem, scheduled wrong study/location, scheduling screening failure, improper preparation instruction/study protocol); (2) delays in scan (late patient arrival/transport, anesthesia/pathology procedure delays, delays in getting correct protocol or checking images); (3) foreign bodies (unanticipated metal/foreign body/pacemaker); (4) non-contrast related (NONCON) patient events (claustrophobia, patient discomfort, body habitus, pregnancy, nausea, pain, motion, need for sedation/general anesthesia, inability to complete the exam, patient dissatisfaction, patient fall, code called for resuscitation); (5) contrast related (CON) patient events (reaction, extravasation, lack of IV access, patient refusal of contrast); (6) technical acquisition issues (fat saturation, breath-holding, contrast bolus timing, mechanical scanner failure). Each category was compared between scanners located in UH vs. CH, and scanners that are solely used for outpatient services (OP) vs. those used for outpatients and inpatients (OP/IP).

## RESULTS

34,587 MRI examinations were assessed (87% UH; 59% OP) with 5,760 (17%) UE; (1.9% of patients had more than one category events). Rates of UE for each category were as follows: 1.8% orders and scheduling [0.06% patient arriving wrong day, and 0.03% patient call-back], 3.3% delays in scan, 0.5% foreign bodies, 10.4% NONCON events, 1.3% CON events, and 1.5% technical issues. Most frequent patient issues were motion, claustrophobia, and need for sedation. UH exams had higher reported rate of UE. OP exams had higher rates of orders and scheduling problems and delays in scans, while OP/IP exams had more patient related and technical issues (all  $P < 0.05$ ).

## CONCLUSION

UE associated with MRI exams are common (17%), with the majority being patient related issues.

## CLINICAL RELEVANCE/APPLICATION

Unanticipated patient events are common. Awareness of the prevalence and types of unanticipated events by MRI staff provides opportunities for practice improvement.

### SSJ12-06 Technologist-directed Radiograph Repeats: Frequency and Associations

Tuesday, Dec. 1 3:50PM - 4:00PM Location: S102D

#### Participants

Jill E. Jacobs, MD, New York, NY (*Abstract Co-Author*) Nothing to Disclose

Andrew B. Rosenkrantz, MD, New York, NY (*Presenter*) Nothing to Disclose

Joseph J. Sanger, MD, New York, NY (*Abstract Co-Author*) Nothing to Disclose

Marc Parente, New York, NY (*Abstract Co-Author*) Nothing to Disclose

Danny C. Kim, MD, White Plains, NY (*Abstract Co-Author*) Nothing to Disclose

Michael P. Recht, MD, New York, NY (*Abstract Co-Author*) Nothing to Disclose

## PURPOSE

The decision to repeat a suboptimal radiograph by the technologist at the time of acquisition, prior to radiologist review, is an infrequently assessed but potentially significant source of excess patient radiation. We assessed the technologist-directed radiograph retake rate in our hospital network.

## METHOD AND MATERIALS

We created an analysis tool to track all technologist-directed radiograph rejections for 52 CR and DR imaging device networks in 9 of our hospital-based imaging centers. The tool captured all acquired images and the reject reason in a reject log file (RLF). All RLFs were downloaded monthly to an encrypted USB flash drive, renamed in standardized convention, and uploaded to a protected network share drive. Information Technology staff reviewed all RLFs to ensure completeness and validity. RLFs were then imported into a Reject Analysis Database. Analysis was performed for a 6 month period (6/1/14-11/30/14). Retake rate by case (RRC) was number of retaken exposures (NR) acquired as a percentage of the total number of cases (TC) performed where  $RRC = (NR/TC) \times 100$ . Retake rate by exposure (RRE) was number of retaken exposures (NR) acquired as a percentage of the total number of expected exposures (EE) for all performed examinations where  $RRE = (NR/EE) \times 100$ . Data was stratified by date, site, imaging device, body part, and reject reason.

## RESULTS

Overall technologist-directed RRC and RRE were 3.4% and 1.8%, respectively. Body part RRC and RRE, respectively were: chest (5.9%, 4.4%); abdomen (3.3%, 1.6%); joint (3.0%, 1.3%); spine (2.6%, 1.2%); skull (1.8%, 1.0%); skeletal survey (1.6%, 0.8%), and unspecified (5.0%, 3.5%). For hospital portable devices, RRC was 9.2% overall (12.5% abdomen; 8.8% chest) and RRE was 9.2% overall (10.8% abdomen and 9.0% chest). The most common reason for repeat exposures was positioning error (2.3% overall) for both portable and non-portable examinations.

## CONCLUSION

Rates of technologist-directed radiograph retake vary by body part and are higher for portable examinations.

**CLINICAL RELEVANCE/APPLICATION**

Technologist education to identify and correct sources of imaging error is necessary to reduce retake rates and decrease excess patient radiation.



**Radiation Oncology (Outcomes/Quality of Life II)**

Tuesday, Dec. 1 3:00PM - 4:00PM Location: S104A



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

**Participants**

Daniel W. Golden, MD, Chicago, IL (*Moderator*) Manager, RadOnc Questions LLC  
Clifton D. Fuller, MD, PhD, Houston, TX (*Moderator*) In-kind support, General Electric Company; Research Grant, Elekta AB; ; ;

**Sub-Events****SSJ24-01 Radiotherapeutic Management of Hidradenitis Suppurativa**

Tuesday, Dec. 1 3:00PM - 3:10PM Location: S104A

**Participants**

Mark G. Trombetta, MD, Pittsburgh, PA (*Presenter*) Nothing to Disclose  
Michael W. Hall, MD, Pittsburgh, PA (*Abstract Co-Author*) Nothing to Disclose  
E Day Werts, PhD, Pittsburgh, PA (*Abstract Co-Author*) Nothing to Disclose  
James Fontanesi, Bloomfield Hills, MI (*Abstract Co-Author*) Nothing to Disclose

**ABSTRACT**

**Purpose/Objective(s):** Hidradenitis Suppurativa (HS) is a chronic condition affecting the apocrine glands and their ducts which can be debilitating and devastating for patients. Patient distress has resulted in chronic anxiety and even suicide in some patients. Standard therapy consists of, weight loss in obese patients, improved skin hygiene, antibiotics, and radical surgery. Radical surgery can be debilitating and for patients for whom conventional therapy is ineffective there are few less morbid options. For this benign disease, we have successfully used low dose radiotherapy in four patients. **Materials/Methods:** Four consecutive female patients with long standing and refractory HS were treated to multiple sites (axillae, the groins, and the inframammary regions) with low dose electron radiotherapy. Between 600 and 750 cGy was delivered in 3 equal fractions using 6 MeV electrons (Dmax) with a 0.5 cm bolus and a 1.0 cm margin surrounding the lesions to treat the apocrine glands in the dermis of the skin and the epidermis to limit follicular hyperkeratosis. In the lone patient who was treated with 600 cGy, retreatment was necessary in 50% of the sites treated. One patient supplemented her therapy with a sustained weight loss facilitated by careful dieting. Another patient had been treated one year prior with 6 MV photon radiotherapy that mimicked our prescribed total dose, but effectively provided only about 25% of prescribed dose to the dermis and epidermis. **Results:** With a mean follow up of 28.5 months (range 4-48 months), all patients were free of recurrence. One patient (4 month follow up patient) had such anxiety about her disease that she decided to undergo radical surgery 4 months from the radiotherapy despite progressive improvement. The time to complete resolution averaged 3-6 months from radiotherapy. One patient developed long term pruritus (the patient previously treated with photons). This remains as a controlled but minor intermittent problem. No other patients had side effects of radiotherapy. **Conclusion:** Conservative management of HA with oral antibiotic therapy and a strict weight loss regimen is an optimal first line approach. However, when more radical and invasive surgical options fail or are undesirable, low dose radiotherapy is a viable option.

**SSJ24-02 Bone Metastases Treatment in A Rural Setting: The Effect of Choosing Wisely**

Tuesday, Dec. 1 3:10PM - 3:20PM Location: S104A

**Participants**

Richard Lovett JR, MD, Rutland, VT (*Presenter*) Nothing to Disclose

**ABSTRACT**

**Purpose/Objective(s):** In 2013, the American Society of Therapeutic Radiology (ASTRO) released its list of Choosing Wisely Initiatives. One of these initiatives, was to use fractionation schemes which allow less than 10 fractions for the palliation of bony metastatic disease. Such schemes may use one or five fractions to treat an uncomplicated case of bone metastases. This project looks at a rural radiation practice, both before and after a decision was made to employ the Choosing Wisely guidelines whenever appropriate. **Materials/Methods:** This is a non randomized, retrospective analysis of 12 months of bone metastasis treatments in a single provider practice comparing the 6 months before Choosing Wisely to the six months after Choosing Wisely. A total of 37 consecutive patients, 63 treatment sites were examined. Fifteen treatment fractions were saved before, 84 treatment fractions were saved after the guidelines were published. **Results:** More fractions of radiotherapy were saved when compared to the same length of time prior to the decision to employ Choosing Wisely Initiatives. This finding, however is seen in a retrospective analysis of a single physician practice, who decided to adopt the Initiative, thus built in bias existed. Before the Choosing Wisely Initiative was released, 14% of patients received shorter fraction schemes, compared with 68% after. Because of these shorter treatment schedules, and assuming similar patient charges for treatments, savings after the Initiatives were released were over 5.5 times as much as prior to the release for the patient population, as a whole (\$69,000 versus \$12,000). In a time when health care costs are growing faster than the GDP, any savings we can achieve can benefit society as a whole. Numerous assumptions must be made in the analysis and the numbers are subject to discussion, but no one can deny that a patient with painful bone metastases would benefit from saving almost 4 hours in the car on rural roads. Care givers may be retired, and may not loose wages, but at the average wage of \$63,000, the average caregiver saved approximately \$170.00 in lost wages bringing in their loved one. The average patient who recieved shortened fractionation saved 145 miles of travel and 5 hours and 35 minutes of commuting and treatment time. Other savings were seen in one patient who needed to be hospitalized for her treatment. Her hospital stay was reduced by the use of shorter fractionation. No patient in this study required retreatment, the minimum follow up period was 6 months. Many patients have passed away from their disease within this follow up period. **Conclusion:** Shorter fraction schemes when used as clinically appropriate do offer savings not only to health care payers, but also to patients and patients families. Consideration of Choosing Wisely Initiatives have saved patients time and expense as opposed to a similar time period before the initiative.

**SSJ24-03 Avoiding Skin Cream Application Right Before Radiation: Myth or Sound Advice?**

Tuesday, Dec. 1 3:20PM - 3:30PM Location: S104A

#### Participants

Brian Baumann, Philadelphia, PA (*Presenter*) Nothing to Disclose  
Chuan Zeng, Philadelphia, PA (*Abstract Co-Author*) Nothing to Disclose  
Ioannis I. Verginadis, Philadelphia, PA (*Abstract Co-Author*) Nothing to Disclose  
Carolyn Vachani, Philadelphia, PA (*Abstract Co-Author*) Nothing to Disclose  
Timothy D. Solberg, PhD, Philadelphia, PA (*Abstract Co-Author*) Nothing to Disclose  
Costas Koumenis, Philadelphia, PA (*Abstract Co-Author*) Nothing to Disclose  
James M. Metz, MD, Philadelphia, PA (*Abstract Co-Author*) Nothing to Disclose

#### ABSTRACT

**Purpose/Objective(s):** Many patients undergoing radiation therapy (RT) experience acute dermatitis, and topical emollients are used to ameliorate this condition, including creams with heavy metals. Patients are traditionally advised to avoid lotions for several hours before RT based on concern that creams might increase skin dose. With modern RT's improved skin sparing, this traditional recommendation may be irrelevant. We hypothesize that the application of either metallic or non-metallic creams before treatment would have minimal effect on skin dose. **Materials/Methods:** We conducted an online, 24-question survey of patients and providers to determine current practices regarding skin creams on the OncoLink website using a convenience sample of users. To evaluate the dosimetric effect of skin creams, we delivered 200 MU at 100 cm SSD to a 10 x 10 cm field and measured the dose at the surface and 2 cm depth in a tissue equivalent phantom, with and without application of two common skin creams, Aquaphor and silver sulfadiazine, using optically stimulated luminescent dosimeters. We assessed the effect of various photon and electron energies, cream thicknesses, and beam incidence on dose. **Results:** The survey showed that 22 of 25 patients and providers (88%) either gave or received the advice to avoid applying skin creams prior to RT treatments. This finding was not affected by diagnosis ( $p=0.6$ ). Measurements showed no difference in dose at the surface or 2 cm depth with or without a relatively thick 1-2 mm application of either cream when using 6 or 15 MV photons. Similarly, there was no impact on surface dose for 6 MV photons delivered at incident angles ranging from 15°- 60°. The same application of cream had no effect on surface dose as a function of beam incident angle, with the exception of a 7% increase at 60° observed only with the silver cream. A significant increase in surface dose was noted for both 6 and 15 MV photons when a thicker (3 mm) layer of cream was applied. For 6 MV beams, the surface dose was 105 cGy with Aquaphor, 102 cGy for the silver cream, and 88 cGy for controls. For 15 MV, the doses were 70, 60 and 52 cGy, respectively. With 6 and 9 MeV electrons, there was only a 2-5% increase in the surface dose with use of creams. No differences in dose were observed at 2 cm depth. **Conclusion:** To our knowledge, this is the first dosimetric assessment of the effect of skin creams for radiation dermatitis. Survey results confirmed that patients are routinely advised to avoid creams prior to RT. Our findings suggest that thin or moderately applied skin creams, even if applied just prior to radiation, have minimal impact on skin dose, regardless of beam energy or beam incidence. Applying very thick amounts of skin cream just prior to RT may have a bolus effect with increased surface dose and should be avoided. Studies in mouse models to evaluate the effect of creams on skin dose using gamma-H2AX IHC staining have been initiated.

#### SSJ24-04 A Comparison of Distress Levels in Cancer Patients During Treatment

Tuesday, Dec. 1 3:30PM - 3:40PM Location: S104A

#### Participants

Kimberly B. Hart, MD, Detroit, MI (*Presenter*) Nothing to Disclose  
Judith Abrams, PhD, Detroit, MI (*Abstract Co-Author*) Founder, Delphinus Medical Technologies, Inc Officer, Delphinus Medical Technologies, Inc  
Carol Devore, RN, Commerce, MI (*Abstract Co-Author*) Nothing to Disclose

#### PURPOSE

**Purpose/Objective(s):** To assess changes in distress level in cancer patients from diagnosis to end of treatment

#### METHOD AND MATERIALS

**Materials/Methods:** All newly diagnosed cancer patients at the Charach Cancer Treatment Center, Huron Valley-Sinai Hospital, were given a baseline distress assessment using the 10 point NCCN Distress Management Tool (DT). Patients classified as not distressed (ND) if they scored 4 or less. Patients were considered distressed (D) if their score was >4 and referred to social work for further assessment. The DT was then administered to ND individuals again at the middle and end of treatment. Demographic data was collected including age, sex, tumor type, marital status, type of therapy received (chemotherapy alone, chemo/RT or RT alone) as well as items on the NCCN problem list that accompanies the DT.

#### RESULTS

**Results:** 153 patients were surveyed, 48 D patients and 105 ND. More D than ND patients were treated with chemotherapy alone (26% vs 6%) and fewer with RT alone (25% vs 47%) although combination therapy was about the same (50% vs 47%) ( $p=0.03$ ). Median age of D individuals was 6 years older than the ND ( $p=0.21$ ). D patients were more likely (31%) than ND (11%) to be single ( $p=0.01$ ). Breast cancer was the most common tumor type (ND 43%, D 29%) followed by prostate (ND 26% D 8%) and lung cancer (ND 11% D 20%). With respect to the NCCN problem list, emotional (D 81% vs ND 48%) ( $p=0.0006$ ) and physical problems (D 92% vs ND 44%)

#### CONCLUSION

**Conclusion:** In this study, patients who demonstrated no distress at the start of cancer treatment had no increase in distress by the conclusion of treatment. This may relate to the difficulty of capturing changes in distress in a patient survey. Given that emotional and physical problems were significant complaints in patients with distress at the start of treatment, more attention needs to be directed at these issues by clinicians. [1]

#### SSJ24-05 Oncology Acupuncture Program Assessment: A Retrospective Review of Patient Population, Cancer Diagnosis and Use of Acupuncture over a 12-month Period at an NCI-Designated Cancer Center

Tuesday, Dec. 1 3:40PM - 3:50PM Location: S104A

#### Participants

Angie L. Rademacher, Portland, OR (*Presenter*) Nothing to Disclose  
Shushan Rana, MD, Portland, OR (*Abstract Co-Author*) Nothing to Disclose  
Charles R. Thomas JR, MD, Portland, OR (*Abstract Co-Author*) Nothing to Disclose  
Yiyi Chen, Portland, OR (*Abstract Co-Author*) Nothing to Disclose  
Oleg Sostin, BS, Beaverton, OR (*Abstract Co-Author*) Nothing to Disclose

## PURPOSE

The management of cancer treatment related side-effects is a continuous challenge to patients and healthcare providers alike. In the therapeutic armamentarium, alternative medicine is slowly gaining popularity as a complementary or substitutive management option. Among well-known alternative medicine modalities, acupuncture has been shown in several studies to reduce or eliminate radiation therapy (RT) induced effects such as RT-induced xerostomia in head and neck cancer and RT-related fatigue. In this study, we analyzed the demographics among RT patients who chose acupuncture, which symptoms prompted referral, and prevalence of combined modalities among these patients.

## METHOD AND MATERIALS

Records of 50 cancer patients who utilized acupuncture between May 2013 and April 2014 were reviewed at our institution. The subset chosen for final analysis was limited to patients who underwent radiation therapy either alone or in combination with other standard cancer treatment modalities. Variables measured included gender, age, payment method, cancer type, treatment modalities, chemotherapy class, and type and number of symptoms prompting acupuncture referral.

## RESULTS

Among 50 pts analyzed in our initial set of acupuncture patients, 26 pts, 8 men (mean age = 64.5 yrs) and 18 women (mean age = 58.5 yrs) received radiation therapy. Twenty-two pts also received chemotherapy, and 15 pts among the chemoradiation cohort underwent surgery. Breast cancer pts (n=11) were the most prevalent users of acupuncture followed by head and neck (n=4) and lung cancer (n=3). Most patients (n=20) requested assistance with 1-2 symptoms with the most common symptoms being neuropathy (n=6), arthralgias (n=6), and nausea (n=6). Among the breast cancer cohort, the most common chief complaint were arthralgias (n=6), myalgias (n=5), and neuropathy (n=4) and the most commonly used chemotherapy were taxanes (n=9).

## CONCLUSION

Among RT patients, women were more prevalent users of acupuncture with majority diagnosed with breast cancer. The majority of patients also received either concurrent or sequential chemotherapy. Neuromusculoskeletal complaints were the most common reason for acupuncture referral.

## CLINICAL RELEVANCE/APPLICATION

These data will be used in future analyses to further characterize symptoms in order to strengthen outcomes evaluations and tailor emphasis to cancer subpopulations' specific symptoms.

## SSJ24-06 The Impact of Body Mass Index on Time from Diagnosis to Surgery and Time from Surgery to Radiation in Patients with Breast Cancer

Tuesday, Dec. 1 3:50PM - 4:00PM Location: S104A

### Participants

Apar Gupta, Boston, MA (*Presenter*) Nothing to Disclose  
Shivani Khanna, Boston, MA (*Abstract Co-Author*) Nothing to Disclose  
Ankit Agarwal, BS, Boston, MA (*Abstract Co-Author*) Nothing to Disclose  
Muhammad M. Qureshi, MBBS,MPH, Boston, MA (*Abstract Co-Author*) Nothing to Disclose  
Divya Ahuja, Boston, MA (*Abstract Co-Author*) Nothing to Disclose  
Ariel E. Hirsch, MD, Boston, MA (*Abstract Co-Author*) Nothing to Disclose

## ABSTRACT

**Purpose/Objective(s):** In breast cancer, both biological and social factors may delay the time from diagnosis to surgery and the time to initiation of radiation therapy (RT). In this study, we analyze the impact of body mass index (BMI) on time from initial diagnosis of breast cancer to surgery (TTS) and from surgery to RT (TTR) in a large cohort of breast cancer patients. **Materials/Methods:** A total of 1409 patients were diagnosed with breast cancer at our institution between 2004 and 2014. Of these, 1073 patients underwent surgery as first treatment and had BMI information available in the electronic health record. We classified patients as normal weight, overweight and obese by BMI (18.5-Results: BMI had no statistically significant impact on TTS. TTS for normal weight (N=252), overweight (N=345) and obese patients (N=476) was 35.2 days, 36.7 days and 33.7 days, respectively (p=0.555). In a subset analysis of 489 patients undergoing follow-up EBRT, BMI did have an impact on TTR. Patients with normal weight (N=104) had the lowest TTR at 64.6 days. Obese patients (N=241) reported longer TTR at 71.7 days however the finding failed to reach statistical significance (p=0.33). Patients who were classified as overweight (N=144) had a significantly higher TTR at 85.3 days (p=0.01). **Conclusion:** In this large retrospective analysis, BMI was associated with a delayed time from surgery to radiation in patients classified as overweight with a BMI between 25-<30. Interestingly, obese patients with a BMI over 30 did not have a statistically longer TTR; further analysis of the overweight patient subset may reveal the reason for their uniquely longer TTR. In breast cancer, several studies link a BMI over 25 to a higher breast cancer related mortality rate. Further research must be done to further explore the impact of BMI on the quality and timeliness of care as well as its potential impact on patient outcomes.

**Pediatric Series: Abdomen**

Tuesday, Dec. 1 3:00PM - 6:00PM Location: S102AB



AMA PRA Category 1 Credits™: 3.25  
ARRT Category A+ Credits: 3.50

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

**Participants**

Brian D. Coley, MD, Cincinnati, OH (*Moderator*) Editor with royalties, Reed Elsevier  
Oscar M. Navarro, MD, Toronto, ON, (oscar.navarro@sickkids.ca) (*Moderator*) Nothing to Disclose  
Ethan A. Smith, MD, Ann Arbor, MI (*Moderator*) Nothing to Disclose  
Jeanne S. Chow, MD, Boston, MA (*Moderator*) Nothing to Disclose

**Sub-Events****RC413-01 Sonography of Neonatal Necrotizing Enterocolitis**

Tuesday, Dec. 1 3:00PM - 3:20PM Location: S102AB

**Participants**

Oscar M. Navarro, MD, Toronto, ON, (oscar.navarro@sickkids.ca) (*Presenter*) Nothing to Disclose

**LEARNING OBJECTIVES**

1) Identify the limitations of abdominal radiographs in necrotizing enterocolitis. 2) Describe sonographic findings in necrotizing enterocolitis. 3) Define the role of sonography in necrotizing enterocolitis.

**ABSTRACT**

Necrotizing enterocolitis (NEC) is a relatively common disease affecting neonates, especially preterm infants, but can also be seen in term neonates. Despite the progress in neonatal medicine, it remains associated with significant morbidity and mortality, with reported death rates up to 20-30%. Traditionally, neonatal NEC has been imaged with abdominal radiographs, and in fact radiographic findings are part of the Bell staging clinical criteria. Radiographic assessment mainly relies in the evaluation of the bowel gas pattern and in the detection of extraluminal gas. However, most of the radiographic findings are indirect signs of bowel involvement in NEC or its complications and are not always present even in severe cases. Sonography, which can be done by the bedside and without the need of radiation, has the advantage that allows direct visualization of the bowel wall and can assess for the presence of pneumatosis, changes in wall echogenicity, wall thickening, wall thinning, peristalsis and even wall perfusion, including hyperemia and decrease or absent vascularity, all of which can be signs of NEC. Sonography also allows direct visualization of the peritoneal cavity and may detect complex free fluid and localized fluid collections, more often associated with complicated NEC. Furthermore, sonography may also detect portal venous gas and pneumoperitoneum, the latter indicative of bowel perforation. Therefore, sonography may provide information not available on radiographs and aid in the diagnosis of NEC and detection of complications. For example, sonography may allow diagnosis of bowel necrosis before perforation occurs and pneumoperitoneum becomes evident on abdominal radiographs thus facilitating early intervention. In summary, sonography has at least a complementary role to radiographs and its use may affect management of patients with neonatal NEC and possibly their outcome.

**RC413-02 Development of a Near Infra-Red (NIR) Plenoptic Imaging System for Detecting Necrotizing Enterocolitis (NEC)**

Tuesday, Dec. 1 3:20PM - 3:30PM Location: S102AB

**Participants**

Rohan Bhavane, PhD, Houston, TX (*Presenter*) Stockholder, Sensulin, LLC  
Zbigniew Starosolski, PhD, Houston, TX (*Abstract Co-Author*) Stockholder, Alzeca Biosciences, LLC  
Barbara Stoll, PhD, Houston, TX (*Abstract Co-Author*) Nothing to Disclose  
Alex Kaay, BS, Santa Barbara, CA (*Abstract Co-Author*) Nothing to Disclose  
Douglas Burrin, PhD, Houston, TX (*Abstract Co-Author*) Nothing to Disclose  
Ananth Annapragada, PhD, Houston, TX (*Abstract Co-Author*) Stockholder, Marval Pharma Ltd Stockholder, Alzeca Biosciences LLC  
Stockholder, Sensulin LLC Stockholder, Abbott Laboratories Stockholder, Johnson & Johnson

**PURPOSE**

An early detection of necrotizing enterocolitis (NEC) in premature infants is key in order to reduce morbidity and mortality. Imaging of premature infants is challenging, since transportation outside the NICU and sedation are both unadvisable. We therefore designed a near infra-red (NIR) plenoptic camera system to image premature infants, and a novel liposomal nanoparticle that localizes to NEC lesions upon intravenous injection. This study tested the visualization of NEC lesions in a preterm piglet model.

**METHOD AND MATERIALS**

The NIR plenoptic camera assembly consists of 3 high-resolution camera CCD detectors mounted on a gantry with 1 axis of rotation with repeatable increment of 0.1 degree. This creates up to 1260 virtual cameras each with a resolution higher than 10 microns (Fig 1.A). Phantoms consisting of a tissue block with capillary tubes filled with the NIR dye - indocyanine green were utilized to fine tune the system for NIR signal detection. For the animal studies, pre term piglets (N=11) were delivered via C-section 2 weeks before reaching full term. The animals were maintained on total parenteral nutrition (TPN) for 2 days after which oral feeds were started. The animals were injected with liposomes containing a NIR dye, indocyanine green, after the oral feeding was commenced. The abdominal region of the animals was imaged at different time points to detect NIR signal.

**RESULTS**

NIR signal was detected from the location of gastro-intestinal (GI) tract. Animals that developed NEC showed stronger signal than those that did not go on to develop NEC. Figure 1.C shows representative images from a NEC positive and NEC negative animal.

## CONCLUSION

The promising results from this preliminary study suggest that NIR optical imaging can aid in early detection of NEC.

## CLINICAL RELEVANCE/APPLICATION

NEC is an inflammatory disease of the gastro-intestinal tract that affects pre-term infants. Early detection is critical to reducing mortality. This study reports an NIR imaging method that could be used for early detection of NEC. This technique eliminates the use of radiation, and is conducive to imaging within the NICU, and without the need for sedation.

### RC413-03 Effectiveness of a Staged Ultrasound and Magnetic Resonance Imaging Protocol to Diagnose Pediatric Appendicitis

Tuesday, Dec. 1 3:30PM - 3:40PM Location: S102AB

#### Participants

Thaddeus W. Herliczek, MD, Providence, RI (*Abstract Co-Author*) Nothing to Disclose

David W. Swenson, MD, Brooklyn, CT (*Presenter*) Nothing to Disclose

Elizabeth H. Dibble, MD, Providence, RI (*Abstract Co-Author*) Nothing to Disclose

Claudia Cartagena, Providence, RI (*Abstract Co-Author*) Nothing to Disclose

Grayson L. Baird, MS, Providence, RI (*Abstract Co-Author*) Nothing to Disclose

## PURPOSE

The purpose of this study was to establish the effectiveness of a staged ultrasound (US) and magnetic resonance imaging (MRI) algorithm for the diagnosis of pediatric appendicitis.

## METHOD AND MATERIALS

A staged imaging algorithm using US and MRI in pediatric patients with suspected appendicitis was implemented at our institution on January 1, 2011, with US as the initial modality, followed by MRI when US findings were equivocal. A search of the radiology database revealed 2180 pediatric patients who underwent imaging for suspected appendicitis, 1,982 (90.9%) of whom were evaluated according to our established imaging algorithm. A review of the electronic medical record (EMR) of all patients was performed. All imaging reports were reviewed and classified as positive, negative or indeterminate/equivocal for appendicitis, and correlated with surgical and pathology reports.

## RESULTS

The prevalence of appendicitis in our patient population was 20.5% (407/1982). Ultrasound alone was performed in 1905 patients (96.1%), yielding sensitivity of 98.7% and specificity of 97.1% for appendicitis. An additional 77 patients underwent MRI following equivocal US, yielding an overall staged imaging algorithm sensitivity of 98.2% and specificity of 97.1%. 0.35% of patients experienced false negative results under the staged protocol. The negative predictive value of the staged protocol was 99.5%.

## CONCLUSION

A staged protocol of US and MRI for pediatric appendicitis is effective. Our study demonstrates a staged protocol of US and MRI has a sensitivity of 98.2% and specificity of 97.1% for appendicitis in pediatric patients.

## CLINICAL RELEVANCE/APPLICATION

We believe staged protocol of US and MRI could supplant other imaging protocols for pediatric appendicitis. Additionally, staged US and MRI is an effective algorithm to assess pediatric appendicitis without the use of ionizing radiation.

### RC413-04 Diagnostic Performance of Noncontrast MRI in Pediatric Appendicitis

Tuesday, Dec. 1 3:40PM - 3:50PM Location: S102AB

#### Participants

Gray R. Lyons, MD, PhD, New York, NY (*Presenter*) Nothing to Disclose

Pooja Renjen, MD, New York, NY (*Abstract Co-Author*) Nothing to Disclose

Ashley E. Giambrone, PhD, New York, NY (*Abstract Co-Author*) Nothing to Disclose

Debra Beneck, MD, New York, NY (*Abstract Co-Author*) Nothing to Disclose

Arzu Kovanlikaya, MD, New York, NY (*Abstract Co-Author*) Nothing to Disclose

## PURPOSE

MRI is increasingly employed as a diagnostic modality for suspected appendicitis in children. However, there is discrepancy as to which MRI sequences are sufficient for safe, timely, and accurate diagnosis. We hypothesized that diffusion weighted imaging (DWI) in conjunction with T2-weighted sequences are sufficient for diagnosis.

## METHOD AND MATERIALS

All MRI examinations (n=112) performed at our institution for the evaluation of appendicitis in children were retrospectively collected for re-evaluation. Exams were re-read by blinded pediatric radiologists first as non-contrast exams, including T2-weighted and DWI sequences, then secondly as contrast exams, including T1-weighted contrast enhanced sequences. Samples were scored as positive, negative, or equivocal for appendicitis, or non-visualized appendix. Findings were compared to pathologic or clinical data in the medical record.

## RESULTS

The sensitivity (with contrast: 1.0, without contrast: 1.0) and specificity (with: 1.0, without: 0.98) of the exams were not significantly different. However, the percentage of nondiagnostic scans was higher for noncontrast exams (with: 26.1%, without: 37.7%). To test the role of contrast in improving certainty of interpretation, nondiagnostic without contrast scans were re-read



with addition of contrast sequences. With addition of contrast sequences, the number of equivocal scans was reduced from 10 to 2 (80% RR, 9.1% AR) and the number of non-visualized appendix scans was reduced from 23 to 15 (35% RR, 9.1% AR).

## CONCLUSION

In the evaluation of appendicitis in children, non-contrast MRI examinations provide similar sensitivity/specificity to contrast-enhanced examinations, however, the number of nondiagnostic studies is higher without contrast. We propose a scanning algorithm whereby an exam is initialized as a noncontrast study and reviewed by a radiologist for diagnostic quality prior to contrast administration, if necessary. With this approach, fewer children will receive intravenous contrast without deterioration in overall diagnostic quality.

## CLINICAL RELEVANCE/APPLICATION

MRI diagnosis of acute appendicitis can be performed without contrast for most patients; injection of contrast can be reserved for only those patients with nondiagnostic noncontrast imaging.

### RC413-05 Shear-wave Elastography for Evaluation of Clinically Significant Portal Hypertension and Hepatic Fibrosis in Children

Tuesday, Dec. 1 3:50PM - 4:00PM Location: S102AB

#### Participants

Hee Mang Yoon, MD, Seoul, Korea, Republic Of (*Presenter*) Nothing to Disclose  
Young Ah Cho, Seoul, Korea, Republic Of (*Abstract Co-Author*) Nothing to Disclose  
Ah Young Jung, Seoul, Korea, Republic Of (*Abstract Co-Author*) Nothing to Disclose  
Jin Seong Lee, MD, Seoul, Korea, Republic Of (*Abstract Co-Author*) Nothing to Disclose  
Chong Hyun Yoon, Seoul, Korea, Republic Of (*Abstract Co-Author*) Nothing to Disclose

#### PURPOSE

To evaluate the correlation among the liver stiffness (LS) measured by shear wave elastography (SWE), clinically significant portal hypertension (CSPH), and degree of hepatic fibrosis in children with liver diseases.

#### METHOD AND MATERIALS

We evaluated 38 consecutive pediatric patients (mean age,  $9.7 \pm 4.6$  years) who underwent ultrasound SWE and transjugular liver biopsy with hepatic venous pressure gradient (HVP) measurement between June 2012 and March 2015. The patients had various liver diseases. Clinical and laboratory data were retrospectively collected. CSPH was defined as a HVP  $\geq 10$  mmHg. Hepatic fibrosis was evaluated based on METAVIR classification of fibrosis. Linear regression analysis was performed to correlate LS with clinically significant PHT. Kruskal-Wallis test was conducted to correlation between LS and degree of hepatic fibrosis. Diagnostic performance of predicting clinically significant PHT and degree of hepatic fibrosis were assessed based on receiver operating characteristic (ROC) curve.

#### RESULTS

LS showed moderate to strong positive correlation with HVP ( $r=0.603$ ,  $p<0.001$ ). On multivariate analysis, LS was a significant associated factor for diagnosis of CSPH (OR =1.275,  $p=0.009$ ). The area of under the curve (AUC) for predicting CSPH was 0.839 ( $p<0.001$ ) and the sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV) for an LS cutoff value of 19.7 kPa were 77.8%, 93.1%, 77.8%, and 93.1%, respectively. There was a significant positive correlation between hepatic fibrosis and LS ( $p=0.007$ ). The AUC for predicting advanced hepatic fibrosis (METAVIR stage, F3 or F4) was 0.845 ( $p<0.001$ ) and the sensitivity, specificity, PPV and NPV of an LS cutoff value of 16.2 kPa were 78.6%, 87.5%, 78.6% and 87.5%, respectively.

## CONCLUSION

LS exhibited significant correlation with HVP and hepatic fibrosis. Cutoff values for predicting CSPH and advanced hepatic fibrosis were 19.7 kPa and 16.2 kPa, respectively.

## CLINICAL RELEVANCE/APPLICATION

Measurement of LS using SWE can be used for noninvasive assessment and monitoring of CSPH and hepatic fibrosis in pediatric patients with various liver diseases.

### RC413-06 US Elastography of Liver and Bowel in Children

Tuesday, Dec. 1 4:00PM - 4:20PM Location: S102AB

#### Participants

Jonathan R. Dillman, MD, Ann Arbor, MI, (jonathan.dillman@cchmc.org) (*Presenter*) Research support, Bracco Group; Research support, Siemens AG

#### LEARNING OBJECTIVES

1) Compare and contrast the different US elastography techniques that can be used in children. 2) Apply US elastography to the evaluation of the pediatric abdomen.

#### ABSTRACT

Multiple forms of ultrasound (US) elastography are available on state-of-the-art clinical ultrasound systems. In general, these techniques are based on either strain or shear wave imaging, and they can easily be performed in children. The basic physics behind each type of US elastography will be explained, and specific advantages and disadvantages will be discussed. Applications of US elastography in the evaluation of the pediatric abdomen will be presented, including assessment of the liver (e.g., for detection of parenchymal fibrosis) and bowel (e.g., for detecting fibrosis within segments of intestine affected by Crohn's disease). Recently published investigations related to US elastography in pediatric populations will be highlighted.

### RC413-07 Pediatric Hepatobiliary Interventions

#### Participants

C. Matthew Hawkins, MD, Decatur, GA, (matt.hawkins@emory.edu) (*Presenter*) Nothing to Disclose

#### LEARNING OBJECTIVES

1) To understand the spectrum of pediatric hepatobiliary disorders in which invasive imaging is required (using vascular and nonvascular interventional techniques). 2) To describe important hepatobiliary disorders where IR plays a central role in patient management (hepatic vascular malformations, vascular shunts, transplant issues). 3) To emphasize collaboration and communication between clinicians, diagnostic and interventional radiology in managing pediatric hepatobiliary disease.

#### **RC413-08 Accuracy of Multi-echo Magnitude-based MRI Proton Density Fat Fraction to Estimate Longitudinal Change in Hepatic Steatosis in Children with Known or Suspected Non-alcoholic Fatty Liver Disease Using MRS as Reference**

Tuesday, Dec. 1 5:00PM - 5:10PM Location: S102AB

#### Participants

Elhamy R. Heba, MBBCh, MD, San Diego, CA (*Presenter*) Nothing to Disclose  
Kevin A. Zand, MD, San Diego, CA (*Abstract Co-Author*) Nothing to Disclose  
Omid Yeganeh, MD, La Jolla, CA (*Abstract Co-Author*) Nothing to Disclose  
Tanya Wolfson, MS, San Diego, CA (*Abstract Co-Author*) Nothing to Disclose  
Gavin Hamilton, PhD, San Diego, CA (*Abstract Co-Author*) Nothing to Disclose  
Michael S. Middleton, MD, PhD, San Diego, CA (*Abstract Co-Author*) Consultant, Allergan, Inc Institutional research contract, Bayer AG Institutional research contract, sanofi-aventis Group Institutional research contract, Isis Pharmaceuticals, Inc Institutional research contract, Johnson & Johnson Institutional research contract, Synageva BioPharma Corporation Institutional research contract, Takeda Pharmaceutical Company Limited Stockholder, General Electric Company Stockholder, Pfizer Inc Institutional research contract, Pfizer Inc  
Jeffrey B. Schwimmer, MD, San Diego, CA (*Abstract Co-Author*) Nothing to Disclose  
Claude B. Sirlin, MD, San Diego, CA (*Abstract Co-Author*) Research Grant, General Electric Company; Speakers Bureau, Bayer AG; Consultant, Bayer AG ; ;

#### PURPOSE

To assess the accuracy of magnitude-based MRI (M-MRI) proton density fat fraction (PDFF) to estimate hepatic steatosis longitudinal change for two to six echoes in children with known or suspected non-alcoholic fatty liver disease (NAFLD), using magnetic resonance spectroscopy (MRS) as reference.

#### METHOD AND MATERIALS

This IRB-approved, HIPAA-compliant, single center, retrospective, longitudinal analysis included children with at least two MR visits between 2008 and 2011. Two-dimensional, spoiled gradient-echo unenhanced M-MRI was used to estimate hepatic PDFF. Low flip angle (10°) and repetition times of 120 to 270 ms were used to minimize T1 dependence. To correct for T2\* decay, six nominally in- and out-of-phase echoes were obtained. Single-voxel MR spectra (STEAM) were analyzed by an experienced MR spectroscopist (8 cm<sup>3</sup> voxel size, right lobe of liver away from artifact and vessels, long TR to avoid T1 dependence, five echoes to permit T2 correction, AMARES algorithm and jMRUI platform for analysis). Three circular regions of interest were placed on fifth-echo MR images on three consecutive slices co-localized to MRS voxel location, and propagated to images for the other echoes. M-MRI estimated PDFF was calculated for each visit from the first two to six echoes using a custom Matlab algorithm. M-MRI PDFF accuracy was assessed by Bland-Altman analysis and linear regression modeling of change in MRS PDFF vs. change in M-MRI PDFF, for each M-MRI method (two to six echoes).

#### RESULTS

Seventy-two children (158 MR examinations) were included in this analysis (50 M, 22 F; mean body mass index 33.6 ± 6.0 kg/m<sup>2</sup>; range 46.1 to 23.2 kg/m<sup>2</sup>). Regression analysis showed close agreement between change in M-MRI PDFF and change in MRS across all methods, with slope and intercept ranges for two to six echoes of 1.02 - 1.04 and 0.008 - 0.017%, respectively (close to the slope and intercept of the identity line), and R<sup>2</sup> ranging from 0.93 to 0.95.

#### CONCLUSION

In comparison to MRS, M-MRI PDFF using two to six echoes provides an accurate estimate of hepatic steatosis change in children with known or suspected NAFLD.

#### CLINICAL RELEVANCE/APPLICATION

M-MRI PDFF may be used to evaluate hepatic steatosis changes in children since it shows strong agreement with MRS PDFF.

#### **RC413-09 Superb Microvascular Imaging for the Detection of Parenchymal Perfusion in Undescended Testes in Young Children**

Tuesday, Dec. 1 5:10PM - 5:20PM Location: S102AB

#### Participants

Mi-Jung Lee, MD, PhD, Seoul, Korea, Republic Of (*Presenter*) Nothing to Disclose  
Yong Seung Lee, Seoul, Korea, Republic Of (*Abstract Co-Author*) Nothing to Disclose  
Myung-Joon Kim, MD, Seoul, Korea, Republic Of (*Abstract Co-Author*) Nothing to Disclose  
Hyun Joo Shin, MD, Seoul, Korea, Republic Of (*Abstract Co-Author*) Nothing to Disclose

#### PURPOSE

Superb Microvascular Imaging (SMI) is a novel, highly sensitive technique that can detect low velocity microvascular flow. The purpose of this study was to evaluate differences in perfusion of undescended testes (UDT) compared with normal testes in young children using this technique.

#### METHOD AND MATERIALS



We prospectively performed testicular ultrasonography including Power Doppler Imaging (PDI) and SMI in young children. The diagnosis of UDT or normal testes was determined according to physical examination by experienced pediatric urologists. Testicular size, volume, and microvascular flow for each testis were evaluated by both PDI and SMI. Microvascular flow was categorized into four grades: grade 0, no detectable intratesticular flow; grade 1, one or two focal areas of flow; grade 2, one linear or more than two focal areas of flow; and grade 3, more than one linear flow. Statistical analysis was performed to compare the differences between undescended and normal testes.

## RESULTS

We imaged 40 testes from 20 boys (age, 2-29 months). Eleven boys had normal testes, seven had unilateral UDT, and two had bilateral UDT. The mean age was younger in boys with UDT (7.8 vs. 15.9 months,  $p < 0.001$ ). Testis sizes and volumes were similar between the 29 normal and 11 UDT. However, SMI, but not PDI, detected differences in flow grades between the groups ( $p < 0.001$ ). In univariate analysis, age (odds ratio [OR], 0.829;  $p = 0.012$ ) and low grade flow on SMI (OR of grade 0, 51.886 with  $p < 0.001$  and OR of grade 1, 14.29 with  $p = 0.017$ ) were associated with UDT. These parameters were also significant in multivariate analysis (area under the curve, 0.892).

## CONCLUSION

This study demonstrated decreased perfusion in the UDT in young children using SMI, which can be helpful for visualizing microcirculation and informing prognosis.

## CLINICAL RELEVANCE/APPLICATION

Superb Microvascular Imaging (SMI) can demonstrate microcirculation that cannot be detected using conventional Doppler imaging in young children with undescended testes.

### RC413-10 Assessment of Pediatric Hydronephrosis via Quantitative Ultrasound Imaging

Tuesday, Dec. 1 5:20PM - 5:30PM Location: S102AB

#### Participants

Juan Cerrolaza, PhD, Washington, DC (*Abstract Co-Author*) Nothing to Disclose  
Nora Lee, Washington, DC (*Abstract Co-Author*) Nothing to Disclose  
Craig A. Peters, MD, Washington, DC (*Abstract Co-Author*) Nothing to Disclose  
Marius G. Linguraru, DPhil, MS, Washington, DC (*Presenter*) Nothing to Disclose

## PURPOSE

To create new ultrasound (US) based quantitative imaging (QI) biomarkers of pediatric hydronephrosis (HN) to identify thresholds of safety for the hydronephrotic renal units where diuretic nuclear renography could be avoided.

## METHOD AND MATERIALS

The retrospective dataset (IRB approved) consists of 50 patients (mean age 9.6 months; range 0-168 months) of variable severity (grade 1 to 4 according to the Society for Fetal Urology HN scale (SFU-HS)) with concurrent renal 2DUS imaging and diuretic renography (MAG-3). Mean differential uptake was: 49% (range 14-100%). Mean washout half time (T1/2) was: 37.3 min. (range 3 to >120 min.). Manual segmentation of renal parenchyma (RP) and collecting system (CS) was performed for calibration and algorithm development. 131 morphological parameters were computed (e.g. RP and CS size, curvature). Based on these parameters, machine learning techniques (support vector machines) were used to identify critical cases based on different T1/2 thresholds that would be clinically relevant at 20, 30 and 40 min. A best-fit model was derived for each threshold using optimal morphological parameters to categorize the renal units and receiver operating characteristic curve analysis was performed. For comparison similar thresholding was performed using the SFU-HS and the HN Index (HI).

## RESULTS

For T1/2 thresholds of 20, 30 and 40 min. and at 100% sensitivity, the specificities were QI: 94, 70 and 74%, SFU-HS: 0, 39 and 33%, and HI: 52, 47, and 62%, respectively. Area under the curve values were QI: 0.98, 0.94 and 0.94, SFU-HS: 0.74, 0.78 and 0.88, and HI: 0.77, 0.78, and 0.80, respectively. The improvement obtained by the QI method was statistically significant ( $p < 0.05$  in all the cases using McNemar's statistical test).

## CONCLUSION

QI analysis of renal US allows to identify thresholds of clinically significant T1/2 with 100% sensitivity and clinically acceptable specificity. This technology can potentially and safely reduce the number of MAG-3 scans between 50 and 62%.

## CLINICAL RELEVANCE/APPLICATION

QI analysis of renal US demonstrates higher diagnostic power than SFU-HS and HI, having the potential to provide robust assessment of HN non-invasively, minimizing the use of ionizing tests and reducing clinical cost.

### RC413-11 Comparison of Contrast-enhanced Voiding Urosonography (ceVUS) in Infants and Children Using Optison to Conventional Fluoroscopic Voiding Cystourethrography (VCUG): Preliminary Results

Tuesday, Dec. 1 5:30PM - 5:40PM Location: S102AB

#### Participants

Carol E. Barnewolt, MD, Boston, MA (*Presenter*) Nothing to Disclose  
Jeanne S. Chow, MD, Boston, MA (*Abstract Co-Author*) Nothing to Disclose  
Catherine Stamoulis, PhD, Boston, MA (*Abstract Co-Author*) Nothing to Disclose  
Harriet J. Paltiel, MD, Boston, MA (*Abstract Co-Author*) Equipment support, Koninklijke Philips NV

## PURPOSE

ceVUS is a radiation-free technique currently used in some European centers for diagnosis of vesicoureteral reflux (VUR) in children, but has not been adopted in the USA. There are no reports on the use of Optison, a second-generation US contrast agent available in the USA, for diagnosis of VUR. This study compares our early experience using Optison for ceVUS to conventional VCUG.

## METHOD AND MATERIALS

We retrospectively reviewed 48 patients who underwent ceVUS with Optison immediately followed by VCUG for evaluation of fetal hydronephrosis (24), febrile UTI (16), solitary functioning kidney (5), urethral valves (2) and family history of VUR (1). 24 males and 24 females ranged in age from 2 days-10 years, median 5 months, (25th, 75th) quartiles (1.0, 11.5 months). Optison doses ranging from 0.125-1.25 cc were injected into 250 cc of saline and instilled via gravity through a urethral catheter into the bladder. Image clips of bladder, ureters and kidneys were obtained during bladder filling and voiding. Patients voided around the catheter and transperineal urethral images were obtained. A conventional VCUG was then performed. Studies were reviewed for presence of VUR. VUR grading for ceVUS was into the ureter (1), renal collecting system (2), upper tract dilation (3); for VCUG the International Grading system (I-V) was used.

## RESULTS

No adverse events related to Optison occurred. Optimal visualization of the urethra, bladder and upper tracts during ceVUS was achieved with a contrast dose of 0.15 cc. Urethral images were obtained in 40/48 patients, with urethral anatomy well shown in all 40 (21M, 19F). Both studies were negative for VUR in 77/96 kidneys (80%), both positive in 7/96 (7%). In 12/96 (13%), ceVUS was positive and VCUG was negative. VUR by ceVUS was grade 1 (0), grade 2 (8), grade 3 (11). VUR by VCUG was grade I (0), grade II-III (2), grade IV-V (5). Compared to VCUG, ceVUS had a sensitivity for detection of VUR of 100% and specificity of 86%.

## CONCLUSION

ceVUS with Optison was easily performed and well tolerated, with high sensitivity and relatively high specificity for diagnosis of VUR compared to VCUG, but without the need for ionizing radiation.

## CLINICAL RELEVANCE/APPLICATION

The high-sensitivity, safety, and ease of performance of ceVUS using the US contrast agent Optison has the potential to largely replace conventional fluoroscopic VCUG for diagnosis of VUR which requires exposure to ionizing radiation. Further study is needed.

## RC413-12 Pediatric Hypertension - The Radiologist's Role

Tuesday, Dec. 1 5:40PM - 6:00PM Location: S102AB

### Participants

Ethan A. Smith, MD, Ann Arbor, MI (*Presenter*) Nothing to Disclose

## LEARNING OBJECTIVES

1) Have a broad understanding of causes of hypertension in children. 2) Understand the basic pathophysiology behind renin mediated hypertension. 3) Be familiar with the different imaging modalities available to evaluate suspected renin-mediated hypertension and to understand the advantages and limitations of these modalities.

## ABSTRACT

Unlike adults, hypertension in children is most commonly secondary to an underlying condition. Renovascular hypertension accounts for between 5-10% of cases of pediatric hypertension and presents clinically with significantly elevated blood pressure, usually refractory to multiple medications. Renovascular hypertension is also associated with a variety of genetic syndromes, including neurofibromatosis type 1 and Williams syndrome. In patients with clinically suspected renovascular hypertension, imaging is employed to confirm the diagnosis, to characterize the renovascular abnormality and to guide surgical or endovascular therapy. Ultrasound with Doppler is the most frequently used initial imaging test, but has historically been thought to be unreliable due to suboptimal sensitivity and specificity. Computed tomography angiography (CTA) and magnetic resonance angiography (MRA) are both useful in the evaluation of suspected renovascular hypertension in adults, but may be less useful in children due to the frequency of intra-renal vascular abnormalities in children which are difficult to resolve with non-invasive imaging. Catheter based digital subtraction angiography remains the gold standard imaging test because of its superior temporal and spatial resolution, allowing for excellent visualization of both extra-renal (aorta, main renal artery) and intra-renal vascular lesions. It is important for the diagnostic radiologist to understand the differences between pediatric and adult renovascular hypertension, and to understand the strengths and weaknesses of the different imaging modalities available, in order to help guide the treatment of these patients.

MSRO33

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

Tuesday, Dec. 1 3:00PM - 4:15PM Location: S103AB



AMA PRA Category 1 Credits <sup>™</sup>: 1.25  
ARRT Category A+ Credits: 1.50

### **Participants**

Steven J. Chmura, MD, PhD, Chicago, IL (*Presenter*) Nothing to Disclose  
Nora M. Hansen, MD, Chicago, IL (*Presenter*) Speakers Bureau, F. Hoffmann-La Roche Ltd  
Karen Y. Oh, MD, Portland, OR (*Presenter*) Nothing to Disclose  
Lucy Chen, MD, Chicago, IL (*Presenter*) Nothing to Disclose

### **LEARNING OBJECTIVES**

1) Improve basic knowledge and skills relevant to radiation therapy use in breast cancer patients. 2) Apply information learned from provided breast cancer case scenarios to clinical practice. 3) Assess technological innovations and advances which can enhance clinical practice and problem-solving in the breast cancer population. 4) Apply principles of critical thinking to ideas from breast oncology experts and peers in the radiologic sciences.

**BOOST: CNS Tumor Board-Case-based Review of PET/MR Imaging and Role in the Clinical Treatment Management of Brain Tumors (An Interactive Session)**

Tuesday, Dec. 1 3:00PM - 4:15PM Location: S103CD



AMA PRA Category 1 Credits™: 1.25  
ARRT Category A+ Credits: 1.50

**Participants**

Christina I. Tsien, MD, Saint Louis, MO (*Moderator*) Speaker Bureau, Merck & Co, Inc  
Soonmee Cha, MD, San Francisco, CA (*Presenter*) Nothing to Disclose  
Michael Vogelbaum, MD, Cleveland, OH (*Presenter*) Stockholder, Infuseon Therapeutics, Inc  
Patrick Y. Wen, MD, Boston, MA (*Presenter*) Research support, Agios Pharmaceuticals, Inc; Research support, Angiochem Inc; Research support, AstraZeneca PLC; Research support, Exelixis, Inc; Research support, F. Hoffmann-La Roche Ltd; Research support, GlaxoSmithKline plc; Research support, Karyopharm Therapeutics, Inc; Research support, Novartis AG; Research support, sanofi-aventis Group; Research support, Regeneron Pharmaceuticals, Inc; Research support, Vascular Biogenics Ltd; Advisory Board, AbbVie Inc; Advisory Board, Cavion; Advisory Board, Celldex Therapeutics, Inc; Advisory Board, Merck & Co, Inc; Advisory Board, F. Hoffmann-La Roche Ltd; Advisory Board, Midatech Pharma; Advisory Board, Momenta Pharmaceuticals; Advisory Board, Novartis AG; Advisory Board, NovoCure Ltd; Advisory Board, Sigma-Tau Pharmaceuticals, Inc; Advisory Board, Vascular Biogenics Ltd; Speaker, Merck & Co, Inc

**LEARNING OBJECTIVES**

1) Present latest advances in imaging of brain tumors with special emphasis on PET/MR Imaging. 2) Review strengths, pitfalls, and limitations of the advanced imaging methods in a case-based format. 3) Discuss key imaging methods and features to differentiate recurrent tumor and treatment effect and to identify brain tumor mimics.

**Physics (MRI II-New Development)**

Tuesday, Dec. 1 3:00PM - 4:00PM Location: S404AB



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

**Participants**R. Jason Stafford, PhD, Houston, TX (*Moderator*) Nothing to DiscloseHo-Ling Liu, PhD, Houston, TX (*Moderator*) Nothing to Disclose**Sub-Events****SSJ23-01 Accelerated Real-Time Cardiac MRI Using Iterative SENSE Reconstruction: Comparing Performance in Sinus Rhythm and Atrial Fibrillation**

Tuesday, Dec. 1 3:00PM - 3:10PM Location: S404AB

**Participants**Bradley D. Allen, MD, Chicago, IL (*Presenter*) Nothing to DiscloseMaria Carr, Chicago, IL (*Abstract Co-Author*) Nothing to DiscloseVarun Chowdhary, MD, BS, Chicago, IL (*Abstract Co-Author*) Nothing to DiscloseMichael Zenge, PhD, Erlangen, Germany (*Abstract Co-Author*) Employee, Siemens AGMichaela Schmidt, Erlangen, Germany (*Abstract Co-Author*) Employee, Siemens AGMariappan S. Nadar, PhD, Princeton, NJ (*Abstract Co-Author*) Employee, Siemens AGBruce Spottiswoode, Chicago, IL (*Abstract Co-Author*) Employee, Siemens AGJeremy D. Collins, MD, Chicago, IL (*Abstract Co-Author*) Nothing to DiscloseJames C. Carr, MD, Chicago, IL (*Abstract Co-Author*) Research Grant, Astellas Group Research support, Siemens AG Speaker, Siemens AG Advisory Board, Guerbet SA**PURPOSE**

To compare accelerated real-time CMR using sparse sampling in space and time and non-linear iterative SENSE reconstruction (RT IS SENSE) with standard real-time CMR (RT) and standard segmented CMR (SEG) in a cohort of patients in persistent atrial fibrillation (AF), sinus rhythm, and healthy volunteers.

**METHOD AND MATERIALS**

A total of n=27 patients were included: 11 patients with AF (age:  $67 \pm 8$  years), 10 patients in sinus rhythm (age  $64 \pm 12$  years), and 6 healthy volunteers (age:  $38 \pm 11$  years). CMR was performed at 1.5T (MAGNETOM Aera and Avanto, Siemens, Germany). Short axis 2D bSSFP cine images covering the left ventricle with 10 mm interslice gaps were acquired with the SEG (GRAPPA accel factor 2, TR 42msec,  $1.8 \times 1.8 \times 6$  mm<sup>3</sup>), RT (GRAPPA accel factor 3, TR 62msec,  $3.0 \times 3.0 \times 9 \times 7$  mm<sup>3</sup>), and RT IS SENSE (accel factor 9.9-12, TR 42msec,  $2.0 \times 2.0 \times 7$  mm<sup>3</sup>). Quantitative left ventricular (LV) functional analysis was performed. A reviewer blinded to acquisition type scored images for overall image quality and artifact using a 5-point Likert scale. All findings were compared using a repeated measures ANOVA with Bonferonni post-hoc correction for the entire cohort and AF and sinus subgroups.

**RESULTS**

In the combined cohort, RT IS SENSE image quality was superior to RT ( $4.4 \pm 0.8$  vs.  $3.7 \pm 0.5$ ,  $p = 0.01$ ), with a trend toward superiority relative to SEG ( $3.9 \pm 1.2$ ,  $p = 0.10$ ). There was no difference in artifact between RT IS SENSE ( $4.4 \pm 0.7$ ) and RT ( $4.9 \pm 0.3$ ,  $p = 0.18$ ) or SEG ( $3.9 \pm 1.4$ ,  $p = 0.16$ ). In the sinus subgroup, RT IS SENSE image quality was higher than RT ( $4.9 \pm 0.3$  vs  $3.5 \pm 0.5$ ,  $p = 0.001$ ) and trended higher than SEG ( $4.3 \pm 1.1$ ,  $p = 0.10$ ). In the AF subgroup, RT IS SENSE image quality was superior to SEG ( $4.7 \pm 0.5$  vs.  $3.0 \pm 1.1$ ,  $p < 0.001$ ) and trended toward superiority relative to RT ( $3.9 \pm 0.3$ ,  $p = 0.09$ ). There was reduced artifact in RT IS SENSE compared to SEG ( $4.4 \pm 0.7$  vs.  $3.0 \pm 1.2$ ,  $p = 0.002$ ). For the complete cohort and in subgroups, there was no significant difference between LV ejection fraction ( $p = 0.66$ ) or cardiac volumes between any of the acquisitions.

**CONCLUSION**

Highly accelerated real-time CMR using sparse sampling with iterative SENSE reconstruction results in improved image quality and reduced artifact, especially in patients with persistent AF.

**CLINICAL RELEVANCE/APPLICATION**

Real-time CMR using sparse sampling and iterative SENSE reconstruction provides high image quality and improved temporal/spatial resolution relative to standard real-time CMR.

**SSJ23-02 Fast Field-Cycling MRI: Demonstration of New Technology for T1-Dispersion Contrast**

Tuesday, Dec. 1 3:10PM - 3:20PM Location: S404AB

**Participants**David Lurie, Aberdeen, United Kingdom (*Presenter*) Nothing to DiscloseLionel M. Broche, PhD, Aberdeen, United Kingdom (*Abstract Co-Author*) Nothing to DiscloseGareth R. Davies, MSc, DPhil, Aberdeen, United Kingdom (*Abstract Co-Author*) Nothing to DiscloseNicholas R. Payne, BSc, Aberdeen, United Kingdom (*Abstract Co-Author*) Nothing to DisclosePeter J. Ross, BSc, MSc, Aberdeen, United Kingdom (*Abstract Co-Author*) Nothing to DiscloseVasileios Zampetoulas, BSc, MSc, Aberdeen, United Kingdom (*Abstract Co-Author*) Nothing to Disclose**PURPOSE**

We have designed and constructed two prototype human-scale scanners which use Fast Field-Cycling (FFC) to measure the

variation of tissues' spin-lattice relaxation time (T1) as a function of magnetic field strength ("T1-dispersion"), in the range 0.001 T to 0.1 T. T1-dispersion is shown to be sensitive to disease state.

## METHOD AND MATERIALS

In an FFC-MRI scanner the magnetic field B0 is switched between three levels during the scan. Initially B0 is set at a high level in order to polarize the spins. It is then switched to a low value for a time of the order of T1, so that the spins evolve. B0 is then switched back to a high value, gradients are applied and NMR signals detected. By repeating the pulse sequence at different "evolution" B0 values, T1-dispersion can be measured and employed as a contrast generator. Detection always occurs at the same field, so no retuning of radiofrequency coils is needed. The FFC-MRI scanner used was designed and constructed in-house, using commercially-available and home-built modules. The whole-body magnet uses a double coaxial design, in which the polarization and detection B0 fields are generated by a Halbach-ring permanent magnet (59 mT). This field is opposed by an inner "offset" resistive magnet in order to generate the lower, evolution B0 values. The evolution field is controlled by changing the current in the offset coil; switching between field levels can be done in ca. 30 ms. Measurements were made on healthy volunteers and on surgically-excised tissues from patients undergoing joint-replacement surgery (normal and osteoarthritic (OA) joints) and resection of breast and musculoskeletal tumours. Full ethical approval was granted, and patient consent was obtained.

## RESULTS

Measurements on healthy volunteers show that good quality FFC-MRI images can be obtained. The figure shows inversion-recovery calculated-T1 FFC-MRI images of a volunteer's brain, at 49 mT and 59 mT evolution B0 values; total acquisition time was 28 min. T1-dispersion plots (T1 versus evolution B0) showed significant differences between normal and diseased tissues, in both OA and in cancer.

## CONCLUSION

This work shows that FFC-MRI is a new imaging modality which can, for the first time, use T1-dispersion as an endogenous MR contrast mechanism which is invisible in conventional MR. Early results show sensitivity of T1-dispersion to disease state.

## CLINICAL RELEVANCE/APPLICATION

Study shows relevance to osteoarthritis and cancer.

### SSJ23-03 A Piecewise Model for Diffusion-weighted Imaging of Prostate at 1.5T

Tuesday, Dec. 1 3:20PM - 3:30PM Location: S404AB

#### Participants

Debo Zhi, BS, Hefei, China (*Presenter*) Nothing to Disclose  
Nan He, Hefei, China (*Abstract Co-Author*) Nothing to Disclose  
Fenfen Li, BS, Hefei, China (*Abstract Co-Author*) Nothing to Disclose  
Bensheng Qiu, PhD, Hefei, China (*Abstract Co-Author*) Nothing to Disclose

## PURPOSE

The aim of this study was to investigate four diffusion-weighted imaging (DWI) models, including monoexponential diffusion model, biexponential diffusion model, statistical diffusion (SDM) model and diffusion kurtosis imaging (DKI) model, and to design a new piecewise model to precisely fit DWI signals of healthy prostate at 1.5 Tesla.

## METHOD AND MATERIALS

DWI of prostate with multiple b-values ranging from 0 to 3000 s/mm<sup>2</sup> at 1.5 T was performed on 11 healthy young men. DWI signals were fitted into four diffusion models in the full range and three segments of b-values respectively. The fitness degrees of the four diffusion models in the full range and the three segments of b-values were calculated for comparison, and then a new piecewise model for prostate DWI with different b-values was proposed.

## RESULTS

In the full range of b-values, the calculated fitness results showed that the diffusion kurtosis and statistical diffusion model were better fitting than the monoexponential diffusion model. The biexponential diffusion model was as good as the diffusion kurtosis and statistical models and was better fitting than the monoexponential diffusion model. In the three b-value segments, the results showed that the biexponential diffusion model was better than the kurtosis and statistical models with b-values smaller than 500 s/mm<sup>2</sup> and larger than 1000 s/mm<sup>2</sup>, and the kurtosis and statistical model were better than the biexponential diffusion model with b-value ranging from 500 to 1000 s/mm<sup>2</sup>.

## CONCLUSION

The four mathematical models revealed different diffusion behaviors on the three b-value segments, and can be combined into a piecewise diffusion model that can fit DWI signals of prostate more precisely. This new model could potentially reveal more biological characteristic that would be helpful for the diagnosis of prostate diseases.

## CLINICAL RELEVANCE/APPLICATION

A piecewise model was proposed to precisely fit DWI decay signals, and could be applied to the data analysis, attributing to improvement of sensitivity and accuracy of diagnosis of prostate cancer.

### SSJ23-04 Reduction in Metal Susceptibility Artifact from Hip Prostheses Using QISS with Fast Low Angle Shot Readout

Tuesday, Dec. 1 3:30PM - 3:40PM Location: S404AB

#### Participants

Ian Murphy, MBChB, MRCS, Chicago, IL (*Abstract Co-Author*) Nothing to Disclose  
Ioannis Koktzoglou, PhD, Evanston, IL (*Abstract Co-Author*) Research support, Siemens AG  
Shivraman Giri, PhD, Chicago, IL (*Abstract Co-Author*) Employee, Siemens AG  
Robert R. Edelman, MD, Evanston, IL (*Abstract Co-Author*) Research support, Siemens AG Royalties, Siemens AG

Marcos P. Botelho, MD, Chicago, IL (*Presenter*) Nothing to Disclose

## PURPOSE

Quiescent-interval single-shot (QISS) magnetic resonance angiography (MRA) has been shown to be an accurate non-contrast technique for the evaluation of peripheral arterial disease (PAD). QISS MRA applies RF pulses to suppress background and venous signal and then relies on the quiescent interval to allow refreshment of arterial spins. The standard QISS technique uses a bSSFP readout. Unfortunately, the bSSFP readout is highly sensitive to off-resonance effects, which is problematic when QISS is used to evaluate elderly patients with PAD who also have prostheses, such as the one for hip or knee. In these patients, QISS MRA may be severely degraded in the vicinity of the prosthesis. We hypothesized that QISS MRA using a fast low angle shot (FLASH) readout would reduce these artifacts and thereby improve the depiction of the arteries located near the prosthesis.

## METHOD AND MATERIALS

The study was approved by the IRB and used written, informed consent. Imaging was performed on 1.5 Tesla system (MAGNETOM Avanto, Siemens AG, Erlangen, Germany). A standard body phantom with a femoral component hip prosthesis placed above the phantom was imaged to test the potential of QISS FLASH for reducing magnetic susceptibility artifact. No fat suppression was applied. Imaging was then carried out on patients with and without arterial disease.

## RESULTS

A marked reduction was observed in the extent of the distortion caused by the metallic artifact using QISS with FLASH readout compared with bSSFP readout in 6 patients scanned at 1.5T (Figure 1). In two cases it allowed visualization of a vessel which was otherwise uninterpretable.

## CONCLUSION

QISS using a high bandwidth FLASH readout reduces magnetic susceptibility artifact and improves image quality near metallic prostheses as compared with QISS using a bSSFP readout. Although the use of a high-bandwidth readout requires multiple signal averages to boost the signal-to-noise ratio, overall study time is only modestly increased since the FLASH readout is just needed for a limited region near the prosthesis.

## CLINICAL RELEVANCE/APPLICATION

This new technique may allow non-contrast MRA evaluation of vessels and stenoses that would otherwise be obscured by artifact from hip prostheses and other metallic implants

## SSJ23-05 Comparison of Different Mathematical Models of Diffusion-weighted Imaging of Normal Prostate at 1.5 T and 3.0 T

Tuesday, Dec. 1 3:40PM - 3:50PM Location: S404AB

### Participants

Debo Zhi, BS, Hefei, China (*Presenter*) Nothing to Disclose

Yuping Chen, Hefei, China (*Abstract Co-Author*) Nothing to Disclose

Bensheng Qiu, PhD, Hefei, China (*Abstract Co-Author*) Nothing to Disclose

## PURPOSE

To find out which diffusion-weighted imaging (DWI) model, including the monoexponential model, the biexponential model, the statistical diffusion model, the diffusion kurtosis model and the stretched-exponential model, can fit diffusion-weighted signals of healthy prostate precisely at 1.5T and 3.0T.

## METHOD AND MATERIALS

Eighteen health subjects (ten subjects at 1.5T, eight subjects at 3.0T) were included in this study. DWI of prostate was performed with multiple b-values ranging from 0 to 2100s/mm<sup>2</sup>. Region of interests (ROIs) were drawn on the transition zone of prostate guided by T2-weighted images. Five DWI models were fitted to diffusion-weighted decay signals using a nonlinear squares fitting algorithm of Levenberg-Marquardt. The degree of fitness and parameters of the five DWI models were calculated for comparison.

## RESULTS

The fitting curves for prostate DWI signals of the five models showed that the diffusion-weighted signals at 3.0T decreased faster than that at 1.5T. The adjusted R-squares showed that compared with the monoexponential model, R-squares of the other four models were larger and the R-square of the biexponential model was the largest at both 1.5T and 3.0T. Parameters of the five models showed that the parameters at 3.0T were bigger than those at 1.5T, except the parameters of statistical diffusion model and diffusion kurtosis model.

## CONCLUSION

Our study demonstrated the biexponential model, the statistical diffusion model, the diffusion kurtosis model and the stretched-exponential model fitted better than the monoexponential model and the biexponential model showed best fitness for the diffusion-weighted signals of healthy prostate at extended b-values at both 1.5T and 3.0T. The parameters of the other four models except for the monoexponential model maybe reveal more biological characteristic.

## CLINICAL RELEVANCE/APPLICATION

Through the comparison of the five DWI models at 1.5T and 3.0T, we can find out which model fit the diffusion-weighted signals better and provide more parameters for diagnosis of prostate diseases.

## SSJ23-06 Increasing SNR in MRI with Multi-Tesla Pre-polarization Pulses

Tuesday, Dec. 1 3:50PM - 4:00PM Location: S404AB

### Participants

Aleksandar Nacev, PhD, Bethesda, MD (*Presenter*) Nothing to Disclose

Ryan Hilaman, Bethesda, MD (*Abstract Co-Author*) Nothing to Disclose



Irving N. Weinberg, MD, PhD, Bethesda, MD (*Abstract Co-Author*) Nothing to Disclose  
Pavel Y. Stepanov, MS, Bethesda, MD (*Abstract Co-Author*) Nothing to Disclose  
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Stanley Fricke, Bethesda, MD (*Abstract Co-Author*) Nothing to Disclose  
Lamar O. Mair, PhD, Bethesda, MD (*Abstract Co-Author*) Nothing to Disclose  
Juan P. Rigla, Valencia, Spain (*Abstract Co-Author*) Nothing to Disclose

## **PURPOSE**

Improving signal-to-noise ratio (SNR) for MRI systems has traditionally been accomplished by increasing the static magnetic field, which increases the magnitude of the magnetization vector. Safety and manufacturing considerations limit the possibilities of constructing clinical MRI systems with very high static fields. An alternative approach to increasing SNR would be to apply a polarizing magnetic pulse prior to the application of a short imaging pulse sequence. Altering magnetic polarization prior to the application of an MR imaging pulse sequence with a pulsed electromagnet has long been used in earth-field (e.g., F Melton and VL Pollak, Rev Sci Instrum 1971) and field-cycling experiments (DJ Lurie et al, Mag Res. Imag. 2005). In those prior studies, the applied polarization field has either been low (e.g., been on the order of 50mT for earth field MRI) or has subtracted field strength from the main static field (in the case of field-cycling). In either prior case, the pre-polarization pulse would not lead to significant increases in SNR when added to a clinical MRI system. Alternatively, pulsed-power techniques with desktop-sized modules have attained high magnetic field magnitudes (e.g., 26T, see GS Nusinovich et al, J Infrared Milli Terahz Waves 2011), and therefore might be well suited for the development of compact clinical MRI high-performance systems that employed rapid magnetic pre-polarization.

## **METHOD AND MATERIALS**

A cooled copper coil (energized by three car batteries) was switched with insulated-gate bipolar transistor crowbar circuitry (Eagle Harbor Technologies, Seattle WA) in order to yield 1,000 amps for several seconds, attaining transient fields of up to 4 T with adiabatic decay, followed by a spin-echo pulse sequence generated with a Radioprocessor-G system (SpinCore, Gainesville FL) in an 0.34-T static magnetic field.

## **RESULTS**

SNR increased in expected concordance with the Bloch equation ( $r=0.95$ ) with strength and duration of the pre-polarizing pulses.

## **CONCLUSION**

Pre-polarized pulsed power techniques applied to low-static-field systems could yield SNR values comparable to high-field MRI devices, with low cost and physical foot-print.

## **CLINICAL RELEVANCE/APPLICATION**

Cost-effective compact high-performance organ-specific MR systems (e.g., prostate, breast, brain) could be implemented with the addition of multi-Tesla pre-polarizing pulsed-power modules.

SSJ05

## Chest (Lung Malignancy/COPD)

Tuesday, Dec. 1 3:00PM - 4:00PM Location: S404CD



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

### Participants

Jin Mo Goo, MD, PhD, Seoul, Korea, Republic Of (*Moderator*) Research Grant, Guerbet SA;  
Mark S. Parker, MD, Mechanicsville, VA (*Moderator*) Nothing to Disclose

### Sub-Events

#### SSJ05-01 Quantitative CT Imaging Features Improve Prediction of EGFR Mutation Status in Lung Adenocarcinomas

Tuesday, Dec. 1 3:00PM - 3:10PM Location: S404CD

### Participants

Ying Liu, Tianjin, China (*Presenter*) Nothing to Disclose  
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Robert J. Gillies, PhD, Tampa, FL (*Abstract Co-Author*) Nothing to Disclose

### PURPOSE

To retrospectively identify the relationship between epidermal growth factor receptor (EGFR) mutation status, predominant histologic subtype, and computed tomographic (CT) characteristics in surgically resected lung adenocarcinomas in an Asian cohort patients.

### METHOD AND MATERIALS

This study was approved by the institutional review board, with waiver of informed consent. Findings of preoperative chest CT were retrospectively evaluated in 385 surgically resected lung adenocarcinomas. 30 CT descriptors that characterized tumor location, size, shape, margin, density, enhancement, internal, external, and associated findings were assessed. EGFR mutations at exons 18 - 21 were determined by using a polymerase chain reaction (PCR)-based assay. Univariable and multivariable analyses were performed for this study. The area under ROC curve (AUC) was computed using the leave-one-out cross-validation method.

### RESULTS

EGFR mutations were found in 168/385 patients (43.6%). Mutations were found more frequently among female, never smokers, and with lepidic predominant adenocarcinomas, intermediate pathologic grade, among tumors of smaller size, with spiculation, GGO or mixed GGO, air bronchogram, cavitation, vascular convergence, thickened adjacent bronchovascular bundles, and pleural retraction, and also among tumors without pleural attachment, well-defined margin, marked heterogeneous enhancement, severe peripheral emphysema, severe peripheral fibrosis, or lymphadenopathy ( $P < 0.05$ ). The most important and significantly independent predictors of harboring EGFR activating mutation for the model with both clinical variables and CT features were never smokers, tumors of smaller size, with cavitation, homogeneous enhancement, and pleural retraction when adjusting for gender, pathologic grade, and thickened adjacent bronchovascular bundles. ROC curve analysis showed that clinical predictors combined with CT features (AUC = 0.76) were superior to clinical predictors alone (AUC = 0.61).

### CONCLUSION

Quantitative CT imaging features of lung adenocarcinomas in combination with clinical predictors can predict EGFR mutation status better than clinical predictors alone.

### CLINICAL RELEVANCE/APPLICATION

Selecting patients with high potential for EGFR mutations by combining imaging-based predictors with known clinical variable may result in a population with a greater sensitivity to EGFR-TKI treatment.

#### SSJ05-02 18F-FDG Uptake as a Prognostic Factor for Tumor Recurrence in Patients with Pathologic Stage I Lung Adenocarcinomas

Tuesday, Dec. 1 3:10PM - 3:20PM Location: S404CD

### Participants

Ying Liu, MD, Beijing, China (*Presenter*) Nothing to Disclose  
Ning Wu, MD, Beijing, China (*Abstract Co-Author*) Nothing to Disclose

### PURPOSE

To analyze the 18F-FDG uptake features and the correlation between 18F-FDG uptake and tumor recurrence in patients with pathologic stage I lung adenocarcinomas.

### METHOD AND MATERIALS

One hundred and seventeen patients with stage I lung adenocarcinomas proved by surgery were studied retrospectively. Eighty-

four patients had a subsequent follow-up. The tumors' SUVmax in different groups of size, density, tumor differentiation degree and T staging were analyzed by Kruskal-Wallis test. The correlations between the SUVmax and clinicopathologic factors were analyzed using Spearman rank correlation. The disease-free survival (DFS) periods in different clinicopathologic groups were estimated using the Kaplan-Meier method and Log-rank test.

## RESULTS

The SUVmax of pathologic stage 1 lung adenocarcinomas were significantly different in different groups of size, density, tumor differentiation degree and T staging, respectively ( $P < 0.01$ ). The SUVmax was positively correlated with the size of the adenocarcinomas ( $P < 0.01$ ), and were both negatively correlated with the density and tumor differentiation degree ( $P < 0.01$ ). But there was no correlation with the tumors' T staging ( $P > 0.05$ ). The patients with an SUVmax of  $< 2.5$  had a much better DFS period than those with an SUVmax of  $\geq 2.5$  ( $P < 0.05$ ). The DFS periods showed no statistical differences in other clinicopathologic groups ( $P > 0.05$ ). But tumor with a poorly differentiated degree was associated with reduced DFS period compared with those with well differentiated degree ( $P < 0.05$ ).

## CONCLUSION

18F-FDG uptake is correlated with the tumor differentiation degree, and has a prognostic value for predicting the tumor recurrence in the patients with pathologic stage 1 lung cancer. The patients with an SUVmax of  $< 2.5$  have a much better DFS periods than those with an SUVmax of  $\geq 2.5$ .

## CLINICAL RELEVANCE/APPLICATION

The level of metabolic activity observed with 18F-FDG uptake correlates with the probability of tumor recurrence in the patients with pathologic stage 1 lung cancer.

### SSJ05-03 Evaluation of Texture Analysis Parameters in EGFR or ALK-Positive Advanced Non-Small Cell Lung Cancer (NSCLC)

Tuesday, Dec. 1 3:20PM - 3:30PM Location: S404CD

#### Participants

Caroline Caramella, MD, Villejuif, France (*Presenter*) Nothing to Disclose  
Maria Virginia Bluthgen, Villejuif, France (*Abstract Co-Author*) Nothing to Disclose  
Silvia Rosselini, Villejuif, France (*Abstract Co-Author*) Nothing to Disclose  
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Charlotte Leduc, MD, Villejuif, France (*Abstract Co-Author*) Nothing to Disclose  
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Eva Haspinger, Villejuif, France (*Abstract Co-Author*) Nothing to Disclose  
Charles Ferte, Villejuif, France (*Abstract Co-Author*) Nothing to Disclose  
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Clarisse Dromain, MD, Villejuif, France (*Abstract Co-Author*) Nothing to Disclose  
Jean-Charles Soria, Villejuif, France (*Abstract Co-Author*) Nothing to Disclose  
Benjamin Besse, Villejuif, France (*Abstract Co-Author*) Nothing to Disclose

## PURPOSE

The quantitative assessment of heterogeneity in tumor images through Texture Analysis is an emerging tool that can potentially provide a non-invasive prognostic biomarker. We investigated if Texture Analysis parameters derived from contrast-enhanced CT (CTTA) were associated with EGFR/ALK status and have a prognostic value in NSCLC patients treated with tyrosine-kinase inhibitors.

## METHOD AND MATERIALS

The CT images of advanced NSCLC patients with EGFR mutation or ALK translocation treated with tyrosine-kinase inhibitors were retrospectively reviewed. CTTA using the filtration-histogram method was applied to the region of interest (ROI) in the primary tumor of the enhanced-CT by two independent operators to examine the inter-individual reproducibility. A wilcoxon test was used to correlate CTTA and EGFR / ALK status and a Cox model to evaluate the prognostic value of CTTA for overall survival. A p-value cutoff of 0.01 was used to adjust for multiple testing.

## RESULTS

CTTA parameters were evaluated in CT scan from 68 patients recruited in 2 centers between 2008 and 2013, of them, 80.9% (n=55) were EGFR mutated and 19.1 % (n=13) ALK+ NSCLC. The CTTA measures were highly reproducible between the 2 operators as indicated by Bland-Altman plots and correlation values. The skewness of the distribution was significantly different between EGFR mutated and ALK+ tumors for coarse texture with spatial filter value 3.3 ( $p = 0.002$ ), filter value 2.8 ( $p = 0.001$ ) and medium texture with spatial filter value 2.2 ( $p = 0.004$ ). The median follow-up time was 35 months; 39 deaths occurred. The A unit increase in skewness in coarse texture (2.8 spatial filter) was significantly associated with better survival with an univariate cox analysis (HR: 0.36 [0.2-0.69]  $p = 0.002$ ). A multivariate analysis adjusted by prognostic factors (PS, lymphocyte count, hepatic and adrenal metastasis) indicate a similar trend for better survival (HR: 0.40 [0.2-0.8]  $p = 0.01$ ).

## CONCLUSION

CTTA parameters were reproducible between the 2 operators. The skewness was significantly different between EGFR mutated and ALK rearranged advanced NSCLC and may have a prognostic value.

## CLINICAL RELEVANCE/APPLICATION

Texture analysis of CT images is a simple tool that has proven inter-individual reproducibility and that might have a potential to provide prognostic and molecular indicators to help clinicians in their treatment strategy

## **SSJ05-04 Dynamic CE-Perfusion Area-Detector CT vs. FDG-PET/CT: Capability for N-Stage Assessment in Non-Small Cell Lung Cancer Patients**

Tuesday, Dec. 1 3:30PM - 3:40PM Location: S404CD

### **Participants**

Yoshiharu Ohno, MD, PhD, Kobe, Japan (*Presenter*) Research Grant, Toshiba Corporation; Research Grant, Koninklijke Philips NV; Research Grant, Bayer AG; Research Grant, DAIICHI SANKYO Group; Research Grant, Eisai Co, Ltd; Research Grant, Terumo Corporation; Research Grant, Fuji Yakuhin Co, Ltd; Research Grant, FUJIFILM Holdings Corporation; Research Grant, Guerbet SA; Shinichiro Seki, Kobe, Japan (*Abstract Co-Author*) Nothing to Disclose  
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### **PURPOSE**

To prospectively and directly compare the capability for N-stage assessment between dynamic contrast-enhanced (CE-) perfusion area-detector CT (ADCT) and FDG-PET/CT in non-small cell lung cancer (NSCLC) patients.

### **METHOD AND MATERIALS**

44 consecutive pathologically diagnosed NSCLC patients (26 males, 18 females; mean age 67 years) who were candidates for surgical treatment underwent dynamic CE-perfusion ADCT that were performed at two or three different positions as single examination, PET/CT, surgical treatment and pathological examination. From all perfusion ADCT data in each subject, whole chest perfusion map was computationally generated based on dual- and single-input maximum slope and Patlak plot methods by means of previously reported software. For quantitative diagnosis of metastatic lymph node and N-stage, perfusion parameters and SUVmax at each lymph node were evaluated by ROI measurement. Then, Student's t-test was performed to determine the difference between metastatic and non-metastatic lymph nodes. To determine the diagnostic capability and feasible threshold value on a per node basis analysis, ROC analyses were performed among all indexes as having significant difference between two groups. Finally, sensitivity, specificity and accuracy for diagnosis of metastatic lymph node and N-stage were compared by means of McNemar's test.

### **RESULTS**

Systemic arterial perfusion from dual-input maximum slope method and SUVmax had significant difference between metastatic and non-metastatic lymph nodes ( $p<0.05$ ). Although there was no significant difference of area under the curve between systemic arterial perfusion and SUVmax on a per node basis analysis ( $p>0.05$ ), specificity (SP: 92.1%) and accuracy (AC: 92.8%) of former were significantly higher than those of latter (SP: 88.3%,  $p=0.004$ ; AC: 88.3%,  $p=0.005$ ). In addition, when assessed N-stage in all patients, accuracy of systemic arterial perfusion (75%) was also significantly higher than that of SUVmax (55.8%,  $p=0.008$ ).

### **CONCLUSION**

Dynamic CE-perfusion ADCT has better potential for N-stage assessment than PET/CT in NSCLC patients.

### **CLINICAL RELEVANCE/APPLICATION**

Dynamic CE-perfusion ADCT has better potential for N-stage assessment than PET/CT in NSCLC patients.

## **SSJ05-05 CT-based Quantification of 3rd Generation Bronchial Luminal Collapsibility in Patients with Chronic Obstructive Lung Disease (COLD) and Correlations with Corresponding Lung Volume Changes**

Tuesday, Dec. 1 3:40PM - 3:50PM Location: S404CD

### **Participants**

Christopher Kloth, Tuebingen, Germany (*Abstract Co-Author*) Nothing to Disclose  
Wolfgang M. Thaiss, MD, Tuebingen, Germany (*Presenter*) Nothing to Disclose  
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Juergen Hetzel, Tuebingen, Germany (*Abstract Co-Author*) Nothing to Disclose  
Konstantin Nikolaou, MD, Tuebingen, Germany (*Abstract Co-Author*) Speakers Bureau, Siemens AG Speakers Bureau, Bracco Group  
Speakers Bureau, Bayer AG  
Marius Horger, MD, Tuebingen, Germany (*Abstract Co-Author*) Nothing to Disclose

### **PURPOSE**

To assess the degree of bronchial lumen collapsibility in 3rd generation bronchi in COPD grade IV (GOLD) patients by using quantitative chest-CT (virtual bronchoscopy) in correlation with corresponding changes of lung volumes between end-inspiration and end-expiration.

### **METHOD AND MATERIALS**

29 patients (male=14; median age=63.36y; range 48-76y) with grade IV COPD underwent chest-CT at our institution from January 2010 to November 2014. Two thin-slice (0.6mm) non-enhanced image data sets were acquired both at end-inspiration and end-expiration using helical technique (120 kV, 100-150 mAs). The software automatically identified the bronchial tree for quantitative bronchial lumen assessment (crosssectional area) both at end-inspiration and end-expiration. Each bronchial lumen was measured at 0.5 cm after the offspring of a 3rd generation bronchus. Subsequently, the edges of the bronchial lumen were corrected hand drawn with using a hand free polygonal ROI. Lung lobes were semi-automatically segmented and the volumes of segmented lobes and the percentage of their volumes below the threshold -950 HU (LAV - 950HU) were calculated. We evaluated the impact of lobar compressibility (Vexp. vs. Vinsp. or residual volume) on bronchial collapsibility

## RESULTS

Mean total lung volume decreased by 17.8% in expiration ( $6877 \pm 1641$  mL in inspiration and  $5495 \pm 1160$  mL in expiration). Mean expiratory bronchial collapse was 15%. The degree of bronchial lumen collapsibility correlated well with the magnitude of volume reduction of the corresponding lobes (Spearman's  $r = 0.7$ ,  $p = 0.001$ ). Importantly, this correlation holds also true for the individual lobes. Considering also the emphysema phenotype, collapsibility and volume reduction were stronger for homogenous compared to heterogeneous emphysematous lobes (diameter reduction 13.1% vs 25.1%; volume reduction 14.2% vs 19.4%, respectively).

## CONCLUSION

With about 15%, collapsibility of 3rd generation bronchi in COPD patients was significantly lower than that in the trachea and the main bronchi compared to earlier published data. Bronchial wall consistency (cartilage rings vs. cartilage + membranous wall) seem to be the reason for these differences. The collapsibility correlated well with the reduction in lung volume.

## CLINICAL RELEVANCE/APPLICATION

The degree and the sites of increased bronchial lumen collapsibility have severe clinical consequences for understanding and planning novel endobronchial therapies.

### SSJ05-06 Sensitivity of Airway Wall Thickness Measurements: Influence of Small Airways

Tuesday, Dec. 1 3:50PM - 4:00PM Location: S404CD

#### Participants

Jean-Paul Charbonnier, Nijmegen, Netherlands (*Presenter*) Nothing to Disclose

Laurens Hogeweg, MSC, Nijmegen, Netherlands (*Abstract Co-Author*) Nothing to Disclose

Jan-Martin Kuhnigk, PhD, MS, Bremen, Germany (*Abstract Co-Author*) Stockholder, MeVis Medical Solutions AG

David A. Lynch, MBBCh, Denver, CO (*Abstract Co-Author*) Research support, Siemens AG; Scientific Advisor, PAREXEL International Corporation; Consultant, Boehringer Ingelheim GmbH; Consultant, Gilead Sciences, Inc; Consultant, F. Hoffmann-La Roche Ltd; Consultant, Veracyte, Inc;

Eva M. Van Rikxoort, PhD, Nijmegen, Netherlands (*Abstract Co-Author*) Stock holder, Thirona BV Co-founder, Thirona BV

## PURPOSE

Changes in the morphology of the airways contributes to lung function impairment in chronic obstructive pulmonary disease (COPD). Measurements of airway morphology might be influenced by the quality of the airway segmentation. In this study we investigate the stability of a commonly used airway measurement (Pi10) from CT scans for varying segmentation depths of the airways.

## METHOD AND MATERIALS

Inspiratory low-dose thoracic CT scans of 267 subjects, well distributed over GOLD stages, were selected for this study. Airways were automatically extracted by a state-of-the-art segmentation method and manually corrected to ensure a leakage free segmentation. Airway wall thickness quantification was performed in orthogonal cross-sections every 1mm throughout the entire airway tree using an intensity-integration technique which accounts for partial volume effects. Using regression on all cross-sectional measurements, airway morphology was expressed as the square root of wall area at airways with a perimeter of 10mm (Pi10). To determine the sensitivity of the Pi10 measurement to the length of the segmented airway tree, sensitivity analysis was performed on Pi10 by leaving-out wall measurements of the smallest airways and recalculating the Pi10. For each subject, Pi10 regression analysis was repeated excluding airways with a lumen perimeter below 6mm, 8mm or 10mm. The recalculated Pi10 measurements were compared to the baseline Pi10.

## RESULTS

The segmented airway trees consisted for 55% of airways with lumen diameters below 10mm, 19% below 8mm, and 1% below 6mm. The average baseline Pi10 of all subjects was  $2.43 \pm 0.56$  (range [1.40, 4.36]), which corresponds to an average airway wall thickness (for an airway with a lumen perimeter of 10mm) of  $0.52\text{mm} \pm 0.21\text{mm}$ . By excluding airways with a lumen perimeter below 6, 8 or 10mm from the regression analysis, absolute changes in Pi10 were  $0.003 \pm 0.004$  (0.11%),  $0.035 \pm 0.023$  (1.46%), and  $0.107 \pm 0.087$  (4.6%), respectively, corresponding to changes in airway wall thickness (at 10mm lumen perimeter) of 0.001, 0.013, and 0.039mm.

## CONCLUSION

The commonly used Pi10 measurement to express airway morphology from a CT scan is insensitive to the exclusion of smaller airways in the computation.

## CLINICAL RELEVANCE/APPLICATION

When expressing airway morphology as Pi10, there is no need to (manually) adjust automatic airway segmentation methods to include smaller airways in order to obtain an accurate Pi10 measurement.

**Informatics (Enterprise Integration and Business Analytics)**

Tuesday, Dec. 1 3:00PM - 4:00PM Location: S402AB



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

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

**Participants**

William W. Boonn, MD, Penn Valley, PA (*Moderator*) Founder, Montage Healthcare Solutions, Inc; President, Montage Healthcare Solutions, Inc; Shareholder, Montage Healthcare Solutions, Inc; Shareholder, Nuance Communications, Inc; Shareholder, Merge Healthcare Incorporated  
Bhavva Rehani, MD, San Francisco, CA (*Moderator*) Nothing to Disclose  
Gary J. Wendt, MD, MBA, Middleton, WI (*Moderator*) Medical Advisory Board, McKesson Corporation; Medical Advisory Board, HealthMyne; Owner, WITS(MD), LLC; ;

**Sub-Events****SSJ13-01 The Clinical Decision Support Mandate: A Pilot Project Using Epic's Best Practice Alerts for PE-CTA Study Orders to Prepare the Hospital Staff**

Tuesday, Dec. 1 3:00PM - 3:10PM Location: S402AB

**Participants**

Alexander Goehler, MD, PhD, New Haven, CT (*Presenter*) Nothing to Disclose  
Jeffrey C. Weinreb, MD, New Haven, CT (*Abstract Co-Author*) Nothing to Disclose  
Howard P. Forman, MD, New Haven, CT (*Abstract Co-Author*) Nothing to Disclose  
Christopher Moore, MD, New Haven, CT (*Abstract Co-Author*) Nothing to Disclose  
Allen Hsiao, New Haven, CT (*Abstract Co-Author*) Nothing to Disclose  
Dan Wismer, Verona, WI (*Abstract Co-Author*) Employee, Epic Systems Corporation  
Jennifer Arango, New Haven, CT (*Abstract Co-Author*) Nothing to Disclose  
Linda D'Amato, Shelton, CT (*Abstract Co-Author*) Nothing to Disclose

**Background**

The Protecting Access to Medicare Act (2014) mandates that starting in Jan 2017, physicians ordering advanced diagnostic imaging exams must consult appropriate-use criteria through a Clinical Decision Support (CDS) system. We aimed to evaluate obstacles to broader application through a pilot.

**Evaluation**

We chose the Emergency Department (ED) as a closed, controlled but scalable environment. Based on a survey of 191 ED providers, PE-CTA studies were considered to be over-utilized by 78% of the respondents. An interdisciplinary committee developed a diagnostic pathway that combined established risk scores and local practice patterns. We then developed a Best Practice Alerts (BPA) within the Epic RIS ordering system (Epic Radiant, 2014) to provide guidance to healthcare providers based on the algorithm. This allowed us to incorporate data from the EHR and direct interactions with the ordering party via a check list. We also developed an automated reporting structure for quality performance measurement that allows for direct provider feedback and is scalable as CDS indications increase.

**Discussion**

The algorithm is integrated as a mandated questionnaire in every CTA-PE study order in the ED (figure). If answers are concordant with the clinical pathway, the study order will be placed without further interaction. If answers are discordant with the pathway, alternative scenarios are recommended. If the user agrees, orders are automatically adjusted. If they are rejected, a reason is required. From 01/2012 until 03/2015, 6,472 PE studies were performed in our EDs among which 8.3% were positive. 39% never had a d-dimer and 4% were conducted despite a negative d-dimer. Within 5 days of our BPA roll-out, 33 PE-CTAs were conducted. 73% were concordant with the recommendation, 6% were positive. In Nov 2015, we expect to have 1,400 studies with detailed analyses on appropriate use, study yield and user feedback.

**Conclusion**

Successful implementation of CDS requires broad awareness among the majority of hospital staff. Epic's BPA provides an approach to quickly establish a local foundation while "off-the-shelf" applications are being reviewed.

**SSJ13-02 An Investigation of Radiologist EMR Usage at a Large Multi-Facility Payer-Provider Healthcare Organization**

Tuesday, Dec. 1 3:10PM - 3:20PM Location: S402AB

**Participants**

Brian J. Kolowitz, DSc, MBA, Pittsburgh, PA (*Presenter*) Nothing to Disclose  
Christopher R. Deible, MD, PhD, Pittsburgh, PA (*Abstract Co-Author*) Nothing to Disclose  
Anna L. von Reden, MA, BEng, Pittsburgh, PA (*Abstract Co-Author*) Nothing to Disclose  
Michael Lichtenstein, MBA, MSc, Pittsburgh, PA (*Abstract Co-Author*) Nothing to Disclose  
Francesco Desensi, Pittsburgh, PA (*Abstract Co-Author*) Employee, General Electric Company  
Wenbang Wang, Pittsburgh, PA (*Abstract Co-Author*) Employee, General Electric Company  
Edwin Wiancko, Pittsburgh, PA (*Abstract Co-Author*) Nothing to Disclose  
Kashyap Patel, Pittsburgh, PA (*Abstract Co-Author*) Nothing to Disclose  
Varalakshmi Anantharaman, Pittsburgh, PA (*Abstract Co-Author*) Nothing to Disclose



Benjamin J. Wilson, Durham, NC (*Abstract Co-Author*) Nothing to Disclose

## Background

This investigation captures the current state of EMR usage at a large multi-facility payer-provider healthcare organization. Prior research suggests low levels of EMR usage by radiologists due to incomplete information, misinformation, and technical difficulties accessing information.

## Evaluation

This study is divided into two phases. Phase one involved contextual observation of 41 radiologists interpreting 344 clinical exams over a 3-month period. Results of these observations led to phase 2: the development of an application that captures radiologist usage of clinical content (Figure 1) across multiple EMRs, and relates usage statistics to key patient and exam identifiers. Phase one of the study is complete and phase two is in progress. Of the 344 case observations, 41 were ED exams, 66 were inpatient exams, and 269 were outpatient exams (Table 1). Radiologists relied solely on imaging for only 8% of the exams. In all other instances radiologists accessed a summarized view of EMR/RIS (40%), prior imaging reports (24%), and other clinical documentation (28%) within the EMR. Within the EMR, Office Notes (11%) and Exam Prescription (7%) were the predominate sources followed by Surgical Notes (2%), Labs (2%), ER notes (2%), Progress Notes (1%), History and Physical (1%), Pathology Notes (1%), Consult Notes (1%), Correspondence (<1%), and Non-Surgical Procedure Notes (<1%).

## Discussion

The results of phase one suggest frequent EMR usage which appears to contradict prior research. Phase two data collection is in progress and will capture a broader set of usage metrics than in-person observation during clinical interpretation. This dataset will be used to inform the creation of a new radiologist centric information hierarchy based on relationships between procedure type, modality, and other patient/exam demographics.

## Conclusion

Observational research shows that radiologists frequently use a variety of clinical data during image interpretation depending on exam type and the clinical context under which the exam was ordered. This work is providing extremely valuable data to help direct development of tools that can intelligently present EMR data to radiologists rather than requiring them to conduct manual searches.

## SSJ13-03 Implementation of an Online Screening/Check-in Process Prior to MRI Studies: An Idea from the Airline Industry

Tuesday, Dec. 1 3:20PM - 3:30PM Location: S402AB

## Awards

### Trainee Research Prize - Resident

#### Participants

Ali Pirasteh, MD, Dallas, TX (*Presenter*) Nothing to Disclose

Maia VanDyke, Dallas, TX (*Abstract Co-Author*) Nothing to Disclose

Jamie Bolton-Ronacher, Dallas, TX (*Abstract Co-Author*) Nothing to Disclose

Yin Xi, Dallas, TX (*Abstract Co-Author*) Nothing to Disclose

Robin C. Eastland, RT, Dallas, TX (*Abstract Co-Author*) Nothing to Disclose

Denise Young, BS, RT, Dallas, TX (*Abstract Co-Author*) Nothing to Disclose

Jennifer C. Escobar, BS, Dallas, TX (*Abstract Co-Author*) Nothing to Disclose

Cecilia Hernandez, Dallas, TX (*Abstract Co-Author*) Nothing to Disclose

Seth Toomay, MD, Dallas, TX (*Abstract Co-Author*) Nothing to Disclose

Travis Browning, MD, Dallas, TX (*Abstract Co-Author*) Advisory Board, Hewlett-Packard Company; Advisor, McKesson Corporation

Ivan Pedrosa, MD, Dallas, TX (*Abstract Co-Author*) Nothing to Disclose

## PURPOSE

To evaluate whether implementing a web-based screening and check-in process for MRI appointments will improve the workflow and patient turn-around time and reduce the operational cost in the Radiology Department.

## METHOD AND MATERIALS

This IRB-approved, HIPAA-compliant study consisted of a prospective collection of the interview/screening duration prior to MRI for all outpatients over a six-week period after implementation of an online screening (OS) questionnaire. 773 patients were divided into OS (200 patients; 86 male; average age 54.4 years) and traditional screening (TS) (573 patients; 255 male, average age 54.3 years) groups. Differences in interview/screening duration were calculated with a generalized linear model with log link function with additional adjustments for differences in prevalence of possible causes of delay between both groups. Impact on operational cost was calculated by the amount of extended working hours of technologist per day and reported in cost-savings per year.

## RESULTS

26% of patients utilized the OS. The average interview/screening duration for the OS group (12.0 minutes, standard deviation (SD) = 7.1) was significantly lower than that of the TS group (14.1 minutes, SD = 12.3,  $p = 0.004$ ); 2 minutes shorter ( $p = 0.03$ ) adjusting for differences in prevalence of potential causes of delay between the two groups. There was no difference in the median interview/screening duration for the OS (10 min) and TS groups (11 min) ( $p = 0.18$ ). The cost reduction in technologist working hours was \$21,000 per year, assuming a 100% utilization rate of the OS process.

## CONCLUSION

Implementation of an online screening process prior to MRI results in faster patient screening, has the potential to result in cost savings, and provides a patient-centered, more efficient solution for screening prior to MRI examinations.

## CLINICAL RELEVANCE/APPLICATION

An online MRI screening system can be implemented as an effective method in reducing delays and patient interview turn-around, has high potential for reduction in costs and possible increase in patient satisfaction.

## SSJ13-04 Participants



## Detailed Workflow Analysis of PACS Usage Patterns by Means of Process Mining

Tuesday, Dec. 1 3:30PM - 3:40PM Location: S402AB

Daniel Forsberg, PhD, Linköping, Sweden (*Presenter*) Nothing to Disclose

Beverly Rosipko, Cleveland, OH (*Abstract Co-Author*) Nothing to Disclose

Jeffrey L. Sunshine, MD, PhD, Pepper Pike, OH (*Abstract Co-Author*) Research support, Siemens AG Travel support, Siemens AG Travel support, Koninklijke Philips NV Travel support, Sectra AB Travel support, Allscripts Healthcare Solutions, Inc

### Background

Over the years, the radiological workflow has undergone large and much research has been devoted to how these changes affect the workflow and efficiencies. However, most of this research has focused on a very high level of the radiological workflow. In this work, we take on a much more detailed perspective as we analyze interaction patterns describing radiologists' usage of.

### Evaluation

Event logs (containing information about commands used in the PACS) from one week of data, corresponding to 567 cases of single view chest radiographs read by 14 radiologists, were extracted for analysis. For each case, number of commands, number of command classes and time to complete a read were recorded. Statistical analysis was applied to compute the correlation and to determine which factors of radiologist, specialty and time of read that affect these variables. Further, techniques from process mining were applied to the interaction patterns to discover process models and to analyze the complexity of the derived process models.

### Discussion

The statistical analysis showed that the number of commands and command classes per case only have a slightly positive correlation with the time to read a case. The factors time of day, radiologist and specialty were shown to affect the number of commands per case, and where radiologist also affects the number of command types. Applying process mining to the event logs of all users showed that a seemingly "simple" examination (single view chest radiographs) can be associated with a complex interaction process. However, repeating the process discovery on each individual radiologist revealed that the initially discovered complex interaction process consists of one group of radiologists with individually well-structured interaction processes and a second smaller group of users with increasingly complex usage patterns.

### Conclusion

Detailed analysis of the workflow corresponding to the interaction patterns of radiologists reading examinations in a PACS presents a fresh opportunity for finding new areas of improvement of the radiological workflow.

## SSJ13-05 No Patient Left Behind: Novel Application of Predictive Analytics to Improve Patient Access and Efficiency of Imaging Resources

Tuesday, Dec. 1 3:40PM - 3:50PM Location: S402AB

### Participants

Alvin Y. Yu, MD, Boston, MA (*Abstract Co-Author*) Nothing to Disclose

Omid Khalilzadeh, MD, MPH, Boston, MA (*Presenter*) Nothing to Disclose

Garry Choy, MD, MS, Boston, MA (*Abstract Co-Author*) Nothing to Disclose

Anand M. Prabhakar, MD, Somerville, MA (*Abstract Co-Author*) Nothing to Disclose

Synho Do, PhD, Boston, MA (*Abstract Co-Author*) Nothing to Disclose

James A. Brink, MD, Boston, MA (*Abstract Co-Author*) Nothing to Disclose

Efren J. Flores, MD, Boston, MA (*Abstract Co-Author*) Nothing to Disclose

### PURPOSE

A missed care opportunity (MCO), defined as missing a health care appointment, impairs short and long term patient care. There are many factors that explain why MCOs occur. This study attempts to define a new paradigm for implementing value-based care in radiology: 'Patient connectivity' as a quantitative measure of patient access to healthcare resources. A real-world analogy is cell phone connectivity to a network - imagine the number of bars of reception. This study suggests a novel predictive model derived using machine learning techniques for quantification of "Patient Connectivity Index" (PCI) and prediction of MCOs in radiologic patient-care. This will allow us to better understand the patient population we serve and improve patient access by personalizing health care delivery.

### METHOD AND MATERIALS

Data from 0.5 million outpatient radiologic exams performed at our institution in the calendar year 2014 was analyzed. Data was obtained and combined from Radiology Order Entry, Electronic Medical Record, City Data, and Google Maps. The dataset was divided into a learning (66%) and test set (33%). Multivariate multilevel regression analysis was used to define a "connectivity" measure based on these factors on the learning set, and the resulting predictive model was used to validate the accuracy of the model on the test set. Specifically, the following variables were implemented in this model: Age, Gender, Distance to hospital and transportation, Insurance, Primary Language, Ethnicity/Race, Time of year, ICD9 codes, and referral pattern.

### RESULTS

Missing radiology appointments were significantly ( $p < 0.01$ ) associated with lower educational level, lower income, language barriers and certain ethnic backgrounds in our predictive model. The PCI (connectivity range 1-20%) could determine the predicted probability of MCOs with a good degree of accuracy.

### CONCLUSION

Connectivity is a dynamic, multifactorial, co-dependent, and patient-specific measure of health care access. Many factors relate to another with linear and non-linear effects, resulting in MCOs. Moreover, external events and disease progression also affects PCI. This study suggests a predictive platform which will pinpoint bottlenecks to connectivity and facilitate specific interventions for increasing patient access and connectivity to the healthcare network.

### CLINICAL RELEVANCE/APPLICATION

This work represents a tangible opportunity to deliver value-based imaging beyond the reading room.

## **SSJ13-06 Personalized Characterization of Nodule Cancer Risk Beyond Lung-Rads 1.0 with NLST Data**

Tuesday, Dec. 1 3:50PM - 4:00PM Location: S402AB

### **Participants**

Michael A. Morris, MD, MS, Baltimore, MD (*Presenter*) Nothing to Disclose  
Jason M. Hostetter, MD, Baltimore, MD (*Abstract Co-Author*) Nothing to Disclose  
Babak Saboury, MD, MPH, Baltimore, MD (*Abstract Co-Author*) Nothing to Disclose  
James J. Morrison, MD, Novi, MI (*Abstract Co-Author*) Nothing to Disclose  
Kenneth C. Wang, MD, PhD, Ellicott City, MD (*Abstract Co-Author*) Co-founder, DexNote, LLC;  
Jean Jeudy JR, MD, Baltimore, MD (*Abstract Co-Author*) Nothing to Disclose  
Eliot L. Siegel, MD, Severna Park, MD (*Abstract Co-Author*) Research Grant, General Electric Company; Speakers Bureau, Siemens AG; Board of Directors, Carestream Health, Inc; Research Grant, XYBIX Systems, Inc; Research Grant, Steelcase, Inc; Research Grant, Anthro Corp; Research Grant, RedRick Technologies Inc; Research Grant, Evolved Technologies Corporation; Research Grant, Barco nv; Research Grant, Intel Corporation; Research Grant, Dell Inc; Research Grant, Herman Miller, Inc; Research Grant, Virtual Radiology; Research Grant, Anatomical Travelogue, Inc; Medical Advisory Board, Fovia, Inc; Medical Advisory Board, Toshiba Corporation; Medical Advisory Board, McKesson Corporation; Medical Advisory Board, Carestream Health, Inc; Medical Advisory Board, Bayer AG; Research, TeraRecon, Inc ; Medical Advisory Board, Bracco Group; Researcher, Bracco Group; Medical Advisory Board, Merge Healthcare Incorporated; Medical Advisory Board, Microsoft Corporation; Researcher, Microsoft Corporation

### **CONCLUSION**

Lung cancer risk within Lung-RADS categories is modified by additional nodule characteristics and patient historical information. A convenient interface for clinicians to interact with large datasets may aid in evaluating additional characteristics affecting the risk of lung cancer compared to a matched cohort in real time.

### **Background**

Lung-RADS 1.0 was developed as a criteria to modernize and standardize recommendations for lung nodule follow-up for patients eligible for lung cancer screening which builds on the Fleischner Society recommendations. A custom web interface previously showed additional patient characteristics from the NLST clinical dataset could provide a more personalized prediction of cancer risk. In this follow-up study, the authors use the same approach if additional characteristics could improve the Lung-RADS prediction from matched cohorts.

### **Evaluation**

A custom web based interface to allow the user to interact with the NLST clinical dataset in real time was created. The largest nodule in each lobe for each patient was organized by slice number and location. These nodules were tracked until cancer was diagnosed or until the last screening study available. If cancer originated in the same lobe as a nodule, the nodule was considered malignant. Lung-RADS categories predict cancer risks that range from <1% for category 2 nodules to >15% for category 4B and 4X nodules. The occurrence of cancer diagnosis was compared to the Lung-RADS predicted rate across matched cohorts with similar personal histories and nodule characteristics. The web interface allows users to compute a personalized cancer risk based on these additional discriminators by querying the NLST dataset for matched cohorts in real time.

### **Discussion**

Lung-RADS characterizes nodules with greater detail than the Fleischner Criteria, however features that increase suspicion for malignancy are not clearly defined and additional factors that may significantly modify cancer risk such as a patient's personal history are excluded. Harnessing large datasets such as the NLST could aid in comparing matched cohorts to identify additional important factors in further personalizing the prediction for a nodule's cancer risk.

## Cardiac (Pericardial and Cardiac Valve Imaging)

Tuesday, Dec. 1 3:00PM - 4:00PM Location: S502AB



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

### Participants

Leena Mammen, MD, Grand Rapids, MI (*Moderator*) Nothing to Disclose  
Scott R. Akers, MD, PhD, Philadelphia, PA (*Moderator*) Nothing to Disclose  
Diana Litmanovich, MD, Haifa, Israel (*Moderator*) Nothing to Disclose

### Sub-Events

#### SSJ03-01 Remote 4D MR Flow Assessment of Aortic Valve Regurgitation

Tuesday, Dec. 1 3:00PM - 3:10PM Location: S502AB

### Participants

Raluca G. Saru, MD, Rotterdam, Netherlands (*Presenter*) Nothing to Disclose  
Albert Hsiao, MD, PhD, San Diego, CA (*Abstract Co-Author*) Founder, Arterys, Inc; Consultant, Arterys, Inc; Research Grant, General Electric Company  
Laurens E. Swart, MD, Rotterdam, Netherlands (*Abstract Co-Author*) Nothing to Disclose  
Piotr A. Wielopolski, PhD, Rotterdam, Netherlands (*Abstract Co-Author*) Nothing to Disclose  
Shreyas S. Vasanawala, MD, PhD, Palo Alto, CA (*Abstract Co-Author*) Research collaboration, General Electric Company; Consultant, Arterys; Research Grant, Bayer AG;  
Koen Nieman, MD, PhD, Rotterdam, Netherlands (*Abstract Co-Author*) Speakers Bureau, Siemens AG Speakers Bureau, Toshiba Corporation Research Grant, Bayer AG Research Grant, General Electric Company

### PURPOSE

4D MR Flow has shown to have advantages over standard cardiac magnetic resonance (CMR), offering both anatomical and functional information in just a single acquisition. Processing of the large amount of data requires dedicated software. We evaluated the feasibility and performance of a cloud-based application that combines pre-processing and visualization of 4D Flow data, and assessed its accuracy for the detection and grading of aortic valve regurgitation (AR) using trans-thoracic echocardiography (TTE) as reference.

### METHOD AND MATERIALS

Between June 2014 and January 2015 patients planned for clinical CMR were consecutively approached to undergo the 4D Flow examination. The 4D Flow data was uploaded to a dedicated web-based software application for eddy-currents correction, interactive visualization of the anatomical and flow components, and detection and grading of the aortic regurgitation. The diagnostic characteristics of 4D MR Flow were evaluated against TTE.

### RESULTS

Fifty-four patients were included. The agreement between 4D Flow and TTE for the grading of AR was good ( $\kappa=0.726$ ). For detection of any degree of AR, 4D MR Flow had a sensitivity of 94.4% (81.3-99.2), a specificity of 72.2% (46.5-90), and a positive (PPV) and negative predictive value (NPV) of 86.7% (59.5-97.9) and 87.1% (72.6-95.7) respectively. To identify clinically relevant moderate or severe AR, 4D Flow MR had a sensitivity of 100% (40.2-100), specificity of 98% (89.3-99.7), PPV of 80% (28.8-96.7) and NPV of 100% (92.7-100).

### CONCLUSION

Aortic regurgitation can be detected and graded accurately using 4D Flow in comparison to TTE. The use of a remote application with advanced data correction, integrated with interactive imaging tools allowed for interpretation of the 4D Flow data.

### CLINICAL RELEVANCE/APPLICATION

The potential advantages of a 4D Flow protocol are that during a free-breathing acquisition of 7-10 minutes, flow sensitive information in all three dimensions is acquired for the entire thorax. Without a need to specify beforehand, or assistance during the examination, flow can be retrospectively measured anywhere and in any direction within the thorax. While 2D sequences measure flow in a static plane, 4D Flow allows for continuous alignment of the measurement plane to the position of moving structures (e.g. valve annulus). In case of regurgitation jets that change direction throughout the heart cycle, 4D Flow imaging can provide more complete visualization.

#### SSJ03-02 Mitral Annular Dimensions and Geometry in Normals and Patients with Mitral Regurgitation: Implications for CT-based Sizing in Transcatheter Mitral Valve Implantation

Tuesday, Dec. 1 3:10PM - 3:20PM Location: S502AB

### Participants

Nicolas J. Bilbey, MD, Vancouver, BC (*Presenter*) Nothing to Disclose  
Christopher Naoum, MBBS, Vancouver, BC (*Abstract Co-Author*) Nothing to Disclose  
Jonathon A. Leipsic, MD, Vancouver, BC (*Abstract Co-Author*) Speakers Bureau, General Electric Company Speakers Bureau, Edwards Lifesciences Corporation Consultant, Heartflow, Inc Consultant, Circle Cardiovascular Imaging Inc  
Anson Cheung, Vancouver, BC (*Abstract Co-Author*) Nothing to Disclose  
Jian Ye, Vancouver, BC (*Abstract Co-Author*) Nothing to Disclose  
George Mak, Vancouver, BC (*Abstract Co-Author*) Nothing to Disclose  
Adam Berger, Vancouver, BC (*Abstract Co-Author*) Nothing to Disclose

Danny Dvir, Vancouver, BC (*Abstract Co-Author*) Nothing to Disclose  
Chesnal Dey Arepalli, MD, Burnaby, BC (*Abstract Co-Author*) Nothing to Disclose  
Jasmine Grewal, Vancouver, BC (*Abstract Co-Author*) Nothing to Disclose  
David Muller, Vancouver, BC (*Abstract Co-Author*) Nothing to Disclose  
Darra T. Murphy, MD, FRCPC, Vancouver, BC (*Abstract Co-Author*) Nothing to Disclose  
Cameron J. Hague, MD, Vancouver, BC (*Abstract Co-Author*) Nothing to Disclose  
Nicolo Piazza, Vancouver, BC (*Abstract Co-Author*) Nothing to Disclose  
John Webb, MD, FRCPC, Vancouver, BC (*Abstract Co-Author*) Consultant, Edwards Lifesciences Corporation  
Philipp Blanke, MD, Vancouver, BC (*Abstract Co-Author*) Consultant, Edwards Lifesciences Corporation ; Consultant, Neovasc Inc

## PURPOSE

The D-shaped mitral annulus was recently proposed as a potentially more appropriate method[DM1] for annular sizing prior to transcatheter mitral valve implantation (TMVI). We sought to firstly establish normative CT values for the D-shaped mitral annulus; and secondly, to evaluate these parameters in patients with mitral regurgitation (MR) and determine drivers of annular size.

## METHOD AND MATERIALS

Patients with retrospectively-gated cardiac CT performed at our institution (2012-2014) and free of cardiovascular disease were included ('normals', n=105, 57±11yrs, 51 female). Patients with mitral regurgitation (MR) being considered for transcatheter mitral therapy were also evaluated (mitral valve prolapse, MVP, n=24, 78±12yrs, 10 female; functional MR, FMR, n=20, 69±14yrs, 6 female). Mitral annular dimensions (projected area, perimeter, trigone-trigone (TT), intercommissural (IC) and septal-lateral (SL) distance) were measured during mid-late diastole and compared between groups. Maximal left atrial (LA) and phasic left ventricular (LV) volumes were also measured.

## RESULTS

Absolute (indexed) mean ± SD mitral annulus area, perimeter, TT, IC and SL values in normals were 8.95±1.53cm<sup>2</sup> (4.68±0.62cm<sup>2</sup>/m<sup>2</sup>), 110±9mm (58±6mm/m<sup>2</sup>), 28.5±3.3mm (15.0±1.9mm/m<sup>2</sup>), 37.5±3.7mm (19.7±2.1mm/m<sup>2</sup>) and 27.8±2.8mm (14.6±1.7mm/m<sup>2</sup>), respectively. Indexed Annular area was larger in MR patients compared to controls (6.49±1.53m<sup>2</sup>/m<sup>2</sup> vs. 4.68±0.62cm<sup>2</sup>/m<sup>2</sup>, P<0.001) and importantly, was larger in MVP patients compared to FMR patients (7.20±1.43cm<sup>2</sup>/m<sup>2</sup> vs. 5.59±1.14cm<sup>2</sup>, P<0.001). Annular distortion was also observed in MR patients with reduced IC/SL ratio compared to normals (1.26±0.11 vs. 1.36±0.14, P<0.001). While LA and LV volumes independently predicted annular size in normals and were both associated with annular size in MVP patients, only LA volume was associated with annular size in FMR patients.

## CONCLUSION

We describe normative CT values for the D-shaped mitral annulus. Moreover, we demonstrate differences in and varied drivers of annular dimensions in patients with MVP and FMR who are being considered for transcatheter mitral therapy.

## CLINICAL RELEVANCE/APPLICATION

The data presented provides useful information regarding annular sizing using cardiac CT for the purposes of TMVI.

## Honored Educators

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

Jonathon A. Leipsic, MD - 2015 Honored Educator

## SSJ03-03 Aortic Valve Planimetry by High-Resolution 3-Dimensional MR Image Acquisition with a Breath-hold: Comparison with Conventional Cine MR Imaging and Echocardiography to Assess the Severity of Aortic Valve Stenosis

Tuesday, Dec. 1 3:20PM - 3:30PM Location: S502AB

## Participants

Hae Jin Kim, Seoul, Korea, Republic Of (*Presenter*) Nothing to Disclose  
Sung Mok Kim, MD, Seoul, Korea, Republic Of (*Abstract Co-Author*) Nothing to Disclose  
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So Hyeon Bak, MD, Seoul, Korea, Republic Of (*Abstract Co-Author*) Nothing to Disclose  
Sung-Ji Park, Seoul, Moldova, Republic Of (*Abstract Co-Author*) Nothing to Disclose  
Yeon Hyeon Choe, MD, PhD, Seoul, Korea, Republic Of (*Abstract Co-Author*) Nothing to Disclose

## PURPOSE

We intended to evaluate the novel application of high-resolution 3-dimensional MR image acquisition with single-breath-hold SSFP sequence to calculate the aortic valve area (AVA).

## METHOD AND MATERIALS

In 88 consecutive patients (66.9 ± 9.59 years, 63% men) with varying degrees of aortic valve stenosis, high-resolution 3D SSFP images (3D planimetry; 2.0 mm slice thickness, 20 contiguous slices; image matrix, 256 × 209) were acquired with single breath-hold during mid systole and mid diastole. SSFP cine MR imaging (2D planimetry) and velocity-encoded cine MRI (slice thickness, 4.5 mm) in three levels of aortic valve were also performed. AVA area was measured by two experienced observers using commercial software (iNtuition, TeraRecon). MR imaging measurements and image quality were compared with transthoracic echocardiographic measurements of effective aortic orifices (EAO) using the continuity equation (1 = severe blurring of images, 2 = moderate blurring of valve contours; 3 = mild blurring of valve contours, 4 = excellent and no artifact). Sensitivity for accurate measurement and receiver operating characteristic (ROC) curve were calculated. Intra- and interobserver agreements were determined by using intraclass correlation coefficient (ICC).

## RESULTS

Mean AVA derived by 2D planimetry, 3D planimetry, and echocardiography were 0.77 ± 1.04 cm<sup>2</sup>, 0.73 ± 1.16 cm<sup>2</sup>, and 0.75 ± 0.22

mean AVA derived by 3D planimetry, 2D planimetry, and echocardiography were  $0.77 \pm 1.04 \text{ cm}^2$ ,  $0.72 \pm 1.10 \text{ cm}^2$ , and  $0.75 \pm 0.52 \text{ cm}^2$ , respectively. The ICC value of 3D planimetry was higher than 2D planimetry [0.799 (CI, 0.691-0.869) vs. 0.743 (CI, 0.605-0.832)] with echocardiographic EAO as the standard of reference. The grade of image quality of 3D planimetry was superior to 2D planimetry ( $3.65 \pm 0.65$  vs.  $3.17 \pm 0.65$ ). The correlation coefficients of maximum peak velocity on velocity-encoded cine MR imaging with 3D planimetry and that with 2D planimetry were 0.42 ( $p < 0.05$ ) and 0.35 ( $p < 0.05$ ). Intra- and interobserver agreements for 3D planimetry were excellent [ICC = 0.949 (CI, 0.881-0.979) and 0.846 (CI, 0.636-0.935), respectively; both,  $p = 0.000$ ].

## CONCLUSION

Novel application of high-resolution 3D SSFP breath-hold MR imaging enables planimetry of AVA in patients with valvular aortic stenosis with better image quality than 2D planimetry with conventional cine MR imaging.

## CLINICAL RELEVANCE/APPLICATION

Our findings support the validity of 3D planimetry at accurate assessment of the severity of aortic valve stenosis.

### SSJ03-04 Association between Geometric Distribution of Wall Shear Stress and Aortic Dilatation in Patients with Aortic Stenosis: Comparison between TAV and BAV

Tuesday, Dec. 1 3:30PM - 3:40PM Location: S502AB

#### Participants

Hojin Ha, Seoul, Korea, Republic Of (*Presenter*) Nothing to Disclose  
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Joon-Won Kang, MD, Seoul, Korea, Republic Of (*Abstract Co-Author*) Nothing to Disclose  
Tae-Hwan Lim, MD, PhD, Seoul, Korea, Republic Of (*Abstract Co-Author*) Nothing to Disclose

## PURPOSE

Although abnormal wall shear stress (WSS) distribution is suspected to have a significant role on the development of the aortic dilatation, the relationship between hemodynamics characteristics and aortic dilatations is not fully understood yet. The present study investigates the association between the WSS distributions and aortic dilatations in aortic-stenosis (AS) patients with tricuspid aortic valves (TAV) and bicuspid aortic valves (BAV).

## METHOD AND MATERIALS

A total of 54 moderate and severe AS-patients (TAV=32, BAV=22) who underwent cardiac computed tomography (CT) and phase contrast magnetic resonance imaging (PC-MRI) at the ascending aorta were retrospectively collected. For calculation of WSS, 2D velocity profiles were extracted from PC-MRI at the level of ascending aorta. Then, a total of 360 velocity line-profiles were extracted from the center of the vessel to the wall with 1 degree angular increments. Aortic diameter was measured at 10 levels from aortic annulus to distal descending aorta using CT. Differences of the aortic diameters and WSS distributions between TAV and BAV were statistically analyzed using student t-test. Association between aortic diameter and regional WSS at the level right pulmonary artery were evaluated using linear regression.

## RESULTS

Patients with BAV showed more asymmetric systole blood flow compared to those with TAV (center of flow r/R;  $0.59 \pm 0.11$  vs.  $0.67 \pm 0.10$ ,  $p = 0.018$ ). As a result, AS patients with BAV has significantly higher systolic WSS ( $0.55 \pm 3.14 \text{ Pa}$  vs.  $2.91 \pm 3.20 \text{ Pa}$ ,  $p = 0.009$ ) at the right-posterior region and lower systolic WSS ( $1.12 \pm 3.58$  vs.  $3.12 \pm 3.36$ ,  $p = 0.044$ ) at the left and left-posterior regions of the ascending aorta. In accordance with the increased WSS distribution, AS patients with BAV are found to have larger diameters of the ascending aorta compared to those with TAV (BAV vs. TAV:  $43.7 \pm 7.2 \text{ mm}$  vs.  $34.1 \pm 4.8 \text{ mm}$ ,  $p < 0.001$ ). Linear regression between the aortic diameter and systolic WSS shows that the increment of the WSS represents about 14% of the aortic dilatation.

## CONCLUSION

Among patients with aortic stenosis, patients with BAV showed more eccentric WSS and larger aortic diameter as compared to those with TAV at the level of ascending aorta. Eccentric distribution of WSS showed significant correlation with aortic diameter.

## CLINICAL RELEVANCE/APPLICATION

WSS may be used to predict future risk of aortic dilatation in patients with aortic stenosis.

### SSJ03-05 Multidetector-row Computed Tomography in Patients with Suspected Prosthetic Valve Dysfunction: A Prospective Study

Tuesday, Dec. 1 3:40PM - 3:50PM Location: S502AB

#### Participants

Dominika Sucha, MD, Utrecht, Netherlands (*Presenter*) Nothing to Disclose  
Steven Chamuleau, MD, PhD, Utrecht, Netherlands (*Abstract Co-Author*) Nothing to Disclose  
Petr Symersky, MD, Amsterdam, Netherlands (*Abstract Co-Author*) Nothing to Disclose  
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Jesse Habets, MD, Utrecht, Netherlands (*Abstract Co-Author*) Nothing to Disclose  
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## PURPOSE

To systematically assess the role of retrospectively ECG-gated multidetector-row computed tomography (MDCT) for the evaluation of patients with suspected prosthetic heart valve (PHV) dysfunction.

## METHOD AND MATERIALS

We performed a prospective cross-sectional study and enrolled patients consecutively during their clinical presentation in two university hospitals. Inclusion criteria were: 1. Aortic PHVs with an increase ( $>20\text{mmHg}$ ) of the max. transprosthetic pressure gradient (TPG), 2. Mitral PHVs with a high mean TPG ( $>10\text{mmHg}$ ), 3. Abnormal (peri)valvular leakage, 4. Leaflet restriction on fluoroscopy ( $>5$  degrees) or 5. Clinical abnormalities likely due to PHV-dysfunction (e.g. stroke). All patients underwent transthoracic (TTE) and transesophageal (TEE) echocardiography  $\pm$  fluoroscopy (routine diagnostic work-up). Additional cardiac retrospectively ECG-gated MDCT imaging was performed on a 256-slice or 64-slice MDCT scanner in all patients.

## RESULTS

Forty-two patients were included (mean age  $62 \pm 13$  years) with 40 mechanical and 9 biological PHVs (34 aortic, 15 mitral). Main reasons for suspected dysfunction were: aortic TPG increase ( $n=20$ , 48%), clinical abnormalities ( $n=14$ , 33%) and/or abnormal (peri)valvular leakage ( $n=12$ , 29%). Median radiation exposure was  $11.6 \text{ mSv}$  [interquartile range  $10.8\text{-}14.4$ ], 40 patients (95%) were imaged on the 256-slice scanner. MDCT detected one or more PHV-related pathologies in 32/42 (76%) patients: pannus ( $n=11$ ), thrombus ( $n=5$ ), pannus/thrombus ( $n=2$ ), PHV angulation ( $n=2$ ), left ventricular outflow tract obstruction ( $n=4$ ), paravalvular leakage ( $n=7$ ), pseudoaneurysms ( $n=2$ ), bioprosthesis degeneration ( $n=1$ ), native annulus remnant ( $n=1$ ), patient prosthesis mismatch suspicion ( $n=2$ ) and restricted leaflet motion of unknown cause ( $n=3$ ).

## CONCLUSION

In this prospective study, MDCT imaging revealed a morphological substrate in 32/42 (76%) patients with suspected PHV dysfunction and showed a valuable imaging tool for PHV evaluation.

## CLINICAL RELEVANCE/APPLICATION

Additional MDCT imaging allows identification of the underlying pathology in the diagnostic work-up of suspected PHV dysfunction.

## SSJ03-06 CT-Angiography Prior to Transcatheter Aortic Valve Replacement (TAVR) - Identification of Different Parameters Leading to a Post-interventional Valvular or Para-valvular Leak

Tuesday, Dec. 1 3:50PM - 4:00PM Location: S502AB

### Participants

Florian Wolf, MD, Vienna, Austria (*Presenter*) Nothing to Disclose  
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Dietrich Beitzke, MD, Vienna, Austria (*Abstract Co-Author*) Nothing to Disclose  
Philip Kresl, Vienna, Austria (*Abstract Co-Author*) Nothing to Disclose  
Sabine Scherzer, Vienna, Austria (*Abstract Co-Author*) Nothing to Disclose  
Christian Loewe, MD, Vienna, Austria (*Abstract Co-Author*) Speaker, Bracco Group Speaker, Guerbet SA Speaker, General Electric Company Speaker, Medtronic, Inc Speaker, Bayer AG Speaker, Siemens AG

## PURPOSE

The purpose of this study was to identify pre-interventional factors by means of CT-Angiography, which could predetermine the incidence of a significant post-interventional paravalvular or valvular leakage (PVL) in TAVR patients.

## METHOD AND MATERIALS

In this retrospective study 160 datasets of patients that underwent TAVR from 2007 until 2013 were analyzed. In 87 patients (36 male, 51 female, mean age  $82.6$  years, range  $63\text{-}95$  years), all necessary post-interventional echocardiographic datasets were available to evaluate the degree of aortic insufficiency up to 30 days after TAVR (mild, moderate, severe - moderate to severe aortic insufficiency was rated as clinically significant). Using the CT-Datasets following parameters were evaluated: diameter (D) and area of the annulus, distance between the annulus and the right and left coronary artery, respectively, valve calcification degree (no, mild, moderate, severe calcification), cover index ( $100 \times [\text{prosthesis D} - \text{D}_{\text{mean Annulus}}] / \text{prosthesis D}$ ) and eccentricity indices ( $\text{D}_{\text{mean Annulus}} - \text{D}_{\text{area Annulus}}$  and  $\text{D}_{\text{max Annulus}} - \text{D}_{\text{min Annulus}}$ ). Data was statistically analyzed by means of linear and multivariate regression analysis and correlated with degree of post-interventional aortic insufficiency.

## RESULTS

CoreValve- and Edwards Sapien prostheses were implanted in 20 and 67 patients, respectively. In 94,3% of the patients a post-interventional PVL of any degree within 30 days was detected by echocardiography. Degree and rate of PVL was not different between the CoreValve or Edwards Sapien System. Univariate regression analysis reported a sole significant ( $p=0.01$ ) reverse relationship between the cover index and severity of post-interventional PVL. All other parameters showed no significant correlation with degree of PVL. In patients with a prosthesis oversizing of at least 15% no clinical relevant PVLs were detected.

## CONCLUSION

In this study the cover index is the strongest and sole predictor of post-interventional PVL in TAVR patients. A certain degree of prosthesis oversizing may be required to reduce the incidence of PVL.

## CLINICAL RELEVANCE/APPLICATION

Pre-interventional identification of factors leading to a post-interventional PVL could help to develop strategies to reduce rate of post-interventional PVL.

SSJ04

## Cardiac (Quantitative Imaging)

Tuesday, Dec. 1 3:00PM - 4:00PM Location: S504AB

CA BQ CT MR

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

FDA Discussions may include off-label uses.

### Participants

Lisa Diethelm, MD, New Orleans, LA (*Moderator*) Nothing to Disclose  
Frank J. Rybicki III, MD, PhD, Ottawa, ON (*Moderator*) Research Grant, Toshiba Corporation;  
Dianna M. Bardo, MD, Seattle, WA (*Moderator*) Speaker, Koninklijke Philips NV; Consultant, Koninklijke Philips NV; Author, Thieme Medical Publishers, Inc

### Sub-Events

#### SSJ04-01 Diagnostic Value of Quantitative Edema Detection Using T2-mapping in Acute Myocarditis

Tuesday, Dec. 1 3:00PM - 3:10PM Location: S504AB

### Awards

#### Trainee Research Prize - Resident

### Participants

Bettina Baessler, MD, Cologne, Germany (*Presenter*) Nothing to Disclose  
Frank Schaarschmidt, Hannover, Germany (*Abstract Co-Author*) Nothing to Disclose  
Anastasia Dick, Cologne, Germany (*Abstract Co-Author*) Nothing to Disclose  
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Alexander C. Bunck, Köln, Germany (*Abstract Co-Author*) Nothing to Disclose

### PURPOSE

To investigate the diagnostic value of T2-mapping in patients with acute myocarditis (ACM) and to define an appropriate cut-off value for edema detection.

### METHOD AND MATERIALS

CMR data of 35 patients with clinically suspected ACM and confirmation of diagnosis by CMR according to the Lake Louise criteria were retrospectively analyzed. 30 healthy volunteers (HV) served as a control. All patients and HV were examined on a clinical 1.5T scanner, where - in addition to the routine CMR protocol - a breathhold Gradient Spin Echo (GraSE) T2-mapping sequence had been acquired at a basal, midventricular and apical slice in short axis view. T2-maps were segmented according to the 16-segments AHA-model and segmental T2 values as well as the segmental pixel-SD were analyzed. Statistical analysis was conducted using independent t-test, multiple logistic regression analyses, random forests, and decision trees.

### RESULTS

Means of global myocardial T2 or pixel-SD showed only small differences between HV and ACM patients (T2:  $58.7 \pm 0.3$  ms vs.  $63.1 \pm 0.4$ ,  $p < .001$ ; pixel-SD:  $7.7 \pm 0.1$  vs.  $8.6 \pm 0.2$ ,  $p < .001$ ), lying in the observed normal range of HV. In contrast, variation of T2 values as well as of pixel-SD was much larger in ACM patients compared to HV. In random forests and multiple logistic regression analyses, the combination of the highest segmental T2 value within each patient (maxT2) and the mean absolute deviation (MAD) of log-transformed pixel-SD (madSD) over all 16 segments within each patient proved to be the best discriminators between HV and ACM patients with an AUC of 0.85 in ROC-analysis. In decision trees, a cut-off of 0.22 for madSD and of 67.7 ms for maxT2 resulted in 83% specificity and 97% sensitivity for classification between HV and ACM, even when not taking into account Lake Louise criteria.

### CONCLUSION

The proposed cut-off values for maxT2 and madSD in the setting of ACM allow edema detection with high sensitivity and specificity and in a quantitative manner. The two parameters have the potential to overcome the hurdles of T2-mapping for its integration into clinical routine and should be validated in a greater patient cohort.

### CLINICAL RELEVANCE/APPLICATION

Myocardial edema is an important factor not only in ACM. T2-mapping promises to be a quantitative approach in edema imaging, overcoming some limitations of qualitative edema assessment.

#### SSJ04-02 Myocardial T1 Mapping in Asymptomatic Subjects: Variations According to Left Ventricular Segments and Correlation with Cardiovascular Risk Factors

Tuesday, Dec. 1 3:10PM - 3:20PM Location: S504AB

### Participants

Moon Young Kim, MD, Seoul, Korea, Republic Of (*Presenter*) Nothing to Disclose  
Soo Jin Cho, Seoul, Moldova, Republic Of (*Abstract Co-Author*) Nothing to Disclose  
Hae Jin Kim, Seoul, Korea, Republic Of (*Abstract Co-Author*) Nothing to Disclose  
Sung Mok Kim, MD, Seoul, Korea, Republic Of (*Abstract Co-Author*) Nothing to Disclose  
Sang-Chol Lee, Seoul, Korea, Republic Of (*Abstract Co-Author*) Nothing to Disclose



## PURPOSE

To evaluate whether there is variation in precontrast and postcontrast myocardial T1 time (prT1 and poT1, respectively) and extracellular volume fraction (ECVF) according to left ventricular (LV) segments and to search for any correlation between them and known cardiovascular risk factors.

## METHOD AND MATERIALS

This study included 198 asymptomatic subjects (180 men and 18 women, age  $54.4 \pm 6.12$  years) who underwent cardiac MR imaging. Precontrast T1 mapping and postcontrast T1 mapping 15 minutes after 0.2 mmol gadobutrol injection were performed using shortened modified look-locker inversion recovery [ShMOLLI] sequence at 1.5T (Magnetom Avanto, Siemens). Short-axial cine MR imaging was performed with SSFP technique. T1 values and ECVFs were calculated in 16 AHA myocardial segments. Those values were compared among LV segments and correlated with presence of hypertension ( $n = 52$ ), diabetes mellitus (DM,  $n = 15$ ), or both ( $n = 17$ ). ECVF was also correlated with LV mass.

## RESULTS

The overall prT1 and poT1 values and ECVF were  $1006 \pm 291.5$  ms,  $454.2 \pm 38.5$  ms, and  $0.24 \pm 0.04$ , respectively. There was significant difference between apical segments and mid-basal segments in poT1 value and ECVF ( $p < 0.03$ ) and between mid-septal segments and mid-lateral segments in T1 values and ECVF ( $p < 0.04$ ). ECVF showed reverse correlation with LV mass ( $p = 0.002$ ). There was significantly lower poT1 value ( $449 \pm 35.6$  ms) and higher ECVF ( $0.24 \pm 0.04$ ) in subjects with hypertension compared with those ( $459 \pm 43.3$  ms and  $0.23 \pm 0.02$ ) of subjects without hypertension ( $p < 0.05$ ). Subjects with DM showed no difference in all T1 values from subjects without DM or hypertension, except poT1 values in mid-septal segments ( $447 \pm 23.6$  ms vs  $459 \pm 45.6$  ms,  $p = 0.02$ ). Subjects with both risk factors showed no difference in all T1 values from subjects without DM or hypertension, except prT1 value between apical septal and lateral segments ( $1007 \pm 126$  ms vs  $999 \pm 156$  ms,  $p = 0.03$ ).

## CONCLUSION

The septal wall showed higher prT1 value and ECVF but lower poT1 value than the lateral wall of mid- and basal levels. PoT1 value and ECVF are significantly affected by hypertension and LV mass.

## CLINICAL RELEVANCE/APPLICATION

Normal range of T1 values and ECVF and their segmental variation should be differentiated from myocardial pathologic conditions. Moreover the cardiovascular risk factors may affect T1 values, ECVF, and LV function in asymptomatic subjects before cardiovascular symptoms develop.

## SSJ04-03 3D-Dixon MRI Based Volumetry of Peri- and Epicardial Fat

Tuesday, Dec. 1 3:20PM - 3:30PM Location: S504AB

### Participants

Rami Homsy, Bonn, Germany (*Presenter*) Nothing to Disclose  
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Alois Martin Sprinkart, MSc, Bonn, Germany (*Abstract Co-Author*) Nothing to Disclose

## PURPOSE

There is growing evidence that pericardial and epicardial fat volume (PFV, EFV) are associated with cardiovascular risk. The aim of this study was to develop a novel approach to accurately measure PFV and EFV using a 3D-Dixon based MRI approach.

## METHOD AND MATERIALS

A cardiac triggered and respiratory navigator gated 3D-gradient echo pulse sequence ( $TR = 5.4$  ms,  $TE1/TE2 = 1.8/4.0$  ms,  $\alpha = 20^\circ$ , voxel size  $1.5 \times 1.5 \times 3.0$  mm<sup>3</sup>) was developed for cardiac Dixon imaging. Based on this sequence fat fraction maps were computed. After correction for relaxation effects and setting of an appropriate noise threshold, voxels with more than 50% signal from fat were added for volumetry. Validation of the measurement accuracy was performed in a phantom consisting of muscle tissue and five different known volumes of fat (50-200 ml). The proposed sequence was acquired in 34 healthy volunteers (22 male, BMI range 14-42 kg/m<sup>2</sup>, age range 21-79y) at 1.5T (Ingenia, Philips). Analysis was performed independently by two readers by drawing two 3D-region of interests, one for EFV and one for PFV. Additionally, EFV and PFV were compared between overweighted and non-overweighted subjects.

## RESULTS

The phantom study showed an excellent agreement of measured and true fat volumes (maximum difference = 5 ml, linear correlation  $R > 0.99$ ). PFV over all volunteers was  $158.0 \pm 126.4$  ml and EFV was  $77.0 \pm 55.3$  ml. PFV and EFV were highly correlated ( $R = 0.96$ ). Inter-reader agreement was good with a mean difference of  $0.2 \pm 5.6$  ml and  $4.5 \pm 4.2$  ml for PFV/EFV, ( $R > 0.99$ , each). EFV and PFV differed significantly between overweighted and non-overweighted subjects (BMI  $> 25$  kg/m<sup>2</sup> and BMI  $< 25$  kg/m<sup>2</sup>,  $n = 17$  each) with PFV  $219.0 \pm 151.8$  ml vs.  $96.9 \pm 44.7$  ml and EFV  $102.3 \pm 66.3$  ml vs.  $51.7 \pm 23.6$  ml ( $p < 0.001$ , each). There was no significant difference in age between the two groups ( $41.4 \pm 14.3$  y vs.  $42.9 \pm 16.0$  y,  $p = 0.76$ ).

## CONCLUSION

The implemented Dixon method allows accurate measurement of PFV and EFV with all benefits of a 3D-approach similar to CT.

## CLINICAL RELEVANCE/APPLICATION

The proposed 3D-Dixon based method allows accurate measurement of cardiac fat volumes, free of ionizing radiation and provides a

valuable tool for cardiovascular risk stratification.

#### **SSJ04-04 Reproducibility of Cine Displacement Encoding with Stimulated Echoes (DENSE) in Human Subjects**

Tuesday, Dec. 1 3:30PM - 3:40PM Location: S504AB

##### **Participants**

Kai Lin, MD, MSc, Chicago, IL (*Presenter*) Nothing to Disclose  
Michael Markl, PhD, Chicago, IL (*Abstract Co-Author*) Nothing to Disclose  
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Gong Feng, MD, PhD, Chicago, IL (*Abstract Co-Author*) Nothing to Disclose  
Bruce Spottiswoode, Chicago, IL (*Abstract Co-Author*) Employee, Siemens AG  
James C. Carr, MD, Chicago, IL (*Abstract Co-Author*) Research Grant, Astellas Group Research support, Siemens AG Speaker, Siemens AG Advisory Board, Guerbet SA

##### **PURPOSE**

To test the hypothesis that two-dimensional (2D) displacement encoding via stimulated echoes (DENSE) is a reproducible technique for the depiction of segmental myocardial motion in human subjects.

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

Following the approval of the institutional review board (IRB), 10 healthy volunteers without documented history of cardiovascular disease were recruited. For each participant, 2D DENSE were performed twice (at different days) and the data were obtained at basal, midventricular and apical levels of the LV with a short-axis view. The first and second principal strains (E1 and E2), radial thickening strain (Err), circumferential rotating strain (Ecc), twist and torsion were calculated. The intra-, inter-observer and inter-study variances were evaluated using coefficient of variation (CoV) and intra-class correlation coefficient (ICC).

##### **RESULTS**

In total, there are 160 pairs of myocardial segments (from 2 scans on 10 subjects) for quantitative analysis and comparison. Figure 1 shows an example set of DENSE images demonstrating myocardial displacement maps from a single subject for scan #1 and #2. The images demonstrated similar image quality and systolic displacement patterns for both acquisitions. These observations were confirmed by segment-by-segment comparisons which showed no significant differences in peak Ecc, E1, E2, twist and torsion between two sequential scans. A difference in radial strain was noted, Err ( $0.43 \pm 0.22$  vs.  $0.38 \pm 0.19$ ,  $p = 0.008$ ). There was good scan-rescan reproducibility of peak Ecc (CoV = 20.59%, ICC = 0.815,  $p < 0.001$ ), E2 (CoV = 14.85%, ICC = 0.757,  $p < 0.001$ ), twist (CoV = 34.12%, ICC = 0.911,  $p < 0.001$ ) and torsion (CoV = 11.07%, ICC = 0.818,  $p < 0.001$ ). There was moderate scan-rescan reproducibility of Err (CoV = 36.36%, ICC = 0.664,  $p < 0.001$ ) and E1 (CoV = 32.74%, ICC = 0.646,  $p < 0.001$ ). The figure shows similar segmental patterns for all indices, significant differences only for 2 apical segments between two scans.

##### **CONCLUSION**

DENSE is a reproducible MRI technique for characterizing regional myocardial motion on a per-segment basis in human subjects.

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

In the present study, we demonstrated the overall reproducibility of DENSE for the description of LV motion on a per-segment basis for human subjects.

#### **SSJ04-05 The Relationship between the Transluminal Attenuation Gradient (TAG) Measured from Coronary CT Angiography (CTA) and Coronary Blood Flow: Validation in Left- versus Right-Dominant Circulation**

Tuesday, Dec. 1 3:40PM - 3:50PM Location: S504AB

##### **Participants**

Dimitris Mitsouras, PhD, Boston, MA (*Presenter*) Research Grant, Toshiba Corporation; Speakers Bureau, Toshiba Corporation  
Rani S. Sewatkar, MBBS, Edison, NJ (*Abstract Co-Author*) Nothing to Disclose  
Mukta Agarwal, MD, Boston, MA (*Abstract Co-Author*) Nothing to Disclose  
Andreas Giannopoulos, MD, Boston, MA (*Abstract Co-Author*) Nothing to Disclose  
Marcus Y. Chen, MD, Bethesda, MD (*Abstract Co-Author*) Institutional research agreement, Toshiba Corporation  
Frank J. Rybicki III, MD, PhD, Ottawa, ON (*Abstract Co-Author*) Research Grant, Toshiba Corporation;  
Elizabeth George, MD, Boston, MA (*Abstract Co-Author*) Nothing to Disclose  
Michael Cheezum, MD, Boston, MA (*Abstract Co-Author*) Nothing to Disclose

##### **PURPOSE**

TAG characterizes the dropoff in contrast enhancement across a coronary artery in a CT angiogram. We sought to validate a theoretical relationship to coronary flow using the known relationships of physiologic flow amongst the three main coronary arteries.

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

We hypothesized that during changing inflow contrast concentration (eg, during bolus up-/down-slope), TAG relates to volumetric flow as  $Q \sim \text{Lumen Area [mm}^2\text{]} \times \text{Inflowing Contrast Enhancement Change [HU/sec] / TAG [HU/mm]}$ . TAG and relative flow metrics using this equation were calculated in 25 patients with <25% diameter stenoses imaged with 320-row CTA (AquilionOne, Toshiba), and compared between those with right- (RD) vs left-/co-dominant (LD) circulation. Lumen area was determined for the arterial length used for TAG measurement. For 22 patients with bolus tracking images additionally available, inflow contrast enhancement change during the CTA was estimated in the ascending aorta. TAG-derived flow was averaged for each major coronary artery of LD and RD patients separately, and compared to invasively-measured flows reported in the PREDICTION trial ( $n=496$  patients; Sakamoto et al, Am J Cardiol 2013;111:1420-).

##### **RESULTS**

20 patients were RD and 5 LD. In those with bolus tracking images, TAG-derived flow in the LAD and LCX was within 4-16% of physiologic values; RCA flow was over/underestimated by 21-40%. In terms of physiologic LD/RD ratios, TAG-derived flow in the

LAD for LD vs RD patients was 1.09 (104 vs 92.5 ml/min), which compares well to the known physiologic ratio of 1.07 (2% difference). Similarly, the ratio for the LCX was 1.47 (113 vs 76 ml/min) compared to the physiologic ratio of 1.57 (6% difference), and in the RCA it was 0.37 (56 vs 158 ml/min) compared to 0.50 (26% difference).

## CONCLUSION

The TAG in coronary arteries appears inversely proportional to resting coronary flow. Knowledge of the temporal change of inflow contrast concentration further enables derivation of coronary flow from TAG.

## CLINICAL RELEVANCE/APPLICATION

Knowledge of the relationship of TAG to coronary flow can enhance detection of functionally significant CAD. We have used this relationship to increase TAG accuracy for predicting a significant invasive fractional flow reserve (FFR<0.8), and to obtain more accurate hyperemic blood flow boundary conditions for FFR-CT estimation via computational fluid dynamics.

### SSJ04-06 Feasibility of the Combined CT Assessment of Coronary CT Angiography and Quantitative Myocardial CT Perfusion Imaging for the Detection of Obstructive Coronary Artery Disease Assessed by Invasive Coronary Angiography and Cardiac Magnetic Resonance

Tuesday, Dec. 1 3:50PM - 4:00PM Location: S504AB

#### Participants

Yuki Tanabe, Toon, Japan (*Presenter*) Nothing to Disclose  
Teruhito Kido, MD, PhD, Toon, Japan (*Abstract Co-Author*) Nothing to Disclose  
Takahiro Yokoi, Toon, Japan (*Abstract Co-Author*) Nothing to Disclose  
Naoki Fukuyama, Toon, Japan (*Abstract Co-Author*) Nothing to Disclose  
Ryo Ogawa, MD, Toon, Japan (*Abstract Co-Author*) Nothing to Disclose  
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Yoshiko Nishiyama, MD, Toon, Japan (*Abstract Co-Author*) Nothing to Disclose  
Tomoyuki Kido, Toon, Japan (*Abstract Co-Author*) Nothing to Disclose  
Akira Kurata, PhD, Toon, Japan (*Abstract Co-Author*) Nothing to Disclose  
Masao Miyagawa, MD, PhD, Toon, Japan (*Abstract Co-Author*) Nothing to Disclose  
Teruhito Mochizuki, MD, Toon, Japan (*Abstract Co-Author*) Nothing to Disclose

## PURPOSE

The aim of this study was to evaluate the diagnostic performance of the combined assessment of coronary computed tomography angiography (CTA) and quantitative myocardial CT perfusion (CTP) to identify obstructive coronary artery disease (CAD).

## METHOD AND MATERIALS

The study group comprised consecutive 34 patients (mean age 68.7 years) who underwent combined CT protocol and cardiac magnetic resonance (CMR) prior to invasive coronary angiography (ICA). CT scan protocol consisted of pharmacological stress dynamic myocardial CTP and coronary CTA using 256-slice CT. Obstructive CAD was defined as stenosis  $\geq 50\%$  on ICA with a corresponding myocardial ischemia on CMR. Quantitative CTP assessment was performed with myocardial blood flow (MBF), which was calculated by model-based deconvolution method using semi-automated prototype software (FUJIFILM RI Pharma Co., Ltd., Tokyo, Japan) built on MATLAB (The MathWorks Inc, Natick, MA). A cut-off value of CT-MBF was determined for detecting myocardial ischemia assessed by CMR using receiver operating characteristic (ROC) analysis at a vessel level. The presence of coronary stenosis was assessed with lesions defined as follows: 0-no luminal stenosis; 1-minimal (<25% stenosis); 2-mild (25-49% stenosis); 3-moderate (50-69% stenosis); 4-severe (70-99% stenosis); and 5-occlusion. Coronary stenosis  $\geq 50\%$  or unavailable vessels were defined as significant, and CT-MBF was referred consequently. A vascular territory with a significant stenosis on CTA along with CT-MBF less than the cut-off value was considered to be positive. Diagnostic performance (sensitivity, specificity, positive and negative predictive value [PPV and NPV]) of CTA, CTP and combined assessment (CTA+CTP) for detecting obstructive CAD.

## RESULTS

A cut-off value of CT-MBF was 1.28 ml/g/min. In comparison with ICA and CMR, sensitivity, specificity, PPV and NPV were 97%, 47%, 52% and 97% for CTA, 84%, 76%, 67% and 89% for CTP and 84%, 89%, 82% and 90% for combined assessment. Area under the ROC curve of CTA, CTP and combined assessment were 0.79, 0.83 and 0.88.

## CONCLUSION

Combined CT assessment of CTA and quantitative CTP imaging allows for evaluating obstructive CAD with high diagnostic accuracy using single modality.

## CLINICAL RELEVANCE/APPLICATION

Combined CT protocol of CTA and CTP allows for anatomical and physiological assessment of coronary artery disease with high diagnostic accuracy by using a single modality.

SSJ21

## Physics (Radiation Dose Control II)

Tuesday, Dec. 1 3:00PM - 4:00PM Location: S403A



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

### Participants

Michael F. McNitt-Gray, PhD, Los Angeles, CA (*Moderator*) Institutional research agreement, Siemens AG; Research support, Siemens AG; ; ; ; ;  
Dianna D. Cody, PhD, Houston, TX (*Moderator*) In-kind support, General Electric Company

### Sub-Events

#### SSJ21-01 Novel Concept for Dose Reduction - Region-setting CT: Is Multileaf Collimator Also Valuable for Diagnostic CT?

Tuesday, Dec. 1 3:00PM - 3:10PM Location: S403A

### Participants

Fumio Hashimoto, Toyooka, Japan (*Presenter*) Nothing to Disclose  
Atsushi Teramoto, PhD, Toyooka, Japan (*Abstract Co-Author*) Nothing to Disclose  
Yasuki Asada, PhD, Toyooka, Japan (*Abstract Co-Author*) Nothing to Disclose  
Shouichi Suzuki, PhD, Toyooka, Japan (*Abstract Co-Author*) Nothing to Disclose  
Hiroshi Fujita, PhD, Gifu City, Japan (*Abstract Co-Author*) Nothing to Disclose

### TEACHING POINTS

A region-setting CT system is a prototype of a diagnostic CT applying the conformal irradiation method, and can strongly reduce the radiation dose outside the ROI. However, there has been no reporting about physical implementation of this system. Therefore, we developed the prototype of a region-setting CT system using a multileaf collimator (MLC). The aim of this exhibit is to show the possibility of our prototype CT for clinical use. The teaching points of this exhibit are: 1. The image quality of the region-setting CT is equivalent to that of conventional CT. 2. A region-setting CT cuts the radiation dose outside ROI by 70%.

### TABLE OF CONTENTS/OUTLINE

1. The principle of a region-setting CT method  
2. Explanation of a region-setting CT system - Block diagram and appearance of the experimental system - Procedure of scanning and image reconstruction algorithm  
3. Quantitative evaluation of acquired volume image  
4. Radiation dose - Conventional CT scan vs. a region-setting CT scan

### PDF UPLOAD

[http://abstract.rsna.org/uploads/2015/15017723/15017723\\_6eb1.pdf](http://abstract.rsna.org/uploads/2015/15017723/15017723_6eb1.pdf)

#### SSJ21-02 Diagnostic Accuracy and Radiation Dose Reduction Achievable in Digital Subtraction Angiogram with Elimination of Pre-contrast Images by Simultaneously Triggering X-ray and Contrast Injection

Tuesday, Dec. 1 3:10PM - 3:20PM Location: S403A

### Participants

Karunakaravel Karuppasamy, MBBS, FRCR, Westlake, OH (*Presenter*) Nothing to Disclose  
Bandar O. Safar, MD, Cleveland Heights, OH (*Abstract Co-Author*) Nothing to Disclose  
Ram Kishore R. Gurajala, MBBS, FRCR, Beachwood, NJ (*Abstract Co-Author*) Nothing to Disclose  
Kevin Wunderle, Broadview Heights, OH (*Abstract Co-Author*) Nothing to Disclose  
Maria del Pilar Bayona Molano, MD, Brecksville, OH (*Abstract Co-Author*) Nothing to Disclose  
Amanjit S. Gill, MD, Cleveland, OH (*Abstract Co-Author*) Nothing to Disclose  
Mark J. Sands, MD, Cleveland, OH (*Abstract Co-Author*) Nothing to Disclose  
Randolph M. Setser, DSc, PhD, Cleveland, OH (*Abstract Co-Author*) Employee, Siemens AG

### PURPOSE

To assess the feasibility, measure diagnostic accuracy and estimate radiation dose reduction by using the first post-contrast image as a mask in digital subtraction angiogram (DSA) compared to conventional DSA that uses a pre-contrast image as mask.

### METHOD AND MATERIALS

In this retrospective study, 30 consecutive patients (18 male, 12 female) who had cavogram during IVC filter placement were included (24-iodinated contrast, 6- CO<sub>2</sub>). In the control group, conventional DSA runs were automatically generated using a pre-contrast image as the mask. In the experimental group, from the same DSA runs, pre-contrast images were removed and by re-masking, the first post-contrast image was assigned as the new mask. In the control group, total number of images, number of pre-contrast images and radiation dose per run were recorded. IVC signal to noise (SNR) was measured in both groups. Following metrics were collected independently by two radiologists: Image quality (scale of 1 to 5; not acceptable to excellent subtracted images), diagnostic confidence (scale of 1 to 5; thrombus is definitely present to definitely absent) and suitability for IVC filter placement (scale of 1 to 4; suitability cannot be determined to suitable for infra-renal filter). Paired t-test was used for analysis.

### RESULTS

In the control group, 23 images per run were obtained (SD 6, range 10-33). Kerma area product and reference point air kerma per run were 2371  $\mu\text{Gy}\cdot\text{m}^2$  (SD 1486, range 306-6273) and 86 mGy (SD 53, range 12-241) respectively. On an average, 7 pre-contrast images were acquired per run (SD 2, range 1-11) and this estimates to 32% (SD 9%) radiation dose. SNR (mean 32.9 vs. 32.5,  $p=0.87$ ), image quality (mean 3.95 vs 3.85,  $p=0.33$ ), diagnostic confidence (mean 4.78 vs 4.81,  $p=0.48$ ) and suitability for IVC filter

placement (mean 3.68 vs. 3.85;  $p=0.11$ ) were similar between the groups.

## CONCLUSION

Elimination of pre-contrast images by simultaneously triggering x-ray and contrast injection and using first post-contrast image as mask achieves significant radiation dose reduction with preserved SNR and diagnostic accuracy in selected DSA.

## CLINICAL RELEVANCE/APPLICATION

It is common practice to obtain pre-contrast images and this adds significantly to overall radiation dose in DSA. In our study, the earliest post-contrast image contained very little contrast near the tip of the catheter and did not impact on the diagnostic usefulness when used as a mask to generate DSA run.

### SSJ21-03 Effect of Cardiac Phase-Based Tube Current Modulation on Dose Efficiency in a Clinical CT Scanner

Tuesday, Dec. 1 3:20PM - 3:30PM Location: S403A

#### Participants

Adam Budde, MS, Madison, WI (*Presenter*) Employee, General Electric Company

Kriti Sen Sharma, PhD, BEng, Woburn, MA (*Abstract Co-Author*) Employee, General Electric Company

Brian E. Nett, PhD, Waukesha, WI (*Abstract Co-Author*) Employee, General Electric Company

## PURPOSE

A novel method for improving dose efficiency in cardiac scans has been developed and implemented on a clinical CT scanner. The method modulates the tube current based on knowledge of the weighting function applied to sinogram data in half-scan reconstructions. We assess the image quality and dose efficiency of this method on a wide-cone CT scanner (Revolution CT, GE Healthcare).

## METHOD AND MATERIALS

Phase-based tube current modulation improves dose efficiency by delivering reduced dose to views that are down-weighted during the reconstruction process. A comparison of this method and the clinical baseline, a constant mA protocol, was performed on a 20 cm water phantom. Since the modulation adjusts based on the amount of phase padding prescribed by the user, a further comparison was performed across clinically-used paddings. Image noise at the center of the phantom was measured through region of interest measurements of image pixel variance. 2D noise power spectrums were also measured and, to quantitatively assess noise isotropy, an NPS radial symmetry metric was calculated as the  $(\max - \min) / \max$  of the tangential average of the 2D NPS. All scans used cardiac reconstructions with a gantry rotation period of 280 ms and had equal dose, as determined by the integral of the mA.

## RESULTS

Using 50 ms phase padding, the equal dose mA modulation reduced the image variance by 29.3% at the center reconstructed phase, 26.7% at the reconstructed phases 25 ms from center, and by 12.9% at the reconstructed phases 50 ms from center. When phase padding was reduced from 50 ms to 0 ms, the image variance at the center reconstructed phase showed an improved reduction of 36.8% from the constant mA value. The NPS radial symmetry metric of the center recons was consistent going from constant mA to the 50 ms phase padding modulation case (0.43 to 0.44), but improved on the 0 ms phase padding case (0.31), indicating some noise isotropy improvement.

## CONCLUSION

Phase-based dose modulation improves dose efficiency in cardiac scans on a clinical CT scanner.

## CLINICAL RELEVANCE/APPLICATION

Radiation dose reduction is achieved on cardiac scans of a clinical CT scanner without compromising image noise levels through phase-based tube current modulation.

### SSJ21-04 The Effect of KV Assist on Radiation Dose Reduction and Image Quality for Abdominal CT in Different BMI Groups

Tuesday, Dec. 1 3:30PM - 3:40PM Location: S403A

#### Participants

Ping Hou, MD, Zhengzhou, China (*Presenter*) Nothing to Disclose

Xiang-Nan Feng, MS, Hong Kong, Hong Kong (*Abstract Co-Author*) Nothing to Disclose

Jianbo Gao, MD, Zhengzhou, China (*Abstract Co-Author*) Nothing to Disclose

Jie Liu, Zhengzhou, China (*Abstract Co-Author*) Nothing to Disclose

Yaojun Jiang, MD, Zhengzhou, China (*Abstract Co-Author*) Nothing to Disclose

## PURPOSE

To evaluate the effect of KV Assist on radiation dose reduction and image quality for abdominal CT in different BMI groups

## METHOD AND MATERIALS

100 patients underwent abdominal CT on a new generation spectral CT scanner (Discovery CT, GE healthcare). The patients were divided into 2 groups for prospective analysis. Group A ( $n=50$ ) used KV assist protocol, which automatically selects an optimal kVp based on the scout view. While the conventional 120kVp scan using auto mA protocol was performed on Group B ( $n=50$ ). The main parameters of protocol were setup with noise index of 10, auto mA ranges at 100-450mA and rotation time at 0.8s. Group A and B were both further divided into two subgroups according to BMI ( $\text{BMI} < 24 \text{ kg/m}^2$  for group A1/B1 and  $\text{BMI} \geq 24 \text{ kg/m}^2$  for group A2/B2). CT values and SD values, CNR of CA, PV, liver, pancreas and image quality score in abdomen were measured and calculated. CTDIvol and DLP of each patient was recorded and compared. Comparison between group A and B was implemented as a representative of those for the subgroups. The data were analyzed using Rand-sum test and t test.

## RESULTS



Image noise of protocol A and B in dual-phase were  $(10.70 \pm 2.65)$ ,  $(8.83 \pm 2.38)$  HU and  $(11.27 \pm 3.82)$ ,  $(8.82 \pm 2.25)$  HU, respectively. However, CNR values obtained in group A vs in group B were comparable or higher in both LAP ( $19.99 \pm 9.98$  vs  $18.64 \pm 6.29$  in CA,  $p > 0.05$ ;  $1.13 \pm 1.13$  vs  $1.13 \pm 1.25$  in liver,  $p > 0.05$ ; and  $3.38 \pm 1.64$  vs  $2.64 \pm 1.42$  in pancreas,  $p < 0.05$ ) and PVP ( $8.61 \pm 3.03$  vs  $7.60 \pm 2.88$  in PV,  $p > 0.05$ ;  $4.30 \pm 1.67$  vs  $3.92 \pm 1.65$  in liver,  $p > 0.05$ ; and  $2.91 \pm 1.46$  vs  $2.25 \pm 1.45$  in pancreas,  $p < 0.05$ ). Besides, the difference of the subjective rating scores in protocol A and B were statistically insignificant ( $p = 0.554$ ). Effective dose in group A was significantly lower than that in group B ( $4.6 \pm 2.4$  mSv vs  $6.6 \pm 3.1$  mSv,  $p = 0.02$ ) and was decreased by 30.31%. Percentages of 80kVp, 100kVp, 120kVp and 140kVp scans using KV assist were 31%, 58%, 11% and 0% for group A1, while 0%, 0%, 35%, and 65% for group A2. The radiation dose reduction in group A1 and A2 were 30.18% and 22.71% compared with group B1 and B2.

## CONCLUSION

Abdominal enhanced CT scans using KV assist can provide better image quality and 30.31% radiation dose reduction. Radiation dose reduction on patients with BMI  $< 24$  kg/m<sup>2</sup> was more than patients with BMI  $\geq 24$  kg/m<sup>2</sup>.

## CLINICAL RELEVANCE/APPLICATION

KV assist allows low kVp scans automatically applied on patients with low to moderate BMI and provides good image quality with lower radiation dose.

### SSJ21-05 Optimization of Soft-Tissue Imaging in CT with the Aid of Additional Tin Filtration

Tuesday, Dec. 1 3:40PM - 3:50PM Location: S403A

#### Participants

Marcel L. Dijkshoorn, RT, Rotterdam, Netherlands (*Presenter*) Consultant, Siemens AG

Ronald Booij, RT, Rotterdam, Netherlands (*Abstract Co-Author*) Nothing to Disclose

Marcel Van Straten, PhD, Rotterdam, Netherlands (*Abstract Co-Author*) Research collaboration, Siemens AG

#### PURPOSE

To assess the dose reduction potential of an x-ray tube with additional tin (Sn) filtration in non-enhanced thoracic and abdominal CT.

#### METHOD AND MATERIALS

Eight anthropomorphic thorax and abdomen phantoms varying from  $10 \times 15$  cm<sup>2</sup> to  $30 \times 40$  cm<sup>2</sup> (QRM, Germany) were scanned on a CT scanner (SOMATOM Force, Siemens) with 11 different beam qualities (70, 80, ..., 150 kV, and 100Sn and 150Sn kV) at a fixed 32 cm CT dose index (CTDI) of 3 mGy. Images were reconstructed with an iterative reconstruction algorithm (ADMIRE) at strength 0 and 3 using soft tissue, bone and lung kernels. The contrast-to-noise ratio divided by the square root of the dose (CNRD) was used as the parameter to be optimized. Contrast was assessed with the aid of tabulated mass attenuation coefficients. Noise was measured in lung and liver equivalent tissue. Besides the reported CTDI, dose was measured with an ionization chamber in the centre and periphery of the phantoms.

#### RESULTS

Image contrast was virtually independent of kV and therefore assumed to be constant over all scans. Measured dose relative to the reported CTDI value was approximately 2.5 times higher for the paediatric thorax phantoms at 70 kV. For higher voltages and larger phantom sizes, differences between measured and reported doses ultimately diminished. Optimal CNRD was found at 100Sn. Based on the measured dose and averaged over all phantoms and kernels, the use of 100Sn resulted in a dose reduction of 22% (range 7%-32%). For high resolution kernels in relatively large phantoms, dose reduction potential was less (up to a factor of two) or even absent. Dose reduction amount was independent of ADMIRE strength. Radiation output in terms of mGy/mAs was 11 times lower at 100Sn than at 100 kV. This prohibits the use of 100Sn in large patients and relatively high dose studies. In general, the use of a tube voltage without tin filtration was then the second best choice for the highest CNRD. The beam quality 150Sn was of use in the largest abdomen phantom only.

## CONCLUSION

Tin filtration at 100 kV results in the most optimal beam quality for the complete range of patient sizes. Due to tube limitations this might not always be an option depending on the baseline reference dose of the scan protocol.

## CLINICAL RELEVANCE/APPLICATION

Best results of added tin filtration are to be expected in smaller sized patients and dedicated low dose soft tissue non-enhanced studies such as screening and lung nodule follow-up.

### SSJ21-06 Has the Radiation Dose of the X-ray Equipment Currently Used for Cardiac Intervention Procedures Been Reduced? A Longitudinal and Cross-sectional Study

Tuesday, Dec. 1 3:50PM - 4:00PM Location: S403A

#### Participants

Yohei Inaba, PhD, Sendai, Japan (*Presenter*) Nothing to Disclose

Koichi Chida, PhD, Sendai, Japan (*Abstract Co-Author*) Nothing to Disclose

Masayuki Zuguchi, MD, Sendai, Japan (*Abstract Co-Author*) Nothing to Disclose

#### TEACHING POINTS

-To understand the importance of measuring/optimizing the radiation dose (cineangiography and fluoroscopy) of x-ray systems used for intervention procedure (IR). -To clearly the entrance doses of x-ray equipment used for IR today and in the past. -To clarify the image quality of cineangiography and fluoroscopy of many IR equipment.

#### TABLE OF CONTENTS/OUTLINE

Radiation dose measurement in x-ray systems used for IR -The entrance doses with cineangiography and fluoroscopy were measured. -The entrance doses for many IR x-ray systems in 2014, 2007, and 2001 were compared. Image quality evaluation for cineangiography and fluoroscopy -The spatial resolution and low contrast detectability were quantified in many IR systems. -Relationship between image quality and radiation dose were investigated. SUMMARY: Even today, many case reports have

documented radiation injury resulting from IR. Therefore, the patient dose should be kept as low as reasonably achievable, especially in IR. Although today, the entrance doses of x-ray equipment used for IR tend to be lower than previously, some equipment has a high radiation dose. Adequate parameters, such as the dose mode and additional filters, are necessary. In addition, checking the image quality of IR x-ray systems is significant issue. It is important to optimize the radiation dose and image quality.

**PDF UPLOAD**

[http://abstract.rsna.org/uploads/2015/15009856/15009856\\_dsk2.pdf](http://abstract.rsna.org/uploads/2015/15009856/15009856_dsk2.pdf)



SSJ22

## Physics (CT V-New Development 2)

Tuesday, Dec. 1 3:00PM - 4:00PM Location: S403B



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

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

### Participants

Rebecca Fahrig, PhD, Palo Alto, CA (*Moderator*) Employee, Siemens AG; Stockholder, TibaRay, Inc; ;

### Sub-Events

#### **SSJ22-01 Dose Optimization of a Novel Single-source Dual-energy CT Technique Using Split Filter Technique: In Vitro Assessment of Low-contrast Detectability, Image Quality and Iodine Quantification**

Tuesday, Dec. 1 3:00PM - 3:10PM Location: S403B

### Participants

Andre Euler, MD, Basel, Switzerland (*Presenter*) Nothing to Disclose  
Anna L. Falkowski, Basel, Switzerland (*Abstract Co-Author*) Nothing to Disclose  
Anushri Parakh, MBBS, MD, Basel, Switzerland (*Abstract Co-Author*) Nothing to Disclose  
Sebastian Manneck, Basel, Switzerland (*Abstract Co-Author*) Nothing to Disclose  
David Dashti, Basel, Switzerland (*Abstract Co-Author*) Nothing to Disclose  
Bernhard Krauss, PhD, Forchheim, Germany (*Abstract Co-Author*) Employee, Siemens AG; ;  
Zsolt Szucs-Farkas, MD, PhD, Berne, Switzerland (*Abstract Co-Author*) Nothing to Disclose  
Sebastian T. Schindera, MD, Basel, Switzerland (*Abstract Co-Author*) Research Grant, Siemens AG; Research Grant, Ulrich GmbH & Co KG; Research Grant, Bayer AG

### PURPOSE

To optimize the radiation dose of a dual-energy technique on a single-source CT scanner using a split filter (TwinBeam Dual-Energy, Siemens) by assessing the low-contrast detectability, image quality and iodine quantification.

### METHOD AND MATERIALS

The study used two different phantoms: a custom liver phantom containing 45 low-contrast lesions, placed in a water container mimicking an intermediate-sized patient (diameter: 30 cm) and an abdominal dual-energy phantom (both QRM, Moehrendorf, Germany) with six different iodine concentrations (2.3, 4.5, 5.3, 8.3, 15.8 and 23.5 mgI/ml) and added fat ring (outer dimensions: 35 cm x 25 cm). The phantoms were scanned on a single-source scanner (SOMATOM Edge, Siemens) with (A) single-energy mode at 120 kVp and 130 ref mAs, (B) dual-energy mode at AuSn120 kVp and 640 ref. mAs (default protocol of the manufacturer) and (C) with a dose-optimized dual-energy mode at AuSn120 kVp and 420 ref. mAs (dose-neutral to the single-energy mode). Lesion detection was performed by three radiologists independently. Image noise, CNR and CTDIvol were assessed. Software provided by the vendor was used for iodine quantification. Descriptive statistics and Fisher exact test were applied.

### RESULTS

The CTDIvol measured 7.3, 10.3, and 6.7 mGy for protocol A, B and C, respectively. The image noise was 25% and 13% lower and the CNR 31% and 14% higher with protocol B and C, respectively, compared with protocol A. There was no significant difference in lesion detection rate between the protocols (80%, 78.5%, 80.7% for protocol A, B and C, respectively ( $p=1.0$ )). The error of measurement for the iodine quantification ranged for protocol B from 2.2 to 14.7% and for protocol C from 2.2 to 9.4%.

### CONCLUSION

The phantom study revealed that the novel split filter technique allows dose-neutral dual-energy acquisition on a single-source CT scanner at similar image quality and diagnostic accuracy compared with single-energy while providing the added value of the dual-energy mode.

### CLINICAL RELEVANCE/APPLICATION

Since the split filter dual-energy technique on a single-source CT scanner benefits from the added information like virtual non-contrast, iodine quantification or stone characterization and the dose-neutral aspect, it can replace single-energy protocols in clinical routine.

#### **SSJ22-02 Whole-body Human Imaging with Photon-counting-based CT at Clinically Relevant Doses**

Tuesday, Dec. 1 3:10PM - 3:20PM Location: S403B

### Participants

Cynthia H. McCollough, PhD, Rochester, MN (*Presenter*) Research Grant, Siemens AG  
Shuai Leng, PhD, Rochester, MN (*Abstract Co-Author*) Nothing to Disclose  
Ralf Gutjahr, Munich, Germany (*Abstract Co-Author*) Grant, Siemens AG  
Zhicong Yu, Rochester, MN (*Abstract Co-Author*) Nothing to Disclose  
Zhoubo Li, Rochester, MN (*Abstract Co-Author*) Nothing to Disclose  
Ahmed Halaweish, PhD, Rochester, MN (*Abstract Co-Author*) Employee, Siemens AG  
Steven M. Jorgensen, Rochester, MN (*Abstract Co-Author*) Nothing to Disclose  
Erik L. Ritman, MD, PhD, Rochester, MN (*Abstract Co-Author*) Nothing to Disclose  
Steffen Kappler, Dipl Phys, Forchheim, Germany (*Abstract Co-Author*) Researcher, Siemens AG

### PURPOSE

The aim of this study was to evaluate and assess human anatomy (using cadaveric specimens) at clinically relevant dose rates on a prototype, whole-body, photon-counting-detector CT scanner.

## METHOD AND MATERIALS

A prototype, whole-body CT scanner (Siemens Healthcare, Forchheim, Germany) was installed in our laboratory. The system is built on a Definition Flash dual-source platform, where the "A" tube/detector subsystem uses a conventional energy integrating detector (EID) and the "B" tube/detector subsystem uses a photon-counting detector (PCD). Following biospecimen committee approval and a thorough physics performance evaluation (dose, spatial and low-contrast resolution, CT number accuracy, etc.), a series of scans was performed on a fresh-frozen human cadaver (head and neck, chest, abdomen/pelvis and extremity scans), three cadaveric heads, a cadaveric arm, and a cadaveric leg at clinically relevant doses (140 kV, 200-220 mAs, 0.5 - 1 s rotation time). Images were acquired using two energy thresholds (25 and 65 keV), resulting in the generation of two threshold datasets and two energy bin datasets. Scans were repeated using the EID and identical scan parameters. The EID data were used for data completion to avoid truncation artifacts when the anatomy was outside the PCD field of view (27.5 cm). Side by side comparisons were made between the EID and PCD images.

## RESULTS

Phantom measurements of image and dose performance demonstrated equivalent image quality and dose between the two systems, with the exception of section sensitivity profile, which was better on the PCD due to the smaller detector pixel size (0.5 mm vs 0.6 mm). PCD images of the cadaveric anatomy were judged to be equivalent to the EID images, with the exception of improved quality in regard to beam hardening; the high energy [65,140 keV] PCD images demonstrated notably decreased beam hardening, particularly in the skull. Ring artifacts, which are common in PCD CT systems, were not present.

## CONCLUSION

The evaluated prototype whole-body PCD CT system was capable of clinical levels of image quality at clinical dose rates.

## CLINICAL RELEVANCE/APPLICATION

The ability to perform whole-body CT scanning using photon-counting detector technology will facilitate clinical investigations of this new technology.

### SSJ22-03 Compressed Sensing-Based Computed Tomography Perfusion Imaging: Preliminary Study

Tuesday, Dec. 1 3:20PM - 3:30PM Location: S403B

#### Participants

Esmail Enjilela, PhD, London, ON (*Presenter*) Nothing to Disclose

Ting-Yim Lee, MSc, PhD, London, ON (*Abstract Co-Author*) Research Grant, General Electric Company Royalties, General Electric Company

Jiang Hsieh, PhD, Waukesha, WI (*Abstract Co-Author*) Employee, General Electric Company

Kelley Branch, MD, Seattle, WA (*Abstract Co-Author*) Speakers Bureau, Pfizer Inc

Robb Glenny, Seattle, WA (*Abstract Co-Author*) Nothing to Disclose

Aaron So, PhD, London, ON (*Abstract Co-Author*) Nothing to Disclose

#### Background

CT perfusion (CTP) of the heart comprised of dynamic scanning over time (~ 30 s) as injected contrast agent perfuses through the myocardium to allow for perfusion imaging based on modeled deconvolution. However, dynamic scanning can result in radiation doses as high as 20 mSv. To reduce radiation dose, we developed a low x-ray dose CTP method for quantitative CT myocardial perfusion (MP) imaging from sparsely sampled low-intensity x-ray projections using a compressed sensing (CS) based algorithm. The feasibility of this approach for myocardial perfusion imaging was demonstrated in a pig. We performed prospective ECG-triggered dynamic CT imaging on a 70 kg farm pig at 140 kV and 80 mA/28 mAs (standard mA) using a GE Healthcare Discovery 750 HD CT scanner with contrast injection. The study was then repeated with the mA/mAs decreased to 20/7 (low mA). For standard mA, CTP images were reconstructed from all (984) and from one-third (328) of available projections with filtered backprojection (FBP) and CS respectively. For low mA, CTP images were produced with one-half (492) of projections with CS reconstruction. Quantitative MP maps from five consecutive 5 mm slices of the porcine heart were generated with CT Perfusion software (GE Healthcare). MP measurements from regions in the lateral free wall of the MP maps of these five slices and from ex-vivo gold standard microsphere measurements were compared.

#### Evaluation

Compared with full view FBP MP maps, CS MP maps had biases of -0.01 (95% CI -0.05-0.03) and -0.05 (95% CI 0.16 - 0.07) mL/min/g, respectively, at standard and low mA. When CS MP maps were compared against ex-vivo microsphere MP measurements, the mean bias was found to be -0.12 (95% CI -0.26 - 0.03) and -0.15 (95% CI -0.04 -0.26) mL/min/g, respectively, at standard and low mA.

#### Discussion

Our study demonstrated that when sparsely sampled low-intensity x-ray projections are coupled with CS image reconstruction, quantitative MP maps with low bias can be generated with eight times lower radiation dose than that of our current technique.

#### Conclusion

The drastic reduction in radiation dose with our low-intensity sparse view scheme could facilitate the clinical use of CTP for MP imaging.

### SSJ22-04 Dose or Noise Reduction for Dynamic CT Perfusion: 4D Adaptive Time-Intensity Profile Similarity (aTIPS) Bilateral Filters (BF)

Tuesday, Dec. 1 3:30PM - 3:40PM Location: S403B

#### Participants

Francesco Pisana, Heidelberg, Germany (*Presenter*) Doctoral student, Siemens AG

Thomas Henzler, MD, Mannheim, Germany (*Abstract Co-Author*) Nothing to Disclose

Heinz-Peter Schlemmer, MD, Heidelberg, Germany (*Abstract Co-Author*) Nothing to Disclose  
Stefan O. Schoenberg, MD, PhD, Mannheim, Germany (*Abstract Co-Author*) Institutional research agreement, Siemens AG  
Marc Kachelriess, PhD, Heidelberg, Germany (*Abstract Co-Author*) Nothing to Disclose

## PURPOSE

To significantly reduce image noise or patient radiation dose in dynamic perfusion CT imaging.

## METHOD AND MATERIALS

Due to the continuous x-ray exposure in CT perfusion, low values of tube current time product (e.g. 100 mAs) and tube voltage settings (e.g. 70 kV) are desired to reduce dose. Noise increases considerably, potentially affecting quantitative perfusion values. Recently a time-intensity profile similarity (TIPS) 3D filter has been proposed for denoising of 4D perfusion CT data, weighing each voxel according to the distance from the central voxel, and to their time attenuation curves (TACs) similarity. In a first step we created a digital brain perfusion phantom, to individually optimize and compare TIPS 3D, multi band frequency (MBF) and running average guided bilateral filters (RAGBF). After filter optimization, TIPS 3D showed better results compared to RAGBF and MBF in terms of spatial noise reduction, while noise in temporal domain was still significant for all filters. In a second step TIPS 3D was modified adding an adaptive temporal width and a spatial bilateral guide (aTIPS-BF 4D). Simulated as well as measured patient data from a third generation dual source CT system were processed to validate our approach. Color maps were generated using commercially available software and compared with adaptive Gaussian filter (aGF).

## RESULTS

aTIPS-BF 4D led to significant improvements in terms of ground truth TACs fidelity (sum of squared differences reduced by a factor of 1.8), and spatial resolution (FWHM of line spread function reduced by a factor of 1.4) when compared to TIPS 3D, while CNR improvement factors were comparable (4.37 in aTIPS-BF 4D and 4.8 in TIPS 3D). aTIPS-BF 4D perfusion maps agreed with the ones obtained with aGF (average values  $y=1.0482x+0.0954$   $R^2=0.9845$ , standard deviations  $y=1.0849x+0.1718$   $R^2=0.8743$ ) with the additional benefit of a higher spatial resolution. This led to a higher detection of small ischemic regions in one stroke case and small active spots in a rectum tumor case.

## CONCLUSION

4D aTIPS-BF significantly increases the CNR while preserving perfusion signal and spatial resolution.

## CLINICAL RELEVANCE/APPLICATION

The possibility to reduce image noise (or alternatively patient dose) when employing the aTIPS-BF filter would make quantitative dynamic CT perfusion more robust, potentially leading to a higher clinical acceptance in daily routine.

## SSJ22-05 Impact of Selective Photon Shielding in Image Quality and Detectability Index for Unenhanced CT of the Chest: Study in a Five-year Old Anthropomorphic Phantom

Tuesday, Dec. 1 3:40PM - 3:50PM Location: S403B

### Participants

Juan Carlos Ramirez-Giraldo, PhD, Malvern, PA (*Presenter*) Employee, Siemens AG  
Marilyn J. Siegel, MD, Saint Louis, MO (*Abstract Co-Author*) Research Consultant, Siemens AG; Speakers Bureau, Siemens AG  
Bernhard Schmidt, PhD, Forchheim, Germany (*Abstract Co-Author*) Employee, Siemens AG

## PURPOSE

Evaluate the impact in image quality and detectability index (DI) of the use of selective photon shielding added to an x-ray tube in unenhanced CT of the chest using an anthropomorphic phantom.

## METHOD AND MATERIALS

A tissue-equivalent anthropomorphic five-year old phantom underwent a simulated nonenhanced CT examination of the chest using a third-generation dual-source CT system using two protocols: (A) 100 kV and (B) 100 kV with a selective photon shield which consists of an additional piece of filtration (e.g. tin material) placed in between the x-ray beam and the patient. All scans used 196 x 0.6 mm collimation, pitch = 1.2, and 0.5 s rotation time. Both scans used automatic exposure control, and were set to operate at the same volume CT dose index of 0.6 mGy. Images were reconstructed with a sharp lung kernel at 3 mm thickness. For image quality evaluation, standard measurements of noise and contrast-to-noise ratio (CNR) between air and soft tissue were calculated. Additionally, a more advanced task-based DI was calculated for a 10-mm diameter task with the purpose to simulate lung nodules. The DI is an image quality metric which incorporates into a single calculation the noise, noise power spectra, contrast-dependent spatial resolution, an eye filter, and task functions of varying contrast and size. All measurements were repeated five times. Paired-t tests were used for statistical comparisons.

## RESULTS

Image noise decreased with protocol B relative to A ( $60.9 \pm 3.3$  HU vs  $79.7 \pm 9.0$  HU,  $p < .01$ ), representing a median reduction of 23.0 [22.0 - 23.2]%, while CNR between air and soft tissue increased with protocol B relative to A ( $13.4 \pm 0.7$  vs  $10.3 \pm 1.2$ ,  $p < .01$ ), representing a median increase in CNR of 30.7 [30.4-37.3]%. At the same time, the DI of tasks of 10mm diameter increased with protocol B relative to A ( $46.6 \pm 1.5$  vs  $37.8 \pm 0.9$ ,  $p < .01$ ), representing a median increase of DI of 20.1 [19.7-23.6]%.

## CONCLUSION

At matched scanner output, the image quality of unenhanced CT of the chest is improved when using the selective photon shield as demonstrated by standard metrics such as noise and CNR, while the detectability index of simulated lung nodules of 10 mm was also improved.

## CLINICAL RELEVANCE/APPLICATION

The results of this phantom study suggest that the addition of the selective photon shield improves image quality and the detectability of relevant tasks such as lung nodules in pediatric unenhanced CT of the chest.

## SSJ22-06 Determining the Minimal Required Ultra Low Dose CT for Reliable Attenuation Correction of F-18 FDG PET-CT: A Phantom Study

#### Participants

Ming-Kai Chen, MD, PhD, New Haven, CT (*Presenter*) Nothing to Disclose

Monica Ghita, PhD, Richmond, VA (*Abstract Co-Author*) Nothing to Disclose

David W. Cheng, MD, PhD, New Haven, CT (*Abstract Co-Author*) Consultant, Bayer AG Consultant, Navidea Biopharmaceuticals, Inc

#### PURPOSE

To investigate minimal required sub mSv ultra low dose CT and corresponding tube current and voltage for reliable attenuation correction and semi-quantitation in FDG PET-CT in an effort for radiation dose reduction.

#### RESULTS

The minimal required ultra low dose of CT for precise quantification in all spheres ( $\pm 10\%$ ) were determined by a combination of 100kVp and 10mA for 0.5s, 0.2mGy measured CTDIvol and 0.31mSv estimated effective dose, or 80kVp and 20mA for 0.5s, 0.22mGy and 0.34mSv. Using the data, we could determine the CT parameters for reliable attenuation correction of PET with significant radiation dose reduction.

#### CONCLUSION

Our phantom study provided guidance in using ultra low dose CT for precise attenuation correction and semi-quantification of FDG PET imaging, which can further reduce CT dose and radiation exposure to patients in clinical PET-CT studies. The new iterative reconstruction algorithms available in CT should be further investigated to improve the image quality of the ultra low dose CT images to provide also acceptable anatomical information in the PET-CT study.

#### CLINICAL RELEVANCE/APPLICATION

Based on the data, we can further reduce the radiation dose to sub mSv using an ultra low dose CT for reliable attenuation correction in clinical FDG PET-CT studies.

SSJ20

## Neuroradiology (Neuro-Oncology)

Tuesday, Dec. 1 3:00PM - 4:00PM Location: N229



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

### Participants

Chad A. Holder, MD, Atlanta, GA (*Moderator*) Nothing to Disclose  
Adam E. Flanders, MD, Penn Valley, PA (*Moderator*) Nothing to Disclose

### Sub-Events

#### SSJ20-01 Non-invasive Detection IDH1 Gene Status in Astrocytoma by DSC MRI: A Retrospective Study of 91 Lesions

Tuesday, Dec. 1 3:00PM - 3:10PM Location: N229

### Participants

Wen Li Tan, MD, Shanghai, China (*Presenter*) Nothing to Disclose  
Dao Ying Geng, MD, Shanghai, China (*Abstract Co-Author*) Nothing to Disclose  
Songhua Zhan, MD, Shanghai, China (*Abstract Co-Author*) Nothing to Disclose  
Ji Xiong, MD, Shanghai, China (*Abstract Co-Author*) Nothing to Disclose  
Wei Yuan Huang, MD, Shanghai, China (*Abstract Co-Author*) Nothing to Disclose  
Jin Song Wu, MD, Shanghai, China (*Abstract Co-Author*) Nothing to Disclose

### PURPOSE

To investigate the value of dynamic susceptibility contrast (DSC) magnetic resonance imaging (MRI) in the noninvasive evaluation of isocitrate dehydrogenase (IDH) 1 status in astrocytoma.

### METHOD AND MATERIALS

We retrospectively analyzed the preoperative DSC MRI data of 91 lesions with pathologically confirmed astrocytoma. We obtained the normalized maximum ratios of relative cerebral blood volume (rCBV) of tumor parenchymata. The enrolled astrocytoma patients were divided into six groups according to the World Health Organization (WHO) classification method and IDH1 gene status. We compared the differences in the rCBV ratio of tumor parenchyma between the IDH1 gene mutant and wild-type groups of WHO grades II, 3 and IV and plotted receiver operating characteristic (ROC) curves for imaging indicators showing statistically significant differences.

### RESULTS

The IDH1 gene mutant and wild-type groups of WHO grades II, II and IV astrocytoma showed statistically significant differences in the rCBV ratio. In WHO grade II astrocytoma, the area under the ROC curve value for the rCBV ratio was 0.83, and the cutoff value was 2.20; in WHO grade III astrocytoma, the area under the ROC curve value for the rCBV ratio was 0.86, and the cutoff value was 3.14; in WHO grade IV astrocytoma, the area under the ROC curve value for the rCBV ratio was 0.94, and the cutoff value was 5.63.

### CONCLUSION

The rCBV ratio value provided by DSC MRI provides a new imaging method for the noninvasive evaluation of the IDH1 status in astrocytomas of various WHO grades.

### CLINICAL RELEVANCE/APPLICATION

DSC MRI can noninvasively judge the IDH1 gene status of astrocytomas.

#### SSJ20-02 IDH Mutation Status in Human Glioma is Associated with Differential Activation of Hypoxia and Angiogenesis Related Signaling and is Non-invasively Predictable with rCBV-imaging

Tuesday, Dec. 1 3:10PM - 3:20PM Location: N229

### Participants

Philipp Kickingereder, Heidelberg, Germany (*Presenter*) Nothing to Disclose

### PURPOSE

The recent identification of isocitrate dehydrogenase (IDH) mutations in gliomas and several other cancers suggests that this pathway is involved in oncogenesis; however effector functions are complex and yet incompletely understood. To study the regulatory effects of IDH on hypoxia-inducible-factor 1-alpha (HIF1A), a driving force in hypoxia-initiated angiogenesis, we performed mRNA-expression and functional, as well as genotype/imaging phenotype correlation analysis.

### METHOD AND MATERIALS

We studied differential mRNA-expression profiles from 288 samples with low-grade and anaplastic gliomas from The Cancer Genome Atlas (TCGA) of HIF1A and related downstream signaling on a single-gene and pathway level, as well as upstream biological causes and probable downstream effects between mutant and wild-type IDH tumors. Genotype/imaging phenotype correlation analysis was performed in a separate (local) dataset with relative cerebral blood volume (rCBV) MRI - an estimate of tumor angiogenesis - in 72 treatment-naive patients with low-grade and anaplastic gliomas.

### RESULTS

We show decreased expression of HIF1A-target genes on a single-gene and pathway level, strong inhibition of upstream regulators such as HIF1A and downstream biological functions such as angio- and vasculogenesis in IDH-mutant tumors. Our radiogenomic imaging approach revealed increased levels of rCBV in IDH wild-type tumors, where a one-unit increase in rCBV corresponded to a two-third decrease in the odds for an IDH-mutation and correctly predicted IDH mutation status in 87% of patients.

## CONCLUSION

Together, these findings show that IDH-mutation status is associated with a distinct angiogenesis transcriptome signature which correlates with rCBV-imaging findings and highlight the potential future role of radiogenomics for noninvasive profiling of cancer genomic key events.

## CLINICAL RELEVANCE/APPLICATION

IDH-mutation status in human glioma is associated with a distinct angiogenesis transcriptome signature which correlates with rCBV-imaging findings and highlight the potential future role of radiogenomics for noninvasive profiling of cancer genomic key events.

### SSJ20-03 The Added Prognostic Value of ADC in Glioblastomas Treated with Temozolomide: Correlation with MGMT Promoter Methylation Status and Survival Analysis

Tuesday, Dec. 1 3:20PM - 3:30PM Location: N229

#### Participants

Yoon Seong Choi, MD, Seoul, Korea, Republic Of (*Abstract Co-Author*) Nothing to Disclose  
Ho Joon Lee, Seoul, Korea, Republic Of (*Presenter*) Nothing to Disclose  
Mina Park, MD, Seoul, Korea, Republic Of (*Abstract Co-Author*) Nothing to Disclose  
Sung Soo Ahn, MD, Seoul, Korea, Republic Of (*Abstract Co-Author*) Nothing to Disclose  
Jinna Kim, MD, Seoul, Korea, Republic Of (*Abstract Co-Author*) Nothing to Disclose  
Seung-Koo Lee, MD, PhD, Seoul, Korea, Republic Of (*Abstract Co-Author*) Nothing to Disclose

## PURPOSE

The prognostic value of ADC in patients with glioblastoma treated with temozolomide, and relationship between ADC and MGMT promoter methylation status are controversial. We investigated the added prognostic value of ADC in combination with MGMT in glioblastomas treated with temozolomide, and the association between ADC and MGMT promoter methylation status, using histogram analysis.

## METHOD AND MATERIALS

This retrospective study consisted of 72 consecutive patients who underwent preoperative DTI for glioblastoma, and operation followed by CCRT with temozolomide. The histogram parameters of ADC, including mean, minimum, 5th (p5), 25th (p25), 50th (p50), 75th (p75), 95th (p95) percentile and maximum values, skewness and kurtosis were calculated from entire enhancing tumors. Univariate analyses for overall survival (OS) were performed with ADC parameters according to MGMT methylation status and other clinical factors. Multivariate Cox regression was performed to build prognostic models with and without ADC parameters. The performance of each model was compared using Harrell's concordance index. In addition, the difference of ADC histogram parameters according MGMT promoter methylation status was assessed using Student t-test.

## RESULTS

In univariate analysis, only lower p75 of ADC was significantly associated with worse OS in overall patients, and lower mean and p75 of ADC in patients with unmethylated MGMT. No parameters of ADC were significantly prognostic in patients with methylated MGMT. Other significant prognostic factors were age and enhancing tumor volume, as well as MGMT methylation status. In multivariate analysis, mean and p75 of ADC were independently prognostic in patients with unmethylated MGMT. The performance of prognostic models were significantly improved when mean and p75 of ADC were added to dichotomize the patients with unmethylated MGMT. Any of ADC parameters was significantly different according MGMT methylation status.

## CONCLUSION

Lower ADC histogram parameters were associated with worse prognosis of glioblastoma treated with temozolomide, especially those with unmethylated MGMT. ADC histogram parameters may have the added prognostic value in combination with MGMT in patients with glioblastoma.

## CLINICAL RELEVANCE/APPLICATION

Preoperative ADC histogram analysis has the added prognostic value in combination with MGMT methylation status, in patients with glioblastoma treated with temozolomide.

### SSJ20-04 The Role of Advanced CT and MRI Perfusion Imaging in Differentiating Diagnosis between Gliomas Masquerading as Acute Cerebral Stroke- Eight-year Experience in a Single Institution

Tuesday, Dec. 1 3:30PM - 3:40PM Location: N229

#### Participants

Xiang Liu, MD, Rochester, NY (*Presenter*) Nothing to Disclose  
Wei Tian, MD, PhD, Rochester, NY (*Abstract Co-Author*) Nothing to Disclose  
Sven E. Ekholm, MD, Rochester, NY (*Abstract Co-Author*) Nothing to Disclose

## PURPOSE

Stroke mimics could account for 3 - 13% of patients primarily diagnosed and treated as acute stroke, thrombolysis in stroke mimics is not only unnecessary and costly, but will delay a correct diagnose/treatment and may result in complications, including hemorrhage. Gliomas could present similar clinical symptom and conventional neuroimaging finding as acute brain stroke. The purpose of this study is to evaluate the value of advanced CT and MRI perfusion imaging in such differential diagnosis.

## METHOD AND MATERIALS

CT and/or MR perfusion imaging findings in 1096 cases with suspected acute stroke onset in eight years of period were reviewed.



There were 22 cases with pathology confirmed gliomas, presenting acute onset of symptoms and conventional neuroimaging findings similar as acute stroke. The ratios of relative cerebral blood volume (rCBV), relative cerebral blood flow (rCBF), and mean transit time (MTT) were evaluated and compared with these stroke patients.

## RESULTS

These 22 stroke-mimicking gliomas are malignant, including 13 Anaplastic astrocytomas, WHO grade III; and 9 glioblastomas, WHO Grade IV. All these gliomas showed non-enhancement or mild enhancement in post-contrast T1WI, and increased rCBV, rCBF and MTT compared to contralateral references, ( $p < 0.001$ , paired t-test). The mean rCBV, rCBF and MTT values of ischemic stroke lesions were significantly lower than contralateral hemisphere ( $p < 0.001$ , paired t-test). The ischemic lesions with re-perfusion could present mixed decreased and increased perfusion within the lesions. The maximal rCBV ratio ( $1.83 \pm 0.57$ ,  $p = 0.022$ ) and rCBF ratio ( $2.91 \pm 0.82$ ,  $p < 0.001$ ) of gliomas were significantly higher than ischemic lesions with re-perfusion (maximal rCBV ratio  $1.16 \pm 0.13$ , maximal rCBF ratio  $1.35 \pm 0.18$ ; mann-whitney U test)

## CONCLUSION

Our study shows that the gliomas mimicking symptom and imaging of acute stroke present higher perfusion than acute cerebral ischemic lesions. Carefully interpretation of multi-parameters derived from advanced CT and MRI perfusion imaging is useful in differentiating between gliomas mimicking acute stroke lesions.

## CLINICAL RELEVANCE/APPLICATION

The perfusion imaging is important and adjuvant tool for accurate diagnosis in differentiating between gliomas mimicking acute stroke lesions.

### SSJ20-05 Clinical Performance Characteristics of Multivoxel Magnetic Resonance Spectroscopy in Distinguishing Between True Progression and Pseudoprogression in a Series of Patients with High-Grade Glial Neoplasm

Tuesday, Dec. 1 3:40PM - 3:50PM Location: N229

#### Participants

Jason M. Johnson, MD, Houston, TX (*Presenter*) Nothing to Disclose  
Rutvij J. Shah, MBBS, Houston, TX (*Abstract Co-Author*) Nothing to Disclose  
Leena M. Ketonen, MD, PhD, Houston, TX (*Abstract Co-Author*) Nothing to Disclose  
Dawid Schellingerhout, MD, Houston, TX (*Abstract Co-Author*) Nothing to Disclose  
Komal B. Shah, MD, Houston, TX (*Abstract Co-Author*) Nothing to Disclose  
Norman E. Leeds, MD, Houston, TX (*Abstract Co-Author*) Nothing to Disclose  
Ashok J. Kumar, MD, Houston, TX (*Abstract Co-Author*) Nothing to Disclose  
Rivka R. Colen, MD, Houston, TX (*Abstract Co-Author*) Nothing to Disclose

## PURPOSE

Rates of pseudoprogression (PsP) following chemoradiotherapy can be as high as 30% and can present a significant clinical and diagnostic burden. Early differentiation between true progression (TP) and PsP affects management decisions particularly in the era of progressive individualized treatments. We sought to review the clinical performance characteristics of MRS in a group of high-grade glial based neoplasm presenting for differentiation of PsP from TP.

## METHOD AND MATERIALS

66 patients with high-grade glial neoplasm (GBM or AA) imaged during 2014 with MRI of the brain including multivoxel MRS with TE of 144 ms were evaluated. Patients were required to have either pathology follow-up or six-months of clinical and imaging follow-up to assess for accuracy. MRS solely was assessed for choline to NAA ratio within suspicious tissue as well as relative choline within suspicious tissue to normal brain parenchyma. A threshold of 2 for Cho/NAA and of  $>1.5$  for relative choline concentrations were used as a guideline. Prior imaging and concurrent anatomic brain sequences were not reviewed.

## RESULTS

Out of the 66 cases reviewed 23 patients were removed from further analysis due to unreliable MRS data. Of the remaining 33 cases (mean age 56 years, 19 males), high-grade glial neoplasm was suspected in 16 cases and not suspected in 17 cases. 15 out of 16 cases suspicious for TP were correct. MRS not thought to be consistent with TP was correct in 16/17 cases. Sensitivity = 93.8% ; Specificity = 94.1% ; PPV = 93.8% ; NPV = 94.1%. The majority of excluded cases were due to calvarial lipid contamination into the shim box. Modest choline elevations were seen in many voxels of suspicious tissue.

## CONCLUSION

High-quality multivoxel MRS is an excellent predictor of high-grade glial neoplasm versus pseudoprogression. Rigorous choline elevation thresholds for tumor versus radiation necrosis must be applied due to the common presence of modestly elevated choline concentrations in the post-treated tissue. Relying upon choline to NAA ratios alone should be done cautiously when a comparative voxel of normal appearing brain is not available for review.

## CLINICAL RELEVANCE/APPLICATION

High quality multivoxel MRS at TE of 144 can provide a high level of accuracy and additional confidence in the evaluation of the post-treatment brain for recurrent high-grade glial based neoplasm.

### SSJ20-06 Investigating Dynamic Susceptibility-weighted Contrast-enhanced (DSC) Perfusion MR Imaging in Posterior Fossa Tumors: Differences and Similarities with Supratentorial Tumors

Tuesday, Dec. 1 3:50PM - 4:00PM Location: N229

#### Participants

Matia Martucci, MD, Rome, Italy (*Presenter*) Nothing to Disclose  
Simona Gaudino, MD, Rome, Italy (*Abstract Co-Author*) Nothing to Disclose  
Annibale Botto, Rome, Italy (*Abstract Co-Author*) Nothing to Disclose  
Anna D'Angelo, Rome, Italy (*Abstract Co-Author*) Nothing to Disclose



Tommaso Tartaglione, MD, Rome, Italy (*Abstract Co-Author*) Nothing to Disclose  
Emma Gangemi, Rome, Italy (*Abstract Co-Author*) Nothing to Disclose  
Emanuela Ruberto, Rome, Italy (*Abstract Co-Author*) Nothing to Disclose  
Rosellina Russo, Rome, Italy (*Abstract Co-Author*) Nothing to Disclose  
Cesare Colosimo, MD, Rome, Italy (*Abstract Co-Author*) Nothing to Disclose

## PURPOSE

DSC perfusion is routinely used in brain tumor imaging, for its added value in glioma grading and tumor differentiation. However, compared to supratentorial tumors (ST), there are only few data about its reliability and its cut-off values for infratentorial tumors (IT). Thus, the aims of our study were: 1- to assess the accuracy of DSC perfusion in the evaluation of IT, for glioma grading and tumor differentiation 2- to evaluate differences and similarities with ST.

## METHOD AND MATERIALS

This retrospective study included 114 patients (3-85 years) with a pathologically proven diagnosis of brain tumor (40 IT, 70 ST), divided in 4 groups: high grade glioma (HGG), low grade glioma (LGG), metastases (MET), primary central nervous system lymphoma (PCNSL). rCBV, mean and min PSR were calculated. For statistical analysis lesions were divided according to the location and histology. Mann-Whitney U test was used to test the differences; accuracy, sensitivity, specificity, PPV and NPV for rCBV and PSR were calculated from ROC curves.

## RESULTS

For IT, rCBV had high accuracy in differentiating HGG from LGG ( $p < 0.001$ ) and PSR (mean and min) resulted significantly higher in PCNSL and HGG compared to MET ( $p < 0.001$ ), showing a good accuracy ( $AUC > 0.9$ ). Comparing IT with ST, some perfusion parameters resulted similar: high rCBV in HGG, high mean PSR in PCNSL, low mean PSR in MET. Main differences between ST and IT were: the optimum threshold value of rCBV (3.05 for ST, 1.89 for IT), the mean PSR significantly higher in LGG than in HGG in ST ( $p = 0.001$ ) and a trend of higher perfusion values in ST. Exchanging of rCBV threshold values between ST and IT decreased both sensitivity and specificity.

## CONCLUSION

rCBV and PSR are helpful in grading and differentiating IT. The overall behaviour of perfusion parameters was similar between ST and IT, but some differences in rCBV and PSR were demonstrated. The difference of rCBV threshold value between ST and IT - to distinguishing HGG from LGG - might be of high clinical relevance, and in our opinion deserves consideration.

## CLINICAL RELEVANCE/APPLICATION

Our study suggests that different rCBV cut-off values should be applied in IT. In fact, our results demonstrated a different optimum threshold value of rCBV for IT (1.89) compared to ST (3.05).

**Vascular/Interventional (Innovation in Non-hepatic Tumor Ablation)**

Tuesday, Dec. 1 3:00PM - 4:00PM Location: N230

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

Juan C. Camacho, MD, Atlanta, GA (*Moderator*) Nothing to Disclose  
 Naganathan B. Mani, MD, Chesterfield, MO (*Moderator*) Nothing to Disclose

**Sub-Events****SSJ26-01 Percutaneous Soft Tissue Cryoablation of the Head and Neck: A Safe and Effective Treatment Option**

Tuesday, Dec. 1 3:00PM - 3:10PM Location: N230

**Participants**

Hussein D. Aoun, MD, Dearborn, MI (*Presenter*) Nothing to Disclose  
 Fatima Memon, MD, Detroit, MI (*Abstract Co-Author*) Nothing to Disclose  
 Mohamed M. Jaber, MD, Detroit, MI (*Abstract Co-Author*) Nothing to Disclose  
 Barbara A. Adam, MSN, Detroit, MI (*Abstract Co-Author*) Nothing to Disclose  
 Evan N. Fletcher, MS, BA, Detroit, MI (*Abstract Co-Author*) Nothing to Disclose  
 Matthew Prus, BS, Detroit, MI (*Abstract Co-Author*) Nothing to Disclose

**PURPOSE**

To assess the technical feasibility and local outcomes of cryoablation for head and neck masses. We hypothesize that head and neck cryoablation responds similarly in terms of recurrence, complication and/or healing rates, regardless of anatomic location and tumor type.

**METHOD AND MATERIALS**

42 CT and/or US-guided, percutaneous cryotherapy procedures were performed for 55 tumors from primary (22) and metastatic cancers (33), in 20 patients. In general, cases were selected to avoid major cranial nerves, skin, and endoluminal involvement. Tumor number and type, prior treatment regimens, ablation volumes, location, abutting vessels >3mm, recurrences, and procedural complications were noted. Complications were graded according to Common Terminology Criteria for Adverse Events Version 4.0 (CTCAE). Local tumor recurrence and involution was monitored over time with 1, 3, 6, 12 month and annual scans thereafter.

**RESULTS**

Percutaneous cryoablation was performed under conscious sedation, with only one patient requiring intubation due to anticipated pharyngeal swelling post-procedure. The 22 primary tumors consisted solely of squamous cell carcinoma and the metastases were from lung (11), osteosarcoma (5), renal (4), sarcoma (3), and other (10) in origin. Of the 42 total procedures, 10 procedures involved multiple tumors being ablated in the same session. Average diameters of tumor and ablation zone were 2.5 cm and 4.2 cm, respectively. Major complications (CTCAE Grade >3) occurred after 2 procedures (4.8%). Of the 2 complications, one was a facial skin debridement as a result of thorough cryoablation coverage. Mean follow-up was 1.7 years (range: 0.03-5.33 years). Although recurrence rates were higher for primary, there was no statistically significant difference in local recurrence rates for primary and metastatic tumors, 18.2% (4/22) and 3.0% (1/33) ( $p>0.05$ ), respectively. All sites of cryoablation involuted to minimal scar formation after 9 months.

**CONCLUSION**

CT/US guided PCA is a safe, effective local cancer control option for oligo-metastatic patients with soft tissue tumors in the head and neck region. With appropriate precautions, local healing is excellent.

**CLINICAL RELEVANCE/APPLICATION**

Oligometastatic disease is becoming more common with improved systemic treatments. Cryoablation of tumors contributes to improved local control for many tumor types, particularly for those having 'escaped' other treatments

**SSJ26-02 Breast Tumors Treated with Imaging-guided Percutaneous Ablation: Systematic Review and Meta-analysis**

Tuesday, Dec. 1 3:10PM - 3:20PM Location: N230

**Participants**

Giovanni Mauri, MD, San Donato Milanese, Italy (*Abstract Co-Author*) Consultant, Esaote SpA  
 Maria P. Fedeli, San Donato Milanese, Italy (*Abstract Co-Author*) Nothing to Disclose  
 Lorenzo C. Pescatori, MD, San Donato Milanese, Italy (*Presenter*) Nothing to Disclose  
 Gianni Di Leo, Milan, Italy (*Abstract Co-Author*) Nothing to Disclose  
 Francesco Sardanelli, MD, San Donato Milanese, Italy (*Abstract Co-Author*) Speakers Bureau, Bracco Group Research Grant, Bracco Group Speakers Bureau, Bayer AG Research Grant, Bayer AG Research Grant, IMS International Medical Scientific  
 Luca Maria Sconfienza, MD, PhD, San Donato Milanese, Italy (*Abstract Co-Author*) Nothing to Disclose

**PURPOSE**

The aim of this study was to systematically review studies on imaging-guided percutaneous treatment of breast tumors.

**METHOD AND MATERIALS**

In March 2015 a literature search was performed on MEDLINE, EMBASE and the Cochrane Database of Systematic Reviews using

the keywords "radiofrequency", "microwave", "laser", "percutaneous", "high-intensity focused ultrasound" (HIFU), "cryoablation", "breast", "cancer" and "ablation". We analyzed only original English literature. For each article we collected information about number of patients, technical success and effectiveness, and minor (local discomfort, burns grade 1) and major (burns grade 2 or 3, necrosis, pneumothorax) complication rate. Studies including <10 patients were excluded. Heterogeneity (I<sup>2</sup>) was evaluated using the Cochrane Q statistics: P-value <0.100 was considered significant and the random-effect model was used to pool the data. Pooled data were given as point estimate and 95% confidence interval.

## RESULTS

A total of 688 articles were initially retrieved, 638 were excluded based on abstract or full text. Fifty articles were finally analyzed, for a total of 1253 patients. The used technique was radiofrequency in 24 articles (576 patients), HIFU in 9 (211 patients), cryoablation in 7 (161 patients), laser in 7 (227 patients), microwave in 3 (78 patients). Range of tumor size was 4-60 mm. Overall technical success and effectiveness were 96% (94%-97%) and 76% (67%-83%), respectively. At subgroup analysis 96% (94%-97%) and 83% (76%-89%) for RFA; 96% (93%-98%) and 62% (36%-83%) for HIFU; 96% (90%-98%) and 73% (44%-90%) for cryoablation; 98% (95%-100%) and 55% (23%-83%) for laser ablation; 93% (81%-97%) and 90% (77%-96%) for microwaves. In subgroup analysis, the difference of technical effectiveness among techniques was borderline significant (P=.052). Overall minor complication rate was 10% (6%-16%); overall major complication rate was 6% (5%-8%).

## CONCLUSION

Percutaneous thermal ablations of breast tumor are technically feasible; radiofrequency and microwaves showed higher effectiveness.

## CLINICAL RELEVANCE/APPLICATION

Percutaneous thermal ablation of breast tumors is technically feasible; radiofrequency and microwaves seems to be more effective, even if high heterogeneity is present in various studies. Further investigations are needed to better clarify the issue.

## SSJ26-03 Dynamic Contrast Enhanced MRI for Response Monitoring after Vertebral Body Cryoablation

Tuesday, Dec. 1 3:20PM - 3:30PM Location: N230

### Participants

Rebecca Krims, DVM, MS, Baltimore, MD (*Abstract Co-Author*) Nothing to Disclose  
Dara L. Kraitichman, DVM, PhD, Baltimore, MD (*Abstract Co-Author*) Nothing to Disclose  
Romiesha Hagoug, BSC, London, United Kingdom (*Abstract Co-Author*) Employee, Image Analysis Ltd  
Diana Roettger, PhD, London, United Kingdom (*Abstract Co-Author*) Employee, Image Analysis Ltd  
Jonathan S. Lewin, MD, Baltimore, MD (*Abstract Co-Author*) Nothing to Disclose  
Jan Fritz, MD, Baltimore, MD (*Presenter*) Research Grant, Siemens AG; Research Consultant, Siemens AG; Speaker, Siemens AG

## PURPOSE

MRI monitoring of osseous cryoablation is desirable. However, expected, chronic MRI changes are not well defined. Dynamic contrast enhanced (DCE) MRI is a function of tissue perfusion and, thus, a marker for tissue viability. Therefore, we sought to prospectively define the longitudinal DCE MRI perfusion parameter changes after vertebral body cryoablation.

## METHOD AND MATERIALS

MR-guided vertebral body cryoablations were performed in four healthy, juvenile Yorkshire pigs at two vertebral locations at 1.5 Tesla. Standard DCE MRI was performed 30 minutes after cryoablation (baseline) and repeated 10-13 days later (follow-up). DCE parameters were obtained using software (Dynamika, Image Analysis Ltd, London, UK) and included color-coded gadolinium maps for persistent, plateau or washout signal intensity curves, initial rate of enhancement (IRE), and maximum enhancement (ME). DEMRIQ scores were calculated as  $DEMRIQ\_IRE = IRE_{mean} * (Number\ of\ Plateau\ Pixels + Number\ of\ Washout\ Pixels)$  and  $DEMRIQ\_ME = ME_{mean} * (Number\ of\ Plateau\ Pixels + Number\ of\ Washout\ Pixels)$ . P values were calculated using a Wilcoxon Signed Rank test.

## RESULTS

All ablation zones demonstrated initially complete absence of gadolinium perfusion, whereas the surrounding ventral body bone marrow was intact. Compared to baseline, the ablation zone decreased in size at follow-up in 8/8 (100%) vertebral bodies and completely disappeared in 4/8 (50%) with parameters indicating increased marrow perfusion along the margin of the ablation zone. Comparing baseline and follow-up, mean plateau pixels increased from  $750 \pm 644$  (range, 205-1926) to  $806 \pm 474$  (269-1546) ( $p < .01$ ), mean washout pixels from  $115 \pm 86$  (4-233) to  $398 \pm 316$  (15-853) ( $p < .01$ ), mean DEMRIQ\_IRE scores from  $2.98 \pm 1.53$  (0.91-5.81) to  $6.60 \pm 3.96$  (2.30-14.39) ( $p < .05$ ) and mean DEMRIQ\_ME scores from  $1345 \pm 909$  (396-2880) to  $1855 \pm 966$  (793-3519) ( $p < .01$ ).

## CONCLUSION

Our results suggest that DCE MRI can be used to visualize the cryoablation zone. Longitudinal changes in parameters suggest a healing response with marrow hyperperfusion along the margins of the ablation zone and centripetal healing in normal swine. Clinical relevance of these findings is ongoing.

## CLINICAL RELEVANCE/APPLICATION

Longitudinal DCE MRI parameters may be a means to monitor response and healing after percutaneous cryoablation therapy.

### Honored Educators

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

Jonathan S. Lewin, MD - 2012 Honored Educator

## SSJ26-04 CT-guided Placement of Hyperthermia Catheters to Support Regional Deep Hyperthermia for Cancer Treatment: Results in 47 Patients

#### Participants

Patric Kroepil, MD, Duesseldorf, Germany (*Abstract Co-Author*) Nothing to Disclose  
Rudiger Wessalowski, Dusseldorf, Germany (*Abstract Co-Author*) Nothing to Disclose  
Peter Liersch, Duesseldorf, Germany (*Abstract Co-Author*) Nothing to Disclose  
Christoph K. Thomas, MD, Dusseldorf, Germany (*Abstract Co-Author*) Speaker, Siemens AG  
Gerald Antoch, MD, Duesseldorf, Germany (*Abstract Co-Author*) Nothing to Disclose  
Rotem S. Lanzman, MD, Duesseldorf, Germany (*Presenter*) Nothing to Disclose

#### PURPOSE

Percutaneous hyperthermia catheter allow for the placement of Bowman probes for temperature measurements inside the tumor during deep regional hyperthermia treatment. The aim of this study was to evaluate the safety and effectiveness of CT-guided placement of percutaneous hyperthermia catheter in patients with sarcoma or recurrent malignancies.

#### METHOD AND MATERIALS

Forty-seven patients (23 female, 24 male, mean age  $45.9 \pm 15.7$  years) scheduled for regional deep hyperthermia treatment of primary sarcoma (n=34) or recurrent malignancies (n=13) were included in this retrospective analysis. A total of 52 hyperthermia catheters were placed under CT-guidance into tumors in the upper/lower extremities (n=19), pelvis (n=16), thoracic/abdominal wall (n=7), liver/upper abdomen (n=5) and retroperitoneum (n=5). In all patients, the tumor was approached using a 13G puncture sheath under CT-guidance and a 6F percutaneous hyperthermia catheter (Somatex, Medical Technologies) was placed via the sheath inside the tumor. The duration of the intervention, technical success, periinterventional complications and the distance of the probe within the tumor were analyzed.

#### RESULTS

51 of 52 (98.1%) percutaneous hyperthermia catheters were placed successfully inside the tumor, whereas one catheter was placed adjacent to the tumor. Mean tumor diameter was  $7.8 \pm 4.6$  cm and the mean catheter distance within the tumor was  $6.4 \pm 3.7$  cm. Mean procedure time was  $30.9 \pm 11.0$  min. Periprocedural complications were observed in 2 of 52 (3.8%) patients; one patient developed an abscess along the subcutaneous catheter pathway and one patient had a self-limiting abdominal hematoma. 2 of 52 (3.8%) catheters dislocated within 2 weeks after the procedure.

#### CONCLUSION

CT-guided hyperthermia catheter placement is a safe and reliable method to support treatment control in deep regional hyperthermia for cancer treatment.

#### CLINICAL RELEVANCE/APPLICATION

Deep regional hyperthermia is a promising salvage treatment option for sarcoma and recurrent malignancies. CT-guidance placement of hyperthermia catheter is a safe and reliable procedure and can therefore be recommended to support temperature measurements inside the tumor during deep regional hyperthermia treatment.

#### SSJ26-05 Two Dimensional Principal Strain Analysis of Tissue Deformation during Microwave Ablation

Tuesday, Dec. 1 3:40PM - 3:50PM Location: N230

#### Participants

Dong Liu, Madison, WI (*Abstract Co-Author*) Nothing to Disclose  
Christopher L. Brace, PhD, Madison, WI (*Presenter*) Shareholder, NeuWave Medical Inc; Consultant, NeuWave Medical Inc; Shareholder, Symple Surgical Inc; Consultant, Symple Surgical Inc

#### PURPOSE

The purpose of the study was to quantitatively analyze tissue deformation during microwave ablations

#### METHOD AND MATERIALS

A total of 40 fiducial markers were positioned in a single plane around a triaxial microwave ablation antenna in ex vivo liver, orthogonal to the scan plane. Powers of 50-100W at 2.45GHz (4-6 per group) were applied for 10min. CT data was acquired over entire volume every 15s. CT data was processed with markers classified into outer, middle and inner lines, which were initially 22mm, 15mm and 8mm radially from, and symmetrically oriented on both sides of the antenna. Principal strain magnitude and direction was calculated in the outer, middle and inner regions by using a triangle meshing technique. Normal and shear strain were calculated such that negative strain denoted contraction and positive strain denoted expansion. Time varying strain curves were calculated to evaluate the extents of tissue deformation in each region.

#### RESULTS

On average, the volumetric strain peaked at first and decayed exponentially over time. All strains were negative; no evidence of tissue expansion was observed in contrast with previous reports using a similar technique. Applied energy was correlated to greater negative strain in the inner region ( $R^2=0.9738$ ). In addition, powers over 50W created significantly greater inner strain than 50W (-65.7% and -54.4% for 75W and 100W, respectively, compared to -38.2% for 50W; One way ANOVA,  $p<0.0001$ ). In the outer region which contained the ablation periphery, volumetric strain dropped to -41.9% and -44.3% at 75W and 100W, respectively ( $p>0.05$ ). Both were significantly greater than the strain of -23.7% at 50W ( $p<0.0001$ ). Outer strain angles at 50W, 75W and 100W were -0.8°, -8.1° and 1.0°, respectively. It demonstrates that the strain is oriented nearly parallel to the radial axis such that the diameter of the ablation zone is contracting more than its length. This result is concordant with previous observations.

#### CONCLUSION

Principal strain, a mechanical indicator of tissue deformation, decreases 30-60% during microwave ablation indicating strong tissue contraction. Greater negative strain was observed at higher applied energies in the inner region of ablation zone. Higher diametric contraction indicates ablation zones appear more elongated than the original volume.

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

Tissue deformation during ablation procedures has an important effect on the treatment planning and follow-up.

## Neuroradiology (Advances in Intracranial CT, MR Angiography and Perfusion)

Tuesday, Dec. 1 3:00PM - 4:00PM Location: N226



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

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

### Participants

Rajan Jain, MD, Northville, MI (*Moderator*) Nothing to Disclose  
Pina C. Sanelli, MD, Manhasset, NY (*Moderator*) Nothing to Disclose

### Sub-Events

#### SSJ18-01 A Task-Driven Parameter Optimization Method for Cerebral CT Perfusion Imaging

Tuesday, Dec. 1 3:00PM - 3:10PM Location: N226

### Participants

Ke Li, PhD, Madison, WI (*Presenter*) Nothing to Disclose  
Kai Niu, MS, Madison, WI (*Abstract Co-Author*) Nothing to Disclose  
Yijing Wu, Madison, WI (*Abstract Co-Author*) Nothing to Disclose  
Pengfei Yang, Shanghai, China (*Abstract Co-Author*) Nothing to Disclose  
Howard A. Rowley, MD, Madison, WI (*Abstract Co-Author*) Research Consultant, Bracco Group; Research Consultant, Guerbet SA; Research Consultant, General Electric Company; Consultant, F. Hoffmann-La Roche Ltd; Consultant, W.L. Gore & Associates, Inc; Consultant, Lundbeck Group; ; ; ; ;  
Guang-Hong Chen, PhD, Madison, WI (*Abstract Co-Author*) Research funded, General Electric Company; Research funded, Siemens AG

### PURPOSE

CT perfusion (CTP) imaging offers great opportunities in improving patient selection for endovascular therapy of acute ischemic stroke due to its potential in differentiating ischemic penumbra from the infarct core. However, several challenges in CTP such as poor image quality and high radiation dose have severely reduced its clinical value. This work introduces a task-driven framework to optimize CTP system parameters for improved imaging performance and reduced radiation dose.

### METHOD AND MATERIALS

The proposed framework quantitatively relates image quality metrics (e.g., noise power spectrum or NPS) of the final CTP functional maps with CTP system parameters such as radiation dose and post-processing filter strength. This was achieved by developing a cascaded chain model for the CTP imaging system. To address the limitation of zero-frequency metrics such as the contrast-to-noise ratio (CNR), the framework used the task-based detectability index to quantify the CTP imaging performance. Using this framework, optimization of the post-processing denoising filter was performed for different radiation dose levels, and the optimized system parameters were validated using an in vivo canine stroke model.

### RESULTS

The NPS predicted by the proposed framework had excellent agreement with the experimental data (relative RMSE<2% for all CTP maps). This indicates that the "noisiness" of the CTP maps can be quantitatively related to CTP system parameters and dose levels. Compared with the CNR that favored the strongest spatial filters, the task-based detectability led to much more reasonable optimal filter selection. With these optimized protocols, numerical simulation results demonstrate a relative increase of 101% (95% CI: [23%, 179%]), 172% (95% CI: [67%, 277%]), or 256% (95% CI: [76%, 436%]) in terms of detectability index for CBV, CBF, and MTT maps, respectively. Visual inspection of the in vivo canine results agreed with the simulation results.

### CONCLUSION

The task-driven framework has successfully guided the optimization of CTP imaging systems, potentially enabling a fundamental improvement in the quality and reliability of CTP-based parametric perfusion measurements.

### CLINICAL RELEVANCE/APPLICATION

It is highly desirable for endovascular therapy, which has demonstrated its benefits in recently published clinical trials, to be able to reliably distinguish the penumbra from the infarct core during patient selection.

#### SSJ18-02 Diagnostic Value of Computed Tomography Perfusion and Computed Tomography Angiography Source Images for Detection of Acute Ischemic Stroke in the Posterior Circulation: A Review of 198 Consecutive Patients

Tuesday, Dec. 1 3:10PM - 3:20PM Location: N226

### Participants

Peter Sporns, MD, Munster, Germany (*Abstract Co-Author*) Nothing to Disclose  
Tarek Zoubi, Muenster, Germany (*Abstract Co-Author*) Nothing to Disclose  
Philipp Heermann, MD, Muenster, Germany (*Abstract Co-Author*) Nothing to Disclose  
Sebastian Zimmer, MD, Munster, Germany (*Abstract Co-Author*) Nothing to Disclose  
Walter L. Heindel, MD, Muenster, Germany (*Abstract Co-Author*) Nothing to Disclose  
Wolfram Schwindt, MD, Muenster, Germany (*Abstract Co-Author*) Nothing to Disclose  
Thomas Niederstadt, MD, Munster, Germany (*Abstract Co-Author*) Nothing to Disclose  
Uta Hanning, MD, Muenster, Germany (*Presenter*) Nothing to Disclose

## PURPOSE

Still no consent could be agreed about imaging of Acute Ischemic Stroke (AIS) in the posterior circulation. To our knowledge there exist only two studies investigating the efficacy of Computed Tomography Perfusion (CTP) for stroke detection in the posterior circulation. A recent study proposes an increase of diagnostic accuracy by additional CTP to protocols including only computed tomography angiography (CTA) and noncontrast computed tomography (NCCT), where another blinded study recognized no significant difference in the detection of supratentorial and infratentorial stroke lesions. However patient populations were relatively small. We therefore conducted a research containing a large number of consecutive patients to evaluate the diagnostic value of CTP in acute posterior circulation stroke.

## METHOD AND MATERIALS

We retrospectively evaluated data of consecutive ischemic stroke patients admitted between January 1st 2012 and March 31st 2015 at a tertiary care center. The inclusion criteria for this study were (1) suspected ischemic stroke of the posterior circulation as defined in the Oxfordshire classification; (2) NCCT, CTA and CTP performed on admission; and (3) CT performed <9 hours after symptom onset. For statistical analysis we used three logistic regression models: (1) NCCT, (2) NCCT + CTA-SI and (3) NCCT + CTA-SI + CTP.

## RESULTS

198 patients with suspected posterior circulation stroke fulfilled the inclusion criteria. Admission NCCT detected 26 (19%), CTA-SI 65 (48%), and CTP 109 (80%) of the 136 patients with an infarct in the posterior circulation on follow up imaging. Model 3 (area under the curve (AUC) from the receiver operating characteristic curve (ROC-curve)=0.90; 95% CI, 0.85-0.94) predicted an infarct in the posterior circulation territory better than models 1 (AUC from ROC-curve=0.597; 95% confidence interval, 0.52-0.67) and 2 (AUC from ROC-curve =0.74; 95% confidence interval, 0.67-0.81).

## CONCLUSION

Our findings in a large cohort of consecutive patients show that CTP detects significantly more ischemic strokes in the posterior circulation than CTA and NCCT alone.

## CLINICAL RELEVANCE/APPLICATION

Computed Tomography Perfusion should be added to standard CT- protocols for detection of ischemic stroke in the posterior circulation.

### SSJ18-03 Optimal Acquisition and Modeling Parameters for Accurate Assessment of Low Ktrans Blood Brain Barrier Permeability Using Dynamic Contrast-Enhanced MRI

Tuesday, Dec. 1 3:20PM - 3:30PM Location: N226

#### Participants

Samuel Barnes, PhD, Detroit, MI (*Abstract Co-Author*) Nothing to Disclose

Thomas S. Ng, MD, PhD, Boston, MA (*Presenter*) Nothing to Disclose

Axel Montagne, Los Angeles, CA (*Abstract Co-Author*) Nothing to Disclose

Eu-Meng Law, MBBS, Los Angeles, CA (*Abstract Co-Author*) Speakers Bureau, Toshiba Corporation; Medical Advisory Board, Bayer AG; Medical Advisory Board, Bracco Group; Medical Advisory Board, FUJIFILM Holdings Corporation;

Berislav Zlokovic, Los Angeles, CA (*Abstract Co-Author*) Nothing to Disclose

Russell E. Jacobs, PhD, Pasadena, CA (*Abstract Co-Author*) Nothing to Disclose

## PURPOSE

The purpose of this study is to determine optimal parameters for acquisition and processing of DCE-MRI to detect small changes in near normal low BBB permeability in the human brain. Dynamic contrast-enhanced (DCE) MRI gives quantitative and semi-quantitative information about the integrity of the blood-brain barrier (BBB). Subtle changes of BBB integrity has been implicated in conditions such as Alzheimer's disease, traumatic brain injury and Multiple Sclerosis. The parameter of interest in BBB integrity is the transfer constant Ktrans, which describes the transfer rate of molecules from plasma space into interstitial space; however, optimal methods to collect and analyze DCE data in order to detect subtle changes to BBB integrity remain unclear.

## METHOD AND MATERIALS

A contrast-to-noise ratio metric (K-CNR) was developed to evaluate for Ktrans precision and accuracy estimation as a function of imaging parameters commonly encountered in a DCE-MRI study. Using the K-CNR, the effects of kinetic model selection, scan duration, temporal resolution, signal drift and length of baseline on the estimation of low permeability values were evaluated with clinically consistent simulations.

## RESULTS

The Patlak model was shown to give the highest K-CNR at low Ktrans. The Ktrans transition point, above which other models gave superior results, was highly dependent on scan duration and tissue extravascular extracellular volume fraction (ve). The highest K-CNR for low Ktrans was obtained when Patlak model analysis was combined with long scan times (10-30 minutes), modest temporal resolution (<60 seconds/image), and long baseline scans (1-4 minute). Signal drift as low as 3% was shown to affect the accuracy of Ktrans estimation with Patlak analysis.

## CONCLUSION

DCE acquisition and modeling parameters are interdependent and should be optimized together for the tissue being imaged. Appropriately optimized protocols can detect even the subtlest changes in BBB integrity and may be used to probe the earliest changes in neurodegenerative diseases such as traumatic brain injury, Alzheimer's disease and Multiple Sclerosis.

## CLINICAL RELEVANCE/APPLICATION

We analyzed the effects of DCE-MRI acquisition parameters and model selection to detect subtle changes in blood-brain barrier permeability, which are implicated in several neurodegenerative diseases.

### SSJ18-04 Choosing the Right Arterial Input Function Selection Mode for T1-DCE MRI in the CNS



#### Participants

Vera C. Keil, MD, Bonn, Germany (*Presenter*) Nothing to Disclose  
Philip J. Ditter, MD, Bonn, Germany (*Abstract Co-Author*) Nothing to Disclose  
Rolf Fimmers, Bonn, Germany (*Abstract Co-Author*) Nothing to Disclose  
Juergen Gieseke, DSc, Bonn, Germany (*Abstract Co-Author*) Employee, Koninklijke Philips NV  
Dariusch R. Hadizadeh Kharrazi, MD, Bonn, Germany (*Abstract Co-Author*) Nothing to Disclose  
Hans H. Schild, MD, Bonn, Germany (*Abstract Co-Author*) Nothing to Disclose  
Anna M. Vogelgesang, Bonn, Germany (*Abstract Co-Author*) Nothing to Disclose

#### PURPOSE

When applying T1-DCE MRI in the CNS, the right selection technique for the arterial input function (AIF) is a disputed question. AIF selection bias is a major obstacle for clinical implementation of the method. This study is aimed to determine the AIF selection mode that allows the most coherent and robust results of T1-DCE parameters.

#### METHOD AND MATERIALS

76 patients with various brain lesions underwent a T1-DCE scan MRI at 3.0 T (Philips Achieva TX, 8-channel head coil): 36 axial slices, TE=1.7 ms, 2 dual flip angle series, dynamic sequence: 50 scans; 12 scans/min.; contrast agent (CA) gadobutrol (0.1 mmol/kg BW; Bayer Healthcare). T1-DCE parameters Ktrans and ve were calculated with Intellispace software (Philips Healthcare). Regions of interest (ROI) were placed in different image slices. The manual AIF was derived from a 7x7 pixel ROI. 4 classical AIF selection modes were tried: (1) a Parker model based selection (MB), manual AIF selection in (2) the terminal ACI, (3) the blood vessel closest to the lesion (CV) and (4) the superior sagittal sinus (SSS, Fig. 1). Reliability of the AIF was approximated by presence of the expected curve shape, peak CA concentration and plausibility of calculated ve (< 100%). Ktrans values resulting from all AIF selection methods were compared for consistency between cases.

#### RESULTS

1085 ROI in brain tissue were the basis of all calculations. Using the SSS AIF, ve is significantly less overestimated compared to ACI or CV AIF ( $p < 0.001$ ). ROI CA peaks falsely exceed AIF peaks significantly more often in ACI or CV AIF than in SSS AIF ( $p < 0.0001$ ). CA peaks are significantly higher in SSS AIF ( $p < 0.001$ ). For glioma, the range of Ktrans values based on SSS AIF correlates best with expected ranges. Peak CA values correlate poorly between AIF selection methods except for ACI and CV AIF ( $r=0.515$ ); T1-DCE parameters differed highly depending on AIF selection method ( $p < 0.001$ ).

#### CONCLUSION

A ROI placement in the SSS for manual AIF selection produces significantly more trustworthy results compared other selection methods in T1-DCE MRI. ROI placements in the ACI and the CV frequently underestimate the peak arterial concentration of contrast agent and consecutively distort T1-DCE parameters.

#### CLINICAL RELEVANCE/APPLICATION

This technical analysis study of effects of AIF selection on T1-DCE parameters is of value for all radiologists using T1-DCE MRI in the CNS concerning interpretation and validation of their results.

#### SSJ18-06 Acceleration-selective Arterial Spin Labeling (ASASL) MR Angiography for Visualization of Distal Cerebral Arteries in Moyamoya Disease

Tuesday, Dec. 1 3:50PM - 4:00PM Location: N226

#### Participants

Osamu Togao, MD, PhD, Fukuoka, Japan (*Presenter*) Nothing to Disclose  
Akio Hiwatashi, MD, Fukuoka, Japan (*Abstract Co-Author*) Nothing to Disclose  
Koji Yamashita, MD, PhD, Fukuoka, Japan (*Abstract Co-Author*) Nothing to Disclose  
Kazufumi Kikuchi, MD, Fukuoka, Japan (*Abstract Co-Author*) Nothing to Disclose  
Makoto Obara, Tokyo, Japan (*Abstract Co-Author*) Nothing to Disclose  
Hiroshi Honda, MD, Fukuoka, Japan (*Abstract Co-Author*) Nothing to Disclose

#### PURPOSE

Time-of-flight (TOF)-MR angiography (MRA) frequently fails to visualize distal arteries to the steno-occlusive lesion because of the slow or retrograde flow. In this study, we evaluated the utility of acceleration-selective arterial spin labeling (ASASL)-MRA in depiction of distal arteries in moyamoya disease.

#### METHOD AND MATERIALS

Fifteen patients with moyamoya disease (age  $26.1 \pm 23.9$  year-old; 6 males, 9 females) were examined with both TOF- and ASASL-MRA on a 3T MR scanner. All patients underwent cerebral digital subtraction angiography (DSA). The ASASL-MRA consists of control (T2-preparation without motion-sensitized gradient: MSG) and label (with MSG) parts followed by 3D T1-weighted gradient-echo sequence. In the label part, MSG employs a motion compensation design to selectively detect spins with acceleration component in arteries. The TOF-MRA was obtained in the same geometry and acquisition time (6min13sec) as ASASL-MRA. In both MRAs, the number of distal MCA branches (#vessel) was counted by a line profile analysis and the contrast-to-noise ratio (CNR) was measured in peripheral branches in each hemisphere on an image of maximum intensity projection with 90mm thickness. Based on the DSA findings, the degree of steno-occlusion of ICA or the development of leptomeningeal anastomosis (LMA) was classified into two grades. The #vessel and CNR were compared between the two MR methods. Increment in #vessel between the two MR methods ( $\#vessel_{ASASL} - \#vessel_{TOF}$ ) was evaluated based on the DSA findings.

#### RESULTS

The average #vessel obtained with ASASL-MRA ( $16.9 \pm 4.9$ ,  $P < 0.0001$ ) was larger than that with TOF-MRA ( $7.2 \pm 4.5$ ). The average CNR with ASASL-MRA ( $20.4 \pm 8.0$ ,  $P < 0.0001$ ) was higher than that with TOF-MRA ( $9.2 \pm 9.2$ ). The increment in #vessel was higher in hemispheres with severe IC stenosis ( $11.0 \pm 4.0$ ,  $P < 0.01$ ) than those with mild stenosis ( $6.8 \pm 2.4$ ). The increment in #vessel was higher in hemispheres with well-developed LMA ( $11.4 \pm 3.9$ ,  $P < 0.01$ ) than those with mildly developed LMA ( $6.8 \pm 2.2$ ).

## **CONCLUSION**

The ASASL-MRA improved the visualization of peripheral arteries distal to the steno-occlusive site reflecting collateral flow via LMA in moyamoya disease.

## **CLINICAL RELEVANCE/APPLICATION**

ASASL-MRA serves as a non-invasive technique to evaluate the status of branches distal to the affected main trunk representing the LMA collateral flow. The method might be useful in the planning of bypass surgery.

## Emergency Radiology (Chest Emergencies)

Tuesday, Dec. 1 3:00PM - 4:00PM Location: N227



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

### Participants

Martin L. Gunn, MBChB, Seattle, WA (*Moderator*) Research support, Koninklijke Philips NV; Spouse, Consultant, Wolters Kluwer NV; Medical Advisor, TransformativeMed, Inc;  
Mariano Scaglione, MD, Castel Volturno, Italy (*Moderator*) Nothing to Disclose

### Sub-Events

#### SSJ06-01 Predicting Pulmonary Embolus in ED Patients with Isolated Below-the-Knee Deep Vein Thrombosis

Tuesday, Dec. 1 3:00PM - 3:10PM Location: N227

### Awards

#### Trainee Research Prize - Resident

### Participants

Alexander S. Misono, MD, MBA, Boston, MA (*Presenter*) Nothing to Disclose  
Rahmi Oklu, MD, PhD, Boston, MA (*Abstract Co-Author*) Nothing to Disclose  
Ali Raja, MD, MBA, Brookline, MA (*Abstract Co-Author*) Medical Advisor, Diagnostics, LLC  
Anand M. Prabhakar, MD, Somerville, MA (*Abstract Co-Author*) Nothing to Disclose

### PURPOSE

Existing literature is mixed regarding risk of isolated below-the-knee deep vein thrombosis (BKDVT) relating to development of pulmonary embolus (PE). Patients with acuity of symptoms triggering an emergency department (ED) visit may be at higher risk. This study aims to quantify and characterize the risk of PE in ED patients found to have BKDVT.

### METHOD AND MATERIALS

In this IRB-approved, HIPAA compliant study, ED lower extremity ultrasounds from 2005-2015 were reviewed to identify patients with isolated BKDVT. Medical records were reviewed for either PE protocol or conventional protocol chest CT within 1 month of the index ultrasound to assess for PE. Key clinical factors at presentation were determined, including venous territories involved and history of DVT, malignancy, medical risk factors (e.g. smoking, genetic predisposition, medications, travel), recent surgery/hospitalization, and respiratory symptoms/pain. Chi Square test was performed to compare utility of clinical factors in assessing risk of PE in patients with BKDVT, with statistical significance set at  $p < 0.05$ .

### RESULTS

135 studies were identified with isolated BKDVT, with patients of average age  $57.1 \pm 17.2$  (mean  $\pm$  SD) with a range of 21-93, including 51% male, 49% female. BKDVT was identified in the posterior tibial (50%), peroneal (42%), gastrocnemius (19%), anterior tibial (2%), and soleal (1%) veins. Patients either had 1 (84%) or 2 territories (16%) involved, with 8% bilateral. 50 patients (37%) underwent chest CT in the prescribed period. No difference was seen in age ( $p = .232$ ), gender ( $p = .774$ ), or territories involved ( $p = .830$ ) in those who underwent CT versus those who did not. Of those with CT, 31 (62%) had PE. Presence of two territories (e.g. posterior tibial and peroneal) was associated with higher likelihood of PE ( $p = 0.018$ ). Other clinical factors were not meaningful, including history of DVT ( $p = .232$ ), malignancy ( $p = .756$ ), medical risk factors ( $p = .255$ ), recent surgery/hospitalization ( $p = 1.00$ ), symptoms ( $p = .773$ ), and bilaterality ( $p = .637$ ).

### CONCLUSION

ED patients presenting with isolated BKDVT have a very high incidence (62%) of concurrent PE. While the utility of predictive factors is limited due to this high incidence, presence of BKDVT in two venous territories was highly associated with PE.

### CLINICAL RELEVANCE/APPLICATION

ED patients with isolated below-the-knee deep vein thrombosis have a much higher rate of PE than traditionally expected.

#### SSJ06-02 Ultra-low-dose Chest CT with Iterative Reconstructions vs Chest X-Ray in Emergency Settings. Is it the Beginning of a New Era? Preliminary Observations

Tuesday, Dec. 1 3:10PM - 3:20PM Location: N227

### Participants

Francesco Macri, MD, Nimes, France (*Presenter*) Nothing to Disclose  
Joel Greffier, Nimes, France (*Abstract Co-Author*) Nothing to Disclose  
Alina Chica Rosa, MD, Nimes, France (*Abstract Co-Author*) Nothing to Disclose  
Cornelia Freitag, Nimes, France (*Abstract Co-Author*) Nothing to Disclose  
Gian Franco Gualdi, MD, Roma, Italy (*Abstract Co-Author*) Nothing to Disclose  
Ahmed Larbi, MD, Nimes, France (*Abstract Co-Author*) Nothing to Disclose  
Jean-Paul Beregi, MD, Nimes, France (*Abstract Co-Author*) Nothing to Disclose

### PURPOSE

To evaluate the diagnostic power of the ultra-low-dose CT (ULD-CT) of the chest compared to the chest X-ray (CXR) at the emergency room (ER).

## METHOD AND MATERIALS

Patients with dubious CXR performed at the ER searching for pneumothorax, fractures and pneumopathy who underwent a ULD-CT within 48 hours. ULD-CT acquisition was performed on a 64 slices MDCT (Somatom Definition AS+, Siemens) with 100 kVp  $\pm$  20 (depending on the patient constitution) and fixed 10 mAs, without injection of intravenous iodinated contrast media. Images were reconstructed with Sinogram-Affirmed-Iterative-Reconstructions (SAFIRE, Siemens) with S4 and I50f for pulmonary parenchyma and with S3 and I30f for the mediastinum. A radio-physicist evaluated the dose differences between CXR and ULD-CT. Two radiologists independently evaluated the diagnostic quality of the images and the diagnostic degree of confidence.

## RESULTS

A total of 136 patients (M 72; F 64) with a mean age of 63 years ( $\pm$  20.5) and a mean BMI 23.6 kg/m<sup>2</sup> ( $\pm$  5.1) were enrolled. The effective dose for CXR was 0.133  $\pm$  0.132 mSv, 59% lower than CXR french Diagnostic Reference Levels (fDRL): 0.225 mSv. The effective dose for ULD-CT was 0.189  $\pm$  0.035 mSv, 97% lower than chest CT fDRL: 6.65 mSv. ULD-CT revealed a higher quantity of small pneumothoraxes and fractures and better depicted the pneumopaties compared to CXR. Readers recorded a high score of diagnostic confidence level for ULD-CT. Diagnostic decision-making was possible even on noisy CT images.

## CONCLUSION

ULD-CT with iterative reconstructions, with an irradiation dose close to CXR, allowed a reliable study of the patients with the suspicion of pneumothorax, fractures and pneumopathy.

## CLINICAL RELEVANCE/APPLICATION

Ultra-low-dose chest CT with iterative reconstructions improves the management of the ER patients with suspicion of pneumothorax, fractures and pneumopathy by reducing the delay of diagnosis and avoiding redundant exposure.

### SSJ06-03 Dual-Energy CT of Chest in Pulmonary Angiography: Maximizing Optimal Contrast Enhancement with a Non-Linear Blending Technique

Tuesday, Dec. 1 3:20PM - 3:30PM Location: N227

#### Participants

Teresa I. Liang, MD, Vancouver, BC (*Presenter*) Nothing to Disclose  
Ismail T. Ali, MBChB, MD, Vancouver, BC (*Abstract Co-Author*) Nothing to Disclose  
Memoona Mian, MD, FRCR, Vancouver, BC (*Abstract Co-Author*) Nothing to Disclose  
Patrick D. McLaughlin, FFRCSI, Cork, Ireland (*Abstract Co-Author*) Speaker, Siemens AG  
Savvas Nicolaou, MD, Vancouver, BC (*Abstract Co-Author*) Institutional research agreement, Siemens AG

## PURPOSE

CT Pulmonary angiography (CT PE) is the gold standard for diagnosis of pulmonary emboli (PE). However, in suboptimal conditions, contrast enhancement is inadequate for diagnostic purposes, and scans often need to be repeated. In this study we evaluate the utility of Dual Energy CT (DECT PE) non-linear blending technique in patients with suspected PE in comparison to a standard 100 kVp scan.

## METHOD AND MATERIALS

Thirty-five patients between September 19, 2013 and 2014 with a suspected PE, underwent a standardized high-pitch DECT PE protocol to generate standard 100kVp (DECT-100) and non-linear blended images (DECT-OC). Visualization of the pulmonary arteries on the two image sets was scored on a Likert scale from 1 to 5 by two readers (Score of 5 = excellent sharp visualization of anatomical structures, no image noise and artifacts; score of 1 = poor visualization of anatomical structures, and severe image noise and artifacts). Each segment was assessed for diagnostic ability of possible PE. Mean and standard deviation of CT values within pulmonary arteries, muscle, and air were recorded, and signal to noise (SNR) and contrast to noise (CNR) ratios were generated as a quantitative index of image quality. Student t-test and Wilcoxon rank sum test were used for statistical analysis, and  $p < 0.05$  was considered significant.

## RESULTS

Visualization scores were significantly better on all segments (Main, left and right, lobar, segmental and subsegmental pulmonary arteries) on the DECT-OC images for both readers ( $p < 0.0001$ ). In the 490 pulmonary artery segments evaluated, 34 were non-diagnostic on the DECT-100 images, whereas only 7 were non-diagnostic on the DECT-OC images ( $p < 0.0001$ ). Mean SNR was 97% higher (27.67 vs. 54.53,  $p < 0.0001$ ) and mean CNR was 105% higher (14.76 vs 30.27,  $p < 0.0001$ ) on the DECT-OC images.

## CONCLUSION

The application of a DECT non-linear blending technique for the diagnosis of PE helps significantly improve SNR, CNR, and arterial visualization in comparison to a standard 100 kVp protocol, yielding substantially improved diagnostic image quality.

## CLINICAL RELEVANCE/APPLICATION

Non-linear blended DECT PE allows optimal visualization of the pulmonary vasculature leading to improved detection of PE, and may be especially useful in suboptimal studies to avoid repeat scans.

### SSJ06-04 Sickie Cell Patients Undergoing CT Pulmonary Angiography in the Emergency Department: An Analysis

Tuesday, Dec. 1 3:30PM - 3:40PM Location: N227

#### Participants

David D. Bates, MD, Boston, MA (*Presenter*) Nothing to Disclose  
Z Liu, MD, Boston, MA (*Abstract Co-Author*) Nothing to Disclose  
Christina A. LeBedis, MD, Boston, MA (*Abstract Co-Author*) Nothing to Disclose  
Nagaraj-Setty Holalkere, MD, Boston, MA (*Abstract Co-Author*) Owner, imaginglink, LLC

## PURPOSE

To analyze the data for patients with sickle cell disease being evaluated in the emergency department with CT pulmonary angiography.

## METHOD AND MATERIALS

This retrospective study was approved by our Institutional Review Board. Patients with sickle cell disease were evaluated with CT pulmonary angiography (CTPA) 42 times in the Emergency Department over 26 months beginning in November 2011. Clinical data and imaging were reviewed and compared with patients from the same period. Studies were classified as positive for acute pulmonary embolus, negative for acute pulmonary embolus, or indeterminate. Wells' scores were calculated for each sickle patient as well as a control group based on the medical records. Statistical analysis was performed.

## RESULTS

Patients with sickle cell undergoing CTPA in the emergency department were significantly more likely to have either 'Moderate' or 'High' risk Wells' scores (53.7% vs. 31.0,  $p < 0.05$ ), more likely to be female (76.19% vs. 62.79%,  $p < 0.05$ ), and had lower mean age (31.74 vs. 55.26 years,  $p < 0.05$ ). No statistically significant difference was observed for the rate of acute PE between sickle cell patients and the ER population (7.14% vs. 10.67%).

## CONCLUSION

Sickle cell patients are younger and are more likely to be female than the general population of patients undergoing CTPA in the ED. Sickle cell patients are also more likely to be categorized as either 'Moderate' or 'High' risk based on Wells' Criteria than a control group. No significant difference in the rate of acute PE was observed for sickle patients compared with the general population of patients when undergoing CTPA in the ED.

## CLINICAL RELEVANCE/APPLICATION

Sickle cell patients are younger, more likely to be female and more likely to be classified as Moderate or High Risk based on Wells' criteria when being evaluated with CTPA in the emergency department (ED). Despite the higher risk profile, no difference was observed in the rate of acute PE for sickle cell patients, though the small sample size limits sensitivity for the detection of a true difference in the incidence of acute PE. Younger and female, sickle cell patients as a group may be at higher risk for the stochastic effects of ionizing radiation. Our study suggests that risk stratification models used in clinical decision pathways for the evaluation of PE in the general population may not be appropriate for use in sickle cell patients.

### SSJ06-05 The Impact of Maximum Aortic Wall Thickness on Patient Outcomes in Acute Type A Intramural Hematoma

Tuesday, Dec. 1 3:40PM - 3:50PM Location: N227

#### Participants

Michael K. Atalay, MD, PhD, Providence, RI (*Presenter*) Nothing to Disclose  
Ashley A. Tuttle, MD, Providence, RI (*Abstract Co-Author*) Nothing to Disclose  
Grayson L. Baird, MS, Providence, RI (*Abstract Co-Author*) Nothing to Disclose  
Dennis Kwon, MD, Providence, RI (*Abstract Co-Author*) Nothing to Disclose  
Neel Sodha, MD, Providence, RI (*Abstract Co-Author*) Nothing to Disclose

## PURPOSE

Aortic intramural hematoma (IMH) is an uncommon acute aortic injury that can heal spontaneously or progress to potentially life-threatening complications. Maximum IMH thickness (Tmax) and luminal compression ratio (LCR) have been proposed as potentially useful metrics for identifying patients who are more likely to experience complications. The aim of this study was to correlate Tmax and LCR with patient outcomes in all Type A IMH cases performed in a large tertiary referral center over 11 years.

## RESULTS

Over the study period, 54 thoracic IMH cases were captured in PACS, 23 (43%) of which were Type A and 31 (57%) Type B. Mean Type A patient age was  $77 \pm 12$  years and 13 (57%) of the 23 patients were female. Outcomes in 7 patients were unknown (1 Type A, 6 Type B). Of those remaining, 7 (32%) Type A cases and 10 (40%) Type B cases showed regression on serial follow-up imaging. A significant interaction for regression was observed for IMH Type and Tmax ( $p=0.039$ ). For each millimeter increase in Tmax the odds of regression for Type A IMH decreased 26%. The Tmax for 50% probability of Type A regression was 8.6 mm. The mean Tmax for those Type A cases showing regression was 8.6 mm and for those showing progression 14.6 mm ( $p=0.015$ ). There was no significant correlation between LCR or Dmax and patient outcomes for Type A IMH.

## CONCLUSION

Maximal aortic wall thickness predicts the odds of spontaneous resolution or stability of Type A IMH and may in turn impact clinical management.

## CLINICAL RELEVANCE/APPLICATION

The maximal aortic wall thickness in Type A IMH may potentially be used as a metric for adverse outcomes to guide medical versus surgical management.

### SSJ06-06 Effect of Patient Lung Volume on Contrast Volume Administration During Computed Tomography Pulmonary Angiography

Tuesday, Dec. 1 3:50PM - 4:00PM Location: N227

#### Participants

Charbel Saade, PhD, Beirut, Lebanon (*Presenter*) Nothing to Disclose  
Fadi M. El-Merhi, MD, New York, NY (*Abstract Co-Author*) Nothing to Disclose  
Mukbil H. Hourani, MD, Beirut, Lebanon (*Abstract Co-Author*) Nothing to Disclose  
Hussain Al-Mohiy, Abha, Saudi Arabia (*Abstract Co-Author*) Nothing to Disclose  
Bassam El-Achkar, MD, Beirut, Lebanon (*Abstract Co-Author*) Nothing to Disclose

## PURPOSE

To investigate the effect of patient lung volume and contrast volume on pulmonary artery opacification using a patient-specific contrast formula during pulmonary multidetector CT angiography.

## METHOD AND MATERIALS

IRB approval for this prospective study was obtained. CTPA was performed on 120 patients with suspected PE using a 64-channel computed tomography scanner and a dual-barrel contrast injector. Patients, were assigned to two protocol groups: protocol A, the department's conventional protocol, employed a fixed 80 mL contrast volume, intravenously injected at 4.5 mL/s; protocol B used a patient-specific contrast formula based on patient cardiovascular dynamics. Both protocols used a 50 mL saline flush at 4.5 mL/s and a craniocaudal scan direction. The mean cross-sectional opacification profile of eight central and eleven peripheral pulmonary arteries and veins were measured for each patient and arteriovenous contrast ratio (AVCR) calculated for each lung segment. Mean lung volume were quantified using a computer aided detection software. Protocols were compared using Mann-Whitney U non-parametric statistics. Inter-observer variations were investigated using Kappa methods.

## RESULTS

: A number of pulmonary arteries demonstrated increases in opacification ( $p < 0.03$ ) for protocol B compared with A whilst opacification in the heart and all veins was reduced in protocol B ( $p = 0.05$ ). Subsequently, increased AVCR in protocol B compared with A was observed at all anatomic locations ( $p < 0.0002$ ) where this ratio was calculated. Mean contrast volume demonstrated a reduction in protocol B ( $33 \pm 9$  mL) compared to A ( $80 \pm 1$  mL). In protocol B larger lung volumes were significantly correlated to larger volumes of contrast ( $p < 0.03$ ). Inter-observer variation was observed with protocol B compared with A with the latter metric increasing from  $\kappa = 0.28$  to  $0.71$  respectively.

## CONCLUSION

Significant improvements in visualisation of the pulmonary vasculature can be achieved with low contrast volume. Patient lung volume is significantly correlated to contrast volume administration employing a patient-specific contrast formula.

## CLINICAL RELEVANCE/APPLICATION

Matching patient lung volume and contrast injection timing with vessel dynamics significantly improves vessel opacification and reduces contrast dose in the assessment of pulmonary embolism (PE) during computed tomography pulmonary angiography (CTPA).



**Neuroradiology/Head and Neck (ENT Oncology)**

Tuesday, Dec. 1 3:00PM - 4:00PM Location: N228

HN	NR	MR	RO	US
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AMA PRA Category 1 Credit™: 1.00  
ARRT Category A+ Credit: 1.00

**Participants**

Ashley H. Aiken, MD, Atlanta, GA (*Moderator*) Nothing to Disclose  
Barton F. Branstetter IV, MD, Pittsburgh, PA (*Moderator*) Nothing to Disclose

**Sub-Events****SSJ19-01 Lymph Node Imaging Reporting and Data System for Ultrasound and Real-time Elastography of Cervical Lymph Node: A Pilot Study**

Tuesday, Dec. 1 3:00PM - 3:10PM Location: N228

**Participants**

Kyeong Hwa Ryu, MD, Busan, Korea, Republic Of (*Abstract Co-Author*) Nothing to Disclose  
Kwanghui Lee, Busan, Korea, Republic Of (*Abstract Co-Author*) Nothing to Disclose  
Jiyeon Baik, MD, Busan, Korea, Republic Of (*Presenter*) Nothing to Disclose  
Ji-Hwa Ryu, Busan, Korea, Republic Of (*Abstract Co-Author*) Nothing to Disclose  
Jung Hee Son, MD, Busan, Korea, Republic Of (*Abstract Co-Author*) Nothing to Disclose

**PURPOSE**

To analyze ultrasound (US) and real-time elastography (RTE) features of cervical lymph node and propose a structural reporting system for lymph node.

**METHOD AND MATERIALS**

Between 2013 and 2014, 291 consecutive patients underwent US guided biopsies and follow-up for cervical lymph nodes were enrolled in a single institution. US features were analyzed as follows; shape, margin, echogenicity, echogenic hilum, gross necrosis, calcification, matting and vascular pattern. RTE features were analyzed; elasticity score and strain ratio. By logistic regression analysis, a score for each significant factor was assigned and multiplied by the  $\beta$  coefficient, and then fitted probability of malignancy was calculated. The risk of malignancy of lymph node was determined, based on the number of suspicious features.

**RESULTS**

Imaging features to be significantly associated with malignancy were round shape, not circumscribed margin, hyperechogenicity, absence of hilum, presence of gross necrosis and calcification, peripheral/mixed vascularity, elasticity score 3 and 4, and high strain ratio ( $p < 0.05$ ). The fitted probability and risk of malignancy increased, as a number of suspicious features increased. Lymph node imaging reporting and data system (LNRADS) was established using a 5-point scale; 1 (probably benign), 2 (low suspicion for malignancy), 3 (moderate suspicion for malignancy), 4 (high suspicion for malignancy), and 5 (highly suggestive for malignancy). The risk of malignancy according to LNRADS categories was as follows; 1: 3.3%, 2: 10.9%, 3: 26.7%, 4: 51.8%-74.4%, 5: 90.6%-98.8%.

**CONCLUSION**

LNRADS was proposed using risk stratification of cervical lymph node according to the number of suspicious US and RTE features.

**CLINICAL RELEVANCE/APPLICATION**

LNRADS will help to determine the optimal strategies for management of cervical lymph node.

**SSJ19-02 How Can We Differentiate Follicular Nodular Lesions with Ultrasonographic Features?**

Tuesday, Dec. 1 3:10PM - 3:20PM Location: N228

**Participants**

Sun Hye Jeong, MD, Bucheonsi, Korea, Republic Of (*Presenter*) Nothing to Disclose  
Hyun-Sook Hong, MD, PhD, Bucheon, Korea, Republic Of (*Abstract Co-Author*) Nothing to Disclose  
Eun Hye Lee, MD, Bucheon, Korea, Republic Of (*Abstract Co-Author*) Nothing to Disclose  
Bora Lee, Bucheon-Si, Korea, Republic Of (*Abstract Co-Author*) Nothing to Disclose

**PURPOSE**

We retrospectively evaluated the ultrasonographic (US) features used to differentiate follicular nodular lesions of thyroid gland (or follicular cell-derived thyroid nodules) and tried to identify specific US features of nodular hyperplasia (NH).

**METHOD AND MATERIALS**

The study included 178 patients (mean age 46.6 (range 17-82) years) with surgically confirmed NH (n=100), follicular adenoma (FA) (n=56), or follicular carcinoma (FC) (n=22). Two radiologists retrospectively analyzed the US features. To determine the predictors of follicular-patterned lesions, univariate and multivariate multinomial logistic regression analyses were conducted. Receiver operating characteristic (ROC) analyses were performed to determine the effectiveness of the final model at predicting NH, FA, and FC. The inter-observer agreement was calculated.

**RESULTS**

Tumor diameter, margin, echotexture, cystic changes, calcification, hypoechoic rim, and vascularity were significant in the

univariate analyses. The multivariate multinomial logistic regression analyses revealed that tumor diameter (FA:  $p=0.002$ , odds ratio (OR) =1.75, 95% confidence interval (CI) 1.22, 2.51; FC:  $p=0.001$ , OR=2.02, 95% CI 1.32, 3.10), absence of cystic changes (FA:  $p=0.127$ , OR=2.21, 95% CI 0.80, 6.13; FC:  $p\leq 0.001$ , OR=17.74, 95% CI 4.00, 78.73), and spongiform appearance (FA:  $p=0.234$ , OR=0.31, 95% CI 0.04, 2.15; FC:  $p<0.001$ , OR=1673.46, 95% CI 671.35, 4171.38) differed significantly among the three follicular nodular lesions, with NH as a reference group. The area under the curve (AUC) for NH, FA, and FC was 0.844, 0.858, and 0.705, respectively. The sensitivity for NH, FA, and FC was 0.698, 0.868, and 0.755, respectively, and the specificity was 0.820, 0.690, and 0.580. Using this model, the diagnostic accuracy of the original data was 72.6%. The inter-observer agreement was moderate to almost perfect.

## CONCLUSION

Tumor diameter, cystic changes and spongiform appearance differed significantly among follicular nodular lesions. Using the US criteria, there was moderate diagnostic ability for NH, FA, and FC.

## CLINICAL RELEVANCE/APPLICATION

Tumor diameter and the presence of cystic changes differed significantly among NH, FA, and FC (or follicular nodular lesions).

### SSJ19-03 The Added Diagnostic Value of DW-MRI to Conventional Parameters in Characterization of Cervical Lymphadenopathy

Tuesday, Dec. 1 3:20PM - 3:30PM Location: N228

#### Participants

A M Aboelsouad, MSc, Assiut, Egypt (*Presenter*) Nothing to Disclose  
Haisam A. Atta, MD, Assiut, Egypt (*Abstract Co-Author*) Nothing to Disclose  
Mohamed M. Abd Ellah, MD, Innsbruck, Austria (*Abstract Co-Author*) Nothing to Disclose  
Hisham M. Imam, MBBCH, MD, Assiut, Egypt (*Abstract Co-Author*) Nothing to Disclose

## PURPOSE

To assess what can DW-MRI add to conventional parameters (Short axis diameter, presence or absence of hilum and presence or absence of necrosis) in prediction of malignant cervical lymphadenopathy.

## METHOD AND MATERIALS

The study population included 72 patients having cervical lymphadenopathy underwent MRI with diffusion on 1.5T machine before they underwent biopsy. The cutoff short axis diameter (determined by ROC curve and Youden index), presence or absence of hilum, presence or absence of necrosis and cutoff ADC value (determined by ROC curve and Youden index) were assessed and finding their ability to predict malignant cervical lymphadenopathy each parameter alone, all parameters and comparing DW-MRI efficacy with that of conventional parameters.

## RESULTS

The short axis diameter achieved 72.13%,45.45 %,88%,22.73% and 68.06% sensitivity, specificity, positive predictive value, negative predictive value and accuracy respectively. Absent hilum criterion achieved 63.9%,27.3%, 83%,12% and 58.3% sensitivity, specificity, positive predictive value, negative predictive value and accuracy respectively. Present necrosis criterion achieved 21.3%,72.7%,81.3%,14.3% and 29.2% sensitivity, specificity, positive predictive value, negative predictive value and accuracy respectively. Combined conventional criteria achieved 86.9%,0%,82.8%,0% and 73.6% sensitivity, specificity, positive predictive value, negative predictive value and accuracy respectively. The DWI with its cutoff ADC achieved 80.33%,63.64%, 92.45%,36.84% and 83.33% sensitivity, specificity, positive predictive value, negative predictive value and accuracy respectively. The combined conventional parameters and DWI achieved 98.4%,0%,84.5%,0% and 83.3% sensitivity, specificity, positive predictive value, negative predictive value and accuracy respectively.

## CONCLUSION

DWI is carrying the highest sensitivity, specificity and accuracy among all conventional parameters, each alone and nearby lower sensitivity with higher specificity and accuracy than combined conventional parameters, thus use of DWI added significant diagnostic value to the ability of conventional parameters to predict malignant cervical lymphadenopathy with no extra time consuming.

## CLINICAL RELEVANCE/APPLICATION

DW-MRI is non invasive and non time consuming method that can predict malignancy in cervical lymphadenopathy and its addition to conventional parameters increases their sensitivity with no significant extra time consuming.

### SSJ19-04 Proposal for an MRI-based Score to Differentiate Pleomorphic Adenoma and Warthin Tumor in Patients with Benign Parotid Neoplasms

Tuesday, Dec. 1 3:30PM - 3:40PM Location: N228

#### Participants

Beatrice Sacconi, MD, Rome, Italy (*Abstract Co-Author*) Nothing to Disclose  
Angelo Iannarelli, Rome, Italy (*Abstract Co-Author*) Nothing to Disclose  
Renato Argiro, Rome, Italy (*Presenter*) Nothing to Disclose  
Marta Bottero, Rome, Italy (*Abstract Co-Author*) Nothing to Disclose  
Emanuela Basile, Rome, Italy (*Abstract Co-Author*) Nothing to Disclose  
Piero Cascone, Rome, Italy (*Abstract Co-Author*) Nothing to Disclose  
Carlo Catalano, MD, Rome, Italy (*Abstract Co-Author*) Nothing to Disclose  
Mario Bezzi, MD, Rome, Italy (*Abstract Co-Author*) Nothing to Disclose

## PURPOSE

To evaluate the diagnostic efficacy of an MRI-based score in the differential diagnosis between parotid pleomorphic adenoma (PA) and Warthin tumor (WT).

## METHOD AND MATERIALS

Twenty patients (M=10, F=10; mean age=63.5 years, range=35-87) complaining of long-standing (stable for at least 3 months) painless parotid mass underwent a 3T MR (Discovery MR750, GE); T2-weighted, DWI and T1-weighted sequences before and after contrast administration (Gadobenic acid, 0.1 ml/Kg) were performed. The lesions were evaluated by three radiologists in consensus using a complex score based on three-point scales rating four different MR features (T2-signal intensity, Apparent Diffusion Coefficient values, enhancement pattern, bilateral/multiple location); total scores of  $\leq 3$  and  $> 3$  were respectively considered as suggestive of PA or WT. Final diagnosis was based on pathology reports after US-guided fine-needle-aspiration cytology (FNAC) or surgical resection.

## RESULTS

Twenty-four lesions were imaged; three lesions were excluded because of MR features suggesting less common histotypes (lipoma, sialolipoma, haemangioma, all confirmed at surgery). Radiologists correctly identified 6/6 PAs and 13/13 WTs; two lesions, defined as PAs, revealed to be an oncocytoma and a granulomatous lymph node (diagnostic accuracy 90.5%).

## CONCLUSION

The score allowed the differential diagnosis in all cases of PAs and WTs; an oncocytoma and a granulomatous lymph node were misdiagnosed, but the incidence of benign lesions other than PA and WT is expected to be low. These data need to be confirmed in larger patient cohorts.

## CLINICAL RELEVANCE/APPLICATION

In case of benign parotid lesions, the surgical plan depends on histology. MRI can suggest tumor histology in case of uncertain cytologic diagnosis and provide information over the entire neoplasm.

### SSJ19-05 Parotid Gland Tumors: Diagnostic Value of Combining Conventional MR Imaging, Diffusion-weighted MR Imaging and Dynamic Contrast Enhanced MR Imaging

Tuesday, Dec. 1 3:40PM - 3:50PM Location: N228

#### Participants

Gongxin Yang, Shanghai, China (*Presenter*) Nothing to Disclose  
Yu Qiang, Shanghai, China (*Abstract Co-Author*) Nothing to Disclose  
Pingzhong Wang, Shanghai, China (*Abstract Co-Author*) Nothing to Disclose  
Yingwei Wu, MD, Shanghai, China (*Abstract Co-Author*) Nothing to Disclose  
Huimin Shi, MD, Shanghai, China (*Abstract Co-Author*) Nothing to Disclose  
Wenjing Zhu, Shanghai, China (*Abstract Co-Author*) Nothing to Disclose  
Xiao-Feng Tao, MD, PhD, Shanghai, China (*Abstract Co-Author*) Nothing to Disclose  
Xin Gong, Shanghai, China (*Abstract Co-Author*) Nothing to Disclose  
Weiqing Gao, Shanghai, China (*Abstract Co-Author*) Nothing to Disclose

## PURPOSE

To evaluate the diagnostic value of the combination of echo-planer diffusion-weighted MR imaging (DWI), dynamic contrast enhanced MR imaging (DCE-MRI) and conventional MR imaging in the characterization of solid neoplasms from parotid gland.

## METHOD AND MATERIALS

148 subjects (101 benign and 47 malignant) involved with parotid gland tumors were recruited in the study. Prior to surgery and pathologic verification, conventional maxillofacial MR imaging, DWI with b factor of both 0 and 1000 s/mm<sup>2</sup> and DCE-MRI were performed on each subject. Logistic regression analysis was performed to see differences of morphological MR features (margin, shape, envelope and signal intensity of masses) between benign and malignant groups. Mean ADC value was calculated from ADC map, and then ADC threshold values between benign and malignant tumors was obtained. Time-intensity curve (TIC) with parameters were obtained from DCE-MRI. Sensitivity, specificity, accuracy, and positive and negative predictive values were calculated for the combination of relative parameters.

## RESULTS

Ill-defined margin, irregular shape, no envelope, ADC value lower than cut-off point of  $1.12 \times 10^{-3}$  mm<sup>2</sup>/s and TIC pattern with time to peak less than 120s and low washout ratio ( $< 30\%$ ) were the valuable parameters for predicting malignancy ( $P=0.005$ ,  $0.004$ ,  $0.001$ ,  $< 0.001$ ,  $< 0.001$ , respectively). However, no significant difference was found in signal intensity of tumors between benign and malignant lesions. A combination of ADC value and TIC pattern yielded a sensitivity, specificity and diagnostic accuracy of 91.5%, 97.0% and 95.3%, respectively. Positive and negative predictive value for distinguishing benign and malignant tumors was 93.5% and 96.1% respectively.

## CONCLUSION

Conventional MR imaging combined DWI and DCE-MRI has the ability to improve the diagnostic accuracy in distinguishing between benign and malignant parotid gland tumors.

## CLINICAL RELEVANCE/APPLICATION

It will be helpful for clinical diagnosis of Parotid gland tumors

### SSJ19-06 Intravoxel Incoherent Motion Diffusion-weighted Magnetic Resonance Imaging for Monitoring of ZD6474 Therapy in Human Nasopharyngeal Carcinoma Xenografts

Tuesday, Dec. 1 3:50PM - 4:00PM Location: N228

#### Participants

Yanfen Cui, Shanghai, China (*Presenter*) Nothing to Disclose  
Caiyuan Zhang, MD, Shanghai, China (*Abstract Co-Author*) Nothing to Disclose  
Huanhuan Liu, Shanghai, China (*Abstract Co-Author*) Nothing to Disclose  
Dengbin Wang, Shanghai, China (*Abstract Co-Author*) Nothing to Disclose

## PURPOSE

To investigate the value of intravoxel incoherent motion (IVIM) diffusion-weighted (DW) imaging biomarkers for monitoring the early response to ZD6474 in an experimental tumor model by quantitative assessments of tumor microcirculation parameters with histopathological validation.

## METHOD AND MATERIALS

Twenty-four female BALB/c nude mice bearing human nasopharyngeal carcinoma xenografts were scanned at baseline and after 1, 3, and 7 days of treatment with ZD6474 (n = 12) or vehicle (n = 12) at a 3T magnetic resonance imager using a custom-built 8-channel receiver coil with 2.5cm inner diameter. For IVIM DW imaging, parameters including apparent diffusion coefficient (ADC), true diffusion coefficient (D), perfusion fraction (f), and blood pseudodiffusion coefficient (D\*) were measured with 12 b-values ranging from 0 to 2000 s/mm<sup>2</sup>. All IVIM DW imaging parameters at different time points were compared between the treated and control groups using Student's t tests or Mann-Whitney tests. Parameters were also analyzed within the treated group by one-way analysis of variance (ANOVA). The relationships between histopathological staining for Ki-67, TUNEL, or CD31 and all IVIM parameters were evaluated by Spearman's rank correlation.

## RESULTS

The percent change of the perfusion-related parameters f and D\* decreased significantly in the treated group as early as the 1-day follow-up compared with those in the control group. In contrast, the diffusion-related parameters ADC and D were significantly higher in the treated group compared with the control group beginning on day 3 (P < 0.05). The substantial decreases in f at day 1 and D\* at day 3 were moderately correlated with the smaller increase in tumor size over the week-long study (r = 0.66 and 0.58, respectively; P < 0.05 for both). Moderate correlations were found between microvessel density and the perfusion-related parameters f and D\* and between increased TUNEL index or decreased Ki-67 index and the diffusion-related parameters ADC and D.

## CONCLUSION

IVIM DW imaging was sensitive to ZD6474-induced changes in the tumor microenvironment. In particular, the f parameter had the potential to allow early prediction of tumor response to anti-angiogenic treatment.

## CLINICAL RELEVANCE/APPLICATION

IVIM DW imaging was sensitive to ZD6474-induced changes in the tumor microenvironment. In particular, the f parameter had the potential to allow early prediction of tumor response to anti-angiogenic treatment.

**Breast Imaging (Quantitative)**

Tuesday, Dec. 1 3:00PM - 4:00PM Location: Arie Crown Theater



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

**Participants**

Fiona J. Gilbert, MD, Cambridge, United Kingdom (*Moderator*) Medical Advisory Board, General Electric Company; Research Grant, GlaxoSmithKline plc; Research Grant, General Electric Company  
Despina Kontos, PhD, Philadelphia, PA (*Moderator*) Nothing to Disclose

**Sub-Events**
**SSJ01-01 Relationship between Computer-extracted MRI-based Phenotypes and the Risk of Breast Cancer Recurrence as Predicted by PAM50 Gene Expression Array**

Tuesday, Dec. 1 3:00PM - 3:10PM Location: Arie Crown Theater

**Participants**

Elizabeth S. Burnside, MD, MPH, Madison, WI (*Presenter*) Stockholder, NeuWave Medical Inc  
Hui Li, MD, PhD, Chicago, IL (*Abstract Co-Author*) Nothing to Disclose  
Charles Perou, PhD, Chapel Hill, NC (*Abstract Co-Author*) Nothing to Disclose  
Karen Drukker, PhD, Chicago, IL (*Abstract Co-Author*) Nothing to Disclose  
Elizabeth A. Morris, MD, New York, NY (*Abstract Co-Author*) Nothing to Disclose  
Maryellen L. Giger, PhD, Chicago, IL (*Abstract Co-Author*) Stockholder, Hologic, Inc; Shareholder, Quantitative Insights, Inc; Royalties, Hologic, Inc; Royalties, General Electric Company; Royalties, MEDIAN Technologies; Royalties, Riverain Technologies, LLC; Royalties, Mitsubishi Corporation; Royalties, Toshiba Corporation; Researcher, Koninklijke Philips NV; Researcher, U-Systems, Inc  
Ermelinda Bonaccio, MD, Amherst, NY (*Abstract Co-Author*) Nothing to Disclose  
Margarita L. Zuley, MD, Pittsburgh, PA (*Abstract Co-Author*) Research Grant, Hologic, Inc;  
Marie A. Ganott, MD, Pittsburgh, PA (*Abstract Co-Author*) Nothing to Disclose  
Jose M. Net, MD, Miami, FL (*Abstract Co-Author*) Nothing to Disclose  
Elizabeth J. Sutton, MD, New York, NY (*Abstract Co-Author*) Nothing to Disclose  
Kathleen R. Brandt, MD, Rochester, MN (*Abstract Co-Author*) Nothing to Disclose  
Gary J. Whitman, MD, Houston, TX (*Abstract Co-Author*) Book contract, Cambridge University Press  
Suzanne Conzen, MD, Chicago, IL (*Abstract Co-Author*) Nothing to Disclose  
Li Lan, Chicago, IL (*Abstract Co-Author*) Nothing to Disclose  
Yitan Zhu, PhD, Evanston, IL (*Abstract Co-Author*) Nothing to Disclose  
Yuan Ji, Chicago, IL (*Abstract Co-Author*) Nothing to Disclose  
Erich Huang, PhD, Bethesda, MD (*Abstract Co-Author*) Nothing to Disclose  
John B. Freymann, BS, Rockville, MD (*Abstract Co-Author*) Nothing to Disclose  
Justin Kirby, Bethesda, MD (*Abstract Co-Author*) Stockholder, Myriad Genetics, Inc  
C. Carl Jaffe, MD, Boston, MA (*Abstract Co-Author*) Nothing to Disclose

**PURPOSE**

Clinical teams are increasingly relying on genetic profiles for breast cancer subtyping, prognostication, and treatment decisions. We investigate the relationship between computer-extracted breast MRI phenotypes with the PAM50 gene array (which includes two methods: PAM50 Risk of Relapse Subtype [ROR-S] and PAM50 Risk of Relapse Subtype + Proliferation [ROR-P]) in order to understand MRI's potential role in assessing risk of breast cancer recurrence.

**METHOD AND MATERIALS**

We analyzed a retrospective dataset of 84 de-identified, breast MRIs contributed by 5 institutions to the NCI's "The Cancer Imaging Archive" (TCIA), along with clinical, histopathological, and genomic data from "The Cancer Genome Atlas" (TCGA). Each MRI examination imaged a biopsy proven invasive breast cancer comprised of 74 (88%) ductal; 8 (10%) lobular, and 2 (2%) mixed. Of these cancers, 73 (87%) were ER +, 67 (80%) were PR +, and 19 (23%) were HER-2 +. We performed computerized analysis on each cancer yielding computer-extracted image-based tumor phenotypes (CEIPs), quantifying size, shape, morphology, enhancement texture, kinetic curve assessment, and enhancement variance kinetics. Regression and ROC analysis were conducted to assess the predictive ability of CEIPs relative to the multi-gene assays' continuous outputs.

**RESULTS**

Multiple linear regression analyses demonstrated statistically significant Pearson correlations (0.5-0.55) between CEIP signatures and the PAM50 recurrence scores. The most important CEIPs included tumor size and enhancement texture patterns characterizing tumor heterogeneity. Use of CEIP in the tasks of distinguishing between good and poor prognosis in terms of levels of recurrence yielded area under the ROC curve values (standard error) of 0.88 (0.05), 0.73 (0.06), 0.72 (0.08), and 0.61 (0.09) for MammaPrint, Oncotype DX, PAM50 Risk of Relapse Subtype (ROR-S), and PAM50 ROR-P (subtype+proliferation), respectively, with all but the latter showing statistical difference from chance.

**CONCLUSION**

Quantitative breast MRI radiomics shows promise as a method for image-based phenotyping to assess risk of breast cancer recurrence. This work helps us begin to understand which MRI features may be most powerfully correlated with genetic recurrence risk.

**CLINICAL RELEVANCE/APPLICATION**

Computerized MRI tumor phenotyping yield quantitative predictive features that have the potential to advance precision medicine and affect patient treatment strategy.

## **SSJ01-02 Dynamic Contrast Enhanced (DCE) Breast MR Features Associated with Prognostic Factors in Triple Negative Breast Cancers (TNBC)**

Tuesday, Dec. 1 3:10PM - 3:20PM Location: Arie Crown Theater

### **Participants**

Bo La Yun, MD, Seongnam, Korea, Republic Of (*Presenter*) Nothing to Disclose  
Sun Mi Kim, MD, PhD, Seongnam-Si, Korea, Republic Of (*Abstract Co-Author*) Nothing to Disclose  
Mijung Jang, Seongnam, Korea, Republic Of (*Abstract Co-Author*) Nothing to Disclose  
Jong Yoon Lee, MD, Seongnam-Si, Korea, Republic Of (*Abstract Co-Author*) Nothing to Disclose  
Ja Yoon Jang, MD, Seongnam-Si, Korea, Republic Of (*Abstract Co-Author*) Nothing to Disclose

### **PURPOSE**

To assess the association of DCE MR features including texture and histogram analysis with pathologic prognostic factors in TNBC.

### **METHOD AND MATERIALS**

From June 2012 to February 2015, 92 TNBC patients (mean age 53  $\pm$ 13 years) based on immunohistochemical staining (IHC) enrolled our study. We excluded patient underwent primary systemic therapy. For texture (13 grey level co-occurrence matrix features) and histogram analysis using in-house program, the ROIs were drawn along the margin of the cancer in the largest diameter image at 1.5 minute after contrast injection. For dynamic enhancement pattern analysis, MR CAD system (CADstream) was used. The percentage of fast or medium initial enhancement and persistent, plateau and washout delayed enhancement were analyzed. The pathologic results of specimens were categorized according to histologic grade and axillary nodal status, and IHC result (Ki-67, cytokeratin 5/6, EGFR, p53). The correlation of texture features and enhancement patterns with each pathological prognostic factor were assessed. Interobserver agreement was also investigated.

### **RESULTS**

High histologic grade was associated with low angular second moment (ASM,  $p=0.025$ ). Axillary nodal metastasis was associated with high maximum MR diameter ( $p=0.013$ ), high entropy ( $p=0.024$ ), and low ASM ( $p=0.026$ ), low information measure of correlation (IMC1,  $p=0.046$ ). High Ki-67 index ( $\geq 14\%$ ) tumors showed high percentage of fast initial enhancement ( $p=0.015$ ), high percentage of plateau or washout delayed enhancement ( $p<0.001$ ,  $p=0.001$ ) on dynamic enhancement pattern, high entropy ( $p<0.001$ ), low ASM ( $p=0.004$ ) and low IMC1 ( $p=0.004$ ) on texture analysis. The positivity of cytokeratin 5/6 or EGFR associated with high entropy ( $p=0.004$ ), high inverse difference moment (IDM,  $p=0.029$ ), low sum average ( $p=0.038$ ), low IMC1 ( $p=0.005$ ) and low IMC2 ( $p=0.038$ ) on texture analysis, and low mean ( $p=0.042$ ) and low median ( $p=0.037$ ) on histogram analysis. Positivity of p53 was not associated with DCE MR features. The agreement of texture and histogram features was good (ICCs $>0.9$ ).

### **CONCLUSION**

Dynamic enhancement pattern, texture and histogram features in DCE MR were associated with pathologic prognosis factors in TNBC. These image features would predict aggressiveness of TNBC on preoperative MR.

### **CLINICAL RELEVANCE/APPLICATION**

DCE MR features would predict TNBC aggressiveness. It could be used for non-invasive evaluation of TNBC before chemotherapy or surgery.

## **SSJ01-03 Automatic and Accurate Breast Cancer Volumetric Segmentation on MRI with Varying Degrees of Background Parenchymal Enhancement**

Tuesday, Dec. 1 3:20PM - 3:30PM Location: Arie Crown Theater

### **Participants**

Harini Veeraraghavan, New York, NY (*Presenter*) Nothing to Disclose  
Brittany Dashevsky, MD, DPhil, New York, NY (*Abstract Co-Author*) Nothing to Disclose  
Girard Gibbons, BA, New York, NY (*Abstract Co-Author*) Nothing to Disclose  
Elizabeth A. Morris, MD, New York, NY (*Abstract Co-Author*) Nothing to Disclose  
Joseph O. Deasy, PhD, New York, NY (*Abstract Co-Author*) Nothing to Disclose  
Elizabeth J. Sutton, MD, New York, NY (*Abstract Co-Author*) Nothing to Disclose

### **PURPOSE**

Breast MRI background parenchymal enhancement (BPE) varies between women and can limit the radiologists ability to accurately define breast cancer extent of disease. Here we sought to develop a computer model that could automatically generate volumetric segmentations of breast cancers on MRI with varying degrees of BPE.

### **METHOD AND MATERIALS**

46 patients with HER2+ invasive breast cancers were included with either mild ( $n=23$ ) or marked ( $n=23$ ) BPE. We developed in-house software that combines dynamic contrast enhanced (DCE) MR images acquired at multiple time points (1 pre and 3 post contrast) to generate volumetric tumor segmentation. The DCE-MR images are combined through spectral embedding from which scalar images are computed. The algorithm is initialized with a manually delineated contour of the tumor on a single slice. A model of the tumor is automatically learned using a Gaussian mixtures model (GMM) using the individual time series and the computed scalar images. The GMM classifications are used to refine a joint segmentation generated from the individual sequences using an automatically seeded grow cut method.

### **RESULTS**

The computer-generated volumetric segmentations were compared with a radiologist-delineated segmentation by computing DICE overlap scores (1.0 -best, 0 -worst). For tumors with mild BPE, the maximum DICE score was 0.92, the lowest was 0.28 and the median was 0.79. For tumors with marked BPE, the maximum DICE score was 0.90, the lowest was 0.04 and the median was 0.71. Two sampled t-test between the scores computed for the mild and marked BPE tumors failed to reject the null hypothesis indicating that there was no difference in the segmentation performance regardless of the extent of BPE.

### **CONCLUSION**



Our method achieves reasonably accurate volumetric tumor regardless of the extent of BPE.

#### CLINICAL RELEVANCE/APPLICATION

Automatic and accurate segmentation of breast cancers with marked BPE can aid the radiologist in accurately defining the extent of disease and minimizing inter-observer variability.

#### SSJ01-04 Association between Quantitative Measures of Breast Parenchymal Complexity and False-Positive Recall from Digital Mammography: Results from a Large Prospective Screening Cohort

Tuesday, Dec. 1 3:30PM - 3:40PM Location: Arie Crown Theater

##### Participants

Shonket Ray, PhD, Philadelphia, PA (*Abstract Co-Author*) Nothing to Disclose

Brad M. Keller, PhD, Philadelphia, PA (*Presenter*) Nothing to Disclose

Jinbo Chen, PhD, Philadelphia, PA (*Abstract Co-Author*) Nothing to Disclose

Emily F. Conant, MD, Philadelphia, PA (*Abstract Co-Author*) Speaker, Hologic, Inc; Scientific Advisory Board, Hologic, Inc; Consultant, Siemens AG

Despina Kontos, PhD, Philadelphia, PA (*Abstract Co-Author*) Nothing to Disclose

##### PURPOSE

To investigate associations between quantitative features of breast parenchymal complexity and false-positive (FP) recall from breast cancer screening with digital mammography.

##### METHOD AND MATERIALS

Digital mammography (DM) images from an entire one-year cohort of women screened for breast cancer at our institution (Sept. 2010 - Aug. 2011) were retrospectively analyzed. A total of 10,571 screening mammography exams were acquired using either a GE Essential or Hologic Selenia full-field digital mammography (FFDM) unit. All images sets consisted of bilateral cranio-caudal (CC) and medio-lateral oblique (MLO) views and were vendor post-processed (i.e., "For Presentation" images). To characterize breast tissue complexity, thirteen texture features were extracted using a locally adaptive computerized parenchymal texture analysis algorithm. As a comparative established risk factor for FP recall, breast percent density (PD) was estimated on a per-woman basis using previously validated automated software. Logistic regression was performed to evaluate associations between FP recall and the extracted complexity features, using a case-control design where FP-recalls (N=1064) were randomly age-matched to negative screening controls (N=3192) at a 1:3 ratio. Odds ratios (OR) and area under the curve (AUC) of the receiver operating characteristic (ROC) were used to assess strength of associations.

##### RESULTS

Combining PD and texture features yielded an AUC=0.62 (95%CI: 0.60-0.64), with PD (OR=1.01; 95%CI: 1.00-1.01), texture energy (OR=1.43; 95%CI: 1.27-1.61) and sum variance (OR=1.23; 95%CI: 1.07-1.52) associated to higher risk of FP recall ( $p<0.05$ ), while texture difference variance (OR=0.67; 95%CI: 0.58-0.78) and information correlation (OR=0.77; 95%CI: 0.69-0.85) were inversely associated to FP recall ( $p<0.05$ ). A baseline model of PD alone yielded had AUC=0.52 (95%CI: 0.50-0.54, PD OR=1.00; 95%CI: 1.00-1.01).

##### CONCLUSION

Quantitative features of mammographic parenchymal texture complexity may be indicative of the risk for false-positive recall from screening with digital mammography.

#### CLINICAL RELEVANCE/APPLICATION

Incorporating quantitative features of breast parenchymal texture may augment breast density as a parenchymal complexity descriptor to help guide personalized breast cancer screening recommendations.

#### SSJ01-05 Prediction of False-Negative Breast Cancer Screens with Digital Mammography: Preliminary evaluation of a Quantitative Breast Complexity Index

Tuesday, Dec. 1 3:40PM - 3:50PM Location: Arie Crown Theater

##### Participants

Andrew Oustimov, Philadelphia, PA (*Presenter*) Nothing to Disclose

Emily F. Conant, MD, Philadelphia, PA (*Abstract Co-Author*) Speaker, Hologic, Inc; Scientific Advisory Board, Hologic, Inc; Consultant, Siemens AG

Lauren Pantalone, BS, Philadelphia, PA (*Abstract Co-Author*) Nothing to Disclose

Brad M. Keller, PhD, Philadelphia, PA (*Abstract Co-Author*) Nothing to Disclose

Meng-Kang Hsieh, Philadelphia, PA (*Abstract Co-Author*) Nothing to Disclose

Despina Kontos, PhD, Philadelphia, PA (*Abstract Co-Author*) Nothing to Disclose

##### PURPOSE

Breast density is a known confounder of mammographic sensitivity, and increasingly reported for guiding supplemental screening recommendations. We assess the predictive value of a refined quantitative index of dense tissue complexity in identifying women at high-risk of false-negative screens.

##### METHOD AND MATERIALS

We retrospectively analyzed data from an entire one-year (09/01/10 to 08/30/11) screening cohort at our institution (N = 10,728). Among women with negative screening, false negatives (FNs) were defined as cancer detected in a follow up period of 12 and up to 24 months prior to the next routine screening exam (N=11). Controls were identified as women confirmed negative also at subsequent screening, and were randomly selected and matched to FNs based on age and race, at a 1:3 ratio (N=33). To specifically determine the added value of our breast complexity index (BCI), controls were also matched to FNs based on BIRADS density, and on the interpreting radiologist. The BCI was derived from a range of computer-extracted parenchymal texture descriptors, including Grey-level Histogram, Haralick, and Edge-enhancement features (N=29), summarized via principal component analysis (PCA). Associations between the BCI-PCA components and the odds of FN screening were determined via univariate

logistic regression and discriminatory capacity was assessed via receiver operating characteristic (ROC) curve analysis.

## RESULTS

The BCI was significantly associated with the odds of FN screening (OR: 0.67, 95% CI: 0.45 - 1.00,  $p = 0.05$ ), while exhibiting potential to discriminate between false negative screeners and controls confirmed as negative at subsequent screening (AUC = 0.69, 95% CI: 0.48 to 0.88). The first 3 principle components accounted for 88% of the total variance in the features.

## CONCLUSION

The significant association between BCI and the odds of FN screen, in a case-control sample with identical BIRADS density distributions, suggests that refined quantitative measures of breast complexity may be more sensitive than qualitative BIRADS density in identifying women at high-risk for a false-negative screening exam.

## CLINICAL RELEVANCE/APPLICATION

Quantitative measures of breast complexity may result in more sensitive markers for guiding supplemental screening recommendations, than the reporting of conventional BIRADS breast density.

### SSJ01-06 Dedicated Computer Aided Detection for Automated 3D Breast Ultrasound Detects Invasive Ductal Cancers Independent of Hormonal Receptor Status

Tuesday, Dec. 1 3:50PM - 4:00PM Location: Arie Crown Theater

#### Participants

Jan Van Zelst, Nijmegen, Netherlands (*Presenter*) Nothing to Disclose

Tao Tan, Nijmegen, Netherlands (*Abstract Co-Author*) Research Grant, QView Medical, Inc

Nico Karssemeijer, PhD, Nijmegen, Netherlands (*Abstract Co-Author*) Shareholder, Matakina Technology Limited; Consultant, QView Medical, Inc; Shareholder, QView Medical, Inc; Director, ScreenPoint Medical BV; Shareholder, ScreenPoint Medical BV;

Ritse M. Mann, MD, PhD, Nijmegen, Netherlands (*Abstract Co-Author*) Speakers Bureau, Bayer AG

## PURPOSE

Prognostic factors such as hormonal receptor (HR) status (estrogen and progesterone) in invasive ductal cancers (IDC) are associated with ultrasonographic imaging phenotypes that may limit differentiating aggressive IDC from benign masses. Therefore, in this study we compared the relative sensitivity of a commercially developed computer aided detection (CADE) program in the detection of HR+ and HR- IDCs and biopsied benign breast lesions.

## METHOD AND MATERIALS

The local IRB waived the need for informed consent for this study. ABUS exams of 101 women with 66 IDCs and 35 biopsied benign lesions were randomly selected from a large image archive. All IDCs were examined by a pathologist on the surgical specimen and benign lesions were examined on a histological core needle biopsy specimen. For all IDCs we extracted HR status from the pathology reports. All lesions were annotated by outlining the contour of the lesion based on radiology and pathology reports. After reading the cases, the CADE program (Qview Medical Inc., Los Altos, ca., USA) generated a series of suspicious region candidates that were marked in the ABUS scans. The location of these candidates were objectively compared to the location of the annotations. Thereafter, the relative sensitivity of the CADE program was computed for the HR+ IDCs, HR- IDCs and the benign lesions. Chi-square tests were used to analyze the differences between the sensitivities of these three groups. Statistical differences are considered significant when  $p < 0.05$ .

## RESULTS

CADE marked 71.2% of the IDC's as suspicious versus 45.7% of the benign lesions ( $p=0.012$ ). Of the HR+ IDCs, 69.2% were marked by CADE. This is significantly higher than the marked proportion of benign lesions ( $p=0.028$ ). Also the detection of HR- IDC's (78.6%) was better than that of the benign lesions ( $p= 0.037$ ). The detection of HR+ IDC's did not statistically differ from the HR- IDC's that were marked by CADE ( $p=0.48$ ).

## CONCLUSION

Computer Aided Detection software can detect and mark IDCs independent from the hormonal status. Furthermore, CADE differentiates between suspicious benign breast lesions and HR negative IDC's that are known for their benign-like ultrasonographic appearance.

## CLINICAL RELEVANCE/APPLICATION

Computer Aided Detection software has the potential to aid radiologists in detecting even the more aggressive breast cancers and may aid in differentiating between aggressive subtypes of cancer and suspicious benign lesions.

SSJ25

## Vascular/Interventional (Advances in Radioembolization)

Tuesday, Dec. 1 3:00PM - 4:00PM Location: E351



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

Discussions may include off-label uses.

### Participants

James T. Bui, MD, Chicago, IL (*Moderator*) Nothing to Disclose

Robert J. Lewandowski, MD, Chicago, IL (*Moderator*) Advisory Board, BTG International Ltd; Advisory Board, Boston Scientific Corporation; Consultant, Cook Group Incorporated; Consultant, ABK Medical Inc

### Sub-Events

#### SSJ25-01 The Effect of Yttrium-90 Radioembolization on the Growth Kinetics of Treated and Untreated Colorectal Liver Metastasis

Tuesday, Dec. 1 3:00PM - 3:10PM Location: E351

### Participants

Atila Arslanoglu, MD, Chicago, IL (*Presenter*) Grant, Siemens AG

Faezeh Sodagari, MD, Chicago, IL (*Abstract Co-Author*) Grant, Siemens AG

Adeel R. Seyal, MD, Chicago, IL (*Abstract Co-Author*) Grant, Siemens AG

Zhuoli Zhang, MD, PhD, Chicago, IL (*Abstract Co-Author*) Nothing to Disclose

Riad Salem, MD, MBA, Chicago, IL (*Abstract Co-Author*) Research Consultant, BTG International Ltd; Research Grant, BTG International Ltd; ;

Vahid Yaghmai, MD, Chicago, IL (*Abstract Co-Author*) Nothing to Disclose

### PURPOSE

To evaluate the effect of 90Y radioembolization (TARE) on the growth kinetics of both the treated and the contralateral untreated colorectal cancer liver metastases as well as on the portal vein (PV) diameter.

### METHOD AND MATERIALS

78 chemorefractory liver metastases from colorectal cancer in 17 patients with two MDCT scans before and one after TARE were evaluated. Liver lesions were divided in two groups: 1) treated lesions and 2) untreated contralateral lobe lesions. Tumor growth kinetics of the two groups was evaluated before and one month after the unilobar TARE comparing reciprocal doubling time (RDT) based. The diameter of the PV in treated and untreated lobes were measured by two radiologists. Student's t-test was used for analysis.  $P < 0.05$  was considered significant.

### RESULTS

For the treated lesions, mean RDT decreased from 8.3 to -5.6 with TARE ( $P < 0.0001$ ), whereas for the untreated lesions, the means RDT increased from 7.5 before TARE to 10.6 after TARE ( $P = 0.028$ ). The mean diameter of PV did not change in the treated or untreated lobes ( $P = 0.12$  and  $P = 0.83$ , respectively).

### CONCLUSION

Lobar / segmental TARE significantly decreases the growth kinetics for the treated metastases but may lead to increase in the growth kinetics of contralateral liver.

### CLINICAL RELEVANCE/APPLICATION

90Y radioembolization may increase in the growth rate of untreated colorectal cancer liver metastasis in the contralateral lobe. This information may be helpful in future treatment planning of contralateral hepatic lobe metastasis.

### Honored Educators

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

Vahid Yaghmai, MD - 2012 Honored Educator

Vahid Yaghmai, MD - 2015 Honored Educator

#### SSJ25-02 Semiautomatic Assessment of Whole-lesion Apparent Diffusion Coefficient (ADC) as an Early Predictor of Liver Tumor Response after Radioembolization

Tuesday, Dec. 1 3:10PM - 3:20PM Location: E351

### Participants

Nils Rathmann, MD, Mannheim, Germany (*Presenter*) Nothing to Disclose

Johannes Budjan, MD, Mannheim, Germany (*Abstract Co-Author*) Nothing to Disclose

Ulrike I. Attenberger, MD, Mannheim, Germany (*Abstract Co-Author*) Research Consultant, Bayer AG

Michael Kostrzewa, MD, Mannheim, Germany (*Abstract Co-Author*) Nothing to Disclose

Stefan O. Schoenberg, MD, PhD, Mannheim, Germany (*Abstract Co-Author*) Institutional research agreement, Siemens AG

Steffen J. Diehl, MD, Mannheim, Germany (*Abstract Co-Author*) Nothing to Disclose

## PURPOSE

A semi-automatic, volume-based ADC measurement tool was evaluated as an early predictor of therapy response after radioembolization (RE) of primary and secondary liver malignancies.

## METHOD AND MATERIALS

In a retrospective analysis, a total of 50 patients suffering from primary or secondary liver tumor treated with Yttrium-90 resin microspheres for RE were included. All patients underwent a baseline MR examination as well as an early follow-up MRI 1 month after intervention. The MRI protocol included diffusion-weighted imaging (DWI, b-Values 50,400,800) as well as contrast-enhanced T1 weighted sequences. Measurement of lesion diameter, mean ADC in a representative single-slice region-of-interest (ADCROI) and mean ADC for the entire lesion volume (ADCVOL) were evaluated in both examinations. ADCVOL was measured using a semi-automatic, image analysis software (MRONcotreat, Siemens Healthcare, Germany). The progression-free interval (PFI) of the individual patients, based on further MRI scans was assessed according to RECIST 1.1 criteria. Changes in lesion diameter, ADCROI and ADCVOL between baseline and early follow up were correlated to PFI.

## RESULTS

Median PFI of all patients was  $3.5 \pm 5.8$  months post RE. Patients with an increase of ADCVOL in the first control MRI showed a statistically significant longer PFI in comparison to patients with a decrease of ADCVOL (median PFI: 6.5 months vs. 2.5 months,  $p = 0.02$ ). No correlation between PFI and early changes in lesion diameter or ADCROI was found.

## CONCLUSION

In contrast to lesion diameter or single-ROI ADC evaluation, semi-automatic, software-based ADC-volume measurement seems to offer a clinically valuable parameter for early assessment of therapy response in patients after RE.

## CLINICAL RELEVANCE/APPLICATION

Software-based ADC-volume assessment helps to early identify patients with tumor response already one month post therapy and therefore could help to triage patients with no response to RE to other therapy options without delay.

### SSJ25-03 Quantitative Enhancement Measurements on Pre-procedure Triphasic CT Can Predict Response to Radioembolization of Colorectal Liver Metastases

Tuesday, Dec. 1 3:20PM - 3:30PM Location: E351

#### Participants

Franz E. Boas, MD, PhD, New York, NY (*Presenter*) Co-founder, ClariPACS  
Constantinos T. Sofocleous, MD, PhD, New York, NY (*Abstract Co-Author*) Consultant, Sirtex Medical Ltd  
Lynn A. Brody, MD, New York, NY (*Abstract Co-Author*) Stockholder, Sirtex Medical Ltd  
Joseph P. Erinjeri, MD, PhD, New York, NY (*Abstract Co-Author*) Nothing to Disclose  
Hooman Yarmohammadi, MD, New York, NY (*Abstract Co-Author*) Nothing to Disclose  
Waleed Shady, MBBCh, New York, NY (*Abstract Co-Author*) Nothing to Disclose  
Sirish Kishore, MD, New York, NY (*Abstract Co-Author*) Nothing to Disclose

## PURPOSE

Colorectal liver metastases (CLM) demonstrate variable response to radioembolization. This may be at least partly due to differences in tumor arterial perfusion. This study examines whether quantitative enhancement measurements on pre-procedure triphasic CT can be used to predict response of CLM to radioembolization.

## METHOD AND MATERIALS

The Institutional Review Board approved this retrospective review of patients with colorectal liver metastases treated with radioembolization, who had pre-treatment PET/CT and triphasic CT, and post-treatment PET/CT. 31 consecutive patients with 60 target tumors were included in the study. For each tumor, we calculated the hepatic artery coefficient (HAC), portal vein coefficient (PVC), and arterial enhancement fraction (AEF) based on the pre-treatment triphasic CT. HAC and PVC are estimates of the hepatic artery and portal vein blood supply. AEF is the arterial phase enhancement divided by the portal phase enhancement, and it provides an estimate of the hepatic artery blood supply as a fraction of total blood supply. Metabolic response to radioembolization for each tumor was classified into two categories - response (complete or partial response), or no response (stable disease or progression) - based on the initial (4-8 weeks) post-treatment PET/CT.

## RESULTS

55% of CLM showed a complete or partial metabolic response. Arterial enhancement, HAC, and PVC did not predict which tumors responded to radioembolization. However, the AEF was significantly greater in responders compared to non-responders ( $p=0.038$ ).  $AEF < 0.4$  was associated with a 40% response rate, whereas  $AEF > 0.75$  was associated with a 78% response rate.

## CONCLUSION

Response to radioembolization can be predicted using the arterial enhancement fraction calculated from pre-procedure triphasic CT.

## CLINICAL RELEVANCE/APPLICATION

AEF could enable better patient selection for radioembolization procedures.

### SSJ25-04 Use of SPECT-CT Following Administration of Technetium-99m-labelled Macroaggregated Albumin Improves Lung Shunt Fraction (LSF) Calculation and May Allow for More Accurate Dosing of Yttrium-90 (Y-90) Treatment for Liver Tumors

Tuesday, Dec. 1 3:30PM - 3:40PM Location: E351

#### Participants

Colin J. McCarthy, MD, Boston, MA (*Presenter*) Nothing to Disclose  
Daniel Tempesta JR, BS, RT, Boston, MA (*Abstract Co-Author*) Nothing to Disclose

David Z. Chow, MD, Cambridge, MA (*Abstract Co-Author*) Nothing to Disclose  
Suvranu Ganguli, MD, Boston, MA (*Abstract Co-Author*) Research Grant, Merit Medical Systems, Inc Consultant, Boston Scientific Corporation  
Rahmi Oklu, MD, PhD, Boston, MA (*Abstract Co-Author*) Nothing to Disclose  
Leonard P. Connolly, MD, Boston, MA (*Abstract Co-Author*) Nothing to Disclose

## PURPOSE

Due to the risk of radiation pneumonitis, dosage of Y-90 microspheres via direct injection into hepatic artery branches for radioembolization of non-resectable metastatic and primary liver malignancies is reduced when LSF, as calculated by a treatment planning Tc-99m MAA study, exceeds 10% and may be contraindicated when LSF exceeds 20%. Because SPECT-CT offers potential advantages to traditionally used planar imaging for accuracy of LSF calculation, we evaluated how values obtained by SPECT-CT could affect management.

## METHOD AND MATERIALS

Patients with estimated LSF greater than or equal to 10% on planar imaging were identified. When SPECT-CT data was available, lung shunt fraction was calculated using software (syngo MI Applications, Siemens AG) and the values were compared to the planar LSF. The Student's t-test was used to assess for statistical significance.

## RESULTS

204 shunt studies in patients with non-resectable hepatic malignancy over an 11 year period were reviewed. The majority (50.9%) of patients had colorectal carcinoma liver metastases. In 28.9% (n = 59) of cases, the LSF was 10% or greater. Of these cases, 25.4% (n=15) were found to have complete SPECT-CT imaging of the chest. The lung shunt fraction was lower when calculated using SPECT-CT in all cases. The mean LSF in this group was 17.2%  $\pm$  8.4% using planar and 7.8%  $\pm$  3.6% using SPECT CT, and this difference was statistically significant (p <0.0001). By utilizing the SPECT-CT LSF, 3 patients who were ineligible on the basis of planar LSF (>20%) became potentially eligible for treatment, 9 patients became eligible for treatment without dose reduction and in 2 cases, lesser amounts of dose reduction would have been required on the basis of the SPECT-CT LSF.

## CONCLUSION

Lung shunt fraction calculations performed prior to Y-90 treatment were lower when calculated using SPECT-CT in all cases in our series. Although planar imaging has traditionally been used in the calculation of LSF, repeat calculations using SPECT-CT data should be considered when such information is available, as it may allow for a higher treatment dose, or obviate the need for an intervening embolization procedure. Further work is required to assess whether utilizing SPECT-CT data alters outcomes in these patients.

## CLINICAL RELEVANCE/APPLICATION

SPECT-CT can improve accuracy of lung shunt fraction calculation in Y-90 treatment planning, and may allow for more accurate dosing.

## SSJ25-05 Total Lesion Glycolysis and Sum of Largest Diameters of Target Lesions are Independent Predictors of Survival after 90Y Radioembolization of Colorectal Liver Metastases

Tuesday, Dec. 1 3:40PM - 3:50PM Location: E351

### Participants

Waleed Shady, MBCh, New York, NY (*Presenter*) Nothing to Disclose  
Sirish Kishore, MD, New York, NY (*Abstract Co-Author*) Nothing to Disclose  
Vlasios S. Sotirchos, MD, New York, NY (*Abstract Co-Author*) Nothing to Disclose  
Richard Kinh Gian Do, MD, PhD, New York, NY (*Abstract Co-Author*) Nothing to Disclose  
Franz E. Boas, MD, PhD, New York, NY (*Abstract Co-Author*) Co-founder, ClariPACS  
Constantinos T. Sofocleous, MD, PhD, New York, NY (*Abstract Co-Author*) Consultant, Sirtex Medical Ltd  
Joseph R. Osborne, MD, New York, NY (*Abstract Co-Author*) Nothing to Disclose  
Lynn A. Brody, MD, New York, NY (*Abstract Co-Author*) Stockholder, Sirtex Medical Ltd  
Elena G. Violari, MD, New York, NY (*Abstract Co-Author*) Nothing to Disclose  
Elena N. Petre, MD, New York, NY (*Abstract Co-Author*) Nothing to Disclose  
Neil H. Segal, MD, New York, NY (*Abstract Co-Author*) Nothing to Disclose  
Nancy Kemeny, MD, New York, NY (*Abstract Co-Author*) Nothing to Disclose

## PURPOSE

To identify predictors of overall survival (OS) after 90Y radioembolization of colorectal liver metastases.

## METHOD AND MATERIALS

We conducted an IRB-approved retrospective review of our prospectively created and maintained 90Y radioembolization clinical database for the time period December 2009 through December 2013. We included all patients treated for colorectal liver metastases (CLM). We excluded patients without an FDG-PET/CT scan at baseline or on the first follow-up. On the baseline portal venous phase CT, up to 5 target tumors per patient were chosen and the sum of largest diameters were calculated. On FDG-PET/CT SUVmax, functional tumor volume (FTV), and total lesion glycolysis (TLG) (meanSUV x FTV) were measured for the target lesions chosen on CT and a sum for each metric was calculated for the patient. OS was calculated from the time of radioembolization until death or last follow-up. Log-rank test was used to analyze predictor of survival on univariate analysis and a Cox-regression model was used for multivariate analysis.

## RESULTS

The study enrolled 47 patients with 122 target tumors; a median of 2 (range: 1-5) tumors per patient. Thirteen patients were treated in 2 sessions, and 34 were treated in 1 session. The median OS was 12.7 months (95% CI: 7.2-16.3). The one-, two-, and three-year OS rates were 51%, 22% and 15% respectively. On univariate analysis predictors of poor survival were: CEA level >200 ng/ml (P=0.001), ECOG status >0 (P<0.001), SUVmax >30 (P=0.002), TLG >600g (P<0.001), FTV >200 cc (P<0.001), and sum of largest diameters >10 cm (P<0.001). On multivariate analysis, only the TLG >600 g (P<0.001) (HR=4.3; 95% CI: 1.8-10.1) and sum of largest diameters >10 cm (P=0.01) (HR=2.8; 95% CI: 1.3-6.2) retained significance.

## CONCLUSION

High tumor metabolic activity and sum of largest diameters >10 cm of the target tumors is associated with poor survival after 90Y radioembolization of CLM.

## CLINICAL RELEVANCE/APPLICATION

Measurement of total lesion glycolysis and the size of target lesions prior to 90Y radioembolization of CLM can provide prognostic information and help predict patient survival.

## SSJ25-06 Radiation Lobectomy: Single Center Investigation of Incidence, Degree, Prognostic Factors and Survival

Tuesday, Dec. 1 3:50PM - 4:00PM Location: E351

### Participants

Andrew G. Kim, Chicago, IL (*Presenter*) Nothing to Disclose  
Ahmad Parvinian, MD, Chicago, IL (*Abstract Co-Author*) Nothing to Disclose  
Nicholas S. Armijo, Chicago, IL (*Abstract Co-Author*) Nothing to Disclose  
James T. Bui, MD, Chicago, IL (*Abstract Co-Author*) Nothing to Disclose  
Ron C. Gaba, MD, Chicago, IL (*Abstract Co-Author*) Nothing to Disclose

## PURPOSE

Yttrium-90 radioembolization (Y90 RE) is a minimally invasive therapy for liver tumors. A unique anatomical response pattern to Y90 RE, termed "radiation lobectomy (RL)," occurs in a subset of treated patients and consists of marked ipsilateral liver lobe atrophy and contralateral hypertrophy. While RL has been anecdotally described, there is limited characterization of this phenomenon in the literature. This study aimed to investigate the incidence and degree of RL, identify prognostic factors for occurrence, and examine association with survival.

## METHOD AND MATERIALS

This single-center, retrospective study included 141 Y90 RE-treated patients from 2006-2012. Cases of right unilobar therapy were selected (n=33), while cases of bilobar treatment and inadequate imaging follow-up were excluded (n=108). Chart and imaging review were used to collect demographic, tumor, and treatment data, and pre-/post-RE hepatic volumes were measured. RL was defined as 25% relative atrophy of treated liver lobes. Measured outcomes included RL incidence, hepatic volumetric changes, parameters associated with RL, and survival.

## RESULTS

The study cohort included 23 men and 10 women (median age 62 years). 58% (n=19) and 42% (n=14) had primary tumors and metastatic disease. Median index tumor size was 6 cm, and patients underwent median 1 (range 1-4) Y90 RE sessions (75% resin, 25% glass), with median cumulative dose of 2.33 (range 1.06-10.31) GBq. RL incidence was 33% (n=11). There were no differences in median pre-RE right (1284 vs. 1240 mL) and left (521 vs. 680 mL) lobe liver volumes between RL and non-RL groups (P>0.05). The median post-RE right (344 vs. 993 mL, P=0.002) lobe liver volume was significantly lower in the RL vs. non-RL group. A significant change between pre- and post-treatment relative right (69% to 25%, P<0.001) and left (31% to 75%, P<0.001) hepatic lobe volumes occurred in the RL group, while no significant change ensued in the non-RL group (right: 64% to 53%, left: 36% to 47%). No parameters had statistical association with RL occurrence. Median survival was significantly greater in patients exhibiting RL pattern response (1036 vs. 493 days, P=0.012).

## CONCLUSION

RL occurs with relatively common frequency among patients undergoing Y90 RE. While associated with enhanced survival, predictive factors for RL occurrence remains elusive.

## CLINICAL RELEVANCE/APPLICATION

RL occurs in about one-third of Y90 RE cases, and confers enhanced survival.



## Gastrointestinal (CT Dose Reduction)

Tuesday, Dec. 1 3:00PM - 4:00PM Location: E352

**CT** **GI** **SQ**

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

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

### Participants

Vahid Yaghmai, MD, Chicago, IL (*Moderator*) Nothing to Disclose  
Mannudeep K. Kalra, MD, Boston, MA (*Moderator*) Nothing to Disclose

### Sub-Events

#### SSJ08-01 **Low Dose Gemstone Spectral CT Imaging in Abdominal Patients: Evaluation of Whether the Virtual Non-enhanced Images from Contrast-enhanced Spectral CT Could Replace True Non-enhanced for Radiation Dose Reduction**

Tuesday, Dec. 1 3:00PM - 3:10PM Location: E352

### Participants

Hai-Feng Duan, MMed, Xianyang, China (*Presenter*) Nothing to Disclose  
Yongjun Jia, MMed, Xianyang City, China (*Abstract Co-Author*) Nothing to Disclose  
Taiping He, Xianyang, China (*Abstract Co-Author*) Nothing to Disclose  
Zhanli Ren, Xianyang, China (*Abstract Co-Author*) Nothing to Disclose  
Xirong Zhang, Xianyang, China (*Abstract Co-Author*) Nothing to Disclose  
Yong Yu, Xianyang City, China (*Abstract Co-Author*) Nothing to Disclose  
Youmin Guo, Xian, China (*Abstract Co-Author*) Nothing to Disclose  
Yang Chuangbo, MMed, Xianyang City, China (*Abstract Co-Author*) Nothing to Disclose

### PURPOSE

To evaluate if the virtual nonenhanced (VNE) images generated from the contrast-enhanced low dose spectral CT images could replace the true nonenhanced (TNE) for radiation dose reduction.

### METHOD AND MATERIALS

Images of 50 consecutive adults (36 males and 14 females, ages: 21-79 years) who underwent 3-phase abdominal CT were retrospectively analyzed. TNE CT was performed with conventional 120kVp. The contrast-enhanced scans in arterial phase (AP) and portal venous phase (VP) were performed with low dose spectral CT mode. VNE images were generated from AP (VNEA) and VP (VNEP) spectral CT images. 2 board-certified radiologists reviewed both TNE and VNE images for image quality and lesion detection. Mean CT value, signal-noise-ratio (SNR) and contrast-noise-ratio (CNR) for liver, pancreas, spleen, kidney and muscle were measured. Lesion detection rate, subjective image rating and radiation dose were assessed and compared.

### RESULTS

Both TNE and VNE images satisfied clinical needs for lesion detection and image quality. The image quality scores were  $4.78 \pm 0.47$ ,  $4.56 \pm 0.76$  and  $4.68 \pm 0.59$  for TNE, VNEA and VNEP, respectively with no difference. There was no difference for the lesion detection rate (number) with the plain CT scan (66.8% (135), 63.4% (128) and 65.8% (133), respectively) ( $p > 0.05$ ). CT number (in HU) in liver, pancreas, spleen, kidney and muscle were, respectively,  $(52.00 \pm 7.38, 34.00 \pm 6.41, 46.35 \pm 5.59, 30.03 \pm 4.48$  and  $45.56 \pm 7.80)$  on TNE,  $(53.01 \pm 6.13, 35.99 \pm 6.73, 49.74 \pm 5.74, 31.91 \pm 3.86$  and  $44.22 \pm 7.10)$  on VNEA and  $(56.17 \pm 5.87, 36.60 \pm 7.12, 50.94 \pm 4.55, 32.61 \pm 3.66,$  and  $46.03 \pm 6.92)$  on VNEP. There was slight bias for CT numbers on VNE. However, the absolute CT number difference between VNE and TNE was less than 5HU, with the largest at VP for the spleen. VNEA had better CT number fidelity with the smallest difference for the liver. CNR values in 3 groups were similar. VNE images provided statistically higher SNR. The potential dose reduction for replacing TNE with VNE was 30.12%.

### CONCLUSION

VNE image generated from the contrast-enhanced abdominal low dose spectral CT provides adequate image quality for lesion depiction, high CT number fidelity and 30% dose reduction compared with TNE.

### CLINICAL RELEVANCE/APPLICATION

VNE images generated from the contrast-enhanced abdominal spectral CT may be used to replace TNE images to provide adequate image quality for lesion depiction and 30% dose reduction.

#### SSJ08-02 **Evaluation of Contrast Enhancement and Image Quality: A Comparison Study between Different Tube Voltages and Iodine Concentrations in Upper Abdominal Dynamic CT Scans in Minipigs**

Tuesday, Dec. 1 3:10PM - 3:20PM Location: E352

### Participants

Maoqing Hu, Guangzhou, China (*Abstract Co-Author*) Nothing to Disclose  
Zaiyi Liu, Guangzhou, China (*Presenter*) Nothing to Disclose  
Chang Hong Liang, MD, Guangzhou, China (*Abstract Co-Author*) Nothing to Disclose  
Xiao Mei Lu, MMed, Shenyang, China (*Abstract Co-Author*) Nothing to Disclose

### PURPOSE

To investigate the enhanced effects of abdominal vessels and liver parenchyma and the image quality in abdominal dynamic CT

scans using different tube voltages and different concentrations of contrast agents at identical iodine delivery rate.

## METHOD AND MATERIALS

Six minipigs underwent repeated upper abdominal dynamic enhanced CT scans (256-slice CT scanner) under 4 protocols: group A (270 mgI/mL, 80kVp + iterative reconstruction (IR, iDose4) algorithm), group B (370 mgI/mL, 80kVp + IR algorithm), group C (270 mgI/mL, 120kVp + FBP algorithm), group D (370 mgI/mL, 120kVp + FBP algorithm). The total iodine dose (600 mg I/kg) and iodine delivery rate (0.92 mg I/s) of injected contrast agents were the same in all groups. The enhanced attenuations of abdominal aorta, portal vein and liver parenchyma were measured and the image noise, SNR and CNR in peak enhancement of liver parenchyma were determined. The subjective image quality was evaluated by two radiologists.

## RESULTS

There were no significant differences in peak enhanced attenuations of abdominal aorta, portal vein and liver parenchyma between 80kVp groups or 120kVp groups respectively (all  $P > 0.05$ ), the attenuations of vessels in 80kVp were significantly higher than in 120kVp (all  $P < 0.05$ ). There were no significant differences in image noise, SNR and CNR of liver parenchyma between groups (all  $P > 0.05$ ). The subjective image quality scores were no significant difference.

## CONCLUSION

Different concentrations of iodinated contrast agents given an injection protocol with the same iodine delivery rate and total iodine dose achieved the same enhancement of the abdominal vessels and liver parenchyma, 80 kVp with IR (iDose4) algorithm acquired acceptable image quality.

## CLINICAL RELEVANCE/APPLICATION

The injection protocols and bolus characteristics of iodinated contrast agent should be optimized to achieve best enhancement and reduce radiation dose meanwhile.

### SSJ08-03 Objective Image Quality and Detectability of Simulated Low-Contrast, Low-Attenuation (LCLA) Liver Lesions on CT without and with an Integrated Circuit (IC) Detector and Iterative Reconstruction (IR): Effect of Radiation Exposure and Subject Size

Tuesday, Dec. 1 3:20PM - 3:30PM Location: E352

#### Participants

Ajit H. Goenka, MD, Cleveland, OH (*Presenter*) Institutional Research Grant, Siemens AG

Brian R. Herts, MD, Cleveland, OH (*Abstract Co-Author*) Research Grant, Siemens AG

Frank Dong, PhD, Solon, OH (*Abstract Co-Author*) Equipment support, Siemens AG Software support, Siemens AG

Nancy A. Obuchowski, PhD, Cleveland, OH (*Abstract Co-Author*) Research Consultant, Siemens AG Research Consultant, Hologic, Inc Research Consultant, Cardiovascular Ultrasound Services, Inc Research Consultant, Elucid Bioimaging Inc

Andrew Primak, PhD, Malvern, PA (*Abstract Co-Author*) Employee, Siemens AG

Wadih Karim, RT, Cleveland, OH (*Abstract Co-Author*) Nothing to Disclose

Mark E. Baker, MD, Cleveland, OH (*Abstract Co-Author*) Research Consultant, Bracco Group; Researcher, Siemens AG; Research support, Siemens AG

## PURPOSE

To assess image quality and LCLA liver lesion detection in semi-anthropomorphic phantom using either discrete circuit (DC) detector and FBP or IC detector and IR at varied radiation exposures and phantom diameters

## METHOD AND MATERIALS

A phantom without and with 5-cm thick fat-mimicking ring (30- and 40-cm diameters) and containing liver inserts with 4 spherical lesions was scanned with 5 exposure settings [30-cm phantom: 200 (CTDIvol 13.5 mGy), 150, 100, 50, and 25 eff mAs; 40-cm phantom: 400 (CTDIvol 26.9 mGy), 300, 200, 100, and 50 eff mAs] on two CT scanners, one equipped with DC and other with IC detector. Images were reconstructed with FBP and IR (SAFIRE;S3) respectively. Image noise and lesion CNR were averaged at each mAs. Four radiologists evaluated lesion presence on a 5-point diagnostic confidence scale. Data analyses included ROC curve analysis, and noninferiority analysis (margin -0.10)

## RESULTS

Image noise was significantly lower with IC-IR than with DC-FBP ( $P < .001$ ) with greater reduction in 40-cm phantom and at lower exposures. Lesion CNR was significantly higher with IC-IR than with DC-FBP ( $P < .001$ ). When compared to DC-FBP at highest exposures, mean reader accuracy with IC-IR was noninferior up to 50% (100 eff mAs) and 25% (300 eff mAs) exposure reductions for 30- and 40-cm phantoms respectively (adjusted  $P < .001$  and  $P = .04$ ). IC-IR improved readers' confidence in presence of a lesion (average difference 0.17 points) ( $P = .029$ ) independent of phantom size or exposure level. At any given exposure level, however, there was no significant difference between mean AUCs with IC-IR and DC-FBP for either of 2 phantoms.

## CONCLUSION

Moderate exposure reductions maintained non-inferior diagnostic accuracy for both detector-reconstruction combinations. Lesion detection in 40-cm phantom was inferior at smaller exposure reduction than in 30-cm phantom. IC-IR improved objective image quality and lesion detection confidence but did not result in superior diagnostic accuracy

## CLINICAL RELEVANCE/APPLICATION

Impact of noise-reduction on threshold radiation exposure below which diagnostic information may be lost depends on the combination of patient size and imaging task. LCLA lesion detectability in simulated patients with larger girths is more sensitive to increased noise at reduced radiation exposures than in simulated smaller patients. Task-specific measures are critical in determining the clinical utility of newer noise-reduction technologies.

### SSJ08-04 The Use of Low Tube Voltage and ASIR Reconstruction to Improve Image Quality of CT Angiography for Tumor Blood Supply Arteries Under Low Concentration Contrast Condition

Tuesday, Dec. 1 3:30PM - 3:40PM Location: E352

#### Participants

Li Ye, Dalian, China (*Presenter*) Nothing to Disclose  
Ailian Liu, MD, Dalian, China (*Abstract Co-Author*) Nothing to Disclose  
Shifeng Tian, Dalian, China (*Abstract Co-Author*) Nothing to Disclose  
Yijun Liu, Dalian, China (*Abstract Co-Author*) Nothing to Disclose  
Jinghong Liu, MD, PhD, Dalian, China (*Abstract Co-Author*) Nothing to Disclose  
Ting Zhang, Da Lian, China (*Abstract Co-Author*) Nothing to Disclose

#### PURPOSE

To investigate the use of low tube voltage and adaptive statistical iterative reconstruction (ASIR) algorithm to improve image quality and diagnostic confidence for tumor blood arteries under low contrast medium concentration.

#### METHOD AND MATERIALS

Fifty-eight patients (body mass index (BMI)  $\leq 22$  kg/m<sup>2</sup>) with suspected gastrointestinal tract malignant tumors CT scans were randomly divided into two groups. Group A (21 men and 11 women, ages 40-90 years) was scanned with 80kVp and low concentration of contrast medium (270mgI/ml) and reconstructed with 50% ASIR. Group B (22 men and 4 female, ages 40-76 years) underwent scanning with conventional 120 kVp and high concentration of contrast medium (350 mgI/ml). CT value and standard deviation (SD) of the tumor blood supplying artery and fat in anterior abdominal wall were measured, and contrast-to-noise ratio (CNR) and value were calculated. Image quality was evaluated by two radiologists using a 5-point rating scale. The inter-observer agreement was estimated by using weighted kappa statistics and Intra-class correlation coefficients (ICC) test. Image quality scores were compared by the Mann-Whitney U test. The paired Student t tests was used to compare the difference in CT value, SD value, CNR and CT dose index (CTDIvol) value between group A and B.

#### RESULTS

There was no difference in sex, age, BMI between two groups. The subjective image quality score of tumor blood supplying arteries of group A was better than that of group B (4.7 Vs. 4.3) with very good inter-observer agreement (Kappa value $>0.80$ ; ICC value $>0.75$ ). The CT value and CNR of group A (458.85 $\pm$ 69.03 HU and 20.20 $\pm$ 3.30) were higher than those of group B (249.76 $\pm$ 41.51HU and 9.31 $\pm$ 1.89) (all  $P<0.001$ ). The CTDIvol of group A (5.24 $\pm$ 1.15 mGy) was lower than that of group B (13.47 $\pm$ 4.73 mGy) ( $P<0.001$ ).

#### CONCLUSION

For patients with BMI  $\leq 22$  kg/m<sup>2</sup>, the low tube voltage and low contrast medium concentration scanning with 50% ASiR algorithm can reduce radiation dose and contrast medium concentration without sacrificing image quality.

#### CLINICAL RELEVANCE/APPLICATION

Low tube voltage with 50% ASiR algorithm may be used for CT angiography of slim patients with adequate image quality to dramatically reduce radiation and contrast dose.

#### SSJ08-05 Comparison of Attenuation Based Automated versus Empirical Method for Tube Voltage Selection in Abdominal-pelvic CT Examinations

Tuesday, Dec. 1 3:40PM - 3:50PM Location: E352

#### Participants

Faezeh Sodagari, MD, Chicago, IL (*Presenter*) Grant, Siemens AG  
Adeel R. Seyal, MD, Chicago, IL (*Abstract Co-Author*) Grant, Siemens AG  
Atilla Arslanoglu, MD, Chicago, IL (*Abstract Co-Author*) Grant, Siemens AG  
Cecil G. Wood III, MD, Chicago, IL (*Abstract Co-Author*) Nothing to Disclose  
Vahid Yaghmai, MD, Chicago, IL (*Abstract Co-Author*) Nothing to Disclose

#### PURPOSE

To compare the performance of attenuation based automated tube voltage (kV) selection software with known empirical method for kV selection in abdominal-pelvic CT examinations.

#### METHOD AND MATERIALS

The study was HIPAA compliant and IRB approved. Eighty patients who underwent abdominopelvic CT examinations were included in the study. All patients were scanned on the same CT scanner using automated kV selection. Lateral-width of the patient was determined. and patients were grouped based on their lateral-widths. Each lateral width group corresponded to an optimal kV (lateral-width based kV selection). Comparison was made between the kV selected using the automated selection software and the optimal kV based on lateral-widths.

#### RESULTS

Attenuation based automated kV selection resulted in a lower optimal tube potential in 32 out of 80 (40%) patients when compared with kV selection based on patient lateral-width ( $P<0.0001$ ). None of the patients were scanned with a higher kV using automated selection. Agreement between the two methods of kV selection was fair ( $\kappa$ -coefficient=0.28, 95% CI: 0.15 - 0.41).

#### CONCLUSION

Attenuation based automated tube voltage selection may be a more effective method for radiation dose reduction when compared to tube voltage selection based on patient width.

#### CLINICAL RELEVANCE/APPLICATION

Attenuation-based automated tube voltage selection allows greater reduction in radiation dose compared to empirical methods.

#### Honored Educators

Presenters or authors on this event have been recognized as RSNA Honored Educators for participating in multiple qualifying

educational activities. Honored Educators are invested in furthering the profession of radiology by delivering high-quality educational content in their field of study. Learn how you can become an honored educator by visiting the website at: <https://www.rsna.org/Honored-Educator-Award/>

Vahid Yaghmai, MD - 2012 Honored Educator  
Vahid Yaghmai, MD - 2015 Honored Educator

## **SSJ08-06 Application of kV Assist Associated with Adaptive Statistical Iterative Reconstruction (ASiR) in Reducing Radiation Dose of Hepatic Enhanced CT Scan**

Tuesday, Dec. 1 3:50PM - 4:00PM Location: E352

### **Participants**

Qingguo Wang, Shanghai, China (*Presenter*) Nothing to Disclose

### **PURPOSE**

To evaluate the impact of kV assist associated with ASiR on dose and image quality in hepatic enhanced CT scan.

### **METHOD AND MATERIALS**

This study included 46 patients who underwent CT angiography for upper abdomen using a 64-row CT scanner (GE Discovery CT750 HD). Patients were divided into two groups using kV assist technique. Group A (n=23, BMI: 20.72±2.37) and group B (n=23, BMI: 22.31±1.82) underwent CT scan with 120kVp and low tube kVp (≤100kVp), respectively. Data of group B were reconstructed with a fixed blending level (50% and 0% respectively) of ASiR for each image set. The baseline was 120 kVp, noise index (NI)=12.0(5mm). The CT values of abdominal fat layer, aorta (AR) and liver were measured. The contrast noise ratio (CNR) of AR and SMA were calculated respectively. The CT dose index volume (CTDIvol) of each patient were recorded. The dose length product (DLP) was recorded and effective radiation dose was calculated.

### **RESULTS**

The mean CTDIvol and effective radiation dose in group B (6.06 ±2.80mGy, 2.31 ±1.06mSv) were significantly lower than group A (9.26±4.69mGy, 3.81 ±2.31mSv) (p<0.05). The mean CT value of liver in group A (70.33±8.09Hu) was not significantly different with that in group B (0% ASiR) (73.82±10.83Hu) and group B (50% ASiR) (73.94±10.80Hu) (each p>0.05), respectively. The SD value of subcutaneous fat in group A (8.17±1.49HU) was lower than group B (50% ASiR) (9.57±1.59HU) (p<0.05). The CNR of liver (16.64±3.66) in group B (50% ASiR) was not significantly different with that in group A (18.99±3.75) (p>0.05). The SNRs of liver in group B (50% ASiR) (9.33±2.07) were higher than in group A (7.57±1.61) (p<0.05).

### **CONCLUSION**

kV assist recommended optimal scan protocol, and approximately 39% radiation dose was reduced without degradation of image quality.

### **CLINICAL RELEVANCE/APPLICATION**

kV assist helps to improve patient care through personalized protocols and simplify scan technique optimization.

SSJ07

## Gastrointestinal (Small Bowel Imaging)

Tuesday, Dec. 1 3:00PM - 4:00PM Location: E353A



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

### Participants

Michael S. Gee, MD, PhD, Jamaica Plain, MA (*Moderator*) Nothing to Disclose

Tracy A. Jaffe, MD, Durham, NC (*Moderator*) Nothing to Disclose

### Sub-Events

#### SSJ07-01 Reproducibility of Magnetic Resonance Enterography Scores for the Assessment of Disease Activity in Crohn's Disease Using Central Readers

Tuesday, Dec. 1 3:00PM - 3:10PM Location: E353A

### Participants

Jordi Rimola, MD, Barcelona, Spain (*Presenter*) Consultant, F. Hoffmann-La Roche Ltd; Consultant, Takeda Pharmaceutical Company Limited

Cynthia S. Santillan, MD, San Diego, CA (*Abstract Co-Author*) Consultant, Robarts Clinical Trials Research Group

Stuart A. Taylor, MBBS, London, United Kingdom (*Abstract Co-Author*) Research consultant to Robarts plc

Karin van Gemert-Horsthuis, MD, Amsterdam, Netherlands (*Abstract Co-Author*) Nothing to Disclose

Barrett G. Levesque, MD, San Diego, CA (*Abstract Co-Author*) Nothing to Disclose

Brian Feagan, London, ON (*Abstract Co-Author*) Nothing to Disclose

### PURPOSE

To evaluate the reproducibility of two MRE disease activity instruments, the MaRIA and London indices, when centrally read by four expert gastrointestinal body imaging radiologist readers in a multi-center trial setting.

### METHOD AND MATERIALS

Four central reader radiologists at different centers in Europe and North America reviewed 50 MRE sequences of patients with a spectrum of Crohn's disease activity and location. Readers assessed the MaRIA and London indices, pre-specified individual MRE findings, and a global rating of severity based on a visual analogue scale (VAS). Intraclass correlation coefficients (ICCs) for intra- and inter-rater agreement were calculated for each assessment.

### RESULTS

Intra-rater ICCs (95% confidence intervals) for the MaRIA, London, London Extended indices and the VAS were 0.89 (0.84 to 0.91), 0.84 (0.76 to 0.88), 0.81 (0.71 to 0.85) and 0.86 (0.81 to 0.90). Corresponding inter-rater ICCs were 0.71 (0.61 to 0.77), 0.50 (0.32 to 0.62), 0.56 (0.40 to 0.64), and 0.71 (0.62 to 0.77). The correlation between each reader's VAS and the MaRIA, London, and London Extended indices were 0.79 (0.71 to 0.85), 0.68 (0.58 to 0.77) and 0.67 (0.58 to 0.76), respectively. These results indicate that there was "almost perfect" intra-rater reproducibility of centrally read MaRIA and London indices. Inter-rater agreement was "substantial" for the MaRIA and "moderate" for the London indices.

### CONCLUSION

The MaRIA index appears to have the best operating characteristics which further supports its implementation as an instrument for use in clinical trials.

### CLINICAL RELEVANCE/APPLICATION

Magnetic resonance enterography (MRE) will likely be increasingly utilized in clinical trials to improve Crohn's disease (CD) patient selection and because it may be more responsive to clinically important changes in inflammatory status than either symptom-based or endoscopic instruments. Reproducibility is a critical property of MRE CD activity indices if they are to be used as outcome measures in clinical trials.

#### SSJ07-02 Genetic Polymorphisms Associated with MR Enterography Imaging Features of Crohn's Disease

Tuesday, Dec. 1 3:10PM - 3:20PM Location: E353A

### Participants

Cynthia Cruz, MD, Boston, MA (*Presenter*) Nothing to Disclose

Abra Guo, Boston, MA (*Abstract Co-Author*) Nothing to Disclose

James H. Thrall, MD, Boston, MA (*Abstract Co-Author*) Board Member, Mobile Aspects, Inc; Board Member, WorldCare International Inc; Consultant, WorldCare International Inc; Shareholder, Antares Pharma, Inc; Shareholder, iBio, Inc; Shareholder, Peregrine Pharmaceuticals, Inc

Vijay Yajnik, MD, PhD, Boston, MA (*Abstract Co-Author*) Nothing to Disclose

Michael S. Gee, MD, PhD, Jamaica Plain, MA (*Abstract Co-Author*) Nothing to Disclose

### PURPOSE

To evaluate for associations between genetic loci related to Crohn's disease (CD) behavior and imaging features of disease.

### METHOD AND MATERIALS

IRB approved HIPAA compliant single institution study of 76 patients with established CD who underwent MRE for disease evaluation. Scans were performed from 2009-2015 on a 1.5T clinical scanner using standard MRE protocol with oral and intravenous

contrast. 53 of these patients also had genetic testing performed on peripheral blood (Sequenom® genotyping platform). Two readers jointly evaluated the studies in consensus for findings of bowel inflammation [Mural early mucosal enhancement (ME), T2 Hyperintensity (T2), bowel wall thickening (BWT), Mesenteric inflammatory changes (MC)], evidence of penetrating disease (ulcer, fistula, or abscess), proximal bowel dilation, disease distribution, and overall length of involvement (LOI). Each scan was scored for disease distribution, activity, and behavior. Genetic analysis included evaluation for presence of 168 single nucleotide polymorphisms (SNPs) associated with inflammation. Fisher's Exact Test was used to assess for statistical significance.

## RESULTS

31 females and 22 males were analyzed (mean age 40 years ranging 20-83). Activity was classified as active in 37(70%), chronic in 8 (15%), and normal in 8(15%) patients; behavior was classified as inflammatory(I) in 27 (60%), structuring(S) in 6(13%), and fistulizing(F) in 12(26%) patients; mean length of involvement was 14.9 +/- 3.6 cm. Out of 168 SNP tested, the highest incidence was observed for IL23(100%) followed by PTPN22(91%) and IL31RA-IL6ST(74%). HLA and CARD9(20%) were only observed in patients with active disease on imaging with a highly significant association ( $p=0.009$ ). IL31R-IL6ST showed a significantly lower incidence in chronic disease ( $p=0.03$ ). Among MRE imaging features, HLA and CARD9 mutations were most significantly associated with BWT ( $p=0.02$ ), with ME and T2 also significant ( $p=0.04$ ). MAP3K8 and TNFR showed a significantly higher associations with F disease ( $p<0.001$ ) and ( $p=0.03$ ) with evidence of abscess (4/37).

## CONCLUSION

Multiple SNPs are associated with CD activity assessed on MRE, with HLA and CARD9 significantly associated with active disease, fistulizing behavior and presence of abscesses. BWT, ME, and T2 are individual imaging features showing significant genetic associations.

## CLINICAL RELEVANCE/APPLICATION

CD patient genotype impacts on imaging phenotype depicted by MRE.

### SSJ07-03 Bowel Imaging with PET/MR Enterography: First Results

Tuesday, Dec. 1 3:20PM - 3:30PM Location: E353A

#### Participants

Karsten J. Beiderwellen, MD, Essen, Germany (*Presenter*) Speaker, Siemens AG; Speaker, Bracco Group  
Sonja Kinner, MD, Essen, Germany (*Abstract Co-Author*) Nothing to Disclose  
Lukas Lenga, Essen, Germany (*Abstract Co-Author*) Nothing to Disclose  
Benedikt Gomez, Essen, Germany (*Abstract Co-Author*) Nothing to Disclose  
Philipp Heusch, MD, Duesseldorf, Germany (*Abstract Co-Author*) Nothing to Disclose  
Lale Umutlu, MD, Essen, Germany (*Abstract Co-Author*) Consultant, Bayer AG  
Jost Langhorst, Essen, Germany (*Abstract Co-Author*) Nothing to Disclose  
Andreas Bockisch, Essen, Germany (*Abstract Co-Author*) Nothing to Disclose  
Thomas C. Lauenstein, MD, Essen, Germany (*Abstract Co-Author*) Nothing to Disclose

## PURPOSE

To evaluate hybrid PET/MR enterography for the diagnostic assessment of intestinal pathologies.

## METHOD AND MATERIALS

43 patients with Crohn's disease, bowel malignancies or fever of unknown origin (female:  $n=20$ , male:  $n=23$ , age:  $51\pm13$  years [20-74 years]) underwent PET/MR enterography (Biograph mMR, Siemens) with either [ $^{18}\text{F}$ ]FDG ( $n=34$ ) or [ $^{68}\text{Ga}$ ]-DOTATOC ( $n=9$ ). For small bowel distension 1500 ml of an oral contrast solution containing mannitol and locust bean gum were ingested. PET was acquired as list mode for 8 min per bed. The MR protocol encompassed: a) coronal TrueFISP; b) coronal T2w HASTE with fat saturation; c) coronal T1w 3D VIBE pre and post gadolinium; d) axial and coronal T1w 2D FLASH post-gadolinium. Datasets were evaluated regarding co-registration of anatomical structures based on a 3-point ordinal scale (3: good co-registration, 2: slight misregistration, 1: significant misregistration) and image quality using a 4-point scale (1: non-diagnostic - 4: excellent quality). Furthermore, visualization of intestinal and extraintestinal pathologies was described.

## RESULTS

PET/MR enterography resulted in a high overall image quality (mean score MRI: 3.3, PET: 2.4) with good results for of PET and MRI co-registration (mean: 2.5 - 2.9). An excellent visualization of small and large bowel pathologies was achieved including inflammatory lesions (in 18 patients) as well as malignant lesions (in two patients). Furthermore, extraintestinal pathologies such as lymph node metastases (in two patients) were identified.

## CONCLUSION

Integrated PET/MR enterography represents a technically robust examination allowing for good co-registration of bowel structures.

## CLINICAL RELEVANCE/APPLICATION

The new method enables a multimodal assessment of bowel lesions in inflammatory as well as malignant disease. The simultaneous data acquisition might be of advantage in the interpretation of PET/MR in comparison to independently acquired PET and MRI data sets due to potential bowel motion artifacts and different patient positioning.

### SSJ07-04 High Radiation Exposure in Symptomatic Crohn's Disease Patients and the Need for Reduction in Utilization of CT Imaging

Tuesday, Dec. 1 3:30PM - 3:40PM Location: E353A

#### Participants

Dorathy Tamayo-Murillo, MD, Dorchester, MA (*Presenter*) Nothing to Disclose  
Alessandra Sax, Boston, MA (*Abstract Co-Author*) Nothing to Disclose  
Christina Jeong, BS, MS, Boston, MA (*Abstract Co-Author*) Nothing to Disclose  
Yu Chen, Boston, MA (*Abstract Co-Author*) Nothing to Disclose



Charles G. Colip, MD, Boston, MA (*Abstract Co-Author*) Nothing to Disclose  
Hannah Miller, Boston, MA (*Abstract Co-Author*) Nothing to Disclose  
Francis Farraye, MD, Boston, MA (*Abstract Co-Author*) Nothing to Disclose  
Stephan W. Anderson, MD, Boston, MA (*Abstract Co-Author*) Nothing to Disclose  
Jorge A. Soto, MD, Boston, MA (*Abstract Co-Author*) Nothing to Disclose

## PURPOSE

Patients with Crohn's disease are at risk of high radiation exposure, particularly from CT imaging. Symptomatic Crohn's patients are often scanned repeatedly due to broad differential diagnoses associated with the presenting complaint. While CT is a valuable tool in the assessment of Crohn's disease and its complications, we must be cognizant of its overutilization. Herein, we evaluated the utilization rate and indications for CT imaging of Crohn's patients at our institution.

## METHOD AND MATERIALS

We performed a retrospective chart review of 100 consecutive Crohn's disease patients who received a CT scan from 2000 to 2015. All incidences of radiation from CT imaging were noted. The total and average number of CT scans were tallied. CT scans were categorized by indication; the total number of normal studies was also obtained.

## RESULTS

100 patients with Crohn's disease were evaluated, 53 female and 47 male, a mean age of 48, with a range of 22 to 88 years. In this study population 491 CT scans were performed. The indications for the imaging studies included assessment of nonspecific abdominal or pelvic pain (46.8%), evaluation of suspected Crohn's flare or Crohn's related complications (30.5%), surgical complication or surgical follow up (9.5%), flank pain (5.2%), trauma (0.4%), or other (7.6%). In this population, the average number of CT scans performed was 4.9, with a range of 1 to 23. A total of 43 patients received  $\geq 5$  CTs, 12 received  $\geq 10$  CTs, 4 received  $\geq 15$  CTs and 2 received  $\geq 20$  CTs. Of the 491 CT scans performed, 135 (27.5%) were reported as normal or with stable chronic changes related to the patients underlying Crohn's disease.

## CONCLUSION

The average number of CT scans per patient in this population approached 5 scans with a maximum of 23 scans in a single patient. Prior studies have shown that radiation above 50mSv ( $\sim 5$  CT scans) increases the risk of cancer, which is particularly pertinent for the Crohn's patient population. Of the scans performed a significant proportion were recorded as normal or with stable chronic changes from Crohn's disease, thus not providing a cause for the patient's symptoms.

## CLINICAL RELEVANCE/APPLICATION

Our findings elucidate there is considerable room for reducing the use of CT imaging in symptomatic Crohn's patients, given the significant number of scans with normal or stable chronic findings

## Honored Educators

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

Jorge A. Soto, MD - 2013 Honored Educator  
Jorge A. Soto, MD - 2014 Honored Educator  
Jorge A. Soto, MD - 2015 Honored Educator

## SSJ07-05 Head-to-head Prospective Evaluation of Small Bowel Distension and Patient Tolerance of a New Enteric Contrast Agent for Enterography

Tuesday, Dec. 1 3:40PM - 3:50PM Location: E353A

### Participants

Amy B. Kolbe, MD, Rochester, MN (*Presenter*) Nothing to Disclose  
Adam Froemming, MD, Rochester, MN (*Abstract Co-Author*) Nothing to Disclose  
Shannon P. Sheedy, MD, Rochester, MN (*Abstract Co-Author*) Nothing to Disclose  
Chi Wan Koo, MD, Mankato, MN (*Abstract Co-Author*) Nothing to Disclose  
Krishna Pundi, BS, Rochester, MN (*Abstract Co-Author*) Nothing to Disclose  
David Bruining, MD, Rochester, MN (*Abstract Co-Author*) Research Grant, Given Imaging Ltd Consultant, Bracco Group  
Jeanne Tung, MD, Rochester, MN (*Abstract Co-Author*) Nothing to Disclose  
W. S. Harmsen, MS, Rochester, MN (*Abstract Co-Author*) Nothing to Disclose  
John M. Barlow, MD, Rochester, MN (*Abstract Co-Author*) Nothing to Disclose  
Jeff L. Fidler, MD, Rochester, MN (*Abstract Co-Author*) Research Grant, Beekley Corporation  
Joel G. Fletcher, MD, Rochester, MN (*Abstract Co-Author*) Grant, Siemens AG; ;

## PURPOSE

To evaluate a new mannitol and sorbitol-containing flavored beverage (FB) as an enteric contrast agent for enterography compared to commercially available low Hounsfield barium sorbitol suspension (BS) for side effects, patient taste and willingness to repeat the exam, and small bowel distension.

## METHOD AND MATERIALS

10 normal subjects ingested 5 different drinking algorithms on separate days (FB2: 1000 mL FB + 350 mL water; FB3: 1500 mL FB; BS2: 900 mL BS + 450 mL water; BS3: 1350 mL BS + 150 mL water; W3: 1500 mL water), with agents ingested over 45 minutes. Coronal SSFSE images were obtained through the bowel at 50 and 60 minutes following initiation of drinking. Subjects completed a questionnaire evaluating side effects, patient taste and willingness to repeat the exam. GI radiologists evaluated MR images using qualitative and quantitative scores for the jejunum, mid-ileum, and terminal ileum, blinded to imaging algorithm and time. Radiologists then ranked algorithms in order of preference based on distension of enteric contrast-filled bowel. Analyses were performed using ANOVA, pairwise Fisher's LSD, with p-values reporting overall significance of the 5 algorithms.

## RESULTS

There was no significant difference in nausea or vomiting among regimens ( $p=0.20$  and  $0.42$ ), but FB3 and V3 resulted in mild cramping ( $p=0.001$ ). Using a 10 point scale, subjects rated taste of BS2 (mean=3.9) and BS3 (4.7) worst ( $p < 0.0001$ ). Willingness to repeat drinking algorithm was highest for FB2 (9.8) and W3 (9.7) ( $p<0.05$ ). There were significant overall differences in subjective small bowel distention for 2/3 readers ( $p=0.003$ ,  $p<0.02$ ), with both W3 regimens ranked significantly worse (Figure). For quantitative analyses, there was no significant difference in the diameter of the most distended small bowel loop for any segment or reader ( $p>0.23$ ), with one reader identifying smaller representative loop diameters for W3 in the jejunum and ileum ( $p<0.03$ ).

## CONCLUSION

FB has a similar side effect profile and results in equivalent small bowel distention compared with BS. Normal subjects rated taste and willingness to repeat the exam with the new FB agent significantly higher.

## CLINICAL RELEVANCE/APPLICATION

By improving taste and maintaining side effect profile and small bowel distention, a new flavored beverage oral contrast agent with sorbitol can result in improved willingness to undergo repeat enterography exams.

## SSJ07-06 IBD Plus CTE Equals a New Equation for Disease Diagnosis

Tuesday, Dec. 1 3:50PM - 4:00PM Location: E353A

### Participants

Jamaal Benjamin, MD, PhD, Dallas, TX (*Presenter*) Nothing to Disclose

Cecelia Brewington, MD, Dallas, TX (*Abstract Co-Author*) Nothing to Disclose

## PURPOSE

The purpose of this study is to harness our expanding understanding of the basic mechanisms of Inflammatory Bowel Disease (IBD) in order to develop more accurate and useful avenues of molecular imaging and Crohn's disease diagnosis.

## METHOD AND MATERIALS

A cohort of 82 Crohn's disease (CD) patients who underwent endoscopy and CT enterography (CTE) was examined for 5 predetermined CT findings - mural hyperenhancement, bowel wall thickening, increased mural fat attenuation, mural stratification and combs sign and 5 predetermined lab measurements - fecal calprotectin, fecal lactoferrin, C-reactive protein (CRP), fecal elastase and serum IgA. For Fecal Calprotectin (FC) a lab value of 16 (mcg/g) or less were set as 16, CRP of 5 (mg/L) or less were set as 5 and Stool elastase (SE) of 500 ( $\mu\text{g/g}$ ) or more were set as 500. Relationships between the variables and whether there was Active IBD were evaluated. Fisher's exact tests were performed on discrete variables while Wilcoxon rank sum tests were performed on continuous variables

## RESULTS

Of the 5 evaluated clinical lab values, fecal calprotectin (FC) and CRP were the most useful predictors of active IBD. Both FC and CRP demonstrated statistically significant smaller median values in non-active IBD than active IBD. Utilizing logistic regression models and ROC curves, we determined threshold cutoff values of 142 (mcg/g) for FC and 5.4 (mg/L) for CRP. Following determination of individual variable threshold values, we then combined the two and developed the following predictive algorithm: If  $\text{FC} < 142$  and  $\text{CRP} < 5.4$  then categorize the case as "No IBD"; Otherwise categorize as "Yes IBD". Utilizing this algorithm, the sensitivity for active IBD was 92.86%, specificity was 77.78%, PPV of 86.67%, NPV of 87.57% and an accuracy of 86.96%.

## CONCLUSION

This work demonstrates that combining CTE and clinical labs can be a powerful tool in the diagnosis of IBD, and that the most useful lab values in CT enterography evaluation of IBD cases are fecal calprotectin and CRP. Therefore, we propose all CT enterography should also include evaluation of FC and CRP for specific numerical thresholds when considering IBD in the differential diagnosis.

## CLINICAL RELEVANCE/APPLICATION

CTE findings for IBD are difficult to interpret, therefore, a methodology for incorporating clinical lab values with CTE findings is critical for accurate initial diagnosis and disease surveillance.

**Genitourinary (Multimodality Imaging of Pregnancy and Pelvic Floor)**

Tuesday, Dec. 1 3:00PM - 4:00PM Location: E353B



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

**Participants**Elizabeth A. Sadowski, MD, Madison, WI (*Moderator*) Nothing to DiscloseMary C. Frates, MD, Sharon, MA (*Moderator*) Nothing to Disclose**Sub-Events****SSJ11-01 Dynamic Contrast-enhanced MRI Combined with Diffusion Weighted Imaging in Differential Diagnosis of Malignant Gestational Trophoblastic Neoplasia and Postpartum Retained Placental**

Tuesday, Dec. 1 3:00PM - 3:10PM Location: E353B

**Participants**Kangkang Xue, Zhengzhou, China (*Presenter*) Nothing to DiscloseJingliang Cheng, MD, Zhengzhou, China (*Abstract Co-Author*) Nothing to DiscloseYong Zhang, DO, Zhengzhou, China (*Abstract Co-Author*) Nothing to DiscloseTianxia Bei, Zhengzhou, China (*Abstract Co-Author*) Nothing to Disclose**PURPOSE**

To explore the application value of dynamic contrast-enhanced MRI (DCE-MRI) combined with diffusion weighted (DW-MRI) in the differential diagnosis of malignant gestational trophoblastic neoplasia (MGTN) and postpartum retained placental tissue (RPT).

**METHOD AND MATERIALS**

The institutional review board approved this retrospective study and waived the requirement for informed consent. 74 cases (median age, 30.6 years; age range, 20-48 years) of MGTN and RPT confirmed clinically were retrospectively analyzed, all patients underwent DCE-MRI and DW-MRI (500 and 1000 mm<sup>2</sup>/s) at 3.0T. Types of time signal-intensity curves (TIC) and quantitative analysis of time to peak (TTP), maximum contrast enhancement ratio (MCER) and ADC values of each case were performed. Differences in TTP, MCER, and ADC values between MGTN and RPT were evaluated using the independent samples t-test respectively. The sensitivity, specificity and accuracy of dynamic contrast-MRI, DW-MRI and combination of the two methods in diagnosing MGTN and RPT were calculated.

**RESULTS**

There were 39 MGTN, of which 13 lesions were invasive mole and 26 lesions were choriocarcinoma. There were 35 RPT, of which 14 lesions were normal retained placenta, 6 lesions were adherent placenta and 15 lesions were implanted placenta. The mean ADC value and TTP of MGTN (1.38±0.11×10<sup>-3</sup> mm<sup>2</sup>/s, 37.84±3.73 s) were significantly different (p<0.01) from that of RPT (2.03±0.56×10<sup>-3</sup> mm<sup>2</sup>/s, 102.11±9.14 s). The MCER of MGTN (248.58±19.28%) was not significantly different (P>0.05) from that of RPT (236.45±16.77%) statistically. The sensitivity, specificity and accuracy in diagnosing MGTN and RPT was 84.62%, 85.71%, 85.13% for DCE-MRI; 89.74%, 88.57%, 89.19% for DW-MRI; 94.87%, 94.29%, 94.59% for combination of the two methods.

**CONCLUSION**

MGTN and RPT has different features in DCE-MRI and DW-MRI respectively, and the combination of the two methods can provide high application value for the differential diagnosis of MGTN and RPT.

**CLINICAL RELEVANCE/APPLICATION**

The clinical issues and standard imaging features of malignant gestational trophoblastic neoplasia and postpartum retained placental tissue are similar, and the combination of DWI and dynamic-enhanced MRI can help clinician distinguish them, so as to decide treatment plans.

**SSJ11-02 Variable Sonographic Features and Imaging Underdiagnosis of Partial Molar Pregnancy**

Tuesday, Dec. 1 3:10PM - 3:20PM Location: E353B

**Participants**Julia Savage, MD, Ann Arbor, MI (*Presenter*) Nothing to DiscloseKatherine E. Maturen, MD, Ann Arbor, MI (*Abstract Co-Author*) Consultant, GlaxoSmithKline plc; Medical Advisory Board, GlaxoSmithKline plcErika Mowers, MD, Ann Arbor, MI (*Abstract Co-Author*) Nothing to DiscloseKatherine Pasque, MD, Ann Arbor, MI (*Abstract Co-Author*) Nothing to DiscloseAshish P. Wasnik, MD, Ann Arbor, MI (*Abstract Co-Author*) Nothing to DiscloseVanessa Dalton, MD, Ann Arbor, MI (*Abstract Co-Author*) Nothing to DiscloseJason Bell, MD, Ann Arbor, MI (*Abstract Co-Author*) Nothing to Disclose**PURPOSE**

The goal of this study is to describe the ultrasound findings in histopathologically proven molar pregnancies and to correlate these findings with clinical parameters including serum beta-hCG levels and partial vs. complete molar pregnancy.

**METHOD AND MATERIALS**

Retrospective chart review revealed 72 women with failed pregnancy or elective termination with histopathologic diagnosis of molar

pregnancy and available ultrasound images between January 1, 2001 to December 31, 2011. Clinical data, ultrasound images and reports were reviewed.

## RESULTS

Mean age of women was  $30.45 \pm 6.97$  years of age (range: 16-49), with  $1.25 \pm 1.49$  prior pregnancies (range: 1-11). Mean gestational age (GA) by last menstrual period was  $74.45 \pm 19.07$  days (range: 39-138) and median serum beta-hCG was 64,400 (range: 447-662,000), with expected positive correlations between mean sac diameter (MSD) vs. beta-hCG ( $r=0.45$ ,  $p=0.004$ ) and MSD vs. GA ( $r=0.54$ ,  $p<0.0001$ ). Pathologic results showed 49 partial and 23 complete moles. By imaging, partial moles were more commonly described as having a discrete gestational sac (85.7 vs 21.7%,  $p<0.0001$ ), yolk sac (48.9 vs. 4.6%,  $p=0.0003$ ), or fetal pole (57.1 vs. 0%,  $p<0.0001$ ), while complete moles were more likely to show clearly abnormal tissue in the uterus (82.6 vs. 20.8%,  $p<0.0001$ ) and to be prospectively diagnosed as molar pregnancy by the dictating radiologist (86.9 vs. 40.82%,  $p=0.0002$ ).

## CONCLUSION

Partial molar pregnancy is associated with a highly variable sonographic appearance and frequent detection of recognizable products of conception, which may contribute to its underdiagnosis by imaging. Complete molar pregnancy is more strikingly abnormal and thus recognizable by imaging, and commonly diagnosed prospectively.

## CLINICAL RELEVANCE/APPLICATION

Suspicion of hydatidiform mole in failed pregnancy has impacts on clinical management including: need for uterine evacuation, submission of products of conception to pathology, and serum b-hCG surveillance; failure to prospectively suggest or diagnose molar pregnancy may negatively impact patient care.

## Honored Educators

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Katherine E. Maturen, MD - 2014 Honored Educator

## SSJ11-03 Performance of Translabial Ultrasound versus Pelvic Floor MRI in the Detection of Transvaginal Mesh Implant Complications

Tuesday, Dec. 1 3:20PM - 3:30PM Location: E353B

### Participants

Karoly Viragh, MD, Los Angeles, CA (*Presenter*) Nothing to Disclose

Seth A. Cohen, MD, Los Angeles, CA (*Abstract Co-Author*) Nothing to Disclose

Shlomo Raz, MD, Los Angeles, CA (*Abstract Co-Author*) Nothing to Disclose

Steven S. Raman, MD, Santa Monica, CA (*Abstract Co-Author*) Nothing to Disclose

## PURPOSE

The goal of the study was to determine the efficacy of 2D and 3D dynamic translabial ultrasound versus pelvic floor MRI in the detection of transvaginal mesh implant complications.

## METHOD AND MATERIALS

With IRB approval and HIPAA compliance, a retrospective observational study was performed to correlate the intraoperative findings of transvaginal mesh implant complications (perforation, extrusion, fluid collections) with the standard pre-operative translabial ultrasound and pelvic floor MRI evaluations in women who were treated with suburethral transvaginal mesh implant for stress urinary incontinence or pelvic organ prolapse. The pre-operative translabial ultrasound and MRI examinations were reviewed with attention to technical details. The sensitivity of ultrasound in identifying complications was calculated. The location of the transvaginal mesh with respect to the bladder and urethra was also evaluated (extraluminal, intramural, intraluminal). Factors for technical improvement were identified.

## RESULTS

The study cohort included 200 women (mean age 55 years) with transvaginal mesh implants for who underwent 2D and 3D dynamic translabial ultrasound, pelvic floor MRI and mesh excision at our institution between 2007 and 2013. Descriptive statistics were provided. 17 patients were found to have perforation into the urethra and/or bladder during surgery. None were found to have extrusion or significant fluid collections. Translabial ultrasound had a sensitivity of (12/17) 70.5%, whereas detection of mesh fragments by MRI was challenging even in retrospect. Limitations were due to suboptimal visualization of the mesh fragments, which could be improved with pre-procedural hydration for bladder distention and the use of vaginal gel to better image the suburethral space.

## CONCLUSION

2D and 3D dynamic translabial ultrasound is a powerful real-time method for transvaginal mesh localization and for visualizing complications, most importantly perforation into the urethra and/or bladder, which allows for better surgical planning and pre-operative patient counseling.

## CLINICAL RELEVANCE/APPLICATION

Translabial ultrasonography is a powerful real-time diagnostic technique for the evaluation of female pelvic floor dysfunction and is more sensitive than MR in detecting transvaginal mesh perforation.

## **SSJ11-04 To Determine the Ultrasound Predictors of Successful Treatment of Ectopic Pregnancy Using a Single Dose Methotrexate Protocol: Preliminary Results**

Tuesday, Dec. 1 3:30PM - 3:40PM Location: E353B

### **Participants**

Margarita V. Revzin, MD, Wilton, CT (*Presenter*) Nothing to Disclose  
Dennis Toy, New Haven, CT (*Abstract Co-Author*) Nothing to Disclose  
Regina J. Hooley, MD, New Haven, CT (*Abstract Co-Author*) Nothing to Disclose  
Leslie M. Scoutt, MD, New Haven, CT (*Abstract Co-Author*) Consultant, Koninklijke Philips NV

### **PURPOSE**

Uncomplicated ectopic pregnancy (EP) usually is managed with methotrexate (MTX) and other non-surgical interventions. There is limited data on the expected US findings of MTX treated EPs. The aim of the present study is to identify US predictors of successful treatment with MTX.

### **METHOD AND MATERIALS**

This is a retrospective IRB approved and HIPAA compliant cohort study, exempt from informed consent. The medical records of 121 women (mean age of 29 + 5.3 years) who were diagnosed with an EP and underwent a single dose treatment with MTX were reviewed. Only those subjects who had a visible EP without heart activity on US prior to treatment and who had a follow up US after treatment were included in the study (n=52). Post treatment EP were evaluated with respect to the change in size, shape, echogenicity of the EP, presence of a gestational and yolk sac, fetal heart rate, vascularity, and hemoperitoneum after treatment. Results were correlated with patient b-hCG levels, clinical symptoms and necessity for surgical intervention. Qualitative and quantitative parameters were analyzed using parametric and nonparametric tests.

### **RESULTS**

Separate assessment of the US findings with respect to their sensitivity (Ss), specificity (Sp), NPV and PPV respectively are as follows: EP change in size 53%, 57%, 45%, 55%, shape 89%, 75%, 85%, 78%, echogenicity 87%, 78%, 85%, 90%, avascularity 79%, 90%, 85%, 88%; and absent or small hemoperitoneum 90%, 86%, 87%, 78% ; A combination of at least three of these findings was most accurate with Ss 95%, Sp 96%, PPV 95%, NPV 90%. Presence of fetal heart activity, increased size of yolk sac and gestational sac, large amount of hemoperitoneum were strong US predictors of failure of MTX treatment with Ss 100%, Sp 100%, PPV 100%, NPV 99%

### **CONCLUSION**

A combination of at least three US findings including stable shape and echogenicity, avascularity and absence or small amount of hemoperitoneum are best US predictors of successful MTX treatment of EPs. Detection of fetal heart activity, large hemoperitoneum, and increase in size of gestational and yolk sac are strong US predictors of a failure of MTX treatment. Change in size of the EP after MTX treatment is not a reliable predictor of either treatment success or failure.

### **CLINICAL RELEVANCE/APPLICATION**

US findings aid in prediction of successful treatment of ectopic pregnancy using a single dose methotrexate protocol

### **Honored Educators**

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Leslie M. Scoutt, MD - 2014 Honored Educator

## **SSJ11-05 Accuracy of MRI in the Prenatal Diagnosis of the Abnormally Adherent Placenta: Comparison with Findings at the Time of Delivery**

Tuesday, Dec. 1 3:40PM - 3:50PM Location: E353B

### **Participants**

Sherelle L. Laifer-Narin, MD, Englewood, NJ (*Presenter*) Nothing to Disclose  
Sidney Z. Brejt, MD, New York, NY (*Abstract Co-Author*) Nothing to Disclose  
Sarah Goodman, MD, New York, NY (*Abstract Co-Author*) Nothing to Disclose  
Jason Wright, New York, NY (*Abstract Co-Author*) Nothing to Disclose  
Jeffrey H. Newhouse, MD, Bronxville, NY (*Abstract Co-Author*) Research Consultant, PAREXEL International Corporation

### **PURPOSE**

To evaluate the accuracy of magnetic resonance imaging in diagnosing invasive placentation.

### **METHOD AND MATERIALS**

A retrospective review of all patients referred for MRI of the placenta from December 2004 to December 2014 was performed. Indications for MRI included abnormal appearance of the placenta on ultrasound, history of prior cesarean delivery, and history of prior uterine surgery. MRI reports were reviewed for placental location, presence or absence of abnormal placentation according to established MRI findings, and suspicion for parametrial involvement. Criteria included the presence of dark intraplacental bands, heterogeneous signal intensity, abnormal vascularization and thickened nodular contour along the urinary bladder surface, uterine bulging into the bladder, and loss of the myometrial margin. MRI was considered positive even if only one of these criteria were present. Comparison was made with findings at either delivery or operation, and pathology reports.

### **RESULTS**

256 MRI exams were reviewed. 144 exams were negative both on MRI and delivery/pathology. 8 exams interpreted as normal on MRI underwent hysterectomy with pathology demonstrating placenta accreta. 80 exams were interpreted as positive for abnormal

placentation, and were diagnosed as accreta, increta, or percreta on delivery/pathology. 24 cases interpreted as positive on MRI had normal placental delivery and pathology. MR diagnosis of abnormal placentation had a sensitivity of 91%, specificity of 86%, PPV of 77%, NPV of 95%, and an accuracy of 87.5%.

## CONCLUSION

Placental adhesive disorder is a significant cause of maternal morbidity and mortality. Prenatal MRI is accurate in evaluating invasive placentation in patients at high risk for this condition.

## CLINICAL RELEVANCE/APPLICATION

MRI can provide topographic information specifically in cases with lateral extension into the parametrical regions. Identification of abnormal placentation assists the clinician in planning the mode of delivery, extent and location of surgical incision, and determining the need for multidisciplinary involvement and assistance.

## SSJ11-06 3T Pelvic MRI Thresholds for Pelvic Organ Prolapse before and after First Childbirth

Tuesday, Dec. 1 3:50PM - 4:00PM Location: E353B

### Participants

Mark E. Lockhart, MD, Birmingham, AL (*Presenter*) Nothing to Disclose

Holly Richter, MD, Birmingham, AL (*Abstract Co-Author*) Research Grant, Pelvalon, Inc; Consultant, Pelvalon, Inc; Consultant, Kimberly-Clark Corporation; Royalties, UpToDate, Inc

Gordon W. Bates, MD, Birmingham, AL (*Abstract Co-Author*) Nothing to Disclose

Timothy M. Beasley, PhD, Birmingham, AL (*Abstract Co-Author*) Nothing to Disclose

Desiree E. Morgan, MD, Birmingham, AL (*Abstract Co-Author*) Research support, General Electric Company

## PURPOSE

To evaluate the usefulness of published 3T MRI parameters suggesting pelvic organ prolapse before and after first childbirth

## METHOD AND MATERIALS

In this IRB-approved HIPAA-compliant prospective cohort study, patients presenting for reproductive assistance were recruited to complete validated questionnaires, clinical pelvic exams, baseline dynamic 3T MRI, and repeat MRI 6 months after delivery. Subjects were nulliparous women, at least 19 years age, and asymptomatic by Pelvic Floor Distress Inventory-20. Predetermined published thresholds or 2 SD beyond means in the literature for pelvic prolapse on MRI were evaluated. Also, a 10% change from baseline to postpartum was considered a significant change. Using 120 cc rectal gel and pelvic phased array coil over the pelvis, static 3mm axial and coronal T2 FSE sequences were followed by 10 mm thick dynamic sagittal HASTE at rest and during strain. The 10 mm sagittal sequence then evaluated pelvic floor mobility during evacuation of the rectal gel. MRI parameters were measured by a fellowship-trained radiologist, blinded to clinical data.

## RESULTS

19 subjects (mean age 31 years) completed baseline clinical and MRI studies, and 10 (mean age 30.5 years) of them completed postpartum clinical and MRI studies. None developed significant pelvic floor symptoms by the PFDI-7 and PISQ-12 questionnaires after childbirth. None had levator tears at baseline; two subjects developed tears postpartum. Mean pelvic floor mobility was increased in patients after childbirth and 17 pelvic soft tissue parameters increased by greater than 10% postpartum. At baseline 7/133 (5.3%), 8/209 (3.8%), and 79/209 (37.8%) of pelvic soft tissue measurements exceeded published thresholds (indicating prolapse) at rest, strain, and evacuation, respectively, majority in the anterior compartment. After pregnancy and childbirth, 4/70 (5.7%), 6/110 (5.5%), and 51/110 (46.4%) exceeded thresholds at rest, strain, and evacuation, respectively, in this asymptomatic population. Osseous parameters remained unchanged.

## CONCLUSION

Although published soft tissue parameters work well for rest and strain MR imaging, their values in evacuatory series are frequently exceeded, even in asymptomatic nulliparous and primiparous women.

## CLINICAL RELEVANCE/APPLICATION

In nulliparous and primiparous women, the evacuatory phase will commonly exceed published MRI thresholds for pelvic organ prolapse and therefore results should be used with caution.



## Gastrointestinal (Liver Fat and Fibrosis)

Tuesday, Dec. 1 3:00PM - 4:00PM Location: E350



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

### Participants

Frank H. Miller, MD, Chicago, IL (*Moderator*) Nothing to Disclose  
Donald G. Mitchell, MD, Philadelphia, PA (*Moderator*) Consultant, CMC Contrast AB

### Sub-Events

#### SSJ09-01 MR Elastography of the Liver: Comparison of GRE and EPI Sequences

Tuesday, Dec. 1 3:00PM - 3:10PM Location: E350

### Participants

Mathilde Wagner, MD, PhD, Paris, France (*Presenter*) Nothing to Disclose  
Temel K. Yasar, New York, NY (*Abstract Co-Author*) Nothing to Disclose  
Cecilia Besa, MD, New York, NY (*Abstract Co-Author*) Nothing to Disclose  
Jad M. Bou Ayache, MD, New York, NY (*Abstract Co-Author*) Nothing to Disclose  
Octavia Bane, PhD, New York, NY (*Abstract Co-Author*) Nothing to Disclose  
Maggie M. Fung, MEng, Bethesda, MD (*Abstract Co-Author*) Employee, General Electric Company  
Bachir Taouli, MD, New York, NY (*Abstract Co-Author*) Consultant, Guerbet SA

### PURPOSE

To compare 2D-GRE (gradient recalled echo) liver MR-Elastography (MRE) with 2D-SE-EPI (echoplanar imaging) MRE in terms of image quality (IQ) and liver stiffness (LS) measurements.

### METHOD AND MATERIALS

36 patients with chronic liver disease or focal liver lesion (M/F:23/13, mean age 57.8 y) who underwent 3T liver MRI (MR750, GE) using 2D-GRE and 2D-SE-EPI liver MRE were enrolled in this single-center IRB approved study. Both sequences were acquired in the axial plane, with 4 slices (same location), 10 mm thickness, a 60Hz mechanical motion, similar FOV (2D-GRE: TR/TE 50/20, 256x80, 60 MEG frequency, ASSET 2 / SE EPI: TR/TE 1000/55.4, 80x80, 155Hz MEG frequency, ASSET 2). Scan time for EPI MRE was 4 sec and 14 sec for GRE MRE (for each slice). One radiologist placed ROIs in the liver parenchyma for measurements of LS (kPa). ROIs were drawn as large as possible, avoiding voxels with less than 95% confidence level on the confidence map, large vessels, parenchyma edge and fissures. IQ scores were assessed by a second radiologist using a four-point scale (0: no observable wave propagation/no confidence map; 3: excellent wave propagation in liver/confidence map covering more than 50% of liver slice). Mean LS values and IQ scores between EPI and GRE MRE were compared using Wilcoxon test. Reproducibility of LS between these two sequences was assessed with intraclass coefficient correlation (ICC), coefficient of variability (CV) and Bland-Altman limits of agreement (BALA).

### RESULTS

In 4 patients, GRE MRE completely failed while there was no case of failure with EPI MRE. IQ scores were significantly higher using EPI versus GRE MRE (score 14.4 vs 8.6,  $P<0.0001$ ). ROI size was significantly higher using EPI than GRE MRE (56.06 cm<sup>2</sup> vs. 14.47 cm<sup>2</sup>,  $P<0.0001$ ). LS measurements were not significantly different between the EPI and GRE MRE (3.41±1.36 kPa vs 3.42±1.56 kPa,  $P=0.51$ ), were significantly correlated (ICC=0.908,  $P<0.0001$ ) and showed a high reproducibility (mean CV=10.2% (0.2-28.2), bias=0.09±0.63 kPa (BALA[-1.15;1.32])).

### CONCLUSION

IQ scores of EPI MRE were significantly higher than GRE MRE, with faster acquisition and equivalent measurements. Larger ROI in EPI MRE allows more comprehensive liver sampling.

### CLINICAL RELEVANCE/APPLICATION

GRE MRE is the most common approach for LS assessment. EPI MRE performs superior in terms of IQ and liver coverage with less breath-holds. This approach might improve the performance of MRE.

#### SSJ09-02 Associations between Nonalcoholic Fatty Liver Disease (NAFLD) Histologic Features and Magnetic Resonance Elastography (MRE)-estimated Liver Stiffness in Adults without Fibrosis

Tuesday, Dec. 1 3:10PM - 3:20PM Location: E350

### Participants

Alexandra A. Schlein, BS, San Diego, CA (*Presenter*) Nothing to Disclose  
Chun Chieh K. Luo, San Diego, CA (*Abstract Co-Author*) Nothing to Disclose  
Kang Wang, PhD, San Diego, CA (*Abstract Co-Author*) Nothing to Disclose  
Paul Manning, MSc, La Jolla, CA (*Abstract Co-Author*) Nothing to Disclose  
Jonathan C. Hooker, BS, San Diego, CA (*Abstract Co-Author*) Nothing to Disclose  
Catherine A. Hooker, BS, San Diego, CA (*Abstract Co-Author*) Nothing to Disclose  
William Haufe, San Diego, CA (*Abstract Co-Author*) Nothing to Disclose  
Tanya Wolfson, MS, San Diego, CA (*Abstract Co-Author*) Nothing to Disclose  
Anthony Gamst, PhD, San Diego, CA (*Abstract Co-Author*) Nothing to Disclose  
Kevin J. Glaser, Rochester, MN (*Abstract Co-Author*) Intellectual property, Magnetic Resonance Innovations, Inc; Stockholder, Resoundant, Inc

Meng Yin, Rochester, MN (*Abstract Co-Author*) The Mayo Clinic and MY have intellectual property rights and a financial interest in MRE technology.

Michael S. Middleton, MD, PhD, San Diego, CA (*Abstract Co-Author*) Consultant, Allergan, Inc Institutional research contract, Bayer AG Institutional research contract, sanofi-aventis Group Institutional research contract, Isis Pharmaceuticals, Inc Institutional research contract, Johnson & Johnson Institutional research contract, Synageva BioPharma Corporation Institutional research contract, Takeda Pharmaceutical Company Limited Stockholder, General Electric Company Stockholder, Pfizer Inc Institutional research contract, Pfizer Inc

Rohit Loomba, MD, MSc, La Jolla, CA (*Abstract Co-Author*) Nothing to Disclose

Claude B. Sirlin, MD, San Diego, CA (*Abstract Co-Author*) Research Grant, General Electric Company; Speakers Bureau, Bayer AG; Consultant, Bayer AG ; ;

## PURPOSE

Magnetic resonance elastography (MRE) has been established as a noninvasive method of estimating liver stiffness and thereby inferring hepatic fibrosis. The purpose of this work is to assess whether the other hepatic pathologies that are observed in NAFLD; steatosis, inflammation, and ballooning, have independent, significant effects on MRE estimated stiffness, and to assess whether they are possible confounds of the stiffness estimation.

## METHOD AND MATERIALS

In this IRB approved study, adults receiving standard-of-care liver biopsy for NAFLD were consented and underwent MRE at 3T within 180 days of biopsy. MRE was performed using three methods (2D at 60 Hz, 3D at 40 Hz, and 3D at 60 Hz), from which MRE-estimated liver stiffness values were calculated. Histologic features were scored based on NASH CRN criteria; subjects with histologically-determined fibrosis were excluded. Associations between liver stiffness and inflammation or ballooning were assessed using t-tests. The association between liver stiffness and steatosis was assessed using Spearman rank correlation analysis. Multivariate linear regression analysis was used to test MRE stiffness against histologic features adjusted for age, BMI, and ALT.

## RESULTS

Sixty-four adults (30 M; mean age 49.5 yrs, range 18.5 to 75.8 yrs) were enrolled in this study. Multivariate linear regression analysis showed a negative correlation of steatosis with log of 3D MRE-estimated liver stiffness at 40 Hz (-0.064,  $p = 0.043$ ) and 60 Hz (-0.068,  $p = 0.018$ ). Univariate analyses of MRE-estimated liver stiffnesses for all three methods showed no association with inflammation ( $p = 0.08$  to  $0.11$ ), ballooning ( $p = 0.51$  to  $0.63$ ), or steatosis ( $\rho = 0.29$  to  $0.39$ ).

## CONCLUSION

Hepatic steatosis has an independent, statistically significant association with the MR elastographic estimation of liver stiffness when BMI, ALT, and age are controlled for. Inflammation and ballooning do not have a statistically significant association with liver stiffness.

## CLINICAL RELEVANCE/APPLICATION

This association between steatosis and liver stiffness is a possible confound in the MRE estimation of liver stiffness, and should be accounted for when MRE is used to estimate fibrosis in adult patients.

## SSJ09-03 Noninvasive Hepatic Fibrosis Staging Using Magnetic Resonance Elastography: The Usefulness of the Bayesian Prediction Method

Tuesday, Dec. 1 3:20PM - 3:30PM Location: E350

### Participants

Shintaro Ichikawa, MD, Chuo-Shi, Japan (*Presenter*) Nothing to Disclose

Utaroh Motosugi, MD, Yamanashi, Japan (*Abstract Co-Author*) Nothing to Disclose

Hiroyuki Morisaka, MD, Kofu, Japan (*Abstract Co-Author*) Nothing to Disclose

Katsuhiro Sano, MD, PhD, Chuo, Japan (*Abstract Co-Author*) Nothing to Disclose

Tomoaki Ichikawa, MD, PhD, Yamanashi, Japan (*Abstract Co-Author*) Nothing to Disclose

Hiroshi Onishi, MD, Yamanashi, Japan (*Abstract Co-Author*) Nothing to Disclose

## PURPOSE

To evaluate the usefulness of the Bayesian prediction method (BPM) for noninvasive hepatic fibrosis staging (HFS) using magnetic resonance elastography (MRE).

## METHOD AND MATERIALS

Chronic liver disease patients ( $n = 309$ ) were included and fibrosis staging and MRE was performed. Receiver operating characteristic analysis was used to determine the optimal cut-off stiffness value (cut-off method; COM) of MRE to distinguish between fibrosis stages. A uniform distribution was assumed for pre-MRE probability of stages using the BPM. The MRE stiffness value determined the post-MRE probability and confidence of HFS. The distinguishing ability of COM and BPM were compared in all patients (Bayesian-all) and in patients with strong confidence ( $\geq 90\%$ ) with BPM (Bayesian-strong).

## RESULTS

The ability to distinguish between hepatic fibrosis stages was not significantly different between COM and Bayesian-all. In patients who had strong confidence with BPM, the sensitivity and negative predictive value (NPV) of Bayesian-strong for diagnosing  $\geq F2$ ,  $\geq F3$ , and  $F4$  were significantly higher than with COM (sensitivity: COM vs. Bayesian-all for  $\geq F2$ , 94.5% vs. 99.1% ( $P = 0.0041$ );  $\geq F3$ , 89.6% vs. 99.4% ( $P = 0.0001$ );  $F4$ , 89.3% vs. 100% ( $P = 0.0018$ ); NPV:  $\geq F2$ , 78.8% vs. 93.9% ( $P = 0.0059$ );  $\geq F3$ , 85.0% vs. 98.7% ( $P < 0.0001$ );  $F4$ , 93.4% vs. 100% ( $P = 0.0009$ )). The specificity of Bayesian-strong for diagnosing  $F4$  was significantly higher than that of COM (97.3% vs. 100% ( $P = 0.0428$ )).

## CONCLUSION

BPM has better distinguishing ability than COM for HFS using MRE if the confidence is strong.

## CLINICAL RELEVANCE/APPLICATION

A liver biopsy followed by histopathological assessment is a common approach for staging liver fibrosis. However, a biopsy can

cause several complications. Consequently, noninvasive methods have been developed for assessing hepatic fibrosis. Recent studies have indicated that MRE is a promising, highly reproducible tool with advanced diagnostic capacity for the non-invasive staging of hepatic fibrosis. Hepatic fibrosis can be assessed more correctly by using BPM.

#### **SSJ09-04 Direct Comparison of 3 Elastometry Devices (Fibroscan, Acoustic Radiation Force Impulse, Supersonic Shearwave Imaging) for the Non-Invasive Diagnosis of Liver Fibrosis in Chronic Liver Diseases**

Tuesday, Dec. 1 3:30PM - 3:40PM Location: E350

##### **Participants**

Victoire Cartier, MD, Angers, France (*Presenter*) Nothing to Disclose  
Jerome Boursier, Angers, France (*Abstract Co-Author*) Nothing to Disclose  
Jerome Lebigot, MD, Angers, France (*Abstract Co-Author*) Nothing to Disclose  
Frederic Oberti, MD, PhD, Angers, France (*Abstract Co-Author*) Nothing to Disclose  
Isabelle Fouchard-Hubert, Angers, France (*Abstract Co-Author*) Nothing to Disclose  
Sandrine Bertrais, Angers, France (*Abstract Co-Author*) Nothing to Disclose  
Paul Cales, MD, PhD, Angers, France (*Abstract Co-Author*) Research Consultant, Echosens SA  
Christophe Aube, MD, PhD, Angers, France (*Abstract Co-Author*) Speaker, Bayer AG Support, General Electric Company

##### **PURPOSE**

Liver stiffness measurement using elastography allows for a non-invasive diagnosis of liver fibrosis with immediate results at bedside. We aimed to evaluate and compare the feasibility and the diagnostic accuracy Fibroscan (FS), Acoustic Radiation Force Impulse (ARFI), and Supersonic Shearwave Imaging (SSI) for the non-invasive diagnosis of liver fibrosis.

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

192 patients with chronic liver disease, liver biopsy, FS, ARFI and SSI were included. Metavir F staging on biopsy was taken as the reference for liver fibrosis. Result for each elastographic device was the median of 10 valid measurements. Diagnostic cut-offs were calculated to maximize the sum of sensitivity + specificity.

##### **RESULTS**

Cause of chronic liver disease was NAFLD in 55.7% of cases, viral hepatitis: 16.1%, alcohol: 16.7%, and others: 11.5%. Fibrosis stage prevalence was: F0: 23.4%, F1: 37.0%, F2: 19.3%, F3: 13.5%, F4: 6.8%. Failure of liver stiffness measurement (no valid measurement) occurred in 18 patients (9.4%) with FS, no patients with ARFI, and 3 patients (1.6%) with SSI ( $p=0.001$  between FS and SSI). Results for the 3 devices were available in 171 patients. Obuchowski indexes were: FS:  $0.855\pm0.018$ , ARFI:  $0.761\pm0.027$ , SSI:  $0.789\pm0.025$  (FS vs ARFI or SSI:  $p\leq0.020$ ). AUROC for significant fibrosis (Metavir  $F\geq2$ ) were: FS:  $0.863\pm0.027$ , ARFI:  $0.749\pm0.039$ , SSI:  $0.781\pm0.036$  ( $p=0.006$ ; FS vs ARFI or SSI:  $p\leq0.021$ ). Diagnostic cut-offs for  $F\geq2$  were: FS: 8.0 kPa, ARFI: 1.29 m/s, SSI: 1.85 m/s. Using this cut-offs, diagnostic accuracy for  $F\geq2$  was: FS: 76.0%, ARFI: 70.2%, SSI: 77.2% ( $p=0.204$ ). AUROC for cirrhosis were: FS:  $0.941\pm0.027$ , ARFI:  $0.895\pm0.048$ , SSI:  $0.870\pm0.035$  ( $p=0.011$ ; FS vs SSI:  $p=0.010$ ). Diagnostic cut-offs for cirrhosis were: FS: 16.6 kPa, ARFI: 1.87 m/s, SSI: 1.93 m/s. Using this cut-offs, diagnostic accuracy for cirrhosis was: FS: 90.6%, ARFI: 79.5%, SSI: 75.4% ( $p<0.001$ , FS vs others:  $p\leq0.001$ ).

##### **CONCLUSION**

ARFI and SSI have better feasibility and similar accuracy for the diagnosis of significant fibrosis than FS. However, FS has the best accuracy for the diagnosis of cirrhosis.

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

Non-invasive diagnosis and evaluation of liver fibrosis in chronic liver diseases using acoustic based elastography.

#### **SSJ09-05 Fibrosis in Nonalcoholic Fatty Liver Disease: Noninvasive Assessment Using CT Volumetry**

Tuesday, Dec. 1 3:40PM - 3:50PM Location: E350

##### **Participants**

Nobuhiro Fujita, MD, PhD, Fukuoka, Japan (*Presenter*) Nothing to Disclose  
Akihiro Nishie, MD, Fukuoka, Japan (*Abstract Co-Author*) Nothing to Disclose  
Yoshiki Asayama, MD, Fukuoka, Japan (*Abstract Co-Author*) Nothing to Disclose  
Kousei Ishigami, MD, Fukuoka City, Japan (*Abstract Co-Author*) Nothing to Disclose  
Yasuhiro Ushijima, MD, Fukuoka, Japan (*Abstract Co-Author*) Nothing to Disclose  
Hiroshi Honda, MD, Fukuoka, Japan (*Abstract Co-Author*) Nothing to Disclose  
Yukihisa Takayama, MD, Fukuoka, Japan (*Abstract Co-Author*) Research Grant, FUJIFILM Holdings Corporation  
Daisuke Okamoto, MD, Fukuoka City, Japan (*Abstract Co-Author*) Nothing to Disclose  
Koichiro Morita, Fukuoka, Japan (*Abstract Co-Author*) Nothing to Disclose

##### **PURPOSE**

To elucidate the morphological change in nonalcoholic fatty liver disease (NAFLD) with fibrosis stage using CT volumetry and to evaluate its diagnostic performance of CT volumetry for discriminating fibrosis stage in patients with NAFLD.

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

A total of 38 patients with NAFLD (F0, 11; F1, 5; F2, 1; F3, 9; and F4, 12) who underwent contrast-enhanced CT were enrolled. On the basis of CT imaging, the volumes of total, left lateral segment, left medial segment, caudate lobe, and right lobe of the liver were calculated automatically and manually with a dedicated liver application. The relationship between the volume percentage of each area and fibrosis stage was analyzed using Spearman's rank correlation coefficient. Receiver operating characteristic (ROC) curve analysis was performed to determine the accuracy of CT volumetry for discriminating fibrosis stage.

##### **RESULTS**

The volume percentages of caudate lobe and left lateral segment significantly increased with fibrosis stage ( $r = 0.815$ ,  $P < 0.001$ , and  $r = 0.465$ ,  $P = 0.003$ , respectively). Contrarily, the volume percentage of the right lobe significantly decreased with fibrosis stage ( $r = -0.563$ ,  $P < 0.001$ ). The volume percentage of caudate lobe had the best diagnostic accuracy for staging fibrosis and

the area under the ROC curve values for discriminating fibrosis stage were as follows:  $\geq F1$ , 0.896;  $\geq F2$ , 0.929;  $\geq F3$ , 0.955; and  $\geq F4$ , 0.923. The best cut-off for advanced fibrosis (F3-F4) was 4.789% with sensitivity of 85.7% and specificity of 94.1%.

## CONCLUSION

The volumes of caudate lobe and left lateral segment increase, and that of right lobe volume decreases with fibrosis stage in NAFLD. The volume percentage of caudate lobe calculated by CT volumetry is a useful diagnostic parameter for staging fibrosis in patients with NAFLD.

## CLINICAL RELEVANCE/APPLICATION

CT volumetry is a powerful clinical tool to help diagnose fibrosis stage in NAFLD noninvasively. It may be useful in monitoring and making treatment decisions in patients with NAFLD.

## SSJ09-06 Application of Ultrasound Texture Analysis For Detection of Liver Fibrosis

Tuesday, Dec. 1 3:50PM - 4:00PM Location: E350

### Participants

David Podhaizer, MD, Boston, MA (*Presenter*) Nothing to Disclose  
Hei Shun Yu, MD, Boston, MA (*Abstract Co-Author*) Nothing to Disclose  
Baojun Li, PhD, Boston, MA (*Abstract Co-Author*) Nothing to Disclose  
Jorge A. Soto, MD, Boston, MA (*Abstract Co-Author*) Nothing to Disclose  
Stephan W. Anderson, MD, Boston, MA (*Abstract Co-Author*) Nothing to Disclose  
Avneesh Gupta, MD, Boston, MA (*Abstract Co-Author*) Nothing to Disclose

### PURPOSE

To determine the ability of ultrasound texture analysis to predict varying degrees of hepatic fibrosis in patients with known chronic liver disease.

### METHOD AND MATERIALS

Following IRB approval, a retrospective chart review was performed on patients who underwent non-targeted ultrasound guided liver biopsies to include 29 patients with chronic liver disease (20 males, 9 females, mean age of 52 years old, range of 19 to 81 years old). For each patient, a single region of interest (ROI) was selected on two to three separate sonographic images that were obtained from the ultrasound guided liver biopsy examinations and the results were averaged. The ROIs were selected from the right lobe of the liver and excluded vessels and bile ducts. Texture analysis was performed on the ROIs using an in-house MATLAB-based program that extracted 45 texture features. Pearson product-moment correlation coefficients were calculated comparing texture features and degrees of hepatic fibrosis.

### RESULTS

Of the 29 patients with chronic liver disease, the following Ishak fibrosis stages were represented, based on liver biopsy: Ishak 0, n=4; Ishak 1, n=4; Ishak 2, n=4; Ishak 3, n=4; Ishak 4, n=4; Ishak 5, n=4; Ishak 6, n=5. Comparisons of the texture features with the degrees of hepatic fibrosis demonstrate strong correlations between Ishak fibrosis stage and Histogram texture features (r-values ranging up to -0.89), GLRL features (r-values ranging up to 0.80), Laws' features (r-values ranging up to 0.93), and GLGM features (r-values ranging up to -0.80). Weak correlation between texture features and degrees of fibrosis were demonstrated with 2-D features (r-values ranging up to 0.36) and GLCM features (r-values ranging up to -0.47).

### CONCLUSION

Sonographic texture features demonstrate strong correlation with Ishak liver fibrosis scores. This suggests that texture analysis of ultrasound images has the potential to non-invasively predict varying degrees of hepatic fibrosis.

### CLINICAL RELEVANCE/APPLICATION

Texture analysis can potentially be applied to ultrasound as a non-invasive method to diagnose and monitor progression of liver fibrosis.

### Honored Educators

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

Jorge A. Soto, MD - 2013 Honored Educator  
Jorge A. Soto, MD - 2014 Honored Educator  
Jorge A. Soto, MD - 2015 Honored Educator

SSJ02

## Breast Imaging (Nuclear Medicine/Molecular Imaging)

Tuesday, Dec. 1 3:00PM - 4:00PM Location: E450A



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

### Participants

Priscilla J. Slanetz, MD, MPH, Belmont, MA (*Moderator*) Nothing to Disclose  
Donna M. Plecha, MD, Strongsville, OH (*Moderator*) Advisory Board, Hologic, Inc;

### Sub-Events

#### SSJ02-01 Multiparametric Evaluation of Breast Lesions with 18-Fluorodeoxyglucose Positron Emission Tomography Magnetic Resonance Imaging

Tuesday, Dec. 1 3:00PM - 3:10PM Location: E450A

### Participants

Courtney A. Garlick, MD, Cleveland, OH (*Presenter*) Nothing to Disclose  
Jenny Wang-Peterman, MD, Cleveland, OH (*Abstract Co-Author*) Nothing to Disclose  
Peter F. Faulhaber, MD, Cleveland, OH (*Abstract Co-Author*) Speaker, Koninklijke Philips NV; Grant, Koninklijke Philips NV; Medical Advisor, MIM Software Inc  
Kuan-Hao Su, Shaker Heights, OH (*Abstract Co-Author*) Research Grant, Koninklijke Philips NV  
Raymond Muzic, PhD, Cleveland, OH (*Abstract Co-Author*) Research Grant, Koninklijke Philips NV  
Maryam Etesami, MD, Cleveland, OH (*Abstract Co-Author*) Nothing to Disclose  
Nelly Salem, MD, Cleveland, AL (*Abstract Co-Author*) Nothing to Disclose  
Donna M. Plecha, MD, Strongsville, OH (*Abstract Co-Author*) Advisory Board, Hologic, Inc;

### PURPOSE

To assess the performance of multiparametric 18-Fluorodeoxyglucose positron emission tomography magnetic resonance imaging (MP PET-MRI) using dynamic contrast-enhanced MRI (DCE-MRI), diffusion weighted imaging (DWI) and FDG-PET in differentiating between benign and malignant abnormalities identified on DCE-MRI.

### METHOD AND MATERIALS

28 newly diagnosed breast cancer patients were prospectively enrolled in this Institutional Review Board (IRB) approved study. 25 patients underwent FDG PET-MRI imaging. Breast abnormalities identified in these patients on DCE-MRI were assessed for their likelihood of malignancy for each individual parameter (DCE-MRI, DWI and PET) as well as for combinations of the parameters. Malignancy vs. benignity of each lesion was then determined by histopathology or, in some cases where final pathologic diagnosis was not available, by pre- and post-chemotherapy imaging. If an abnormality showed a response to chemotherapy, it was presumed malignant. Sensitivity, Specificity, PPV and NPV were then measured.

### RESULTS

60 lesions were identified, of which 6 had no pathology or imaging follow-up, 11 were deemed benign and 43 malignant (6 presumed malignant). MP PET-MRI significantly improved specificity over DCE-MRI (100% vs 45%,  $p=0.012$ ) and DCE-MRI combined with PET (100% vs 36%,  $p=0.004$ ) or DWI (100% vs 44%,  $p=0.011$ ). There was a trend toward increased PPV with MP PET-MRI vs DCE-MRI (100% vs 88%), but was not statistically significant. Further, there was no statistically significant differences in sensitivity or NPV ( $p>0.05$ ).

### CONCLUSION

Multiparameter 18FDG PET-MRI increases specificity and decreases false positives of DCE-MRI without significant loss of sensitivity.

### CLINICAL RELEVANCE/APPLICATION

MP PET-MRI improves specificity of DCE-MRI which may lead to more accurate staging, decreasing false positives and unnecessary biopsies.

#### SSJ02-02 Visualization of Primary Breast Cancer Lesions with a Dedicated PET for Hanging Breast Imaging in Comparison to PET/CT

Tuesday, Dec. 1 3:10PM - 3:20PM Location: E450A

### Participants

Suzana Teixeira, MD, Amsterdam, Netherlands (*Presenter*) Nothing to Disclose  
Jose Ferrer Rebollada, MD, Valencia, Spain (*Abstract Co-Author*) Nothing to Disclose  
Bastiaan Koolen, MD, Amsterdam, Netherlands (*Abstract Co-Author*) Nothing to Disclose  
Jelle Wesseling, Amsterdam, Netherlands (*Abstract Co-Author*) Nothing to Disclose  
Raul Sanchez Jurado, Valencia, Spain (*Abstract Co-Author*) Nothing to Disclose  
M P. Stokkel, MD,PHD, Leiden, Netherlands (*Abstract Co-Author*) Nothing to Disclose  
Maria Del Puig Cozar Santiago, MD, Valencia, Spain (*Abstract Co-Author*) Nothing to Disclose  
Vincent van der Noort, PhD, Amsterdam, Netherlands (*Abstract Co-Author*) Nothing to Disclose  
Emiel Rutgers, Amsterdam, Netherlands (*Abstract Co-Author*) Nothing to Disclose  
Renato Valdes Olmos, Amsterdam, Netherlands (*Abstract Co-Author*) Nothing to Disclose

### PURPOSE

Evaluate the performance of a dedicated PET for hanging breast imaging (MAMMI-PET) for the visualization of breast cancer lesions



in two European hospitals while comparing the results obtained with whole body PET/CT.

## METHOD AND MATERIALS

After institutional review board approval we prospectively included 230 female patients (age: mean 52 y, range 24-82y) with  $\geq 1$  histologically confirmed primary breast cancer lesion (=index lesion) between March 2011 and March 2014. All patients that gave written informed consent were scanned with the MAMMI-PET (Oncovision, Valencia, Spain) after injection of 180-240 MBq and following standard whole body PET/CT. All index lesions on the MAMMI-PET scored 0, 1 or 2 for quantity of FDG uptake, which was tested in relation to histological (ductal, lobular) and molecular (ER/PR/Her2) breast cancer subtype, tumor grade, breast length, maximal tumor diameter and affected breast quadrants. We also compared the visibility score of the primary tumor between MAMMI-PET with standard PET/CT.

## RESULTS

Totally 234 affected breasts were scanned with proven primary breast cancer lesions (diameter 5-170 mm). The MAMMI-PET sensitivity was 98.6% for lesions located within the device scanning range. Twenty-three lesions (9.8%) near the pectoral muscle did not reach the scanning range and where therefore not visualised by MAMMI-PET. Of 11 index lesions smaller than 1 cm 9 where visualised by MAMMI-PET. Lesion visibility was not influenced by tumor grade ( $p=0.21$ ) or cancer subtype ( $p=0.8345$ ). In comparison to PET/CT MAMMI missed 19 lesions of which 18 were outside its scanning range. However PET/CT was not able to detect 15 index lesions visualized by MAMMI ( $p=0.61$ ). MAMMI-PET detected 41 additional lesions of which 16 where proven malignant (39%), 15 (36.6%) seen on other modalities, and 14 (34.2%) only visible on MAMMI-PET.

## CONCLUSION

Without limitations due to tumor size, grade or histological subtype the MAMMI-PET is able to detect almost all breast cancer index lesions located within its scanning range and is for this lesion category more sensitive than PET/CT.

## CLINICAL RELEVANCE/APPLICATION

With the dedicated MAMMI-PET it is possible to visualise primary breast cancer lesions in prone position without compression without the limitation known for PET/CT of tumor size and histological subtype.

## SSJ02-03 Pretreatment Prediction of Response to Preoperative Chemotherapy by Multiparametric F-18 Fluorodeoxyglucose Positron Emission Tomography - Magnetic Resonance Imaging in Breast Cancer Patients

Tuesday, Dec. 1 3:20PM - 3:30PM Location: E450A

### Participants

Maryam Etesami, MD, Cleveland, OH (*Presenter*) Nothing to Disclose  
Peter F. Faulhaber, MD, Cleveland, OH (*Abstract Co-Author*) Speaker, Koninklijke Philips NV; Grant, Koninklijke Philips NV; Medical Advisor, MIM Software Inc  
Courtney A. Garlick, MD, Cleveland, OH (*Abstract Co-Author*) Nothing to Disclose  
Jenny Wang-Peterman, MD, Cleveland, OH (*Abstract Co-Author*) Nothing to Disclose  
Raymond Muzic, PhD, Cleveland, OH (*Abstract Co-Author*) Research Grant, Koninklijke Philips NV  
Kuan-Hao Su, Shaker Heights, OH (*Abstract Co-Author*) Research Grant, Koninklijke Philips NV  
Nelly Salem, MD, Cleveland, AL (*Abstract Co-Author*) Nothing to Disclose  
Donna M. Plecha, MD, Strongsville, OH (*Abstract Co-Author*) Advisory Board, Hologic, Inc;

## PURPOSE

To assess whether multiparametric [F-18]fluorodeoxyglucose (FDG) positron emission tomography (PET) - magnetic resonance imaging (FDG-PET/MR) using dynamic contrast-enhanced MRI (DCE-MRI), diffusion-weighted imaging (DWI), and FDG-PET is able to predict response to preoperative chemotherapy in breast cancer patients. A pilot study.

## METHOD AND MATERIALS

A prospective, IRB approved study including twenty seven female patients with biopsy proven primary breast cancer underwent breast-specific PET/MR using Philips Ingenuity TF, 3T system. Patients treated with preoperative chemotherapy followed by surgery or post chemotherapy imaging were enrolled. Patients who had evidence of systemic metastases were excluded. DCE-MRI, DWI, and FDG-PET were qualitatively and semiquantitatively analyzed. The response to chemotherapy was assessed by the pathologic analysis of surgical specimen, or post chemotherapy imaging in two patients awaiting definitive surgery, and then correlated with PET/MR data.

## RESULTS

Eighteen patients met the criteria to be enrolled in the study. Response to chemotherapy was complete in 4 (22%), partial in 8 (44%), and no response in 6 (33%) patients. On MRI, the apparent diffusion coefficient (ADC) value for responders to chemotherapy (partial or complete) ( $\text{mean}=0.78 \times 10^{-3} \text{ mm}^2/\text{s}$ ) was significantly higher than for non-responders ( $\text{mean}=0.56 \times 10^{-3} \text{ mm}^2/\text{s}$ ) ( $p=0.45$ ). All the responders had ADC value of greater than  $0.65 \times 10^{-3} \text{ mm}^2/\text{s}$ . With FDG-PET, there was no significant difference in maximum standardized uptake value (SUV<sub>max</sub>) in responders ( $\text{mean}=7.38$ ) versus non-responders ( $\text{mean}=6.87$ ) ( $p=0.85$ ). The DCE-MRI kinetic curves and morphology showed no significant difference between responders and non-responders.

## CONCLUSION

In our pilot study, DCE-MRI with DWI was found to be valuable for pretreatment prediction of response to chemotherapy in breast cancer. Higher ADC values were associated with response. With limited number of patients, there was no proven benefit of PET/MR over DCE-MRI in the prediction of response to chemotherapy. Further studies with larger cohorts and evaluating imaging characteristic changes after an early dose of chemotherapy would be helpful.

## CLINICAL RELEVANCE/APPLICATION

DCE-MRI with DWI may improve the ability to predict response to preoperative chemotherapy in patients with breast cancer.

## SSJ02-04 Insights in Physiology of Breast Parenchyma: Is There a Correlation of Breast Parenchymal Uptake of 18FDG, Breast Parenchymal Enhancement on DCE-MRI, Amount of Fibroglandular Tissue and Age?



Tuesday, Dec. 1 3:30PM - 3:40PM Location: E450A

#### Participants

Doris Leithner, Frankfurt am Main, Germany (*Presenter*) Nothing to Disclose  
Pascal A. Baltzer, MD, Vienna, Austria (*Abstract Co-Author*) Nothing to Disclose  
Heinrich Magometschnigg, Vienna, Austria (*Abstract Co-Author*) Nothing to Disclose  
Georg J. Wengert, MD, Vienna, Austria (*Abstract Co-Author*) Nothing to Disclose  
Thomas H. Helbich, MD, Vienna, Austria (*Abstract Co-Author*) Research Grant, Medisor, Inc; Research Grant, Siemens AG; Research Grant, C. R. Bard, Inc  
Katja Pinker-Domenig, MD, Vienna, Austria (*Abstract Co-Author*) Nothing to Disclose

#### PURPOSE

To assess and correlate breast parenchymal uptake (BPU) in 18FDG PET-CT with breast parenchymal enhancement (BPE) and amount of fibroglandular tissue (FGT) with 3T DCE-MRI and to determine the influence of patient age on BPU, BPE and FGT.

#### METHOD AND MATERIALS

In this IRB-approved prospective study 129 patients with a BIRADS 4/5 lesion underwent 18FDG PET-CT and 3T DCE-MRI. Examinations were no longer than six days apart. Patients were injected with approximately 300 MBq 18FDG. After 60 min a prone PET-CT dataset over the breasts was acquired and CT data was solely used for attenuation correction. For DCE-MRI a contrast-enhanced high resolution 3D-T1-weighted sequence before and after application of a standard dose of 0.1 mmol/kg Gd-DOTA (Dotarem®) was employed. BPU and BPE were assessed in the healthy contralateral breast. BPU was calculated quantitatively using SUVmax. FGT and BPE were qualitatively assessed by two independent readers using the revised ACR BI-RADS® classification. To assess reproducibility all measurements were repeated by reader 1. Appropriate statistical tests were used to assess correlation of FGT, BPE, BPU, inter- and intra-reader agreement.

#### RESULTS

There was no BPE in 58, mild in 54, moderate in 14 and marked in 3 patients. SUVmax for patients with no BPE was 1.57 (SD 0.6), for mild BPE 1.93 (SD 0.6), for moderate BPE 2.42 (SD 0.5), and for marked BPE 1.45 (SD 0.3). There were highly significant correlations between age, BPU, BPE and FGT. Correlation coefficients ranged between moderate and strong. While BPE, BPU and FGT were positively correlated with each other, all of these parameters were negatively correlated with age (Figure 1). The intraclass correlation coefficient for BPU measurements was excellent with 0.973. Inter-reader and intra-reader agreement for BPE was very good with a Kappa-value of 0.860 and 0.822 respectively.

#### CONCLUSION

BPU of normal breast parenchyma can be reproducibly assessed using SUV metrics and is positively correlated with BPE and FGT in DCE-MRI. There is a negative correlation of BPU, BPE and FGT with age.

#### CLINICAL RELEVANCE/APPLICATION

BPU, BPE and FGT provide insights in tumor physiology and decrease with age. In patients with dense breasts a possible masking effect of lesions by BPU/BPE must be considered.

#### SSJ02-05 Clinical Comparison of MBI and BSGI for Low Dose Breast Imaging

Tuesday, Dec. 1 3:40PM - 3:50PM Location: E450A

#### Participants

Zaiyang Long, PhD, Rochester, MN (*Presenter*) Nothing to Disclose  
Carrie B. Hruska, PhD, Rochester, MN (*Abstract Co-Author*) Institutional license agreement, Gamma Medica, Inc  
Michael K. O'Connor, PhD, Rochester, MN (*Abstract Co-Author*) Royalties, Gamma Medica, Inc

#### PURPOSE

Breast specific gamma imaging (BSGI) and molecular breast imaging (MBI) are promising techniques for supplemental imaging in women with dense breast tissue. This study compares the performance of such systems at administered doses of Tc-99m sestamibi that are acceptable for low dose imaging.

#### METHOD AND MATERIALS

The BSGI system comprised a single-head multi-crystal NaI system (pixel size 3.2×3.2 mm) equipped with a hexagonal-hole lead collimator. The MBI system comprised a dual-head cadmium zinc telluride detector system (pixel size 1.6×1.6 mm) equipped with registered tungsten collimators. System sensitivity, uniformity, energy and spatial resolution were measured using NEMA methods. A 6-cm thick contrast detail (CD) phantom with 48 hot spots (3-10 mm diameter) was used to assess contrast-noise-ratio (CNR) using average background count densities observed in clinical studies at 4mCi dose. 25 patients receiving 4-8mCi doses were imaged on both systems under IRB approval.

#### RESULTS

The BSGI and MBI systems had integral uniformities of 6.1% and 3.8%, and energy resolution (at 140 keV) of 13.1% and 4.3%, respectively. System sensitivity was 403 cpm/uCi (BSGI) and 790 cpm/uCi (MBI) using a standard +/- 10% energy window. In clinical use, MBI employs an energy window of 110-154 keV, yielding a sensitivity of 1042 cpm/uCi. At distances of 1, 3 and 5 cm from the collimator, spatial resolution was 4.1, 5.1 and 6.2 mm on BSGI, and 2.0, 4.7 and 7.3 mm on MBI, respectively. However, with the dual head configuration of MBI, spatial resolution at 5 cm distance from one detector is equivalent to 1cm from the opposing detector for the most frequently observed compressed breast thickness of 6cm. Application of the Rose criterion for lesion detection (CNR>3) to images of the CD phantom showed that for BSGI, 9 hot spots at 4mCi were undetectable. For MBI, 5 hot spots at 4mCi were undetectable. In the 25 patient studies, 5 lesions (CNR>3) were identified on MBI whereas 3 were identified on BSGI.

#### CONCLUSION

Over the clinical range 0-6 cm, the MBI system demonstrated better spatial resolution than the BSGI system while yielding a 2.6-

fold greater sensitivity. This resulted in improved lesion detection and allows MBI to be utilized at lower doses than BSGI.

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

Molecular breast imaging (MBI) system demonstrated better performance characteristics than BSGI system. MBI is more suitable for low dose breast imaging.

#### **SSJ02-06 Correlation of Semi-Quantitative Breast-Specific Gamma Imaging Findings with Dynamic Contrast-Enhanced MRI Parameters assessed by a Computer-Aided Evaluation Program and Prognostic Factors of Breast Cancers**

Tuesday, Dec. 1 3:50PM - 4:00PM Location: E450A

##### **Participants**

Saemee Ahn, MD, PhD, Seoul, Korea, Republic Of (*Presenter*) Nothing to Disclose  
Hye Ryoung Koo, MD, Seoul, Korea, Republic Of (*Abstract Co-Author*) Nothing to Disclose  
Jeong Seon Park, MD, Seoul, Korea, Republic Of (*Abstract Co-Author*) Nothing to Disclose  
Soo-Yeon Kim, MD, Guri, Korea, Republic Of (*Abstract Co-Author*) Nothing to Disclose

##### **PURPOSE**

To investigate whether a correlation exists between the semi-quantitative breast-specific gamma imaging (BSGI) findings and dynamic contrast-enhanced (DCE) MRI parameters assessed by a computer-aided evaluation program or prognostic factors of breast cancers

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

Semi-quantitative index of lesion to non-lesion ratio (L/N) in BSGI and DCE-MRI parameters assessed by a computer-aided evaluation program and histopathologic prognostic factors of 47 invasive breast cancers were obtained. Correlation between L/N ratio and DCE-MRI parameters assessed by a computer-aided evaluation program, including tumor size (cm), angio-volume (cc), degree of initial peak enhancement (%), persistent enhancement proportion (%), washout enhancement proportion (%), or prognostic factors, including axillary nodal status, histologic grade, expression of estrogen receptor (ER), progesterone receptor (PR), human epidermal growth factor receptor 2 (HER2) and Ki-67 were analyzed.

##### **RESULTS**

The mean L/N ratio of 47 tumors was  $3.63 \pm 2.19$  (range: 1-13.1). The L/N ratio was higher in tumors with larger tumor size ( $P<0.001$ ), increased angio-volume ( $P<0.001$ ), higher degree of initial peak enhancement ( $P<0.001$ ), increased washout enhancement proportion ( $P=0.003$ ), high histologic grade ( $P=0.013$ ), and higher Ki-67 ( $P=0.002$ ). The calculated multiple correlation coefficient was 0.80 ( $P<0.001$ ).

##### **CONCLUSION**

There was a strong multiple correlation between the semi-quantitative L/N ratio in BSGI with DCE-MRI parameters assessed by a computer-aided evaluation program and prognostic factors of breast cancers.

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

The relationship between the radiotracer uptake in molecular imaging and DCE-MRI parameters may offer an in-depth understanding into the characterization of breast cancer.

## Musculoskeletal (Bone Strength, Fragility and Stress Fractures)

Tuesday, Dec. 1 3:00PM - 4:00PM Location: E450B



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

### Participants

Bruce B. Forster, MD, Vancouver, BC (*Moderator*) Travel support, Siemens AG; Travel support, Toshiba Corporation;  
Leon Lenchik, MD, Winston-Salem, NC (*Moderator*) Nothing to Disclose

### Sub-Events

#### SSJ16-01 3 T MRI-based Metrics of Proximal Femur Microarchitecture and Strength Can Discriminate between Subjects with and without Fragility Fractures When BMD Cannot

Tuesday, Dec. 1 3:00PM - 3:10PM Location: E450B

### Participants

Hamza Alizai, MD, New York, NY (*Presenter*) Nothing to Disclose  
Chamith Rajapakse, PhD, Philadelphia, PA (*Abstract Co-Author*) Nothing to Disclose  
Stephen Honig, MD, New York, NY (*Abstract Co-Author*) Nothing to Disclose  
Cheng Chen, Iowa City, IA (*Abstract Co-Author*) Nothing to Disclose  
Punam K. Saha, PhD, Iowa City, IA (*Abstract Co-Author*) Nothing to Disclose  
Gregory Chang, MD, New York, NY (*Abstract Co-Author*) Speaker, Siemens AG

### PURPOSE

Dual-energy x-ray absorptiometry (DXA) measurement of areal bone mineral density (BMD) poorly discriminates between subjects with and without fragility fractures. We investigated whether magnetic resonance imaging (MRI)-derived proximal femur microarchitectural parameters can discriminate between these two groups.

### METHOD AND MATERIALS

This study had institutional review board approval. We recruited 22 females with fragility fractures (mean age=67.1±6.1 years) and 22 healthy female controls without fracture (mean age=64.1±6.5 years). All subjects underwent high-resolution 3T MRI of the non-dominant hip. We performed digital topological and finite element analyses within 10x10x10 mm<sup>3</sup> femoral neck volumes-of-interest to assess: trabecular number, thickness, plate-to-rod ratio, connectivity; and elastic modulus (metric of bone strength). All subjects underwent DXA of the same hip. We performed receiver operating characteristics (ROC) analyses to assess discriminatory performance.

### RESULTS

For MRI, femoral neck elastic modulus, trabecular plate-to-rod ratio, and connectivity could discriminate between subjects with and without fractures (area under the curve (AUC)=0.75-0.87,  $p<0.05$ ), but trabecular thickness and number could not (AUC=0.46-0.53,  $p>0.78$ ). For DXA, femoral neck and total hip BMD T-scores could not discriminate between the two groups (AUC=0.47-0.49,  $p>0.80$ ).

### CONCLUSION

Metrics of proximal femur microarchitecture and strength may be able to detect high fracture risk individuals even when BMD cannot.

### CLINICAL RELEVANCE/APPLICATION

MRI based analysis of bone microarchitecture and strength may provide better measures of bone quality than Dual-Energy x-ray absorptiometry (DXA)

#### SSJ16-02 Long-term Radiographic Follow-up of Bisphosphonate-related Femur Fractures

Tuesday, Dec. 1 3:10PM - 3:20PM Location: E450B

### Participants

Jennifer L. Favinger, MD, Seattle, WA (*Presenter*) Nothing to Disclose  
Daniel S. Hippe, MS, Seattle, WA (*Abstract Co-Author*) Research Grant, Koninklijke Philips NV; Research Grant, General Electric Company  
Alice S. Ha, MD, Seattle, WA (*Abstract Co-Author*) Grant, General Electric Company

### PURPOSE

Although the initial appearance of atypical femur fractures associated with bisphosphonate use has been well documented, there are no prior studies evaluating long-term radiographic follow up of how these fractures change over time. It has been shown that bisphosphonates remain in bone for years after drug discontinuation, suggesting these fractures might not heal with the same pattern as normal bone.

### METHOD AND MATERIALS

In this retrospective study, bisphosphonate-related fracture radiographs and CTs were reviewed by two radiologists for presence of a fracture line, callus, and the characteristic cortical beak. Indications of healing were defined as the fracture line or cortical beak appearing distinctly less conspicuous, though not necessary absent, compared to the prior study. Kaplan-Meier (KM) curves were used to analyze the time to first indication of healing. KM curves were compared between groups using the logrank test.

## RESULTS

47 femurs with a bisphosphonate-related femur fracture were identified in 28 women, average age 65 years. 85% took a bisphosphonate for greater than 5 years, 59% for greater than 10 years. Median follow up time was 1.7 years with a median of 6 exams per femur. Median time to beak healing was 265 weeks. Median time to fracture line healing was 56 weeks in the 31 femurs with a baseline fracture. Healing rates of the beak ( $p = 0.03$ ) and fracture line ( $p = 0.07$ ) tended to be higher in those who discontinued bisphosphonate by 1 week after the initial exam compared to those who discontinued later. However, even in this group that discontinued earlier, only 53% demonstrated fracture line healing and 24% demonstrated beak healing at 6 months follow up.

## CONCLUSION

Despite drug discontinuation, bisphosphonate-related fractures fail to show normal radiographic healing patterns in long-term follow-up, in keeping with recent pathology studies that showed persistent intraosseous drug presence years after drug discontinuation. These fractures demonstrate abnormally long healing time with less than 5% of patients showing any form of fracture healing at 6 weeks, and less than 50% showing any healing at 26 weeks. Therefore, these patients remain at high risk for displaced fractures and non-union.

## CLINICAL RELEVANCE/APPLICATION

Atypical femur fractures are associated with significant morbidity and demonstrate abnormal or incomplete healing even years after drug discontinuation.

### SSJ16-03 Does Intravenous Contrast Administration Affect Bone Mineral Density Assessment Using Multi-detector Computed Tomography?

Tuesday, Dec. 1 3:20PM - 3:30PM Location: E450B

#### Participants

Sabarish Narayanasamy, MBBS,MD, Aligarh, India (*Presenter*) Nothing to Disclose  
Jitender Singh JR, MD, Aligarh, India (*Abstract Co-Author*) Nothing to Disclose  
Saifullah Khalid, MD, Aligarh, India (*Abstract Co-Author*) Nothing to Disclose  
Paul A. Sathiadoss, MBBS, Aligarh, India (*Abstract Co-Author*) Nothing to Disclose  
Breethaa J. Selvamani, Aligarh, India (*Abstract Co-Author*) Nothing to Disclose  
Mohd. Khalid, MBBS, MD, Aligarh, India (*Abstract Co-Author*) Nothing to Disclose

## PURPOSE

The aim of our study was to evaluate whether contrast media administration has significant influence on Computed tomography (CT) derived bone density measurements by comparing the unenhanced and contrast enhanced CT examinations.

## METHOD AND MATERIALS

89 patients (47 Males and 42 Females; Mean age  $\pm$  SD,  $53 \pm 10.6$ ) who underwent both unenhanced and contrast enhanced CT examinations in the same setting between January 2014 and January 2015 were retrospectively selected. The only exclusion criterion was patients less than 40 years of age. CT attenuation values in Hounsfield units were measured in the first lumbar (L1) vertebra (using simple non-angled ROI) in both the unenhanced and contrast enhanced examinations. Comparisons were made between the measurements using appropriate statistical methods.

## RESULTS

The mean CT attenuation value in the contrast enhanced phase (Mean  $\pm$  SD,  $186.7 \pm 49.7$ ) was significantly higher as compared to the unenhanced phase ( $170.1 \pm 52.2$ ,  $p = 0.000$ ). The mean CT attenuation values were higher in males as compared to females in both unenhanced (Males vs Females;  $180.8 \pm 52.1$  vs  $158.2 \pm 50.1$ ,  $p=0.04$ ) and contrast enhanced phases ( $192.2 \pm 50.9$  vs  $180.5 \pm 48.1$ ,  $p = 0.27$ ). When a threshold of 160HU or less is used to define osteoporosis, measurements in the contrast enhanced phase resulted in 8% false negatives.

## CONCLUSION

Our study demonstrates that intravenous contrast administration significantly affects the Bone Mineral density assessment using CT. This must be factored in, when CT is used as a screening tool for osteoporosis.

## CLINICAL RELEVANCE/APPLICATION

There are significant differences in CT attenuation values depending on the phase of image acquisition and therefore standardized image acquisition protocols must be used for bone density assessment.

### SSJ16-04 Multi-modality Imaging for Tumor Localization in Patients with Tumor-induced Osteomalacia: A Retrospective Analysis of Five Cases

Tuesday, Dec. 1 3:30PM - 3:40PM Location: E450B

#### Participants

Kersten Peldschus, MD, Hamburg, Germany (*Presenter*) Nothing to Disclose  
Thomas Brunkhorst, Hannover, Germany (*Abstract Co-Author*) Nothing to Disclose  
Christian Wisotzki, Hamburg, Germany (*Abstract Co-Author*) Nothing to Disclose  
Thorsten Derlin, MD, Hannover, Germany (*Abstract Co-Author*) Nothing to Disclose  
Gerhard B. Adam, MD, Hamburg, Germany (*Abstract Co-Author*) Nothing to Disclose  
Michael Amling, Hamburg, Germany (*Abstract Co-Author*) Nothing to Disclose  
Stefan Breer, Hamburg, Germany (*Abstract Co-Author*) Nothing to Disclose

## PURPOSE

The purpose of this retrospective study was to evaluate imaging findings of patients with tumor-induced osteomalacia who underwent multi-modality imaging to localize the underlying tumor.

## METHOD AND MATERIALS

Five patients who were successfully treated after suffering up to several years from tumor-induced osteomalacia and who underwent multi-modality imaging to localize the tumor were included in the analysis. All patients underwent <sup>111</sup>In-octreotide scintigraphy and <sup>68</sup>Ga DOTATATE PET/CT for somatostatin receptor imaging as well as MRI and additional CT (only 3 patients) of suspicious lesions from radionuclide imaging to further characterize the tumors for surgical treatment planning. Tumors were evaluated regarding tracer accumulation, size and contrast enhancement. Data sets were analyzed in consensus by experienced radiologists and nuclear medicine specialists.

## RESULTS

Out of the five patients (50.4±7.3 y/o, 3 female, 2 male) <sup>111</sup>In-octreotide scintigraphy revealed a suspicious lesion in 2 patients, whereas <sup>68</sup>Ga DOTATATE PET/CT demonstrated tumor suspicious tracer enhancement in all 5 patients (mean SUV<sub>max</sub> 14.9±10.0). Contrast-enhanced MRI could confirm tumorous lesions (mean diameter 2.5±1.6 cm) in all cases. After surgical removal histopathological analysis revealed three mesenchymal tumors of mixed connective tissue variant and two odontogenic fibroma, endothelium rich type. On MRI the mean size of tumors identifiable with <sup>111</sup>In-octreotide scintigraphy was 4.5±0.6 cm versus 1.2±0.1 cm for tumors detectable only with <sup>68</sup>Ga DOTATATE PET/CT. Complete surgical removal was achieved in all patients, no recurrence was observed during 1-year follow-up.

## CONCLUSION

In patients with tumor-induced osteomalacia <sup>68</sup>Ga DOTATATE PET/CT was able to detect significantly smaller tumors than <sup>111</sup>In-octreotide scintigraphy. Subsequent MRI (and CT) were required to further characterize the tumors for surgical treatment planning.

## CLINICAL RELEVANCE/APPLICATION

In patients with suspected tumor-induced osteomalacia <sup>68</sup>Ga DOTATATE PET/CT may allow the detection of small tumors that are negative on <sup>111</sup>In-octreotide scintigraphy.

### SSJ16-05 The Effect of Body Mass Index on Bone Mineral Density and Trabecular Bone Score

Tuesday, Dec. 1 3:40PM - 3:50PM Location: E450B

#### Participants

Cristian G. Monaco, MD, San Donato Milanese,, Italy (*Presenter*) Nothing to Disclose  
Carmelo Messina, MD, Milan, Italy (*Abstract Co-Author*) Nothing to Disclose  
Alessandro Poloni, Milano, Italy (*Abstract Co-Author*) Nothing to Disclose  
Giovanni Di Leo, San Donato Milanese, Italy (*Abstract Co-Author*) Travel support, Bracco Group  
Luca Maria Sconfienza, MD, PhD, San Donato Milanese, Italy (*Abstract Co-Author*) Nothing to Disclose  
Francesco Sardanelli, MD, San Donato Milanese, Italy (*Abstract Co-Author*) Speakers Bureau, Bracco Group Research Grant, Bracco Group Speakers Bureau, Bayer AG Research Grant, Bayer AG Research Grant, IMS International Medical Scientific

## PURPOSE

Trabecular Bone Score (TBS) measured on lumbar spine dual energy x-ray absorptiometry (DXA) provides an indirect index of trabecular microarchitecture. According to proponents, TBS is adjusted to the patient's body mass index (BMI). In obese patient, bone mineral density (BMD) is usually increased due to image noise related to soft tissue superimposition. Our aim was to investigate the effect of BMI on BMD and TBS.

## METHOD AND MATERIALS

After ethics committee approval, we retrospectively reviewed the last 197 DXA examinations performed at our institution. For each patient, data on TBS, BMI, and BMD were registered. An experienced reader evaluated all examinations. TBS and BMD were automatically averaged from L1 to L4. T-score was categorized according the WHO criteria. The presence of osteoarthritis was determined when a difference of more than a 1.0 T-score was found between two adjacent vertebrae, in agreement to the International Society for Clinical Densitometry guidelines. Correlation was estimated using the Pearson coefficient and multivariate regression using TBS as dependent variable. Data were presented as mean±standard deviation.

## RESULTS

T-score diagnosis was normal in 54 patients (27.4%), osteopenia in 95 (48.2%), and osteoporosis in 48 (24.4%). Overall, BMI was 26±5 kg/m<sup>2</sup>; BMD 0.877±0.153 g/cm<sup>2</sup>; TBS 1.224±0.117 mm<sup>-1</sup>. Osteoarthritis was evident in 55 (28%) patients. Bivariate correlation analysis between TBS and BMI was significant ( $r = -0.396$ ,  $P < .001$ ); this correlation was higher in patients with BMI≥30 kg/m<sup>2</sup> ( $r = -0.501$ ,  $P = .015$ ) than in those with BMI<30 kg/m<sup>2</sup> ( $r = -0.207$ ,  $P = .006$ ). The correlation between TBS and BMD was:  $r = 0.313$  ( $P < .001$ ), overall;  $r = 0.431$  ( $P = .040$ ), in patients with BMI≥30 kg/m<sup>2</sup>;  $r = 0.408$  ( $P < .001$ ), in patients with BMI<30 kg/m<sup>2</sup>. Multivariate regression analysis confirmed that BMI and BMD are independently associated to TBS ( $P < .001$ ), both overall and only in patients without osteoarthritis.

## CONCLUSION

The higher the BMI the lower the TBS. BMI and BMD were independent predictors of TBS.

## CLINICAL RELEVANCE/APPLICATION

TBS evaluation may be impaired in patients with high BMI, especially when BMI≥30 kg/m<sup>2</sup>.

### SSJ16-06 Stress Fracture Diagnosis on Conventional Radiography and MRI: Variations Based on Fracture Location, Patient Age, and Time to MRI

Tuesday, Dec. 1 3:50PM - 4:00PM Location: E450B

#### Participants

Gregory S. Matthews, MD, Winston-Salem, NC (*Presenter*) Nothing to Disclose  
Scott D. Wuertzer, MD, MS, Winston-Salem, NC (*Abstract Co-Author*) Nothing to Disclose  
Maha Torabi, MD, Winston Salem, NC (*Abstract Co-Author*) Nothing to Disclose  
Pushpender Gupta, MBBS, Winston-Salem, NC (*Abstract Co-Author*) Author, Reed Elsevier

## PURPOSE

To determine if the diagnosis of stress fracture on conventional radiographs (CR) and MRI is influenced by fracture location, age of patient, and time between CR and MRI.

## METHOD AND MATERIALS

Imaging studies of patients with suspected stress fractures over a five year period were evaluated. Only patients with CR and MRI studies less than 3 months apart were included. Stress fractures were categorized into three anatomic regions: 1) foot/ankle, 2) tibia/distal femur, 3) pelvis/proximal femur. Sensitivity and specificity of CR was determined by region. Odds ratios (95% CI) between patient age and positive CR and MRI diagnosis were determined. Also, odds ratio between days between CR and MRI and positive diagnosis of fracture was determined.

## RESULTS

285 patients (mean age, 41 years; age range, 4-91 years) with clinical suspicion of stress fracture were evaluated with both CR and MRI. Based on CR, stress fractures were diagnosed (or highly suspected) in 61/295 (20.7%) of patients, including 25/144 (17.4%) in foot/ankle, 19/49 (38.8%) in tibia/distal femur, and 17/91 (18.7%) in pelvis/proximal femur. Based on MRI, stress fracture or stress reaction was diagnosed in 133/295 (45.1%) of patients, including 82/144 (56.9%) in foot/ankle, 26/49 (53.1%) in tibia/distal femur, and 25/91 (27.5%) in proximal femur/pelvis. Sensitivity of CR was 23% in foot/ankle, 31% in tibia/distal femur, and 12% in pelvis/proximal femur. Specificity of CR was 90% in foot/ankle, 52% in tibia/distal femur, and 79% in pelvis/proximal femur. For each decade of life, the odds of a positive CR diagnosis increased by 21% (OR: 1.21; 95% CI: 1.04,1.40], whereas the odds of a positive MRI diagnosis decreased by 14% (OR: 0.86; 95% CI: 0.76,0.97). There was no significant relationship between days between CR and MRI and positive diagnosis of fracture.

## CONCLUSION

The diagnosis of stress fracture varies by fracture location and age of patient.

## CLINICAL RELEVANCE/APPLICATION

Approach to imaging of stress fractures should take into account fracture location and age of patient.



SSJ10

## Genitourinary (Prostate Intervention)

Tuesday, Dec. 1 3:00PM - 4:00PM Location: E353C



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

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

### Participants

Aytekin Oto, MD, Chicago, IL (*Moderator*) Research Grant, Koninklijke Philips NV; ; ;  
Temel Tirkes, MD, Indianapolis, IN (*Moderator*) Nothing to Disclose

### Sub-Events

#### SSJ10-01 MR-guided In-bore versus MRI/Ultrasound Fusion Plus TRUS-guided Prostate Biopsy: A Prospective Randomized Trial in Patients with Prior Negative Biopsies

Tuesday, Dec. 1 3:00PM - 3:10PM Location: E353C

### Awards

#### Trainee Research Prize - Resident

### Participants

Lars Schimmoeller, MD, Duesseldorf, Germany (*Presenter*) Nothing to Disclose  
Michael Quentin, MD, Dusseldorf, Germany (*Abstract Co-Author*) Nothing to Disclose  
Christian Arsov, MD, Duesseldorf, Germany (*Abstract Co-Author*) Nothing to Disclose  
Dirk Blondin, MD, Duesseldorf, Germany (*Abstract Co-Author*) Nothing to Disclose  
Robert Rabenalt, Duesseldorf, Germany (*Abstract Co-Author*) Nothing to Disclose  
Gerald Antoch, MD, Duesseldorf, Germany (*Abstract Co-Author*) Nothing to Disclose  
Andreas Hiester, Dusseldorf, Germany (*Abstract Co-Author*) Nothing to Disclose  
Erhard Godehardt, Duesseldorf, Germany (*Abstract Co-Author*) Nothing to Disclose  
Helmut Erich Gabbert, D-40225 Dusseldorf, Germany (*Abstract Co-Author*) Nothing to Disclose  
Peter Albers, MD, PhD, Duesseldorf, Germany (*Abstract Co-Author*) Nothing to Disclose

### PURPOSE

This study prospectively compares the PCa detection rate (PCa-DR) of MR-guided in-bore biopsy (IB-GB) alone and MRI/ultrasound fusion-guided biopsy combined with a systematic TRUS-GB (FUS+TRUS-GB) in patients with at least one negative TRUS-GB and PSA level  $\geq 4$  ng/ml.

### METHOD AND MATERIALS

253 patients were included in this study. After multiparametric prostate MRI (T2WI, DWI, DCE-MRI) at 3T patients with any PI-RADS sum score  $\geq 10$  were prospectively randomized to IB-GB or FUS+TRUS-GB. Analysis of detection rates for PCa and significant PCa (Gleason score  $\geq 7$ ), highest Gleason score, number of biopsy cores to detect one (significant) PCa, positivity rate of biopsy cores, and tumor involvement per biopsy core were performed.

### RESULTS

210 patients met all study requirements and were prospectively randomized, 106 patients receiving IB-GB and 104 patients FUS+TRUS-GB (age  $65.3 \pm 7.1$  vs.  $66.7 \pm 6.8$  years; median PSA 10.0 vs. 10.8 ng/ml, IQR 7.8-14.9 vs. 7.4-15.5 ng/ml). Mean number of cores was  $5.61 \pm 0.80$  vs.  $17.38 \pm 1.17$ ;  $p < 0.001$ . PCa-DR for IB-GB was 36.8% (29.2% for significant PCa) and for FUS+TRUS-GB 39.4% (31.7%);  $p = 0.776$  and  $p = 0.765$ . Mean highest Gleason score of  $7.24 \pm 0.96$  vs.  $7.46 \pm 1.01$ ;  $p = 0.233$ . Positivity rate per biopsy core was 20.7% (123/595) vs. 11.6% (210/1,808);  $p < 0.001$ . Number of biopsy cores needed to detect one PCa or one significant PCa was 15.3 vs. 44.1 and 19.2 vs. 54.8.

### CONCLUSION

The combined biopsy approach did not significantly improve the overall PCa-DR compared to targeted IB-GB alone, but required significantly more cores. A prospective comparison of MR-targeted biopsy alone to systematic TRUS-GB is justified.

### CLINICAL RELEVANCE/APPLICATION

We did not observe a difference between IB-GB and FUS+TRUS-GB to detect PCa.

#### SSJ10-02 Accuracy of Targeted Prostate Biopsy Using MR-ultrasound Fusion to Guide Biopsies Directed to Focal Lesions Suspicious for Malignancy: A Retrospective Study of 286 Patients

Tuesday, Dec. 1 3:10PM - 3:20PM Location: E353C

### Participants

Guilherme C. Mariotti, MD, Jundiai, Brazil (*Presenter*) Nothing to Disclose  
Tatiana Martins, MD, Belo Horizonte, Brazil (*Abstract Co-Author*) Nothing to Disclose  
Marcos R. Queiroz, MD, Sao Paulo, Brazil (*Abstract Co-Author*) Nothing to Disclose  
Thais Mussi, MD, Sao Paulo, Brazil (*Abstract Co-Author*) Nothing to Disclose  
Rodrigo Gobbo, Sao Paulo, Brazil (*Abstract Co-Author*) Nothing to Disclose  
Ronaldo H. Baroni, MD, Sao Paulo, Brazil (*Abstract Co-Author*) Nothing to Disclose

### PURPOSE

Demonstrate an increase in the accuracy of targeted prostate biopsy using MR-ultrasound fusion to guide biopsies directed to focal

demonstrate an increase in the accuracy of targeted prostate biopsy using MR-ultrasound fusion to guide biopsies directed to focal lesions suspicious for malignancy in a retrospective study of 286 patients.

## METHOD AND MATERIALS

A single-institutional, IRB approved retrospective analysis of 286 patients in our database, which underwent targeted prostate biopsies using MR-ultrasound fusion from August 2013 to January 2015. We included all patients with suspected prostatic cancer based on clinical or laboratory findings (positive digital rectal examination or high PSA) submitted to multiparametric MRI and US-MRI fusion prostate biopsy. We excluded 7 patients with MRI-biopsy interval  $\geq 6$  months, 17 patients that underwent biopsy for staging of known cancer or active surveillance and 1 patient for whom clinical data was unavailable.

## RESULTS

A total of 261 patients were included. Of these, 45 patients (17%) underwent previous negative transrectal US-guided biopsies. Table 1 summarizes demographic data of our casuistic. Pre-procedure MRI followed a Likert scale for suspicion: Likert 1: 1 patient (0,4%); Likert 2: 18 patients (6,9%); Likert 3: 100 patients (38,3%); Likert 4: 75 patients (28,7%); Likert 5: 67 patients (25,7%). Overall positivity of the biopsies for tumors was 59% (154 cases), with 79% (123 cases) significant cancer (Gleason  $\geq 7$ ), 19% (30 cases) non-significant cancer (Gleason 6) and 1 case of STUMP. Analyzing only the Likert 4 and 5 cases, in a total of 142 cases, the overall positivity was 76% (108 cases), with 90% (96 cases) significant cancer (Gleason  $\geq 7$ ), 10% (11 cases) non-significant cancer (Gleason 6) and 1 leiomyoma. In our institution, the positivity of US-guided random biopsies, in a large sample of other patients in the same period (331 patients), was around 52%.

## CONCLUSION

Our study demonstrates a significant improvement in the performance of prostate biopsy with US- MRI fusion compared to random US-guided biopsies, with potential clinical impact.

## CLINICAL RELEVANCE/APPLICATION

Random prostate biopsies performed on a sextant-basis have a high incidence of false-negative results, and often diagnose microfocal lesions with low clinical significance. Targeted prostate biopsies using MR-ultrasound fusion have shown to detect clinically significant lesions and increase the accuracy of the procedure, with better clinical outcomes.

### SSJ10-03 Targeted MR-guided Prostate Biopsy: Are Two Biopsy Cores per MRI Lesion Required?

Tuesday, Dec. 1 3:20PM - 3:30PM Location: E353C

#### Participants

Lars Schimmoeller, MD, Duesseldorf, Germany (*Presenter*) Nothing to Disclose  
Michael Quentin, MD, Dusseldorf, Germany (*Abstract Co-Author*) Nothing to Disclose  
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Frederic Dietzel, Dusseldorf, Germany (*Abstract Co-Author*) Nothing to Disclose  
Dirk Blondin, MD, Duesseldorf, Germany (*Abstract Co-Author*) Nothing to Disclose  
Gerald Antoch, MD, Duesseldorf, Germany (*Abstract Co-Author*) Nothing to Disclose  
Andreas Hiester, Dusseldorf, Germany (*Abstract Co-Author*) Nothing to Disclose  
Robert Rabenalt, Duesseldorf, Germany (*Abstract Co-Author*) Nothing to Disclose  
Peter Albers, MD, PhD, Duesseldorf, Germany (*Abstract Co-Author*) Nothing to Disclose

## PURPOSE

This study evaluates the efficiency and potential benefit of taking two biopsy cores per MRI lesion when performing targeted MR-guided prostate biopsy.

## METHOD AND MATERIALS

1545 biopsy cores of 774 intraprostatic lesions (two cores per lesion) in 290 patients (66.2 $\pm$ 7.8 years; median PSA 8.2 ng/ml; IQR 6.0-12.0 ng/ml) were retrospectively evaluated regarding PCa detection, Gleason score, and tumor infiltration of the first (FBC) compared to the second biopsy core (SBC). All patients received previously a multiparametric (mp)-MRI (T2WI, DWI, DCE) of the prostate at 3T and all lesions were histologically verified by MR-guided in-bore biopsy.

## RESULTS

491 biopsy cores were prostate cancer (PCa) positive, 239 of 774 (30.9%) FBC and 252 of 771 (32.7%) SBC ( $p=0.446$ ). 61 FBC vs. 78 SBC detected significant PCa with a Gleason score  $\geq 4+3=7$  (25.5% vs. 31.0%;  $p=0.125$ ). 687 SBC (89.1%) showed no histologic difference to the FBC. 74 SBC resulted in a higher tumor involvement per core when detecting the same Gleason score (38.1%). In total 29.9% of the PCa lesions were Gleason-upgraded by SBC. 40 SBC detected PCA by negative FBC (5.2%). 43 SBC resulted in a Gleason upgrade (5.6%). 20 SBC showed a Gleason upgrade from a Gleason score 3+3=6 to  $\geq 3+4=7$  (2.6%) and 4 SBC to a Gleason score  $\geq 4+3=7$  (0.5%). 14 SBC showed a Gleason upgrade from 3+4=7 to  $\geq 4+3=7$  (1.8%).

## CONCLUSION

The benefit of a second targeted biopsy core per suspicious MRI lesion is likely minor, especially regarding a significant Gleason upgrade. Therefore a further reduction of biopsy cores is feasible when performing a targeted MR-guided in-bore prostate biopsy.

## CLINICAL RELEVANCE/APPLICATION

Provided a correct biopsy position was documented a second biopsy core per MRI lesion may be omitted for targeted MR-guided in-bore biopsy.

### SSJ10-04 Prostate Cancer Aggressiveness: Correlation Between Multiparametric MRI and Molecular Staging Using the CCP Score (Prolaris™ test)

Tuesday, Dec. 1 3:30PM - 3:40PM Location: E353C

#### Participants

Raphael M. Renard-Penna, Paris, France (*Presenter*) Nothing to Disclose  
Geraldine Cancel-Tassin, Paris, France (*Abstract Co-Author*) Nothing to Disclose

Eva M. Comperat, MD, Paris, France (*Abstract Co-Author*) Nothing to Disclose  
Justine Varinot, Paris, France (*Abstract Co-Author*) Nothing to Disclose  
Pierre Mozer, MD, PhD, Paris, France (*Abstract Co-Author*) Nothing to Disclose  
Morgan Roupert, Paris, France (*Abstract Co-Author*) Nothing to Disclose  
Marc O. Bitker, Paris, France (*Abstract Co-Author*) Nothing to Disclose  
Olivier Lucidarme, MD, Paris, France (*Abstract Co-Author*) Consultant, Bracco Group Consultant, F. Hoffmann-La Roche Ltd  
Consultant, Boehringer Ingelheim GmbH  
Olivier Cussenot, Paris, France (*Abstract Co-Author*) Nothing to Disclose

## PURPOSE

To correlate the ESUR-PI-RADS components as prognostic imaging biomarkers in localized prostate cancer to the Gleason score and the molecular CCP score (Prolaris™) .

## METHOD AND MATERIALS

107 patients who had a multiparametric (mp) MRI before (RP) were selected. The largest lesion (index lesion) was measured on T2-MRI (Fig 1A) and ADC map and was classified with the ESUR-PI-RADS scoring system. A region of interest (ROI) was drawn in the center of each target, on the ADC map . A single ADC ROI was correlated to histologically index proven lesion. The index lesions pointed out by mp MRI were matched on RP specimens and were run in Myriad's Research Laboratory in accordance with the Prolaris™ protocol in order to perform CCP score

## RESULTS

For each index lesion the Pearson's correlations between, pretherapeutic CAPRA score, components of the ESUR-PI-RADS score, including the maximal diameter (Tmax) and the topography of the index tumor were compared with the histo-pathological observations on the RP specimen.ESUR-PI RADS score and its components were tested with logistic regression model in order to assess their predictive value for Gleason's grade 4, CCP score value on the index lesion.On one hand, significant negative correlation was found between mean ADCs and diameter of the index lesion with Gleason's grade 4 (  $p=0.0078$ ). The logistic regression model including Tmax (over 10mm) and ADC (under 800) predict with confidence Gleason's grade 4 in the index lesion (Fig 3). On the other hand, The Tmax or ADC size of the index lesion, remains unable to point out the aggressiveness of 7 tumours defined by CCP score. Among those, six were Gleason 6 (3+3) with a median Tmax of 8mm, and one of 8 mm was Gleason 7(3+4)

## CONCLUSION

By mapping image features to gene expression data we were able to show that diffusion imaging and tumor size offer a potential for in vivo non invasive assessment of prognostic cancer aggressiveness.However CCP score related to high risk of lethal cancer did not, completely match with the mpMRI tumour map and Gleason score in 7% of patients. These results previously suggested by large scale genomic analysis suggest that the further management of early stages PCa could strongly benefited of targeted biopsy with molecular analysis

## CLINICAL RELEVANCE/APPLICATION

This radio genomic correlation suggest that management of PCa could strongly benefit from both MRI targeted biopsy and subsequent molecular analysis.

## SSJ10-05 Multi-parametric MRI (MpMRI) Findings after Focal Laser Ablation for Prostate Cancer (Pca)

Tuesday, Dec. 1 3:40PM - 3:50PM Location: E353C

### Participants

Aytekin Oto, MD, Chicago, IL (*Presenter*) Research Grant, Koninklijke Philips NV; ; ;  
Shiyang Wang, PhD, Chicago, IL (*Abstract Co-Author*) Nothing to Disclose  
Xiaobing Fan, PhD, Chicago, IL (*Abstract Co-Author*) Nothing to Disclose  
Stephen Thomas, MD, Chicago, IL (*Abstract Co-Author*) Nothing to Disclose  
Ambereen Yousuf, MBBS, Chicago, IL (*Abstract Co-Author*) Nothing to Disclose  
Gregory S. Karczmar, PhD, Chicago, IL (*Abstract Co-Author*) Nothing to Disclose  
Tatjana Antic, Chicago, IL (*Abstract Co-Author*) Nothing to Disclose  
Scott Eggener, Chicago, IL (*Abstract Co-Author*) Research Grant, Visualase, Inc Speakers Bureau, Johnson & Johnson

## PURPOSE

To describe the quantitative and qualitative MpMRI findings following focal laser ablation of Pca

## METHOD AND MATERIALS

27 patients with 36 cancer foci on baseline MRI, underwent MRI guided focal laser ablation were prospectively followed with, immediate (36/36 sites), 3-month (36/36 sites) and 12-month (24/36 sites) post-procedure 3T MpMRI and TRUS guided biopsy at 12 months. Qualitative and quantitative MpMRI findings including size and appearance of ablation defect, ADC, K(trans) and Ve were recorded and compared between the follow-up studies and between patients with and without residual disease.

## RESULTS

36 cancer foci were ablated in 27 patients. Ablation defect was clearly visible on 36/36, 11/36 and 0/24 sites on the immediate, 3-month and 12-month post-contrast DCE-MR images respectively, with a gradual decrease in size on 3 month MRI even in visible cases. Focal atrophy/scarring was noted at the site of ablation in 10/36 and 20/24 sites on 3-month and 12-month MRI. Mean K(trans) values were significantly lower on post-procedure MRI's compared to baseline values ( $p<0.05$ ). Mean ADC values on 3-month MRI were significantly higher than the baseline ADC values ( $p<0.05$ ). There was not significant change in Ve ( $p>0.05$ ). In 2/4 cases with residual cancer, focal early enhancement was noted on 12-month DCE-MR Images. Other than 1 case with residual cancer, no focal lesion (other than diffuse and ill-defined changes secondary to ablation) was noted at the ablation site on 12-month T2 and ADC images.

## CONCLUSION

Immediate post-contrast MR images are helpful for identification of the ablation defect. Quantitative MR parameters such as ADC and K (trans) change significantly following ablation. Early focal enhancement on DCE-MR Images at the ablation zone at 12-month

MRI is a suspicious finding for residual tumor.

#### CLINICAL RELEVANCE/APPLICATION

Follow-up MR images can be obtained at 12 months after laser ablation and early focal enhancement at the ablation zone can be considered suspicious for residual cancer.

#### Honored Educators

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

Aytekin Oto, MD - 2013 Honored Educator

#### SSJ10-06 Primary and Secondary Prostate Biopsy Settings: Differences When Performing Targeted MR-guided Biopsies

Tuesday, Dec. 1 3:50PM - 4:00PM Location: E353C

#### Participants

Frederic Dietzel, Dusseldorf, Germany (*Presenter*) Nothing to Disclose  
Lars Schimmoeller, MD, Dusseldorf, Germany (*Abstract Co-Author*) Nothing to Disclose  
Michael Quentin, MD, Dusseldorf, Germany (*Abstract Co-Author*) Nothing to Disclose  
Dirk Blondin, MD, Dusseldorf, Germany (*Abstract Co-Author*) Nothing to Disclose  
Christian Arsov, MD, Dusseldorf, Germany (*Abstract Co-Author*) Nothing to Disclose  
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Peter Albers, MD, PhD, Dusseldorf, Germany (*Abstract Co-Author*) Nothing to Disclose

#### PURPOSE

This study evaluates the MR-guided in-bore biopsy (IB-GB) in patients, who were either biopsy naive (primary biopsy) or who had undergone at least one previous negative trans-rectal ultrasound-guided biopsy (secondary biopsy) with regard to cancer detection rate, tumor localization and lesion size.

#### METHOD AND MATERIALS

In total, 1,602 biopsy cores from 297 patients (66.1±7.8y; median PSA 8.2ng/ml; prostate volume 58±30ml) in primary (n=160) and secondary (n=137) prostate biopsies settings were evaluated in this retrospective study. All patients received diagnostic prostate MRI (T2WI, DWI, DCE) at 3T. All lesions described on MRI were biopsied with IB-GB and examined histologically.

#### RESULTS

In 148 patients 511 cores were positive for prostate cancer (PCa). Clinically significant PCa was found in 82.4% (any Gleason pattern ≥4). PCa detection rate for patients with primary biopsies was 55.6% and 43.1% for secondary biopsies. In patients with primary vs. secondary biopsies, PCa was located peripherally in 62.5% vs. 49.5% (p=0.04), in the transition zone in 27.3% vs. 27.5% (p=0.53), and in the anterior stroma in 10.2% vs. 22.9% (p<0.01). Higher grade PCa (Gleason score ≥4+3=7) occurred apically in 38.5% (p=0.01). PCa detection rates for patients with smaller prostate volumes (<30ml vs. 30-50ml vs. >50ml; p<0.01) or larger lesion sizes (>0.5cm<sup>3</sup> vs. 0.5-0.25cm<sup>3</sup> vs. <0.25cm<sup>3</sup>; p<0.01) were significantly higher.

#### CONCLUSION

In primary and secondary prostate biopsies PCa detection rates were significantly higher for larger lesions and smaller prostate glands. In secondary biopsies, PCa was anteriorly located at a significantly more frequent rate. Higher grade PCa was detected in both settings in an apical location more often.

#### CLINICAL RELEVANCE/APPLICATION

MRI-guided in-bore biopsy led to high detection rates, especially of clinically significant PCa, in primary and secondary prostate biopsies.

## Musculoskeletal (Quantitative MR Applications)

Tuesday, Dec. 1 3:00PM - 4:00PM Location: E451A

**MK** **BQ** **MR**

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

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

### Participants

Martin Torriani, MD, Boston, MA (*Moderator*) Nothing to Disclose  
Gregory Chang, MD, New York, NY (*Moderator*) Speaker, Siemens AG

### Sub-Events

#### SSJ15-01 Quantitative MRI Perfusion Analysis of Osteoid Osteomas Pre- and Post Microwave Ablation using an Open Source Software Tool (UMMPerfusion)

Tuesday, Dec. 1 3:00PM - 3:10PM Location: E451A

### Participants

Michael Kostrzewa, MD, Mannheim, Germany (*Presenter*) Nothing to Disclose  
Patricius Diezler, MD, Mannheim, Germany (*Abstract Co-Author*) Nothing to Disclose  
Thomas Henzler, MD, Mannheim, Germany (*Abstract Co-Author*) Nothing to Disclose  
Nils Rathmann, MD, Mannheim, Germany (*Abstract Co-Author*) Nothing to Disclose  
Stefan O. Schoenberg, MD, PhD, Mannheim, Germany (*Abstract Co-Author*) Institutional research agreement, Siemens AG  
Steffen J. Diehl, MD, Mannheim, Germany (*Abstract Co-Author*) Nothing to Disclose

### PURPOSE

To quantitatively evaluate blood perfusion of osteoid osteomas prior and after percutaneous microwave (MW) ablation in time-resolved imaging with stochastic trajectories (TWIST) MRI sequences using an open source software tool.

### METHOD AND MATERIALS

In 17 patients (11 males, 6 females, mean age 26y) with osteoid osteomas percutaneous, CT guided, MW ablation was performed (Medwaves, San Diego, California, USA). Lesions measured on average  $5 \pm 2$  mm in diameter. Lesion diameter dependent MW ablation parameters were: 16 Watts, 915MHz, 80°C for 45 to 160 seconds. Prior to and after MW ablation 3D dynamic contrast enhanced MRI imaging was performed with 3D TWIST gradient echo sequences (Siemens Healthcare). Mean plasma flow (PF, ml/100ml/min), mean volume of distribution (VD, ml/100ml) and mean transit time (MTT, sec) were measured within the lesion in the pre and post MW ablation MRI TWIST data using an open source software tool for quantitative MRI perfusion analysis (UMMPerfusion, OpossUMM, Germany).

### RESULTS

16 patients were free of symptoms within one week after treatment, one patient had decreased but persisting symptoms after MW ablation. No minor or major adverse events were observed according to SIR criteria. Mean PF, VD and MTT were  $253 \pm 226$  ml/100ml/min,  $63 \pm 60$  ml/100ml and  $17 \pm 7$  sec prior to ablation and  $55 \pm 64$  ml/100ml/min,  $23 \pm 39$  ml/100ml and  $17 \pm 12$  sec after ablation respectively. In a paired t-test there was no statistically significant change in MTT prior to and after ablation ( $p > 0.05$ ), whereas PF ( $p = 0.002$ ) and VD ( $p = 0.02$ ) decreased significantly. In the patient with persisting symptoms continuously high values for PF (229 ml/100ml/min) and VD (118 ml/100ml) were found in the MRI after MW ablation in a small portion of the lesion, this was attributed to imprecise needle placement and to too short ablation time.

### CONCLUSION

Treatment success of percutaneous MW ablation of osteoid osteomas can be reliably quantified by MRI perfusion analysis, especially by evaluating pre and post procedural PF and VD within the lesion. MRI perfusion analysis helps to identify small remnants of perfused osteoid osteoma tissue after MW ablation.

### CLINICAL RELEVANCE/APPLICATION

Quantitative MRI perfusion analysis is clinically valuable in the evaluation of treatment success of percutaneous MW ablation for osteoid osteomas.

#### SSJ15-02 A Phase I Study to Assess the Feasibility of Quantitative Molecular Imaging of ACL Grafts

Tuesday, Dec. 1 3:10PM - 3:20PM Location: E451A

### Participants

Katherine Binzel, PhD, Columbus, OH (*Presenter*) Nothing to Disclose  
Robert Magnussen, Columbus, OH (*Abstract Co-Author*) Nothing to Disclose  
Wenbo Wei, Columbus, OH (*Abstract Co-Author*) Nothing to Disclose  
Melanie U. Knopp, Malibu, CA (*Abstract Co-Author*) Nothing to Disclose  
David Flanigan, MD, Columbus, OH (*Abstract Co-Author*) Consultant, Vericel; Consultant, Smith & Nephew plc  
Michael V. Knopp, MD, PhD, Columbus, OH (*Abstract Co-Author*) Nothing to Disclose  
Christopher C. Kaeding, MD, Columbus, OH (*Abstract Co-Author*) Consultant, Biomet, Inc

### PURPOSE

Injury to the anterior cruciate ligament (ACL) commonly requires reconstruction with a graft to restore stability and function. The rate at which graft ligamentization occurs is not well delineated by magnetic resonance imaging (MRI). This initial study aims to



demonstrate the feasibility of combined MRI with dynamic positron emission tomography (PET) in order to evaluate the graft healing process following reconstructive surgery.

#### **METHOD AND MATERIALS**

MRI was performed on a 3T Achieva on 20 patients post-ACL reconstruction. Dynamic PET/CT was acquired on a Gemini TF 64 and/or new digital detector PET/CT system, Vereos TF (all Philips Healthcare, Cleveland, OH). An in-house fabricated cushion was used to match positioning during PET acquisitions to that of the dedicated MRI knee coil. A single bed position centered on the knees was acquired continuously for 75 minutes using an ultra-low dose 3 mCi 18F-fluorodeoxyglucose (FDG) protocol. Patients were grouped according to time since surgery, 0-6 months, 6-12 months, 12-24 months, and 24 months or greater. Standardized uptake values (SUVmax) were measured for regions of interest placed over the proximal, middle, and distal portions of the graft, the femoral and tibial tunnels, the posterior cruciate ligament (PCL), and quadriceps muscle for reference. Matched ROIs were drawn in the contralateral knee.

#### **RESULTS**

Dynamic PET images were readily co-registered to MRI for all patients. In the 0-6 month group, the average slope of the metabolic uptake curve was 0.20 in the distal graft, 0.21 in the mid graft, 0.27 in the proximal graft, and 0.28 in the femoral tunnel. In the 24+ month group the averages were 0.06, 0.05, 0.07, and 0.03, respectively. In addition to decreasing slopes of the uptake curves over time, patients with longer recovery times were seen to have SUVs more comparable to those in healthy knees than those who more recently had ACL repair.

#### **CONCLUSION**

We demonstrated that the quantitative evaluation of ACL graft ligamentization and healing is feasible by molecular PET imaging co-registered to MRI. Digital PET appears to enable further FDG dose reduction making a combined molecular imaging PET/MRI approach to assess ACL graft viability clinically feasible.

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

A first-in-human study evaluating ACL graft healing with quantitative molecular imaging using combined PET/MRI

#### **SSJ15-03 MRI Defined Ecologic Habitats in Extremity Soft Tissue Sarcomas: Characterization and Quantification of Tumor Heterogeneity and Potential Implications on Patient Outcomes-Early Experience**

Tuesday, Dec. 1 3:20PM - 3:30PM Location: E451A

##### **Participants**

Meera Raghavan, MD, Tampa, FL (*Presenter*) Nothing to Disclose  
Hamidreza Farhizadeh, Tampa, FL (*Abstract Co-Author*) Nothing to Disclose  
Lawrence O. Hall, PhD, Tampa, FL (*Abstract Co-Author*) Nothing to Disclose  
Dmitry Goldgof, PhD, Tampa, FL (*Abstract Co-Author*) Nothing to Disclose  
Robert J. Gillies, PhD, Tampa, FL (*Abstract Co-Author*) Nothing to Disclose  
Robert A. Gatenby, MD, Tucson, AZ (*Abstract Co-Author*) Nothing to Disclose

#### **PURPOSE**

We propose a novel computer-aided, spatially-explicit image analysis of magnetic resonance (MR) examinations to classify extremity STS based on radiologically defined spatial sub-regions, or "habitats." The identification of spatially distinct habitats can quantify and characterize the ecologic basis of intratumoral heterogeneity and may be helpful to guide targeted biopsy, tailor therapeutic options and offer prognostic information.

#### **METHOD AND MATERIALS**

T1-w gadolinium enhanced and fluid-sensitive MR images were assessed from pretreatment scans of 36 patients with extremity STS. There were three main steps: tumor segmentation based on pixel signal intensity; pixel and texture analysis within each distinctive habitat; and prediction of metastatic disease and histologic therapy response. Patient outcomes such as progression free survival (PFS), overall survival (OS), and presence of metastases were also assessed.

#### **RESULTS**

Habitat color maps (HCM) demonstrated spatially distinct intratumoral subregions (Fig. 1). Metastatic disease was classified correctly with 86.11% accuracy based on five texture features, and histologic necrosis with 75.75% accuracy based on four features. Specific subregions were also predictive for metastatic disease and histologic response to therapy. The post contrast T1 high/T2 low subregion was prognostic for overall survival ( $p=0.036$ ).

#### **CONCLUSION**

This technique can define distinct habitats within each STS based on MR imaging features and allows spatial variations to be assessed and quantified. We demonstrate the role of advanced clinical image analysis in providing critical insight into the evolutionary and ecologic landscape of STS. The preliminary results presented here show that distinct intratumoral subregions or habitats within STS can be identified and quantified and give useful clinical and prognostic information which can shape personalized and adaptive therapeutic regimens.

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

Change in size alone does not accurately reflect response to therapy and tumor biology of STS. We have developed an image analysis technique to non-invasively characterize and quantify tumor subregions on MR imaging. The identification of these radiologically defined habitats can give insight into the evolutionary and ecologic dynamics which are the basis of heterogeneity in STS. This can in turn offer more tailored personalized treatments to patients.

#### **SSJ15-04 Quantitative Magnetic Resonance Imaging of Meniscal Pathology**

Tuesday, Dec. 1 3:30PM - 3:40PM Location: E451A

##### **Participants**



Anthony S. Tadros, MD, San Diego, CA (*Presenter*) Nothing to Disclose  
Sheronda Statum, San Diego, CA (*Abstract Co-Author*) Nothing to Disclose  
Karen C. Chen, MD, San Diego, CA (*Abstract Co-Author*) Nothing to Disclose  
Won C. Bae, PhD, San Diego, CA (*Abstract Co-Author*) Nothing to Disclose  
Reni Biswas, San Diego, CA (*Abstract Co-Author*) Nothing to Disclose  
Betty Tran, San Diego, CA (*Abstract Co-Author*) Nothing to Disclose  
Jiang Du, PhD, San Diego, CA (*Abstract Co-Author*) Nothing to Disclose  
Eric Y. Chang, MD, San Diego, CA (*Abstract Co-Author*) Nothing to Disclose  
Christine B. Chung, MD, San Diego, CA (*Abstract Co-Author*) Nothing to Disclose

#### PURPOSE

To determine the capability of conventional and UTE quantitative MR values to detect meniscal pathology in cadaveric meniscal samples.

#### CLINICAL RELEVANCE/APPLICATION

Quantitative MR values may correlate with structural and biochemical meniscal alterations, complementing currently limited techniques in early diagnosis and postoperative evaluation of the meniscus.

#### SSJ15-05 Correlation of Age Dependent Whole Body Fat and Whole Body Skeletal Muscle Volume on DIXON MR Sequences in a Healthy Population with Normal BMI

Tuesday, Dec. 1 3:40PM - 3:50PM Location: E451A

#### Participants

Erika J. Ulbrich, MD, Zurich, Switzerland (*Presenter*) Nothing to Disclose  
Daniel Nanz, PhD, Zurich, Switzerland (*Abstract Co-Author*) Nothing to Disclose  
Olof Dahlqvist Leinhard, PhD, Linköping, Sweden (*Abstract Co-Author*) Consultant, AMRA AB  
Magda Marcon, MD, Udine, Italy (*Abstract Co-Author*) Nothing to Disclose  
Michael A. Fischer, MD, Stockholm, Sweden (*Abstract Co-Author*) Nothing to Disclose

#### PURPOSE

To test a correlation of age- and gender-dependent reference standards of MR normative values of total adipose tissue (TAT), abdominal subcutaneous adipose tissue (ASAT) with the corresponding lean muscle tissue (LMT).

#### METHOD AND MATERIALS

Fat and water MR whole body images were acquired with a 2-point mDIXON sequence (Repetition time/echo time, 4,2 msec/1.2 msec, 3.1 msec) at 3 Tesla (Ingenia, Philips) in 80 healthy volunteers with normal BMI (18.5 to 25.5 kg/m<sup>2</sup>) aged between 20 and 60 years (10 men/10 women per decade). Volumes were measured from TAT, ASAT and LMT by a semi-automatic segmentation algorithm allowing separate quantification of each compartment (Advanced MR Analytics, AMRA, Linköping, Sweden). Pearson and Spearman correlations between Volume and several body measures were calculated. ANOVA was used to test for Volume differences among age subgroups. Prospective IRB approved study with written informed consent.

#### RESULTS

Overall mean Volume (liter)  $\pm$  standard deviation for women/men: 20.8 $\pm$ 5.2/19.5 $\pm$ 6.3 (TAT) and 15.7 $\pm$ 2.2/23.2 $\pm$ 2.3 (LMT). TAT/height<sup>2</sup> and LMT/height<sup>2</sup> didn't show any age dependency for women/men ( $p = 0.973/0.557$  and  $p = 0.483/0.539$ , respectively) nor TAT/height<sup>2</sup> and LMT/height<sup>2</sup> differences among age subgroups for both gender. There was significant correlation between TAT/height<sup>2</sup> and body mass index (BMI) for women/men ( $p < 0.001$  both), but not between LMT/height<sup>2</sup> and BMI ( $p = 0.276/0.634$ ). LMT/height<sup>2</sup> correlated with TAT/height<sup>2</sup> ( $p = 0.038/0.005$ ) and ASAT/height<sup>2</sup> ( $p = 0.011/0.002$ ), but not with VAT/height<sup>2</sup> ( $p = 0.205/0.252$ ).

#### CONCLUSION

Women had higher TAT and lower LMT than men, but without significant age dependence. LMT/height<sup>2</sup> correlated with TAT/height<sup>2</sup> and ASAT/height<sup>2</sup>, but not with BMI.

#### CLINICAL RELEVANCE/APPLICATION

Normative values of LMT allow to determine muscular trophic in patients and might help to diagnose myopathy. Side Note for reviewer only please: Volunteers of this abstract are identical to Abstract number 15013444, but as the topic of fat quantification is very complex, we decided to put the data in two abstracts with the first dealing with the age dependent different fat volumes and the second abstract dealing with the correlation of the skeletal muscle volumes and the different fat volumes

#### SSJ15-06 Effect of Iterative Reconstruction Algorithms on Measurement of Trabecular Bone Microstructure with Clinical MDCT: A Cadaver Study Using Micro-CT as the Reference Standard

Tuesday, Dec. 1 3:50PM - 4:00PM Location: E451A

#### Participants

Miyuki Takasu, MD, Hiroshima, Japan (*Presenter*) Nothing to Disclose  
Chikako Fujioka, RT, Hiroshima, Japan (*Abstract Co-Author*) Nothing to Disclose  
Masao Kiguchi, RT, Hiroshima, Japan (*Abstract Co-Author*) Nothing to Disclose  
Chihiro Tani, MD, Hiroshima, Japan (*Abstract Co-Author*) Nothing to Disclose  
Yoko Kaichi, Hiroshima, Japan (*Abstract Co-Author*) Nothing to Disclose  
Kazuo Awai, MD, Hiroshima, Japan (*Abstract Co-Author*) Research Grant, Toshiba Corporation; Research Grant, Hitachi, Ltd; Research Grant, Bayer AG; Research Grant, DAIICHI SANKYO Group; Medical Advisor, DAIICHI SANKYO Group; Research Grant, Eisai Co, Ltd; Research Grant, Nemoto-Kyourindo; ; ; ;  
Nobuhito Nango, Tokyo, Japan (*Abstract Co-Author*) Nothing to Disclose  
Masafumi Machida, Musashimurayamashi, Japan (*Abstract Co-Author*) Nothing to Disclose

#### PURPOSE

Clinical multidetector computed tomography (MDCT) has been used to evaluate bone quality. The purpose of this study was to determine the efficacy of iterative reconstruction (IR) for measuring bone architecture through a comparison with micro-computed tomography (micro-CT) as the gold standard.

## **METHOD AND MATERIALS**

L1 and L2 vertebrae of 10 fresh human cadavers were scanned by 64-section MDCT (LightSpeed VCT; reconstruction kernel, BONEPLUS; IR, ASiR; collimation, 64×0.625 mm), 80-section MDCT (Aquilion One Vision Edition; FC30, ADIR3D, 80×0.5 mm), and micro-CT (TOSCANER). Reconstructed voxel sizes were 0.2 × 0.2 × 0.16 mm for MDCT and 0.052 × 0.052 × 0.072 mm for micro-CT. Images were reconstructed using standard filtered back-projection and IR algorithms. Four patterns of CT images were reconstructed: without IR (IR (0%)), with 25-30% of IR (weak), with 50% of IR (mild), and with high-dose protocol without IR (120kV and 250mAs, HD). Trabecular parameters and tissue bone mineral density (tBMD) of the central 10-mm-thick portion of the vertebrae were calculated. Relationships between MDCT- and micro-CT-derived trabecular indices were compared using Pearson's correlation coefficient.

## **RESULTS**

Metric parameters and tBMD measured by 64-section MDCT correlated better with micro-CT values with IR (mild) ( $r=0.611-0.948$ ) than with IR (0%) ( $r=0.703-0.945$ ). The correlation coefficients were significantly different ( $p<0.05$ ). Non-metric parameters showed better correlations with micro-CT values with IR (0%) ( $r=0.712-0.883$ ) than by IR (30% and 50%) ( $r=0.694-0.871$ ). For 80-section MDCT, five of seven morphological parameters and tBMD correlated better with micro-CT values with IR (0%) ( $r=0.698-0.914$ ) than with IR (25% and 50%) ( $r=0.663-0.888$ ,  $p<0.05$ ). For three of eight parameters by 64-section MDCT and six out of eight parameters with 80-section MDCT, the correlation coefficients were lowest with the HD protocol.

## **CONCLUSION**

IR improved the correlation between 64-section MDCT and micro-CT-derived metric parameters. In the assessment of trabecular microstructure, IR algorithms showed different strengths according to the vendor and category of trabecular parameters.

## **CLINICAL RELEVANCE/APPLICATION**

To ensure the accurate measurement of trabecular bone microstructure by clinical MDCT, it is important to select the appropriate reconstruction algorithm and imaging protocol.

## Molecular Imaging (Prostate/Neuroendocrine Tumors)

Tuesday, Dec. 1 3:00PM - 4:00PM Location: S504CD

**GU BQ MI MR**

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

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

### Participants

Peter L. Choyke, MD, Rockville, MD (*Moderator*) Researcher, Koninklijke Philips NV Researcher, General Electric Company Researcher, Siemens AG Researcher, iCAD, Inc Researcher, Aspyrian Therapeutics, Inc Researcher, ImaginAb, Inc Researcher, Aura Biosciences, Inc  
Vikas Kundra, MD, PhD, Houston, TX (*Moderator*) License agreement, Introgen Therapeutics, Inc

### Sub-Events

#### SSJ14-01 Promising Role of Ga-68 PSMA PET/CT over Conventional Imaging in Staging and Restaging of Carcinoma Prostate

Tuesday, Dec. 1 3:00PM - 3:10PM Location: S504CD

### Participants

Venkatesh Rangarajan, MBBS, Mumbai, India (*Presenter*) Nothing to Disclose  
Archi Agrawal, MBBS, Mumbai, India (*Abstract Co-Author*) Nothing to Disclose  
Rasika Kabnurkar, MBBS, Mumbai, India (*Abstract Co-Author*) Nothing to Disclose  
Nilendu C. Purandare, DMRD, Mumbai, India (*Abstract Co-Author*) Nothing to Disclose  
Sneha A. Shah, Mumbai, India (*Abstract Co-Author*) Nothing to Disclose

### PURPOSE

1) To study the utility of Ga-68 Prostate Specific Membrane Antigen (PSMA) Positron Emission Tomography/Computed Tomography (PET/CT) for staging and restaging of Carcinoma Prostate (CaP). 2) To compare the efficacy of Ga-68 PSMA PET/CT with Contrast Enhanced Computed Tomography (CECT) and F18 Sodium Fluoride (NaF) PET/CT for lesion detection

### METHOD AND MATERIALS

Retrospective audit of prospectively maintained data of 25 patients of CaP (3 for staging and 22 with biochemical failure for restaging) who underwent Ga-68 PSMA PET/CT, CECT and F18 NaF PET/CT scan. The imaging findings were analyzed on lesion-lesion and patient-patient basis for concordance and discordance.

### RESULTS

All the 3 cases imaged for staging evaluation demonstrated Ga-68 PSMA uptake at the site of primary while CECT demonstrated lesion in only 1 patient. In cases with suspected biochemical failure, local recurrence was detected in 59% (13/22) patients on Ga-68 PSMA PET/CT as against 9 % (2/22) detected on CECT. In 25 patients studied, Ga-68 PSMA PET/CT detected 43 metastatic nodes compared to 29 detected on CECT. Ga-68 PSMA detected additional metastases in sub cm sized nodes in 24% (6/25) patients. Ga-68 PSMA had incremental value in detecting occult extranodal metastases involving urinary bladder, pararectal nodule and peritoneal deposit in 8% (2/25) patients. In 25 patients, 109 skeletal lesions were detected on Ga-68 PSMA while F18 NaF PET/CT demonstrated 147 lesions. Concordance in imaging findings of Ga-68 PSMA PET/CT and F 18 Fluoride PET/CT was noted in 68% (17/25) patients. Ga-68 PSMA PET/CT had an incremental value in staging of 1 patient where it detected lytic and marrow metastases. In restaging group, 7 patients showed additional lesions on F18 NaF PET/CT.

### CONCLUSION

Ga-68 PSMA PET/CT is superior in detection of primary, nodal and soft tissue metastases as compared to conventional imaging techniques. However, F18 NaF PET/CT appears to detect more skeletal lesions in patients with biochemical failure in our study and further prospective trials are warranted to confirm these findings.

### CLINICAL RELEVANCE/APPLICATION

Ga-68 PSMA PET/CT has an incremental value as a one stop shop in staging and restaging of carcinoma prostate

#### SSJ14-02 18F-fluoro-4-thia-palmitate (18F-FTP) PET Imaging for Evaluation of Exogenous Fatty Acid Metabolism in Prostate Cancer: Implications for Treatment Optimization

Tuesday, Dec. 1 3:10PM - 3:20PM Location: S504CD

### Participants

Pedram Heidari, MD, Boston, MA (*Presenter*) Nothing to Disclose  
Shadi A. Esfahani, MD, MPH, Boston, MA (*Abstract Co-Author*) Nothing to Disclose  
Giorgia Zadra, PhD, Boston, MA (*Abstract Co-Author*) Nothing to Disclose  
Michael S. Placzek, PhD, Charlestown, MA (*Abstract Co-Author*) Nothing to Disclose  
Benjamin Larimer, PhD, Charlestown, MA (*Abstract Co-Author*) Nothing to Disclose  
Jacob M. Hooker, PhD, Charlestown, MA (*Abstract Co-Author*) Nothing to Disclose  
Massimo Loda, MD, Boston, MA (*Abstract Co-Author*) Nothing to Disclose  
Umar Mahmood, MD, PhD, Charlestown, MA (*Abstract Co-Author*) Research Grant, Sabik Medical Inc; Advisory Board, Blue Earth Diagnostics Limited;

### PURPOSE

Upregulation of de novo lipogenesis is a major metabolic change in PCa development, and correlates with tumor progression and poor prognosis. Differentiation of diet-derived versus de novo fatty acid (FA) utilization in PCa is essential in designing anti-lipogenic therapeutics. We aim to evaluate the use of 18F-fluoro-4-thia-palmitate (18F-FTP) PET for assessment of exogenous FA utilization by PCa.

#### METHOD AND MATERIALS

14C incorporation into lipids of LNCaP cells by a glucose donor (marker of de novo lipogenesis) was measured by a beta-counter after treatment with vehicle, IPI-9119, or C75. Growth inhibition rescue of LNCaP cells was performed using Cell Titer Glo assay after incubation with IPI-9119 alone or in the presence of BSA or of BSA-conjugated palmitate. For in-vitro 18F-FTP uptake study LNCaP cells were incubated with IPI-9119, C75, Etomoxir, SSO, DMSO, and combination of IPI-9119 with Etomoxir or C75 for 24 hours. The cells were then incubated with 18F-FTP and harvested to measure retained activity corrected for cell count. IACUC approval was obtained. Mice with subcutaneous LNCaP xenografts were fasted. PET data was acquired in list mode after injection of 18F-FTP. The SUVmean and tracer influx constant were measured.

#### RESULTS

14C incorporation in lipids decreased to approximately 25% of control using both IPI-9119 and C75 indicating FASN inhibition. LNCaP growth inhibition was aborted by BSA-conjugated palmitate. 18F-FTP uptake significantly increased with IPI-9119 treatment, while C75, etomoxir, SSO treatment reduced 18F-FTP uptake. 18F-FTP PET demonstrated significantly decreased uptake in LNCaP tumors following treatment with C75 and etomoxir compared to control (SUVmean=0.20±0.01, 0.25±0.2, and 0.40±0.02, respectively).

#### CONCLUSION

We demonstrated that metabolic imaging using 18F-FTP can be used to assess the exogenous FA utilization by PCa. As expected, IPI-9119 (selective FASN inhibitor) increased the exogenous FA (18F-FTP) uptake while C75, which induces a host of metabolic modulations other than FASN inhibition paradoxically reduces 18F-FTP uptake. Etomoxir (FAO inhibitor) and SSO (FA transporter inhibitor) reduce 18F-FTP uptake as expected.

#### CLINICAL RELEVANCE/APPLICATION

Understanding the effect of exogenous lipid availability on therapeutic potential of targeting de novo lipogenesis is critical in prostate cancer treatment. This could lead to treatment strategies that result in maximal efficacy.

#### SSJ14-03 Feasibility of Hyperpolarized 13C-Pyruvate Magnetic Resonance Spectroscopy for Pancreatic Cancer Diagnostic Imaging

Tuesday, Dec. 1 3:20PM - 3:30PM Location: S504CD

##### Participants

Stephanie K. Carlson, MD, Rochester, MN (*Presenter*) Royalties, Medspira, LLC  
Alan Penheiter, PhD, Rochester, MN (*Abstract Co-Author*) Nothing to Disclose  
Prasanna K. Mishra, PhD, Rochester, MN (*Abstract Co-Author*) Nothing to Disclose  
Fergus J. Couch, PhD, Rochester, MN (*Abstract Co-Author*) Nothing to Disclose  
Slobodan I. Macura, PhD, Rochester, MN (*Abstract Co-Author*) Nothing to Disclose  
John D. Port, MD, PhD, Rochester, MN (*Abstract Co-Author*) Nothing to Disclose  
Malgorzata Marjanska, PhD, Minneapolis, MN (*Abstract Co-Author*) Nothing to Disclose  
Claire E. Bender, MD, Rochester, MN (*Abstract Co-Author*) Nothing to Disclose

#### PURPOSE

Hyperpolarized (HP) 13C magnetic resonance spectroscopic imaging (MRSI) is a recently developed technique that allows the detection of injected 13C-labeled agents and their metabolites in real-time. The purpose of this study was to identify and explore potential metabolic pathways in pancreatic ductal adenocarcinoma (PDAC) that could be targeted with HP-13C MRSI to increase the diagnostic accuracy of pancreatic cancer imaging.

#### METHOD AND MATERIALS

We performed gene expression profiling using laser capture microdissection and RNAseq on histologically-confirmed primary PDAC tumors and normal pancreas tissue from 21 patients. A promising, highly upregulated and imageable metabolic pathway (the conversion of pyruvate to lactate) was identified. To further explore this pathway in vivo, mice bearing genetically-engineered PDAC tumors were injected with 200 microliters of 80 mM [1-13C]-pyruvate. Tumors were quench-frozen and excised 30 s post-injection. Spectroscopic data on tumor lysates was obtained using 1H and 13C nuclear magnetic resonance. Studies were approved by our IRB and IACUC.

#### RESULTS

Gene expression studies showed that transcripts encoding transporters and enzymes responsible for cellular import of pyruvate, export of lactate, and conversion of pyruvate to lactate are almost universally upregulated in PDAC compared to normal pancreas, while competing pathways of mitochondrial pyruvate metabolism and cytoplasmic pyruvate to alanine conversion are consistently low. NMR analysis of PDAC tumors showed a tumor metabolic signature consistent with a very high lactate concentration and high lactate-to-alanine ratio. Quantitative analysis after injection of [1-13C]-pyruvate showed a 4.8-fold enrichment of intratumoral [1-13C]-lactate over natural abundance, indicating that ~5% of the total lactate in the tumor at 30 s post-injection was derived from the injected [1-13C]-pyruvate.

#### CONCLUSION

PDAC tumors have a pyruvate-lactate metabolic signature that can be quantitated with 13C-pyruvate NMR. Further exploration of HP-13C-pyruvate MRSI for PDAC is warranted.

#### CLINICAL RELEVANCE/APPLICATION

A new molecular imaging strategy for PDAC used in conjunction with existing morphological imaging could transform patient management in clinically-challenging scenarios.

#### SSJ14-04 Evaluation of Fast Non-enhanced PET/MR Examination Protocols in a Fully Integrated PET/MR

## System for Patients with Neuroendocrine Tumours: Direct Comparison to Multiphase Contrast-enhanced PET/CT

Tuesday, Dec. 1 3:30PM - 3:40PM Location: S504CD

### Participants

Ferdinand F. Seith, BSC, Tuebingen, Germany (*Presenter*) Nothing to Disclose  
Christian la Fougere, Munich, Germany (*Abstract Co-Author*) Nothing to Disclose  
Christina Pfannenberger, MD, Tuebingen, Germany (*Abstract Co-Author*) Nothing to Disclose  
Konstantin Nikolaou, MD, Tuebingen, Germany (*Abstract Co-Author*) Speakers Bureau, Siemens AG Speakers Bureau, Bracco Group  
Speakers Bureau, Bayer AG  
Nina Schwenzer, MD, Tuebingen, Germany (*Abstract Co-Author*) Nothing to Disclose  
Cornelia Brendle, MD, Tuebingen, Germany (*Abstract Co-Author*) Nothing to Disclose  
Christina Schraml, MD, Tuebingen, Germany (*Abstract Co-Author*) Nothing to Disclose

### PURPOSE

In patients with neuroendocrine tumours (NET), kidney failure is a common complication of radionuclide therapy. It is known that multiphase contrast-enhanced PET/CT is superior to non-enhanced PET/CT in diagnosing metastases with low or no tracer uptake as well as small lesions especially in the liver. However, due to the superior soft tissue contrast of MRI it is possible that non-enhanced PET/MR offers the same information as contrast-enhanced PET/CT. The aim of the study was therefore to evaluate a fast protocol in PET/MR without contrast agent in direct comparison to multiphase contrast-enhanced PET/CT as gold standard.

### METHOD AND MATERIALS

39 Patients (22 female, 58±13 years) were examined in multiphase contrast-enhanced 68Ga-DOMITATE-PET/CT in a clinical setup and in PET/MR subsequently. 2 blinded readers investigated PET/MR examinations of the abdomen with 3 different setups: T2HASTE+PET (30min), T2HASTE+TSET2+PET (35min) and T2HASTE+TSET2+DWI+PET (35min). The T2HASTE was acquired under free breathing with continuous table move. DWI was acquired with two b-values (0, 800 s/mm<sup>2</sup>). Metastatic lesions were defined as functional and/or morphological suspicious lesions or lymph nodes. The results were compared with the contrast-enhanced PET/CT, follow-up examinations and histopathology, if available.

### RESULTS

T2HASTE sequences were of diagnostic quality in all patients. DWI suffered from artefacts especially in the upper regions of the liver. Compared with contrast-enhanced PET/CT high agreement was found with T2HASTE+TSET2+DWI+PET.

### CONCLUSION

A protocol for PET/MR including T2HASTE, TSET2, DWI and PET seems to provide comparable results compared with multiphase contrast-enhanced PET/CT. With an estimated time of 35 min for a whole body examination, this might serve as a legitimate alternative to contrast-enhanced PET/CT for patients with kidney failure in the future.

### CLINICAL RELEVANCE/APPLICATION

In patients with neuroendocrine tumours (NET) and kidney failure, fast non-enhanced PET/MR protocols can serve as a legitimate alternative to multiphase contrast-enhanced PET/CT examinations.

### SSJ14-05 Qualitative and Quantitative Comparison of 68Ga-DOTATATE PET/CT and PET/ MRI in Neuroendocrine Tumours

Tuesday, Dec. 1 3:40PM - 3:50PM Location: S504CD

### Participants

Francesco Fraioli, MD, London, United Kingdom (*Presenter*) Nothing to Disclose  
Alshaima Alshammari, London, United Kingdom (*Abstract Co-Author*) Nothing to Disclose  
Evangelia Skoura, Athens, Greece (*Abstract Co-Author*) Nothing to Disclose  
Rizwan Syed, MBBS, FRCR, London, United Kingdom (*Abstract Co-Author*) Nothing to Disclose  
Sofia Michopoulou, London, United Kingdom (*Abstract Co-Author*) Nothing to Disclose  
Jamshed Bomanji, London, United Kingdom (*Abstract Co-Author*) Nothing to Disclose  
Ashley M. Groves, MBBS, Hitchin, United Kingdom (*Abstract Co-Author*) Investigator, GlaxoSmithKline plc; Investigator, General Electric Company; Investigator, Siemens AG; ;

### PURPOSE

Many Neuroendocrine tumours (NET) show high somatostatin receptor avidity. The aim of this study is to compare 68Ga-DOTATATE PET/CT with 68Ga-DOTATATE PET/MRI imaging in patients with known NET, and assess the confidence in anatomic lesion detection and localization. Furthermore, the value of each sequence of MRI was separately evaluated.

### METHOD AND MATERIALS

We analysed the data of 38 NET patients. Cross over of both 68Ga-DOTATE PET/CT and PET/MRI scans were performed. MR protocol was as follow: T1 MPR, pre and post gadolinium injection, T2 haste, DW1 (b0, 500, 1000). Two observers for 68Ga-DOTATATE PET/MRI and one observer for 68Ga-DOTATATE PET/CT, independently, reviewed the images and inter observer and inter modality correlation was assessed by using interclass correlation.

### RESULTS

Our initial data showed good inter modality correlation between 68Ga-PET/CT and PET/MRI. All lesions considered as malignant in PET/CT were equally depicted in PET/MRI in the compared regions. Both modalities, revealed liver metastases in the same number of patients (18 patients), and bone metastases in 7 patients. However, counting the number of liver lesions in each patient, 68Ga-DOTATATE PET/MRI was able to recognize more lesions in 3 patients. On the other hand, more lung lesions were detected in the lung in the CT component compared to MRI component (7 lesions versus 4). The contrast and DWI sequence of PET/MRI did not have a significant effect on final outcome, but in a selected number of cases these images confirmed and helped to further characterize and detect more lesions. Inter observer reliability was equally very good in both modalities.

## CONCLUSION

This study demonstrates the potential of 68Ga-DOTATOC PET/MRI in patients with NET, with special advantages in the characterization of liver lesions.

## CLINICAL RELEVANCE/APPLICATION

68Ga-DOTATOC PET/MRI can help in diagnosis and staging of patients with NET, with special advantages in the characterization of liver lesions.

### SSJ14-06 68Ga-DOTATOC Uptake in Somatostatin Expressing Tumors is Directly Related to Specific Activity: Implications for Receptor Quantitation Imaging

Tuesday, Dec. 1 3:50PM - 4:00PM Location: S504CD

#### Participants

Pedram Heidari, MD, Boston, MA (*Presenter*) Nothing to Disclose

Dominik Berzaczy, MD, Vienna, Austria (*Abstract Co-Author*) Nothing to Disclose

Alicia Leece, Boston, MA (*Abstract Co-Author*) Nothing to Disclose

Shadi A. Esfahani, MD, MPH, Boston, MA (*Abstract Co-Author*) Nothing to Disclose

Umar Mahmood, MD, PhD, Charlestown, MA (*Abstract Co-Author*) Research Grant, Sabik Medical Inc; Advisory Board, Blue Earth Diagnostics Limited;

## PURPOSE

The importance of specific activity (SA) has been previously shown in functional PET imaging studies. We hypothesized that tracer uptake, measured using semiquantitative (SUV) or quantitative (Patlak plot) parameters, would vary considerably according to SA in cancer receptor imaging. This study aims to evaluate the effect of SA on PET parameters used for quantitation of 68Ga-DOTATOC uptake in somatostatin receptor (SSTR) tumor models.

## METHOD AND MATERIALS

In-vitro, SSTR2 expression level was assessed using Western blot across multiple cancer lines including IMR32, Capan1, A549 and AR42J, and was normalized for B-actin expression. The SSTR2/B-actin ratio was correlated to in-vitro 68Ga-DOTATOC uptake normalized for cell counts. AR42J and IMR32 normalized 68Ga-DOTATOC uptake was plotted against 68Ga-DOTATOC SA ranging from 0.2 to 20 Ci/g and correlation was assessed. The in-vitro studies were performed in triplicate. For in-vivo studies Institutional Animal Care and Use Committees approval was obtained. Subcutaneous AR42J xenografts were implanted in Nu/Nu mice. Dynamic PET scans in list mode were acquired following injection of 68Ga-DOTATOC with a wide range of SAs (0.3 - 50 Ci/g). Net tracer influx (Ki), SUVmax and SUVmean were plotted against the SA to establish the correlation between quantitative parameters and SA. Patlak-plot was used to calculate the tracer influx constant for the tumor ( $Ki = (k1 \times k3 / k2 + k3)$ ).

## RESULTS

We observed a consistent ratio between 68Ga-DOTATOC uptake per cell and SSTR2/B-actin level across the cell lines ( $R^2=0.95$ ,  $p<0.024$ ). In-vitro we demonstrated a linear correlation between SA and 68Ga-DOTATOC uptake per cell in IMR32 ( $R^2=0.98$ ,  $P<0.015$ ) and AR42J ( $R^2=0.99$ ,  $P<0.005$ ). We found that Ki, SUVmax, and SUVmean decreased in a linear fashion with reduction in SA. Quantitative 68Ga-DOTATOC PET parameters had a direct linear correlation with SA ( $R^2=0.89$ ,  $p<0.0001$  for Ki,  $R^2=0.66$ ,  $p<0.0001$  for SUVmax and  $R^2=0.82$  and  $p<0.0001$  for SUVmean).

## CONCLUSION

68Ga-DOTATOC uptake is strongly correlated to SSTR2 expression for each given SA. However, 68Ga-DOTATOC uptake in SSTR-expressing tumors increases in a linear fashion with increase in SA, over the range studied.

## CLINICAL RELEVANCE/APPLICATION

68Ga-DOTATOC uptake by tumors can vary widely with change in specific activity. Quantitation for radiotherapy dosimetry and response assessment is improved with correction for specific activity.



MSAS34

## Developing the Hybrid Technologist in US and Canada (Sponsored by the Associated Sciences Consortium) (An Interactive Session)

Tuesday, Dec. 1 3:30PM - 5:00PM Location: S105AB

OT

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

### Participants

Lynne Roy, MBA, MS, Los Angeles, CA (*Moderator*) Nothing to Disclose

Steven P. DeColle, Edmonton, AB (*Moderator*) Nothing to Disclose

### LEARNING OBJECTIVES

1) Attendees will learn the additional curriculum that is needed to formally educate technologists who operate hybrid equipment. 2) Attendees will be able to compare educational practices in the United States and in Canada. 3) Attendees will understand the opportunities and challenges that certified technologists face when cross training in different imaging disciplines and will be able to proactively mitigate some of these hurdles.

### ABSTRACT

Imaging technology is evolving faster than we can develop technologists to competently perform molecular and cross sectional imaging. Both Canada and the United States have designed curriculum that address these essential learning modules. These two educational models will be compared, contrasted, and discussed in detail. In addition, the practicing technologist must be given an opportunity to learn this new technology and to safely and effectively operate it to deliver the necessary information so that the patient can reap the benefit of this technology. This path can be challenging but if undertaken in a planned fashion, and using lessons from the field to mitigate hurdles, on the job training can produce very competent, dual licensed and credentialed individuals.

### Sub-Events

#### MSAS34A Educating the Technologist for Future Practice -The United States Perspective

### Participants

David Gilmore, MS, Boston, MA (*Presenter*) Nothing to Disclose

### LEARNING OBJECTIVES

View learning objectives under main course title.

#### MSAS34B Lessons from the Field: Becoming a Hybrid Technologist

### Participants

Mark C. Hyun, ARRT, Los Angeles, CA, (mark.hyun@cshs.org ) (*Presenter*) Technical Consultant, Astellas Group; Speakers Bureau, Astellas Group

### LEARNING OBJECTIVES

View learning objectives under main course title.

### Active Handout: Mark C. Hyun

[http://abstract.rsna.org/uploads/2015/15002395/Active\\_MSAS34B.pdf](http://abstract.rsna.org/uploads/2015/15002395/Active_MSAS34B.pdf)

MSCC34

## Case-based Review of Nuclear Medicine: PET/CT Workshop-Lymphoma/Melanoma/Sarcoma (In Conjunction with SNMMI) (An Interactive Session)

Tuesday, Dec. 1 3:30PM - 5:00PM Location: S406A



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

### Participants

Janis P. O'Malley, MD, Birmingham, AL (*Director*) Nothing to Disclose

Samuel E. Almodovar-Reteguis, MD, Birmingham, AL (*Presenter*) Nothing to Disclose

### LEARNING OBJECTIVES

1) Discuss imaging presentation and special considerations when interpreting FDG PET/CT studies for lymphoma, melanoma and sarcoma. 2) Formulate a systematic approach to interpreting PET/CT studies for this patient population. 3) Discuss pertinent correlative findings on CT for each diagnosis on a case by case basis.

### ABSTRACT

MSES34

## Essentials of Cardiac Imaging

Tuesday, Dec. 1 3:30PM - 5:00PM Location: S100AB



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

### Participants

### Sub-Events

#### MSES34A CMR Basics - Patterns of Enhancement

### Participants

Nikhil Goyal, MD, Staten Island, NY (*Presenter*) Nothing to Disclose

### LEARNING OBJECTIVES

1) Understand the basic components of a post contrast Cardiac MRI (CMRI) examination. 2) Understand the concept of myocardial nulling and its role in delayed enhancement CMRI. 3) Learn the patterns of delayed enhancement associated with ischemic and nonischemic cardiac disease.

#### MSES34B Congenital Anomalies of the Coronary Arteries with Pathologic Correlation

### Participants

Seth J. Kligerman, MD, Denver, CO (*Presenter*) Nothing to Disclose

### LEARNING OBJECTIVES

1) Recognize various congenital anomalies of the coronary arteries on cross-sectional imaging. 2) Learn which anomalies are benign and which can lead to adverse cardiac events. 3) Understand how anomalies in the origin, course, and termination of the coronary arteries can lead to a abnormal perfusion of the myocardium.

#### MSES34C Cardiac CT and MRI: Seeing the Unseen

### Participants

Musturay Karcaaltincaba, MD, Ankara, Turkey, (musturayk@gmail.com) (*Presenter*) Speaker, General Electric Company; Speaker, Koninklijke Philips NV

### LEARNING OBJECTIVES

1) To describe the cardiac CT and MRI findings that can not be seen or characterized by echocardiography and catheter angiography. 2) To depict imaging features of mild atherosclerosis, napkin ring sign, bypass grafts, interatrial septal and myocardial pathologies. 3) To elucidate our understanding of cardiac pathologies ( such as fibrosis, iron overload and amyloidosis) than can be diagnosed without biopsy.

## Nerve Ultrasound Based on a Regional Approach: Elbow to Hand (Hands-on)

Tuesday, Dec. 1 4:30PM - 6:00PM Location: E264



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

### Participants

Carlo Martinoli, MD, Genova, Italy, (carlo.martinoli@unige.it) (*Moderator*) Nothing to Disclose  
J. Antonio Bouffard, MD, Detroit, MI (*Presenter*) Nothing to Disclose  
Catherine J. Brandon, MD, Ann Arbor, MI (*Presenter*) Stock options, VuCOMP, Inc  
Mary M. Chiavaras, MD, PhD, Ancaster, ON (*Presenter*) Nothing to Disclose  
Joseph G. Craig, MD, Detroit, MI (*Presenter*) Nothing to Disclose  
Michael A. Di Pietro, MD, Ann Arbor, MI (*Presenter*) Nothing to Disclose  
David P. Fessell, MD, Ann Arbor, MI (*Presenter*) Nothing to Disclose  
Ghiyath Habra, MD, Royal oak, MI (*Presenter*) Nothing to Disclose  
Marnix T. van Holsbeeck, MD, Detroit, MI, (marnix@rad.hfh.edu) (*Presenter*) Consultant, General Electric Company Consultant, Koninklijke Philips NV Stockholder, Koninklijke Philips NV Stockholder, General Electric Company Grant, Siemens AG Grant, General Electric Company  
Rachel B. Hulen, MD, Novi, MI (*Presenter*) Nothing to Disclose  
Marina Kislyakova, MD, Moscow, Russia, (mkisliakova@yandex.ru) (*Presenter*) Nothing to Disclose  
Joseph H. Introcaso, MD, Neenah, WI (*Presenter*) Nothing to Disclose  
Jon A. Jacobson, MD, Ann Arbor, MI (*Presenter*) Consultant, BioClinica, Inc; Royalties, Reed Elsevier; ;  
Kenneth S. Lee, MD, Madison, WI (*Presenter*) Research Consultant, SuperSonic Imagine; Consultant, Echometrix, LLC; Royalties, Reed Elsevier  
Humberto G. Rosas, MD, Madison, WI (*Presenter*) Nothing to Disclose  
Matthieu Rutten, MD, Hertogenbosch, Netherlands (*Presenter*) Nothing to Disclose  
Courtney E. Scher, DO, Detroit, MI (*Presenter*) Nothing to Disclose  
Alberto S. Tagliafico, MD, Genova, Italy (*Presenter*) Nothing to Disclose  
Ximena L. Wortsman, MD, Santiago, Chile, (xworts@yahoo.com) (*Presenter*) Nothing to Disclose  
Andrea Klauser, MD, Innsbruck, Austria (*Presenter*) Nothing to Disclose

### LEARNING OBJECTIVES

1) Familiarize course participants with the ultrasound appearance of nerves and the scanning techniques used to image them in the distal upper extremity. 2) Emphasize the ultrasound anatomy of the median, ulnar, radial nerves and their divisional branches at the most common sites of entrapments, including the carpal tunnel and the cubital tunnel. 3) Learn the technique to image some minor nerves in their course throughout the distal upper extremity, such as the the lateral and the medial antebrachial cutaneous. 4) Outline the range of clinical conditions where ultrasound is appropriate as the primary imaging modality for nerve assessment.

### ABSTRACT

In recent years, ultrasound of the musculoskeletal and peripheral nervous systems is becoming an increasingly imaging tool with an expanding evidence base to support its use. However, the operator dependent nature and level of technical expertise required to perform an adequate ultrasound assessment means that appropriate training is required. For this purpose, the present course will demonstrate the basic principles of musculoskeletal ultrasound with a special focus on nerves of the distal upper extremity (elbow to hand). The standardized techniques of performing an adequate ultrasound study of the median, ulnar, radial and their divisional branches, lateral cutaneous of the forearm and medial cutaneous of the arm and the forearm will be illustrated. The hands-on workshops will provide the opportunity to interactively discuss the role of ultrasound in this field with expert instructors. Participants will be encouraged to directly scan model patients. A careful ultrasound approach with thorough understanding of soft-tissue planes and extensive familiarity with anatomy are prerequisites for obtaining reliable information regarding the affected structure and the site and nature of the disease process affecting it.

### Honored Educators

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

Jon A. Jacobson, MD - 2012 Honored Educator

## Standardized Terminology in Radiology: Applications and New Developments using RadLex and Playbook

Tuesday, Dec. 1 4:30PM - 6:00PM Location: S102D



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

### Participants

Kenneth C. Wang, MD, PhD, Ellicott City, MD, (kcwang@gmail.com) (*Moderator*) Co-founder, DexNote, LLC;

### LEARNING OBJECTIVES

1) To recognize the need for standardized terminology for radiology imaging examinations. 2) To describe the RadLex Playbook, which provides standard names and codes for radiology orderables. 3) To demonstrate the value of RadLex Playbook for improving radiology practice.

### Sub-Events

#### RCC35A Terminology Standardization in CT: Progress and Challenges

### Participants

Laurel Burk, Springfield, VA, (laurel.burk@fda.hhs.gov) (*Presenter*) Nothing to Disclose

### LEARNING OBJECTIVES

1) Identify challenges associated with non-standard CT terminologies. 2) Compare currently available standard CT lexicons. 3) Explain the role of consensus standards in FDA's regulation of radiological devices.

### ABSTRACT

The inconsistency in names used for CT acquisition and reconstruction parameters across different scanner models can be confusing to operators, possibly leading to unnecessary radiation exposure or poor image quality. The AAPM Working Group on Standardization of CT Nomenclature and Protocols (WGCTNP) is working toward a set of consensus recommended CT parameter terms and definitions. Ongoing work includes: identifying relevant terms from existing standard lexicons; mapping generic terms to vendor-specific terminology (lexicon published on the AAPM 'CT Scan Protocols' website); and identifying preferred names based on use in the literature and clinical practice.

#### RCC35B RadLex® Playbook: Standardized Terminology for Naming and Coding Imaging Procedures

### Participants

Kenneth C. Wang, MD, PhD, Ellicott City, MD, (kcwang@gmail.com) (*Presenter*) Co-founder, DexNote, LLC;

### LEARNING OBJECTIVES

1) To illustrate the motivations for RadLex Playbook. 2) To describe the Playbook semantic model. 3) To review Playbook implementation strategies. 4) To introduce the Playbook / LOINC harmonization project.

### ABSTRACT

The historical lack of a standard naming scheme for imaging studies has limited exam interoperability. The RadLex Playbook provides a system for creating standard radiology procedure names and codes, enabling a variety of applications in dose tracking and optimization, enterprise integration, and quality improvement. This presentation will illustrate the motivations for Playbook adoption, and describe the semantic model used to create Playbook codes. We will also review strategies and technical considerations in Playbook implementation. Finally, we will describe work to harmonize Playbook with the LOINC system of codes.

#### RCC35C Standard Terminology for Radiology Reporting

### Participants

Charles E. Kahn JR, MD, MS, Philadelphia, PA, (charles.kahn@uphs.upenn.edu) (*Presenter*) Nothing to Disclose

### LEARNING OBJECTIVES

1) Define the roles of standardized vocabularies in radiology reporting. 2) Describe how terms from standardized vocabularies are being incorporated to RSNA's radiology reporting templates. 3) Understand how standardized vocabularies allow reporting templates and radiology reports to be interoperable across a variety of languages, information systems, and applications.

### ABSTRACT

Standardized terminologies can help radiologists communicate the results of imaging procedures more effectively. A well-defined terminology can eliminate ambiguity, and can guide radiologists to use appropriate descriptive terms. Standardized vocabularies can overcome language barriers and the limitations of proprietary systems. This presentation will explore the roles of standardized terminologies in the reporting templates being developed by the RSNA Reporting Initiative. Structured reporting gives radiologists the opportunity to incorporate controlled vocabularies, such as RadLex®, into their reports to enhance the reports' clinical usefulness, facilitate data extraction, and improve quality.

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educational content in their field of study. Learn how you can become an honored educator by visiting the website at:  
<https://www.rsna.org/Honored-Educator-Award/>

Charles E. Kahn JR, MD, MS - 2012 Honored Educator



## Advanced Vascular Imaging Techniques and Applications

Tuesday, Dec. 1 4:30PM - 6:00PM Location: S504AB



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

### Participants

### Sub-Events

#### RC412A Cardiovascular 3D Printing

### Participants

Frank J. Rybicki III, MD, PhD, Ottawa, ON (*Presenter*) Research Grant, Toshiba Corporation;

### LEARNING OBJECTIVES

1) To understand the difference between 3D visualization and 3D printing as related to cardiovascular diagnoses. 2) To review the different 3D printing technologies that have impacted and will impact cardiovascular care. 3) To review the clinical impact of current 3D modelling in both cardiovascular diagnoses and intervention.

### ABSTRACT

While advanced visualization in cardiovascular imaging is instrumental for diagnoses and communication with referring clinicians, there is an unmet need to render DICOM images as 3D printed models capable of providing both tactile feedback and tangible depth information of both anatomic and pathologic states. 3D printed models are being rapidly embraced in cardiovascular diagnoses. The purpose of this this lecture is to review and summarize the numerous studies to date that support such benefits from cardiovascular 3D printing, as it is expected that the number of 3D printed models generated from DICOM images for planning intervention and fabricating implants will grow exponentially. 3D printing has closed the gap on the unmet need for true 3D visualization in cardiovascular surgical planning. Source image data is primarily contrast-enhanced MRI and CT. Various approaches have been used to develop a hollow STL model, including segmenting the blood pool and printing vessels with a high-resolution technology to achieve a smooth lumen. Growing data supports the use of models to capture complex anatomy including congenital heart disease requiring surgery. Applications have included acquired cardiac abnormalities such as ventricular aneurysms and cardiac tumors. Models have been useful to plan high-risk valve cases and for intra-operative navigation. Electrocardiographic (ECG) gated CT studies for Trans-catheter Aortic Valve Replacement (TAVR) planning enable 3D printed models of the aortic annulus and surrounding structures for potentially safer valve deployment. Incorporation of patient-specific elasticity of the normal versus calcified aorta will likely be an important area of future research. Models of the aorta and other smaller vessels, including the coronary arteries, enable studies of blood flow dynamics that otherwise would not be possible in vivo.

#### RC412B Renal MRA and Functional MRI

### Participants

Ulrike I. Attenberger, MD, Mannheim, Germany (*Presenter*) Research Consultant, Bayer AG

### LEARNING OBJECTIVES

1) To describe the technical pre-requisites for successful contrast and non-contrast-enhanced renal MRA (i.e. signal-to-noise-ratio, scan time, spatial resolution, voxel size). 2) To review contrast-agent dose optimization strategies. 3) To understand the basics of functional renal MR imaging techniques and to illustrate their potential implications on patient care.

#### RC412C Functional CTA in Athletes

### Participants

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

### LEARNING OBJECTIVES

1) Identify anatomic and functional lesions that predispose to vascular entrapment and fibrotic syndromes in athletes. 2) Describe methods to assess vascular entrapment and fibrotic syndromes in athletes using dynamic, functionally challenged CTA and MRA. 3) Describe the imaging findings for diagnosis and follow-up of affected athletes.

### ABSTRACT

While exercise is a mainstay in preventing and treating atherosclerotic peripheral vascular disease, some vascular disorders manifest primarily in athletes. Both recreational and competitive athletes are at risk for development of non-atherosclerotic vascular diseases. These disease entities range from iliac endofibrosis in cyclists, popliteal entrapment syndrome in running sports, and thoracic inlet / outlet syndromes in "overhead" athletes. Recently, computed tomography angiography (CTA) and magnetic resonance angiography (MRA) have become valuable diagnostic options for many vascular diseases that can occur in the athlete. Optimum imaging in these disorders requires the ability to tailor the exam protocol to the specific disease entity and vascular territory in question. By combining rapid CT image acquisition with functional, physiologic provocative maneuvers, diagnostic information can be maximized. Newer blood-pool MR contrast agents also allow functional assessment without ionizing radiation exposure. This session will review the pathophysiology, risk factors, diagnosis, and classification of vascular diseases seen in the athlete. Logical protocol development utilizing (when necessary) provocative maneuvers will be reviewed. Interpretation strategies for interacting with these resulting large, dynamic datasets will also be reviewed.

**Active Handout: Richard Lee Hallett**

**RC412D      Aortic Imaging - Beyond Diameters**

Participants

Michael D. Hope, MD, San Francisco, CA, (michael.hope@ucsf.edu) (*Presenter*) Nothing to Disclose

**LEARNING OBJECTIVES**

1) Explain why imaging approaches beyond assessment of vessel diameter are needed for improved risk stratification of aortic disease. 2) List potential aortic imaging targets for improved evaluation of disease progression. 3) Appraise the merits of advanced aortic imaging techniques including the use of MRI and PET for the evaluation of aortic hemodynamics and vessel wall inflammation.

RC417

## Emerging Breast Imaging Strategies

Tuesday, Dec. 1 4:30PM - 6:00PM Location: S505AB

**BR** **DM** **MR**

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

### Participants

Catherine J. Moran, PhD, Stanford, CA (*Moderator*) Research support, General Electric Company

### Sub-Events

#### RC417A Diffuse Optical Spectroscopy of Breast Cancer

### Participants

David R. Busch, PhD, Philadelphia, PA, (drbusch@sdf.org) (*Presenter*) Nothing to Disclose

### LEARNING OBJECTIVES

1) Describe light transport through tissue. 2) Describe the current applications of diffuse optics in medicine and technological limitations. 3) Summarize applications of diffuse optics to breast cancer, including cutting edge work and implications for future clinical applications.

### ABSTRACT

Diffuse optics utilizes near-infrared light to probe tissue without ionizing radiation. These tools permit rapid and pain-free assessment of endogenous cancer signatures, including oxygenated and deoxygenated hemoglobin, lipid, and water concentrations. Relatively inexpensive instrumentation can monitor the progress of neoadjuvant chemotherapy in a clinic, rather than an imaging suite, using convenient hand-held probes, even in radiologically dense breasts. Very recently, similar optical monitoring tools have been developed to measure microvascular blood flow. More elaborate diffuse optical imaging systems construct three dimensional tomograms of multiple tissue constituents, permitting multi-parameter computer aided detection and localization of tumors. In addition to endogenous chromophores, these optical measurements are exquisitely sensitive to contrast agents, holding significant promise for imaging of highly specific contrast agents at pico- or femto-molar concentrations. Diffuse optical instrumentation can readily be combined with other imaging techniques. These multi-modality data sets provide the opportunity to combine the advantageous aspects of both techniques. We will discuss recent advances in optical monitoring, imaging, and combinations with other modalities.

### URL

[www.sas.upenn.edu/~drbusch/rsnaHandout-DiffuseOptics-Breast.pdf](http://www.sas.upenn.edu/~drbusch/rsnaHandout-DiffuseOptics-Breast.pdf)

#### RC417B Contrast Enhanced Mammography and Tomosynthesis

### Participants

John M. Lewin, MD, Denver, CO (*Presenter*) Consultant, Hologic, Inc; Research Grant, Hologic, Inc; Consultant, Novian Health Inc

### LEARNING OBJECTIVES

1) To discuss the indications and utility of contrast-enhanced mammography (CEM) and contrast-enhanced tomosynthesis (CET). 2) To understand the feasibility, limitations, and technical issues of CEM / CET. 3) To compare the utility of CEM and CET against non-contrast techniques and discuss future directions.

### Active Handout: John Morton Lewin

<http://abstract.rsna.org/uploads/2015/13029341/RC417B.pdf>

### Active Handout: John Morton Lewin

<http://abstract.rsna.org/uploads/2015/13029341/Active RC417B.pdf>

#### RC417C High Resolution Dynamic Contrast Enhanced Breast MRI

### Participants

Catherine J. Moran, PhD, Stanford, CA (*Presenter*) Research support, General Electric Company

### LEARNING OBJECTIVES

1) Be able to select appropriate spatial and temporal resolution parameters to run a dynamic contrast-enhanced (DCE) breast MRI sequence. 2) Explain to colleagues the difference between temporal resolution and temporal footprint for fast DCE scans. 3) List 3 different approaches to fat suppression, and be able to set up a scan protocol using at least one of these on the learner's scanner.

### ABSTRACT

This talk will provide an overview of high-resolution breast MRI techniques. Initially, MRI concepts including parameter tradeoffs, contrast mechanisms, and parallel imaging will be reviewed. Fat suppression techniques are essential for high-quality breast MRI, and include further tradeoffs. Finally, techniques for high spatiotemporal resolution sampling to resolve rapid contrast kinetics while also offering sharp images will be described.

### URL

RC418

## Imaging of Tumor Syndromes (An Interactive Session)

Tuesday, Dec. 1 4:30PM - 6:00PM Location: S103CD



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

### Participants

### Sub-Events

#### RC418A Von Hippel Lindau and Other Hereditary Renal Cancer Syndromes

##### Participants

Peter L. Choyke, MD, Rockville, MD, (pchoyke@nih.gov) (*Presenter*) Researcher, Koninklijke Philips NV Researcher, General Electric Company Researcher, Siemens AG Researcher, iCAD, Inc Researcher, Aspyrian Therapeutics, Inc Researcher, ImaginAb, Inc Researcher, Aura Biosciences, Inc

##### LEARNING OBJECTIVES

1) To identify the key genetic aspects of von Hippel Lindau (VHL) disease and their relevance to treatment. 2) To distinguish radiologic features of VHL from other hereditary renal cancers. 3) To explain the implications of hereditary renal cancers for sporadic renal cancers.

##### ABSTRACT

Hereditary renal cancers include clear cell carcinomas associated with von Hippel Lindau Disease (VHL), chromophobe carcinomas associated with Birt Hogg Dube, papillary carcinomas associated with hereditary papillary cancer syndrome and type II papillary carcinomas associated with Hereditary Leiomyoma-Renal Carcinoma (HLRC) syndrome. Additional rare syndromes exist. This talk will focus on the distinguishing features of each entity from a radiologic perspective but also will describe the lexicon underlying the description of the genetics of these entities. This should enable the participant to understand the 'language' of genetics when describing hereditary entities in general, including terms such as tumor suppressor gene, oncogene, hypoxia inducible factor and metabolomics. The participant should come away with a fuller understanding of these hereditary entities and their implications for more common, sporadically occurring renal cancers.

#### RC418B Neurocutaneous Syndromes

##### Participants

Petra Vajtai, MD, Portland, OR (*Presenter*) Nothing to Disclose

##### LEARNING OBJECTIVES

1) To identify the key distinguishing radiologic features of each of the most common phakomatoses: neurofibromatosis types I and II, tuberous sclerosis, and Sturge-Weber syndrome. 2) To provide guidance on the appropriate use of surveillance imaging in affected individuals.

##### ABSTRACT

The phakomatoses are a group of hereditary neuroectodermal diseases, each characterized by its unique cutaneous as well as radiologic manifestations. The most common phakomatoses are neurofibromatosis (types I and II,) tuberous sclerosis, and Sturge-Weber syndrome, whose respective characteristic neuroradiological finding is the neurogenic tumor, the tuber and angiomas. The talk should enable the participant to distinguish the addressed phakomatoses based on radiologic characteristics, to describe the presentation, diagnosis and prognosis of each, and to provide guidance on the appropriate use of surveillance imaging in affected individuals.

#### RC418C Multiple Endocrine Neoplasia

##### Participants

Bryan R. Foster, MD, Portland, OR, (fosterbr@ohsu.edu) (*Presenter*) Nothing to Disclose

##### LEARNING OBJECTIVES

1) Distinguish between MEN 1, MEN 2A and MEN 2B syndromes. 2) Apply the appropriate modality for specific imaging indications. 3) Describe common and uncommon imaging findings for various tumors seen in MEN.

##### ABSTRACT

Multiple endocrine neoplasia (MEN) is a heterogeneous group of inherited genetic disorders in which patients develop both endocrine and non-endocrine tumors. MEN 1 patients commonly develop pituitary adenomas, parathyroid adenomas and pancreatic neuroendocrine tumors. MEN 2 patients commonly develop medullary thyroid cancers and pheochromocytomas. Familial medullary thyroid cancer is also considered part of the MEN syndrome as these patients have mutations in genes similar to MEN 2 patients. Imaging plays an important role in the detection, staging and followup of tumors in these patients and often many different modalities are employed to optimally image these patients.

#### RC418D Lynch and Other Hereditary Colonic Cancer Syndromes

##### Participants

Richard Kinh Gian Do, MD, PhD, New York, NY (*Presenter*) Nothing to Disclose

#### **LEARNING OBJECTIVES**

1) Describe the advances in genetics for Lynch and other hereditary colonic cancer syndromes. 2) Identify the gastrointestinal and non-GI malignancies of Lynch and other polyposis syndromes. 3) Examine the role of imaging for monitoring hereditary colonic cancer syndromes.

#### **Active Handout: Richard Kinh Gian Do**

[http://abstract.rsna.org/uploads/2015/13010497/Active\\_RC418D.pdf](http://abstract.rsna.org/uploads/2015/13010497/Active_RC418D.pdf)

## Image-guided Stereotactic Body Radiotherapy (SBRT) for Spinal Metastases - Spinal Imaging, Target Delineation and Post-SBRT Response Evaluation

Tuesday, Dec. 1 4:30PM - 6:00PM Location: S102C



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

### Participants

Simon S. Lo, MD, Cleveland, OH, (Simon.Lo@UHhospitals.org) (*Moderator*) Research support, Elekta AB;

### LEARNING OBJECTIVES

1) To understand the basics of stereotactic body radiotherapy (SBRT) for spinal metastasis. 2) To know the basics of diagnostic imaging for spinal metastasis. 3) To learn the principles and methods of target delineation for SBRT for spinal metastasis. 4) To know the principles and methods of response evaluation after SBRT for spinal metastasis.

### ABSTRACT

Stereotactic body radiotherapy (SBRT) has become an important treatment modality for spinal metastases in various settings. To facilitate safe and effective delivery of SBRT for spinal metastases, proper pre-SBRT evaluation including appropriate diagnostic imaging, and proper target delineation and contouring of organs-at-risk are necessary. The gold standard for post-SBRT response evaluation for spinal metastases is not well-defined and this is an emerging area of research interest. This refresher course will provide an overview of the spinal SBRT process, diagnostic imaging for spinal metastasis, target delineation for SBRT for spinal metastases, and post-SBRT response evaluation for spinal metastases.

### Sub-Events

#### RC420A Overview of SBRT for Spinal Metastases

### Participants

Simon S. Lo, MD, Cleveland, OH (*Presenter*) Research support, Elekta AB;

### LEARNING OBJECTIVES

1) To know the indications for stereotactic body radiotherapy (SBRT) for spinal metastasis. 2) To know the technical aspects of SBRT for spinal metastasis. 3) To know the expected outcomes of SBRT for spinal metastasis. 4) To know the potential toxicities of SBRT for spinal metastasis.

### ABSTRACT

This subsection will provide an overview of the indications, technical aspects, expected outcomes, and toxicities of stereotactic body radiotherapy (SBRT) for spinal metastasis.

#### RC420B Pre-SBRT Imaging of Spinal Metastases

### Participants

Pejman Jabehdar Maralani, MD, FRCPC, Toronto, ON, (pejman.maralani@utoronto.ca) (*Presenter*) Nothing to Disclose

### LEARNING OBJECTIVES

1) To understand the role of different imaging modalities in diagnosis of spinal metastasis. 2) To understand relevant imaging characteristics of spinal metastasis.

### ABSTRACT

This section will provide an overview of multiple imaging modalities used for diagnosis and treatment planning of spinal metastasis.

#### Active Handout:Pejman Jabehdar Maralani

[http://abstract.rsna.org/uploads/2015/15002564/Active\\_RC420B.pdf](http://abstract.rsna.org/uploads/2015/15002564/Active_RC420B.pdf)

#### RC420C Target Delineation of Spinal Metastases

### Participants

Kristin J. Redmond, MD, MPH, Baltimore, MD (*Presenter*) Research support, Elekta AB

### LEARNING OBJECTIVES

1) To understand target and normal tissue delineation for patients receiving SBRT for malignant spinal metastases.

### ABSTRACT

The purpose of this section will be to review principles involved with target and normal tissue delineation in patients being treated with SBRT for malignant spinal metastasis. This will include review of both current consensus guidelines as well as areas of controversy.

#### Active Handout:Kristin Janson Redmond

[http://abstract.rsna.org/uploads/2015/15002565/RC420C\\_RSNA\\_target\\_delineation\\_handout\\_2015.pdf](http://abstract.rsna.org/uploads/2015/15002565/RC420C_RSNA_target_delineation_handout_2015.pdf)



**Participants**

Arjun Sahgal, Toronto, ON, (arjun.sahgal@sunnybrook.ca) (*Presenter*) Speaker, Medtronic, Inc; Speaker, Elekta AB; Medical Advisory Board, Varian Medical Systems, Inc; Speaker, Accuray Incorporated; Research Grant, Elekta AB

**LEARNING OBJECTIVES**

1) To understand the challenges of post-spine SBRT response assessment. 2) To understand the current state of response criteria consensus.

**ABSTRACT**

The aim of this presentation is to highlight the challenges of post spine SBRT response assessment, and current consensus work to standardize imaging and evaluation.

RC422

## Proton: Imaging for Treatment Guidance and Verification

Tuesday, Dec. 1 4:30PM - 6:00PM Location: S104A



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

### Participants

Jon J. Kruse, PhD, Rochester, MN (*Moderator*) Research Grant, Varian Medical Systems, Inc

### ABSTRACT

Proton therapy dose distributions are highly conformal and are often used to deliver therapeutic doses to tumors close to critical, radiosensitive normal anatomy. Precise daily reproduction and alignment of the patient anatomy is crucial, then, for successful outcome of proton radiotherapy. This course will describe modern approaches to pre- and intra-treatment imaging to align the patient for proton therapy as well as post-treatment modalities which can verify patient alignment and proton beam range. Pre-treatment image guidance for protons has evolved differently than many common approaches for standard external beam radiotherapy. One reason for this is the dissimilar impact of setup variations on the delivered proton dose distributions, while another is related to the expense of building a proton center and the need to maximize efficiency by moving as many complex processes out of the treatment room as possible. Additionally, the sensitivity of proton dose distributions to intra-fractional changes has led to the development of novel techniques to monitor patient anatomy throughout a treatment. Modest errors in patient positioning or in calculation of proton range could lead to tumor or healthy tissues receiving vastly different doses than were planned. This has led to the development of a number of approaches for post treatment verification of proton beam placement and range. Proton dose verification via positron emission tomography, prompt gamma imaging, and magnetic resonance imaging will be presented.

### Sub-Events

#### RC422A Pre- and Intra-treatment Imaging Strategies for Patient Alignment

### Participants

Jon J. Kruse, PhD, Rochester, MN (*Presenter*) Research Grant, Varian Medical Systems, Inc

### LEARNING OBJECTIVES

1) Explain the impact of inter- and intra- fractional variations in patient anatomy on proton dose distributions. 2) Describe proton specific approaches to pre-treatment and intra-treatment imaging for patient alignment. 3) Compare various imaging modalities for post-treatment verification of a delivered proton dose distribution.

#### RC422B Advanced Imaging Techniques for Range Verification

### Participants

Thomas R. Bortfeld, PhD, Boston, MA (*Presenter*) Research Grant, Koninklijke Philips NV; Research Grant, RaySearch Laboratories AB

### LEARNING OBJECTIVES

1) Explain the impact of inter- and intra- fractional variations in patient anatomy on proton dose distributions. 2) Describe proton specific approaches to pre-treatment and intra-treatment imaging for patient alignment. 3) Compare various imaging modalities for post-treatment verification of a delivered proton dose distribution.

**Service Excellence in Radiology (Sponsored by the RSNA Professionalism Committee) (An Interactive Session)**

Tuesday, Dec. 1 4:30PM - 6:00PM Location: S103AB



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

**Participants**

Kenneth A. Buckwalter, MD, Indianapolis, IN (*Moderator*) Research Grant, Siemens AG  
Ella A. Kazerooni, MD, Ann Arbor, MI (*Presenter*) Nothing to Disclose  
Brent J. Wagner, MD, Reading, PA (*Presenter*) Nothing to Disclose  
Brandon P. Brown, MD, MA, Indianapolis, IN (*Presenter*) Nothing to Disclose

**LEARNING OBJECTIVES**

1) Understand who the customer is in Radiology and why customer satisfaction scores are important. 2) Review how Radiology can document the added value role it plays in the enterprise. 3) Discuss how to onboard new staff members successfully

**ABSTRACT**

ServiceExcellence in healthcare is used generally to refer to patient or customer satisfaction, and our ability to consistently meet if not exceed the expectations of patients, their families and visitors. It can be more widely expanded to include interactions among staff within a group, across groups or job descriptions or across departments. Inherently it is the concept that healthcare is more than just the technical act of delivering service, in radiology that would be the performance of a diagnostic test for example that hit high marks for classic quality metrics like image quality, radiation dose optimization and clarity and accuracy of the interpretation. Service excellence embraces the notion that healthcare must address the psyche, emotions and worries of those we care for, who come to us for service because they are ill and concerned about their health, the impact of disease on themselves and their families. It is about HOW we deliver the care too. From looking people in the eyes at check in, asking if there is anything else we can do for them, letting them know how they will get their test results, acknowledging when we can do better without blame, and knowing when and how to say thank you. On a more tangible level, high marks for Service Excellence also translates into higher employee engagement, retention of staff and a drop in time and resources spent doing service recovery. Hiring for Service Excellence is important to having the right people in your organization, and sometimes letting those go who cannot live up to those expectations may be necessary to move forward. In the end, a commitment to Service Excellence is not about an expensive program delivered by others to you to train to, it is about treating everyone with respect and both setting and often exceeding expectations. With higher patient satisfaction scores comes retention of patients/customers, and word of mouth marketing that your program is THE destination for care now and in future.

**Active Handout: Brent Joseph Wagner**

<http://abstract.rsna.org/uploads/2015/13011742/RC416BW.pdf>

**Honored Educators**

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Ella A. Kazerooni, MD - 2014 Honored Educator

## Strategies for Developing Business Leadership Skills in the Midst of Healthcare Reform Challenges

Tuesday, Dec. 1 4:30PM - 6:00PM Location: S404CD

ED

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

### Participants

Richard Duszak JR, MD, Atlanta, GA (*Moderator*) Nothing to Disclose

### LEARNING OBJECTIVES

1) To develop programs to cultivate trainee and practicing radiologist non-clinical interests in practice management, economics, and health policy, and apply newly acquired knowledge and insights into current and future practice. 2) To help radiologists at all levels in both private practice and academic medical centers understand the complex environment in which health care services are delivered and the roles and relationships of various stakeholders including professional societies, private and academic practices, hospitals and health systems, payers, governmental bodies and private sector industry. 3) To guide radiology residency programs in fulfilling new formal residency training requirements in non-interpretative skills as they pertain to healthcare economics and practice management.

### ABSTRACT

As healthcare delivery systems undergo rapid and dramatic changes, the need for dynamic physician leadership in both academic and private practice settings has increased. Traditional graduate medical education curricula have often left young radiologists ill-equipped to address complex issues related to practice management, health policy and economics. Given the many leadership opportunities available for practicing radiologists, additional education and training in these areas should enhance their effectiveness as clinical and non-clinical leaders to positively impact healthcare systems through appropriate use and integration of medical imaging. This course is intended to introduce such educational opportunities at the resident, fellow, and practicing radiologist level and share the early experience of several academic and private medical centers in these pursuits.

### Sub-Events

#### RC402A Residency Training Perspective

### Participants

Falgun H. Chokshi, MD, Atlanta, GA (*Presenter*) Nothing to Disclose

### LEARNING OBJECTIVES

View learning objectives under main course title.

#### RC402B Fellowship Training Perspective

### Participants

Raymond W. Sze, MD, Washington, DC (*Presenter*) Nothing to Disclose

### LEARNING OBJECTIVES

View learning objectives under main course title.

#### RC402C Faculty Perspective

### Participants

Frank J. Lexa, MD, Philadelphia, PA (*Presenter*) Nothing to Disclose

### LEARNING OBJECTIVES

View learning objectives under main course title.

#### RC402D Private Practice Perspective

### Participants

Scott M. Truhlar, MD, MBA, Coralville, IA, (smtruhlar@hotmail.com) (*Presenter*) Nothing to Disclose

### LEARNING OBJECTIVES

View learning objectives under main course title.

RC421

## Medical Physics 2.0: Ultrasonography

Tuesday, Dec. 1 4:30PM - 6:00PM Location: S404AB

PH US

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

### Participants

Ehsan Samei, PhD, Durham, NC (*Director*) Nothing to Disclose  
Douglas E. Pfeiffer, MS, Boulder, CO (*Director*) Nothing to Disclose

### Sub-Events

#### RC421A Ultrasonography Perspective

### Participants

Paul L. Carson, PhD, Ann Arbor, MI (*Presenter*) Research collaboration, General Electric Company; Research collaboration, Light Age, Inc

### LEARNING OBJECTIVES

1) Understand the roles of medical physicists and other providers of ultrasound system QC, performance evaluation and user education. 2) Gain an understanding of the longer term potential of medical ultrasound to aid in medical physics planning and training.

### ABSTRACT

A very brief overview is given of the innovations that have led to current medical ultrasound systems and QC thereof. A clear connection to clinical performance/cost effectiveness has not been established, but the ratio is improving. To aid in medical physics planning and training, more distant (beyond 10 years) and less robust predictions are ventured than in Dr. Hangiandreous' talk. The reduction in artifacts and improvement in resolution will be surprisingly large. It is posed that ultrasound will be headed toward almost ubiquitous use in personal hands as well as those of medical personnel, for monitoring and control of chronic conditions, for direct treatment and for precisely localized drug delivery and enhancement of radiation therapy. Medical physicists who can help keep the computer controls integrated, the systems properly calibrated and the users properly trained will find a substantial role in society.

**Active Handout:Paul L. Carson**

[http://abstract.rsna.org/uploads/2015/13010884/RC421A\\_RSNA015RC221AplcTrim2.pdf](http://abstract.rsna.org/uploads/2015/13010884/RC421A_RSNA015RC221AplcTrim2.pdf)

#### RC421B Ultrasonography 1.0

### Participants

Zheng Feng Lu, PhD, Chicago, IL (*Presenter*) Nothing to Disclose

### LEARNING OBJECTIVES

1) Describe the current role of ultrasound medical physics in clinical practice. 2) Explain the ultrasound image quality metrics utilized in current ultrasound QA/QC testing. 3) Outline the methods and tools available for ultrasound system QA/QC in current clinical practices. 4) Survey the available standards and voluntary accreditation guidelines for medical ultrasound imaging systems. 5) Understand the need for QC at different levels of time and financial investment.

### ABSTRACT

This talk will focus on the present role of ultrasound medical physics in clinical practices. It will review the ultrasound image quality metrics currently utilized in ultrasound QA/QC testing. It will describe testing procedures required and/or recommended by accreditation programs and advisory organizations. General guidelines and available standards will be discussed regarding tolerances for acceptance testing and commissioning of these devices, as well as periodic quality control tests, as applicable to diagnostic B-mode imagers. A brief review of ultrasound phantoms used in these testing procedures will be presented.

**Active Handout:Zheng Feng Lu**

[http://abstract.rsna.org/uploads/2015/13010885/RC421B\\_20151123-ZFL-Ultrasound\\_1.0.pdf](http://abstract.rsna.org/uploads/2015/13010885/RC421B_20151123-ZFL-Ultrasound_1.0.pdf)

**Active Handout:Zheng Feng Lu**

[http://abstract.rsna.org/uploads/2015/13010885/Active\\_RC421B.pdf](http://abstract.rsna.org/uploads/2015/13010885/Active_RC421B.pdf)

#### RC421C Ultrasonography 2.0

### Participants

Nicholas J. Hangiandreou, PhD, Rochester, MN (*Presenter*) Nothing to Disclose

### LEARNING OBJECTIVES

1) Identify the roles expected for medical physics to play in future clinical ultrasound practices. 2) Demonstrate understanding of emerging ultrasound imaging performance metrics that are expected to be in routine practice in the future. 3) Demonstrate understanding of emerging ultrasound imaging technologies that are expected to be in routine practice in the future. 4) Identify approaches for implementing comprehensive medical physics services in future clinical ultrasound practices.

## **ABSTRACT**

Ultrasound imaging is evolving at a rapid pace, adding new imaging functions and modes that continue to enhance its clinical utility and benefits to patients. This talk will look ahead 10-15 years and consider how medical physicists can bring maximal value to the clinical ultrasound practices of the future. The roles of physics in accreditation and regulatory compliance, image quality and exam optimization, clinical innovation, and education of staff and trainees will all be considered. A detailed examination of expected technology evolution and impact on image quality metrics will be presented. Clinical implementation of comprehensive physics services will also be discussed.

**Active Handout:** [Nicholas James Hangiandreou](#)

<http://abstract.rsna.org/uploads/2015/13010886/RC421C.pdf>



## Radio-Genomic Research: Accessing Clinical Imaging-Genomics-Pathology Data from Public Archives-The Cancer Imaging Archive (Hands-on)

Tuesday, Dec. 1 4:30PM - 6:00PM Location: S401CD



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

### Participants

C. Carl Jaffe, MD, Boston, MA, (carljaffe@gmail.com) (*Presenter*) Nothing to Disclose  
John B. Freymann, BS, Rockville, MD (*Presenter*) Nothing to Disclose  
Justin Kirby, Bethesda, MD (*Presenter*) Stockholder, Myriad Genetics, Inc  
Fred W. Prior, PhD, Little Rock, AR (*Presenter*) Stockholder, Siemens AG  
Lawrence R. Tarbox, PhD, Saint Louis, MO (*Presenter*) Nothing to Disclose

### LEARNING OBJECTIVES

1) Learn how to propose new data sets for hosting in The Cancer Imaging Archive (TCIA). 2) Identify and download existing TCIA data sets which match your research interests. 3) Collaborate with other researchers using Shared Lists and Digital Object Identifiers. 4) Identify support resources including the TCIA helpdesk, FAQs, and system documentation.

### ABSTRACT

Access to large-scale genomic-clinical-pathology databases are essential for researchers to understand disease and devise precision medicine pathways, especially in cancer. But HIPAA compliant collections of network downloadable diagnostic clinical images, publically accessible that link to comprehensive molecular physiologic and clinical data has been limited till now. This hands-on session will teach the basic skills needed to navigate the "Big Data" Cancer Imaging Archive open-access database of diagnostic radiology and pathology images that are cross-linked to clinical disease cases analyzed and archived in the NIH Cancer Genome Atlas. With this knowledge radiologists and imaging scientists can undertake cutting-edge research capable of linking clinical imaging to discover new genomic-based disease signatures.

### URL

**Targeted Treatment and Imaging of Liver Cancers: Basic to Advanced Techniques in Minimally-Invasive Therapies and Imaging**

Tuesday, Dec. 1 4:30PM - 6:00PM Location: S403A



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

**Participants**

John J. Park, MD, PhD, Duarte, CA (*Moderator*) Proctor, Sirtex Medical Ltd; Advisory Board, Guerbet SA  
Jinha Park, MD, PhD, Duarte, CA (*Moderator*) Speakers Bureau, Bayer AG; Advisory Board, Guerbet SA  
John J. Park, MD, PhD, Duarte, CA (*Presenter*) Proctor, Sirtex Medical Ltd; Advisory Board, Guerbet SA  
Jinha Park, MD, PhD, Duarte, CA (*Presenter*) Speakers Bureau, Bayer AG; Advisory Board, Guerbet SA  
Andrew C. Price, MD, Scottsdale, AZ (*Presenter*) Nothing to Disclose  
Steven S. Raman, MD, Santa Monica, CA (*Presenter*) Nothing to Disclose  
Marcelo Guimaraes, Charleston, SC (*Presenter*) Consultant, Cook Group Incorporated ; Consultant, Baylis Medical Company;  
Consultant, Terumo Corporation; Patent holder, Cook Group Incorporated

**LEARNING OBJECTIVES**

1) Discuss the role of the interventional radiologist in the treatment and management of patients with primary and metastatic liver cancer as part of the multidisciplinary team. 2) Learn best practice techniques in the treatment of liver cancers, with emphasis on both locoregional and focal therapeutic approaches, and indications for treatment. 3) Explore various tips and tricks for each treatment modality and learn how to avoid complications through good patient selection, choosing the appropriate techniques, and knowing what common mistakes to avoid. 4) Learn about newer and developing techniques and devices, their potential roles and indications, and potential pitfalls. 5) Explore advanced imaging modalities in the detection of tumors and for monitoring treatment response.

**ABSTRACT**

## A Practical Approach for Beginning Radio-genomic Research

Tuesday, Dec. 1 4:30PM - 6:00PM Location: S501ABC



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

### Participants

Maryellen L. Giger, PhD, Chicago, IL (*Presenter*) Stockholder, Hologic, Inc; Shareholder, Quantitative Insights, Inc; Royalties, Hologic, Inc; Royalties, General Electric Company; Royalties, MEDIAN Technologies; Royalties, Riverain Technologies, LLC; Royalties, Mitsubishi Corporation; Royalties, Toshiba Corporation; Researcher, Koninklijke Philips NV; Researcher, U-Systems, Inc  
Hui Li, MD, PhD, Chicago, IL (*Presenter*) Nothing to Disclose  
Karen Drukker, PhD, Chicago, IL, (kdrukker@uchicago.edu) (*Presenter*) Nothing to Disclose  
Elizabeth S. Burnside, MD, MPH, Madison, WI (*Presenter*) Stockholder, NeuWave Medical Inc  
Yuan Ji, Chicago, IL (*Presenter*) Nothing to Disclose  
Alexandra V. Edwards, Chicago, IL (*Presenter*) Nothing to Disclose  
John Papaioannou, MSc, Chicago, IL (*Presenter*) Nothing to Disclose  
Chun-Wai Chan, MS, Chicago, IL (*Presenter*) Nothing to Disclose  
Yitan Zhu, PhD, Evanston, IL (*Presenter*) Nothing to Disclose  
Robert Tomek, MSc, Darien, IL (*Presenter*) Employee, Quantitative Insights, Inc  
Michael R. Chinander, Chicago, IL (*Presenter*) Researcher, Quantitative Insights, Inc

### LEARNING OBJECTIVES

1) Understand what planning and online resources are needed to create a successful cross-disciplinary radio-genomic research team that can efficiently meet hypothesis-generated imaging/genomic science objectives. 2) Comprehend what skill set distinctions are needed for a hypothesis-resolving radio-genomic research team and how those essential components can be assembled to investigate and/or discover a given disease signature. 3) Learn how to grasp a radio-genomic conceptual research framework that may at first seem unfamiliar to imaging scientists.

### ABSTRACT

RC414

## **Interventional (An Interactive Session)**

Tuesday, Dec. 1 4:30PM - 6:00PM Location: S502AB



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

### **Participants**

Steven M. Zangan, MD, Chicago, IL (*Presenter*) Nothing to Disclose  
Rakesh C. Navuluri, MD, Chicago, IL (*Presenter*) Nothing to Disclose  
Jeffrey A. Leef, MD, Chicago, IL (*Presenter*) Nothing to Disclose

### **LEARNING OBJECTIVES**

1) Recognize vascular and non-vascular conditions and their image-guided treatment in the chest, abdomen and pelvis. Please bring your charged mobile wireless device (phone, tablet or laptop) to participate.

## Ultrasound Elastography

Tuesday, Dec. 1 4:30PM - 6:00PM Location: S406B



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

### Participants

### Sub-Events

#### RC410A Thyroid Elastography

### Participants

Richard G. Barr, MD, PhD, Campbell, OH (*Presenter*) Consultant, Siemens AG; Consultant, Koninklijke Philips NV; Research Grant, Siemens AG; Research Grant, SuperSonic Imagine; Speakers Bureau, Koninklijke Philips NV; Research Grant, Bracco Group; Speakers Bureau, Siemens AG; Consultant, Toshiba Corporation; Research Grant, Esaote SpA

### LEARNING OBJECTIVES

1) Explain the difference between strain and shear wave elastography. 2) Understand the techniques to be able to perform thyroid ultrasound elastography. 3) Apply ultrasound elastography into routine clinical practice of thyroid nodules.

### ABSTRACT

Thyroid nodules are very common and work-up of these nodules remains challenging. Fine needle aspiration has been the method of choice for diagnosing suspicious lesions with a sensitivity of 54%-90% and specificity of 60-96% for detection of malignant lesions. Malignant thyroid lesions are statistically stiffer than benign lesions. Ultrasound elastography can assess the stiffness of thyroid lesions. Several studies have been performed evaluating strain and shear wave elastography to characterize thyroid nodules. Strain elastography is qualitative while shear wave elastography is quantitative. These studies suggest that ultrasound elastography may improve sensitivity and specificity of characterizing thyroid lesions over B-mode imaging alone. There is a learning curve for performing adequate thyroid ultrasound elastography. Both cystic lesions and calcified lesions are difficult to evaluate with elastography. There is some overlap of stiffness values between benign and malignant thyroid nodules and elastography should not eliminate biopsy of suspicious lesions based on B-mode imaging. Stiff lesions on elastography should increase the suspicion for malignancy. This presentation will discuss the differences between strain and shear wave elastography, discuss technique and pitfalls in performing the examination, review the literature, and discuss published guidelines.

#### RC410B Renal Elastography: Where Are We?

### Participants

Nicolas Grenier, MD, Bordeaux CEDEX, France, (nicolas.grenier@chu-bordeaux.fr) (*Presenter*) Advisory Board, Supersonic Imagine; Travel support, Guerbet SA

### LEARNING OBJECTIVES

1) To become familiar with the advantages and limits of the different elastography technologies applied to kidney. 2) To understand the factors affecting reliability and reproducibility of elasticity measurement within the kidney. 3) To learn about the intrarenal changes responsible for elasticity changes. 4) To learn about the clinical impact of elasticity measurement in renal parenchymal diseases. 5) To learn about the clinical impact of elasticity measurement in renal tumors.

### ABSTRACT

Ultrasound elastography is a new imaging technique under development that provides information about renal stiffness. Kidney elasticity quantification with ultrasound should be better performed with a quantitative technique, based on shear wave velocity measurements (ARFI or SSI methods). Kidney stiffness changes can be affected by mechanical factors such as external pressure induced by the probe and intrarenal characteristics such as tissue anisotropy, which is high in renal medulla, vascularization, which is high within the cortex, and hydronephrosis. Chronic kidney disease (CKD) incidence and prevalence are increasing in Western countries, due particularly to diabetes mellitus and hypertension-related nephropathies. During progression of such renal parenchymal diseases, cellular density may increase, mainly during acute inflammatory phases, and the interstitial matrix may be invaded by fibrosis. All components of these tissue changes may induce an increase of renal elasticity which is not specifically related to fibrosis. Tubular, glomerular, interstitial and vascular changes may also be responsible for an increase of stiffness. This is why, further studies are now necessary before to understand the real impact of elastography measurement in clinical nephrology. Considering characterization of renal tumors with elastography, clinical experience is still limited. Preliminary results show that benign tumors seem to have lower values of elasticity than malignant ones, but, here too, more experience is also necessary.

#### RC410C Liver Elastography

### Participants

Paul S. Sidhu, MRCP, FRCR, London, United Kingdom, (paulsidhu@nhs.net) (*Presenter*) Speaker, Bracco Group; Speaker, General Electric Company

### LEARNING OBJECTIVES

1) To understand the concept of liver fibrosis grading and the implications for healthcare management. 2) To review the basis for the assessment of liver fibrosis using elastography, with emphasis on the different techniques. 3) To understand the differences in the techniques and the variability in measurement assessment. 4) To achieve an overview of the need and position of this technique in clinical care.

## ABSTRACT

Liver fibrosis and cirrhosis from many causes is an important cause of long term morbidity and mortality. Most cases are a consequence of chronic viral disease (Hepatitis B and C) with alcoholic liver disease an important aetiological factor. The degree of liver fibrosis, and the presence of established cirrhosis confer different management strategies, with imaging playing an important role in the non-invasive assessment of patients with chronic liver disease. Fibrosis grading traditionally performed using the Metavir or Ishak scoring system is essentially a histological grading system. Ultimately the possibility to avoid a liver biopsy is the aim, if a non-invasive technique can stage the grade of fibrosis, establishing correct patient management. Liver ultrasound elastography is a developing technique that offers this possibility, with varying methods of assessment ranging from strain methods and shear wave methods. These techniques will be explained, the status of the current standing of the techniques will be summarised, and the level of technology offered by different machines will be reviewed. An overall summary of the current status and the implications for clinical practice will be discussed.



**Practical Issues in Chest Imaging (An Interactive Session)**

Tuesday, Dec. 1 4:30PM - 6:00PM Location: E353C

**CH**AMA PRA Category 1 Credits™: 1.50  
ARRT Category A+ Credits: 1.50**Participants****Sub-Events****RC401A A Pattern Based Approach to Acute Parenchymal Opacities****Participants**Amita Sharma, MBBS, Boston, MA, (asharma2@mgh.harvard.edu) (*Presenter*) Nothing to Disclose**LEARNING OBJECTIVES**

1) At the conclusion of the session the attendee will be able to identify patterns of acute parenchymal opacities in a patient presenting with acute dyspnea. The attendee will learn to classify the distribution of disease according to the craniocaudal, axial distribution and distribution relative to the secondary pulmonary lobule. They will understand how to describe radiologic abnormalities as air-space opacities, including ground glass and consolidation, nodular opacities, linear opacities and areas of decreased attenuation. This knowledge will enable the attendee to apply a pattern based approach to differential diagnosis of acute parenchymal opacities in their clinical practice. This will enable a more focused differential diagnosis that can be used to direct further evaluation and management.

**ABSTRACT**

Patients often present to the emergency room with acute dyspnea. The chest radiograph or chest CT scan may show diffuse parenchymal opacities that may be due to a number of etiologies, such as infection, pulmonary edema, or malignancy. By analyzing the distribution of disease, characterizing the most pronounced radiologic abnormalities and incorporating the presence of ancillary findings, it is possible for the radiologist to offer a limited differential diagnosis to direct further evaluation or management. This talk will illustrate the common diseases that present with acute dyspnea and provide practical tips on the approach to diffuse parenchymal abnormalities detected on imaging.

**RC401B Unravelling Pulmonary Lymphoproliferative Disorders****Participants**Sam S. Hare, MBBS, MA, London, United Kingdom (*Presenter*) Nothing to Disclose**LEARNING OBJECTIVES**

1) Describe native pulmonary lymphoid tissue with emphasis on MDCT appearances of intrapulmonary lymph nodes. 2) Provide a simple classification system for the pulmonary lymphoproliferative disorder spectrum. 3) Identify the breadth of MDCT patterns associated with pulmonary lymphoproliferative disease. 4) Contrast the imaging manifestations of LIP versus pulmonary lymphoma. 5) Detect key MDCT patterns in secondary pulmonary lymphoma.

**ABSTRACT**

Pulmonary lymphoproliferative disorders (LPD) comprise a complex group of focal or diffuse abnormalities: benign LPD and primary pulmonary lymphoma are relatively rare whereas secondary pulmonary lymphoma is far more common. Understanding the spectrum of LPD, coupled with the diversity of potential imaging findings, is crucial because the radiologist is often the first to suggest the diagnosis and is therefore pivotal in differentiating these entities. This presentation will discuss practical LPD concepts relevant to everyday chest imaging by reviewing the more commonly encountered CT patterns in this disorder spectrum.

**RC401C ICU Radiology****Participants**Matthew D. Gilman, MD, Boston, MA (*Presenter*) Nothing to Disclose**LEARNING OBJECTIVES**

1) Understand the anatomic considerations of the more common ICU tubes and lines. 2) Recognize the proper positioning and malpositions of the more common ICU tubes and lines. 3) Understand the techniques of VA and VV ECMO and the implications for imaging.

**ABSTRACT**

Critical care patients often require invasive support and monitoring devices to support life and direct clinical management decisions. These tubes and lines are among the most common urgent findings in the imaging of the ICU patient. This presentation will illustrate the anatomy, proper positioning, and malpositions of the more common tubes and lines with illustrations and examples. Newer support devices (ECMO) and the potential pitfalls in imaging these patients will also be illustrated.

**RC401D Infections in Immunocompromised Hosts: Keeping Pace with the Changing Landscape****Participants**Rachna Madan, MD, Boston, MA, (rmadan@partners.org) (*Presenter*) Nothing to Disclose

## LEARNING OBJECTIVES

1) Discuss spectrum of immunocompromised hosts and infections associated with specific immune deficits. 2) To review clinical presentation, and imaging findings of pulmonary infections with emphasis on immunocompromised hosts. 3) Review imaging signs in infections. 4) Review the role of percutaneous sampling especially in tissue invasive infections where bronchoscopy and bronchial lavage may have low yield. 5) Discuss revised EORTC/MSG criteria for diagnosis of invasive fungal infections. 6) Emphasize diagnostic conundrums such as presence of multiple infectious processes, mimics of infection and immune reconstitution inflammatory syndrome (IRIS). 7) Use case scenarios to illustrate formulation of differential diagnosis by combining clinical, serological data with imaging findings.

## ABSTRACT

Infections are the most common pulmonary complications in immunocompromised patients and lung is the most frequently affected site of tissue invasive infection. It is imperative to adopt an aggressive approach to getting specific microbiologic diagnosis. Early cross sectional imaging with CT allows narrowing of differential diagnosis using radiological features and gives clues about the mechanism of spread, possible organism, burden of disease and guides subsequent invasive procedures such as lung biopsy. Imaging signs must be applied with caution and it is important to consider non-infectious etiologies. Pursuit of a unifying diagnosis is not always possible. Multiple infections may co-exist in a single organ. The radiologist must take on the role of an image guided clinician and combine clinical, serological and microbiological data with imaging features in making a diagnosis.

RC406

## Head and Neck College Bowl! (An Interactive Session)

Tuesday, Dec. 1 4:30PM - 6:00PM Location: E450B



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

### Participants

C. Douglas Phillips, MD, New York, NY (*Presenter*) Stockholder, MedSolutions, Inc Consultant, Guerbet SA  
Richard H. Wiggins III, MD, Salt Lake City, UT (*Presenter*) Nothing to Disclose  
Lawrence E. Ginsberg, MD, Houston, TX (*Presenter*) Nothing to Disclose

### LEARNING OBJECTIVES

1) Review important head and neck imaging differentials. 2) Recognize imaging appearances of common head and neck pathologies. 3) Understand important head and neck pathologies relationships to normal anatomy. Please bring your charged mobile wireless device (phone, tablet or laptop) to participate.

### ABSTRACT

A fun and light-hearted review of important head and neck imaging anatomy and pathology important differentials. This interactive session will use RSNA Diagnosis Live™. Please bring your charged mobile wireless device (phone, tablet or laptop) to participate.

### Honored Educators

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

Richard H. Wiggins III, MD - 2012 Honored Educator

**Quality and Safety in GU Radiology: Update on Best Practices, Contrast Material, and Radiation Dose**

Tuesday, Dec. 1 4:30PM - 6:00PM Location: E350

AMA PRA Category 1 Credits™: 1.50  
ARRT Category A+ Credits: 1.50**Participants**

Giles W. Boland, MD, Boston, MA (*Coordinator*) Principal, Radiology Consulting Group; Royalties, Reed Elsevier  
Richard H. Cohan, MD, Ann Arbor, MI, (rcohan@umich.edu) (*Presenter*) Consultant, General Electric Company; ; ;  
James A. Brink, MD, Boston, MA (*Presenter*) Nothing to Disclose

**LEARNING OBJECTIVES**

1) Understand the background and current status of best practice clinical and workflow management and its imperative for improving patient outcomes. 2) To review indications for premedication prior to contrast material administration. To summarize the current understanding of iodinated contrast media nephrotoxicity. To describe common errors made in treating contrast reactions. 3) To understand the requirement to match radiation dose according to the individual patient, clinical question and modality used. To outline meaningful radiation metrics including organ dosages and the overall radiation absorbed to estimate patient risk.

**ABSTRACT**

**BEST PRACTICES:** Increasingly medicine is being defined and evaluated based on patient outcomes rather than procedural events. While best practices are evolving and sometimes incomplete, many do exist, yet there is marked departmental variation from one organization to another. This session will outline why and how best practice implementation, particularly as it relates to IV contrast use and radiation dose, is essential to achieve better patient outcomes. This will require evaluation of current practices and comparison to nationally driven guidelines, with subsequent compliance to guidelines where they exist. **CONTRAST SAFETY:** Some patients have contrast reactions despite premedication. Patients who have repeated reactions in this setting tend to have reactions of similar severity. Studies performed with control groups suggest that there is minimal to no increased risk of contrast-induced renal failure in patients who receive iodinated contrast material; however, the control groups likely included patients at increased risk of acute kidney injury. Some errors treating contrast reactions relate to failure to administer epinephrine or using the wrong dose / wrong route. The act of administering this drug can also be problematic. **RADIATION DOSE:** In all radiological examinations that utilize x-rays, there are always three important issues that must be taken into consideration. The first relates to the appropriate amount of radiation to be used, which must always explicitly take into account the imaging task at hand as well as the physical characteristics of the patient undergoing the CT examination. The second issue is how to transform the radiation incident on the patient into the organ doses received which are essential to understanding (any) patient risks. The final consideration is to understand the radiological significance of the radiation absorbed by the patient, and to estimate (any) radiological risks, as well as the corresponding uncertainties.

RC415

## Breast MR Imaging (An Interactive Session)

Tuesday, Dec. 1 4:30PM - 6:00PM Location: E450A



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

### Participants

### Sub-Events

#### RC415A Image Quality and Interpretation

##### Participants

Debra M. Ikeda, MD, Stanford, CA (*Presenter*) Consultant, F. Hoffmann-La Roche Ltd; Consultant, Bracco Group

##### LEARNING OBJECTIVES

1) To review standard MRI acquisition parameters recommended by ACR Breast MRI BI-RADS. 2) To review MRI Interpretation according to ACR Breast MRI BIRADS terminology.

#### RC415B MR BI-RADS 3

##### Participants

Debra L. Monticciolo, MD, Temple, TX (*Presenter*) Nothing to Disclose

##### LEARNING OBJECTIVES

1) To review the current literature for BIRADS 3 in the MR setting. 2) To understand interpretations for which BIRADS 3 would or would not be appropriate.

##### ABSTRACT

Discussion will include the current literature on use of BIRADS 3, with attention to the MR setting. Cases where BIRADS 3 would be considered as well as cases not appropriate for BIRADS3 at MR will be shown.

#### RC415C Challenging Cases

##### Participants

Sujata V. Ghatge, MD, Durham, NC (*Presenter*) Nothing to Disclose

##### LEARNING OBJECTIVES

1) Identify challenging cases on breast MRI. 2) Recognize MR imaging findings of unusual breast lesions. 3) Review do's and don't of the breast MRI report. 4) Recommend appropriate management for difficult or esoteric lesions seen on MRI.

##### ABSTRACT

This lecture will review challenging cases on breast MRI. Participants will learn to identify MR imaging features of common breast diseases, recognize unusual and esoteric lesions, understand the importance of a clear and concise MRI report, and manage difficult cases seen on breast MRI. A total of 12 cases will be reviewed and imaging findings and appropriate management for each case will be discussed. At the conclusion of the case conference, audience participants will have the opportunity to ask questions and discuss unusual cases.

RC408

## Emergency Neuroradiology (An Interactive Session)

Tuesday, Dec. 1 4:30PM - 6:00PM Location: E353B



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

### Participants

### Sub-Events

#### RC408A Imaging of Non-traumatic Intracranial Hemorrhage

##### Participants

Diego B. Nunez JR, MD, MPH, New Haven, CT, (diego.nunez@yale.edu) (*Presenter*) Nothing to Disclose

##### LEARNING OBJECTIVES

1) Differentiate the imaging patterns of non-traumatic intracranial hemorrhage on initial presentation. 2) Recognize opportunities for providing a more precise diagnosis based on the initial CT findings. 3) Define and recommend the best additional imaging approach for appropriate patient management.

#### RC408B Imaging of Spine Infection

##### Participants

Wayne S. Kubal, MD, Tucson, AZ (*Presenter*) Stockholder, Stryker Corporation; Stockholder, Sarepta Therapeutics Inc; Stockholder, CVS Health Corporation

##### LEARNING OBJECTIVES

1) Understand how pathophysiology and anatomy determine the imaging appearance of spine infection. 2) Critically assess which imaging options offer the greatest sensitivity for both initial diagnosis and post treatment assessment of spine infection. 3) Be able to differentiate spine infection from common mimics most notably degenerative disease.

#### RC408C Imaging of Cervical Spine Trauma

##### Participants

Stuart E. Mirvis, MD, Baltimore, MD (*Presenter*) Nothing to Disclose

##### LEARNING OBJECTIVES

1) Recognize circumstances in which MRI is indicated for blunt cervical spine trauma. 2) Be familiar with the spectrum of radiologic findings associated with atlanto-occipital dissociation injuries. 3) Understand similarity in appearance and methods to distinguish stable from unstable hyperflexion injuries. 4) Know association of cervical spine injury patterns with vertebral artery injury.

##### ABSTRACT

##### Honored Educators

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

Stuart E. Mirvis, MD - 2015 Honored Educator

RC453

## Clinical Decision Support: Impact and Lessons from Large Scale Implementations

Tuesday, Dec. 1 4:30PM - 6:00PM Location: E353A



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

### Participants

Emanuele Neri, MD, Pisa, Italy (*Moderator*) Nothing to Disclose

### Sub-Events

#### RC453A Results and Lesson from the Medicare Imaging Demonstration

### Participants

Keith D. Hentel, MD, MS, New York, NY, (keh9003@med.cornell.edu) (*Presenter*) Nothing to Disclose

### LEARNING OBJECTIVES

1) To understand the lessons learned in the Weill Cornell Implementation of CDS for the MID. 2) Apply lessons learned in the MID to guide future CDS implementations.

#### RC453B Mass General Hospital

### Participants

Jeffrey B. Weilburg, MD, Boston, MA (*Presenter*) Nothing to Disclose

#### RC453C Virginia Mason

### Participants

C. Craig Blackmore, MD, MPH, Seattle, WA, (craig.blackmore@vmmc.org) (*Presenter*) Royalties, Springer Science+Business Media Deutschland GmbH

### LEARNING OBJECTIVES

1) To understand the implementation of clinical decision support at Virginia Mason. 2) To apply lessons learned from successful implementation of clinical decision support. 3) To analyze factors contributing to the success or failure of clinical decision support in decreasing inappropriate imaging.

### ABSTRACT

At Virginia Mason, we published one of the earliest clinical decision support programs for advanced imaging. That program differed in many important ways from other programs, including the Medical Imaging Demonstration project, by deploying a targeted intervention directed at a limited number of high cost/high utilization studies. Our clinical decision support system achieved 25% decreases in imaging across the included studies through use of a "hard stop" barrier whereby inappropriate imaging was not permitted to proceed.

#### RC453D Brigham and Women's Hospital

### Participants

Ramin Khorasani, MD, Roxbury Crossing, MA (*Presenter*) Consultant, Medicalis Corp

### ABSTRACT

Clinical Decision Support (CDS) has been recognized as an important tool in helping reduce inappropriate use of medical imaging to improve the quality of care and reduce waste by providing evidence-based recommendation to ordering providers at the time of order entry. Three federal regulations aimed to assess the impact of imaging CDS on use of high cost imaging, and promote and accelerate its use. 1. (Medicare Improvements for Patients and Providers Act or MIPPA) required CMS to perform a large scale demonstration project (Medicare Imaging Demonstration or MID; 2011-2014) to assess the impact of imaging CDS based on pre-determined professional society guidelines on utilization of ambulatory targeted high cost imaging procedures for Medicare fee for service patients. 2. Stage two of Meaningful Use of health IT federal regulations provide modest financial incentives for adoption of CDS, including for imaging, and 3. Promoting Evidence-Based care section of the Protecting Access to Medicare Act (PAMA) of 2014 mandates use of imaging CDS for specified ambulatory high cost imaging services as a requirement for payment for such services beginning January 2017. Despite these ongoing federal initiatives, adoption of imaging CDS has been limited in part because of ongoing debate on best practices for implementation and use of imaging CDS. In this session, speakers with experience in use of imaging CDS, including large scale implementation, will share their experience on impact of CDS, and lessons learnt from implementation of imaging CDS to help inform best practices for imaging CDS.



RC423

## Molecular Imaging Mini-Course: Clinical Applications of Molecular Imaging - Oncology

Tuesday, Dec. 1 4:30PM - 6:00PM Location: E352



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

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

### Participants

### Sub-Events

#### RC423A      **Diagnosis**

### Participants

Terence Z. Wong, MD, PhD, Chapel Hill, NC (*Presenter*) Nothing to Disclose

### LEARNING OBJECTIVES

1) Discuss the potential roles and limitations of PET imaging for amyloid and tau protein in evaluating patients with dementia. 2) Describe anatomic and functional MRI techniques for evaluating Alzheimer's disease. 3) Understand the clinical challenges of diagnosing and managing patients with dementia.

#### RC423B      **Staging**

### Participants

Dominique Delbeke, MD, PhD, Nashville, TN (*Presenter*) Nothing to Disclose

### LEARNING OBJECTIVES

1) The potential clinical indications of PET and PET/CT in the evaluation of patients with malignancies. 2) The impact on patient care. 3) Recommendations for PET/CT in the NCCN guidelines.

#### RC423C      **Evaluation of Treatment**

### Participants

David A. Mankoff, MD, PhD, Philadelphia, PA, (david.mankoff@uphs.upenn.edu) (*Presenter*) Speaker, Koninklijke Philips NV; Consultant, General Electric Company

### LEARNING OBJECTIVES

1) List applications of quantitative imaging for clinical trials. 2) Describe the approach to the design of cancer imaging trials. 3) Discuss biomarkers application for cancer imaging.

### Honored Educators

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

David A. Mankoff, MD, PhD - 2013 Honored Educator

**Abdominal Dual Energy CT in Practice**

Tuesday, Dec. 1 4:30PM - 6:00PM Location: E351



AMA PRA Category 1 Credits™: 1.50

ARRT Category A+ Credits: 1.50

**Participants**Desiree E. Morgan, MD, Birmingham, AL (*Presenter*) Research support, General Electric CompanyAlec J. Megibow, MD, MPH, New York, NY (*Presenter*) Consultant, Bracco GroupEric P. Tamm, MD, Houston, TX (*Presenter*) Nothing to DiscloseDaniel T. Boll, MD, Durham, NC (*Presenter*) Research Grant, Siemens AG; Research Grant, Koninklijke Philips NV; Research Grant, Bracco Group**LEARNING OBJECTIVES**

1) Understand the principles of image acquisition and post processing of dual energy CT technologies currently commercially available in the US. 2) Assess the technological innovations made possible with dual energy CT and the potential advances to enhance clinical practice and problem-solving in abdominal imaging. 3) Contrast the workflow issues and limitations of the various dual energy approaches as applicable to imaging of patients with abdominal disease.

**ABSTRACT**

After a brief overview of basic physics principles that distinguish the currently available dual energy CT scanner technologies, a variety of topics regarding dual source dual energy CT, single source dual energy CT, and sandwich detector dual energy CT will be covered by three experts using the technology in clinical practice. This will include image acquisition and patient experience, development of specific abdominal imaging protocols, workflow considerations, such as automated generation of blended images, virtual monoenergetic energy images, iodine/water material density images or iodine maps at the scanner level versus radiologist image manipulation, and will focus on real experience approaches to image interpretation. Strengths and limitations of dual source, single source, and sandwich detector dual energy CT will be demonstrated and discussed.

## Predicting Outcome with Cardiac CT - Which Is Best?

Tuesday, Dec. 1 4:30PM - 6:00PM Location: N226



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

### Participants

### Sub-Events

#### RC403A Calcium Scoring

### Participants

John J. Carr, MD, MS, Nashville, TN (*Presenter*) Nothing to Disclose

### ABSTRACT

Coronary artery calcifications document the presence of advanced atheroma in the coronary arteries. Calcified plaque is the "sclerosis" of atherosclerosis and thus is an established imaging biomarker of coronary artery disease. In this presentation we will review the evidence of CAC supporting application of CT measured CAC as a risk marker of coronary artery disease and evidence-based application for clinical practice and prevention in 2015 and beyond.

#### RC403B Coronary CT Angiography (CCTA)

### Participants

John R. Lesser, MD, Minneapolis, MN, (jrlesser1@gmail.com) (*Presenter*) Nothing to Disclose

### LEARNING OBJECTIVES

1) -Review the data predicting cardiac events from information obtained on cardiac CT angiography. 2) -Understand the predictive value of coronary CT angiography in the setting of acute chest pain in the emergency room. 3) -Understand the predictive value of CT angiographic findings in the setting of chronic chest pain. 4.) Review the additional predictive value of coronary CT angiography relative to calcium scoring in symptomatic vs asymptomatic populations.

### ABSTRACT

**Active Handout:** John Raymond Lesser

<http://abstract.rsna.org/uploads/2015/15003315/RC403B.pdf>

**Active Handout:** John Raymond Lesser

<http://abstract.rsna.org/uploads/2015/15003315/Active RC403B.pdf>

#### RC403C Myocardial Perfusion

### Participants

Ricardo C. Cury, MD, Miami, FL (*Presenter*) Research Grant, General Electric Company; Research Consultant, General Electric Company; Research Consultant, Novartis AG; Research Consultant, Heartflow, Inc

### LEARNING OBJECTIVES

1) To review the available literature supporting the growing evidence of myocardial perfusion to predict outcomes. 2) To discuss new imaging modalities, such as myocardial CT perfusion, and their current role. 3) To describe the current limitations and challenges of combined CTA/CTP evaluation and its future role.

### ABSTRACT

Myocardial perfusion imaging (MPI) is an integral component for the diagnosis and management of patients with coronary artery disease. Single photon emission computed tomography (SPECT) is the most frequently requested and widely available non-invasive MPI modality. Importantly, it provides an accurate assessment of the presence or absence of a myocardial perfusion abnormality, yields incremental prognostic information, and contributes to therapeutic decision making. Coronary CT angiography (CTA) is a non-invasive procedure with high diagnostic performance for the detection and exclusion of obstructive coronary stenosis. While CTA offers high sensitivity and negative predictive value, its specificity and positive predictive value are less robust and indicate a systematic over-estimation of stenosis severity. Further, even for high-grade stenoses correctly identified by CTA, comparison with a fractional flow reserve or SPECT reference standard indicates that more than half do not cause ischemia. These findings have evoked concerns that CTA without adjunctive physiologic data may promote excess referral to invasive angiography and/or revascularization. Stress myocardial CT perfusion (CTP) has been shown to provide a combined assessment of both cardiac anatomy and physiology. Multiple single-center studies have established its feasibility using stress agents such as adenosine, dipyridamole and regadenoson, with similar diagnostic accuracy compared with other techniques, including SPECT, fractional flow reserve, cardiac magnetic resonance imaging, and invasive coronary angiography (ICA). Recent multi-center trials also demonstrated promising results of using combined CTA and Stress myocardial CT perfusion (CTP) for a comprehensive cardiac evaluation.

## Preoperative Brain Tumor Imaging

Tuesday, Dec. 1 4:30PM - 6:00PM Location: N227



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

### Participants

Jay J. Pillai, MD, Baltimore, MD (*Moderator*) Medical Advisory Board, Prism Clinical Imaging, Inc; Author with royalties, Springer Science+Business Media Deutschland GmbH; Author with royalties, Reed Elsevier  
Haris I. Sair, MD, Baltimore, MD (*Moderator*) Research support, Carestream Health, Inc

### LEARNING OBJECTIVES

1) To understand, based on anatomic considerations, how to localize lesions along the brain surface. 2) To become familiar with DTI techniques, their limitations and their applications to neurosurgical planning. 3) To understand the value of BOLD fMRI in presurgical mapping of brain functional systems and appreciate the types of paradigms that are in clinical use.

### ABSTRACT

State-of-the-art preoperative brain tumor imaging will be described from the standpoint of neurosurgical planning. The lectures included in this course will cover gyral and other anatomic considerations for lesion localization, as well as the role that both diffusion tensor imaging (DTI) and blood oxygen level dependent (BOLD) functional MRI (fMRI) play in the delineation of eloquent cortex and white matter tracts. The importance of both DTI and BOLD fMRI in the accurate assessment of brain functional networks will be stressed in the context of presurgical mapping. The value, as well as limitations, of each of these approaches will be discussed.

### Sub-Events

#### RC405A Localization of Lesions Along the Brain Surface

### Participants

Thomas P. Naidich, MD, New York, NY (*Presenter*) Nothing to Disclose

#### RC405B Preoperative Diffusion Tensor Imaging: Toward Improving Neurosurgical Outcomes

### Participants

John L. Ulmer, MD, Milwaukee, WI, (julmer@mcw.edu) (*Presenter*) Stockholder, Prism Clinical Imaging, Inc Medical Advisory Board, General Electric Company

### LEARNING OBJECTIVES

1) To become familiar with DTI technique, visualization strategies, and limitations, as well as to identify strategies for defining spatial relationships between lesion borders and functional brain networks in order to guide Neurosurgical decision making.

### ABSTRACT

Presurgical mapping has revolutionized the neurosurgical care of brain tumor patients. Maximizing resections more safely can improve the accuracy diagnosis, optimized treatment algorithms, and most importantly, decrease the incidence of devastating postoperative deficits associated with injury to functional brain networks. Presurgical mapping in tumor and epilepsy patients is clearly a multi-parameter process, but diffusion tensor imaging (DTI) has had the most significant impact in reducing postoperative neurological complications and warrants focus. At the same time, the technique is among the available, easy to acquire, and easily translatable to clinical practice. By understanding the DTI technique, data visualization methods, effects of pathological processes, and technical limitations, and combining the DTI data with expertise in functional white matter anatomy, physicians can create patient-specific neurosurgical plans that define spatial relationships between lesion borders and functional brain networks. This, in turn, can impact surgical decision making, guide intraoperative assessments, and improve post-operative outcomes. Through case illustrations, this presentation provides strategies to translate DTI and fiber tracking, with all of their limitations, to clinical presurgical brain mapping. The presentation emphasizes the emerging and powerful clinical application of pre-surgical DTI.

#### RC405C Identification of Eloquent Cortex Using BOLD fMRI

### Participants

Jay J. Pillai, MD, Baltimore, MD (*Presenter*) Medical Advisory Board, Prism Clinical Imaging, Inc; Author with royalties, Springer Science+Business Media Deutschland GmbH; Author with royalties, Reed Elsevier

### LEARNING OBJECTIVES

1) Understand the value of Blood Oxygen Level Dependent functional magnetic resonance imaging (BOLD fMRI) in presurgical mapping in patients with resectable brain lesions. 2) Describe the functional systems that can be reliably activated using BOLD fMRI in the clinical setting. 3) Appreciate the types of BOLD fMRI paradigms that are typically utilized for presurgical mapping.

### ABSTRACT

This lecture will provide a basic overview of Blood Oxygen Level Dependent functional magnetic resonance imaging (BOLD fMRI) and how it can be used to effectively map eloquent cortex in various functional systems. Specifically, applications of BOLD fMRI to sensorimotor mapping, vision mapping as well as mapping of the language network will be described. The value that clinical BOLD fMRI has added to current state-of-the-art presurgical planning will be emphasized. In particular, the specific value that BOLD fMRI can add to standard structural brain MRI in the setting of resectable brain lesions such as brain tumors that distort classical

functional anatomic landmarks will be discussed.

RC409

## Gastrointestinal: CT Colonography (CTC)

Tuesday, Dec. 1 4:30PM - 6:00PM Location: E451A



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

### Participants

### Sub-Events

#### RC409A Colorectal Cancer Screening and CT Colonography

##### Participants

Kevin J. Chang, MD, Sharon, MA, (kchang@lifespan.org) (*Presenter*) Nothing to Disclose

##### LEARNING OBJECTIVES

1) Review the epidemiology and pathophysiology of colorectal cancer and justifications for colorectal screening. 2) Identify the targets of colorectal screening and provide the rationale for selective polypectomy. 3) Compare and contrast CT Colonography with other screening options.

##### ABSTRACT

#### RC409B Optimizing CTC-based CRC Screening - Programmatic Approach and QA Metrics

##### Participants

Elizabeth G. McFarland, MD, Saint Charles, MO (*Presenter*) Consultant, Toshiba Corporation

##### LEARNING OBJECTIVES

1) To review why CTC for screening is valuable for radiology practices. 2) To review the key elements of ACR Practice Parameters for patient preparation and CTC technique. 3) To review current insurance coverage issues and coding for CTC for screening and diagnostic uses. 4) To understand the ACR quality metrics for CT colonography currently in practice.

#### RC409C Technical Pitfalls at CTC and Problem Solving

##### Participants

Jessica B. Robbins, MD, Madison, WI, (jrobbins@uwhealth.org) (*Presenter*) Nothing to Disclose

##### LEARNING OBJECTIVES

1) Identify potential technical challenges encountered with CTC. 2) Describe techniques which may optimize colonic preparation. 3) Employ modifications to improve colonic distention in challenging situations.

##### ABSTRACT

#### RC409D Interpretative Pitfalls at CTC

##### Participants

Judy Yee, MD, Clayton, CA, (judy.yee@ucsf.edu) (*Presenter*) Research Grant, EchoPixel, Inc

##### LEARNING OBJECTIVES

1) To understand the causes of errors of CT colonography interpretation on both 2D and 3D images. 2) To learn the morphologic appearance of pitfalls on CT colonography and their differential diagnosis. 3) To apply strategies to avoid common and uncommon interpretive errors. 4) To apply appropriate techniques to avoid polyp measurement errors on untagged and tagged cases.

##### ABSTRACT

This presentation will provide a discussion of the causes of errors of interpretation on CT colonography. The appearances of common and common pitfalls will be demonstrated. The differential diagnosis of morphologic types of lesions will be presented. Accurate lesion measurement is essential for CT colonography since this directly impacts management recommendations. Causes of inaccurate measurements will be reviewed along with strategies as to how to improve measurement accuracy.

## Muscle-Tendon-Enthesal Unit: Form, Function, and Dysfunction with Emphasis on MR

Tuesday, Dec. 1 4:30PM - 6:00PM Location: E451B

MK

MR

AMA PRA Category 1 Credits™: 1.50

ARRT Category A+ Credits: 1.50

### Participants

Donald L. Resnick, MD, San Diego, CA (*Director*) Nothing to Disclose

Donald L. Resnick, MD, San Diego, CA (*Presenter*) Nothing to Disclose

Mini N. Pathria, MD, San Diego, CA (*Presenter*) Nothing to Disclose

Christine B. Chung, MD, San Diego, CA (*Presenter*) Nothing to Disclose

Brady K. Huang, MD, San Diego, CA (*Presenter*) Nothing to Disclose

### LEARNING OBJECTIVES

1) Understand how variations in the macroscopic architecture of muscle relate to its physiological function, affect its risk of injury, and determine the pathoanatomy and imaging appearance following muscle strain. 2) Understand anatomy and histology of tendon, its normal and abnormal imaging appearances, and common patterns of tendon pathology based on anatomic location. 3) Review the anatomy of the tendon-enthesal unit with emphasis on the types of lesion that affect the region of the footprint, with emphasis on MR imaging.



RC432

## Measuring Quality in Radiology

Tuesday, Dec. 1 4:30PM - 6:00PM Location: N230



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

### Participants

### Sub-Events

#### RC432A Business Intelligence and Analytics in Radiology: Scorecards, Dashboards, Big Data, and Beyond

### Participants

Paul J. Chang, MD, Chicago, IL, (pchang@radiology.bsd.uchicago.edu) (*Presenter*) Co-founder, Stentor/Koninklijke Philips NV; Researcher, Koninklijke Philips NV; Medical Advisory Board, lifeIMAGE Inc; Medical Advisory Board, Merge Healthcare Incorporated

### LEARNING OBJECTIVES

1) The technical steps required to develop and implement dashboards and scorecards (including data/state aggregation, semantic normalization, modeling, data mining, and presentation) will be discussed. 2) Specific strategies and technologies that can be used to create dashboards and scorecards (including HL7, DICOM, ETL, web services, and SOA) will be illustrated. 3) Strategies to create a sustainable and agile architecture to support advanced business intelligence and analytics (BIA) tools will be explored. (This course is part of the Leadership Track)

### ABSTRACT

Current and near future requirements and constraints will require radiology practices to continuously improve and demonstrate the value they add to the enterprise. Merely "managing the practice" will not be sufficient; groups will be required to compete in an environment where the goal will be measurable improvements in efficiency, productivity, quality, and safety. Although the phrase "one cannot improve a process unless one can measure it" is a familiar platitude, it is an increasingly important and relevant concept. The proper leveraging of formal Business Intelligence and Analytics (BIA) is a critical, absolutely essential strategy for any radiology group. Although currently underutilized, concepts such as Key Performance Indicators (KPIs), tactical dashboards, and strategic scorecards, should be familiar tools for radiology groups attempting to "navigate disruption."

#### RC432B Quality: Going Beyond the Metrics

### Participants

Jonathan W. Berlin, MD, Evanston, IL (*Presenter*) Nothing to Disclose

### LEARNING OBJECTIVES

1) Define population health and articulate the essential role of quality in this new health care paradigm. 2) Consider the key role of patient experience in the concept of radiology quality. 3) Explore the concepts of quality and value in radiology. (This course is part of the Leadership Track)

### ABSTRACT

Quality has become an essential component of radiology practices. But what is quality and how is it measured? The course will attempt to answer these questions from three perspectives. First, the perspective of quantitative radiology quality metrics and ways of measuring them will be explored, and methods of data analytics will be considered. Second, the concept of quality as it applies to a new health care delivery paradigm of population health will be analyzed. Population health is a framework in which health care entities and providers are tasked with keeping an entire defined population healthy, rather than the current healthcare delivery system that focuses largely on individual sick patients. The third speaker will address the essential role of patient satisfaction and positive patient experience in the concept of quality in radiology. These areas are increasingly prevalent in on line rating sites, a domain that is not typically assessed with current standardized quality metrics.

#### RC432C Demonstrating Quality to CMS and the Other Payors

### Participants

William T. Thorwarth JR, MD, Reston, VA (*Presenter*) Nothing to Disclose

### LEARNING OBJECTIVES

1) Define population health and articulate the essential role of quality in this new health care paradigm. 2) Consider the key role of patient experience in the concept of radiology quality. 3) Explore the concepts of quality and value in radiology. (This course is part of the Leadership Track)

### ABSTRACT

Quality has become an essential component of radiology practices. But what is quality and how is it measured? The course will attempt to answer these questions from three perspectives. First, the perspective of quantitative radiology quality metrics and ways of measuring them will be explored, and methods of data analytics will be considered. Second, the concept of quality as it applies to a new health care delivery paradigm of population health will be analyzed. Population health is a framework in which health care entities and providers are tasked with keeping an entire defined population healthy, rather than the current healthcare delivery system that focuses largely on individual sick patients. The third speaker will address the essential role of patient satisfaction and positive patient experience in the concept of quality in radiology. These areas are increasingly prevalent in on line rating sites, a domain that is not typically assessed with current standardized quality metrics.

**Histiocytosis from Head to Toe (In Conjunction with the American Institute for Radiologic Pathology)**

Tuesday, Dec. 1 4:30PM - 6:00PM Location: N229



AMA PRA Category 1 Credits™: 1.50

ARRT Category A+ Credits: 1.50

**Participants**Mark D. Murphey, MD, Reston, VA, (mmurphey@acr.org) (*Moderator*) Nothing to DiscloseMark D. Murphey, MD, Reston, VA, (mmurphey@acr.org) (*Presenter*) Nothing to DiscloseJeffrey R. Galvin, MD, Baltimore, MD (*Presenter*) Nothing to DiscloseKelly K. Koeller, MD, Rochester, MN (*Presenter*) Nothing to DiscloseDarcy J. Wolfman, MD, Bethesda, MD (*Presenter*) Nothing to DiscloseEllen M. Chung, MD, Bethesda, MD (*Presenter*) Nothing to Disclose**LEARNING OBJECTIVES**

1) Describe the typical clinical and pathological features of Langerhans cell histiocytosis. 2) Define the characteristic imaging patterns of Langerhans cell histiocytosis. 3) Understand the pathological basis for the imaging patterns of Langerhans cell histiocytosis.

**Honored Educators**

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

Mark D. Murphey, MD - 2015 Honored Educator

**Lung Cancer Screening: Getting Paid to Do Good**

Tuesday, Dec. 1 4:30PM - 6:00PM Location: N228



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

**Participants**

Pamela Kassing, Reston, VA (*Coordinator*) Nothing to Disclose

Pamela Kassing, Reston, VA (*Moderator*) Nothing to Disclose

Geraldine B. McGinty, MD,MBA, New York, NY (*Presenter*) Nothing to Disclose

Ezequiel Silva III, MD, San Antonio, TX, (zekesilva3@gmail.com) (*Presenter*) Nothing to Disclose

Mark O. Bernardy, MD, Conyers, GA (*Presenter*) Nothing to Disclose

Robert K. Zeman, MD, Washington, DC (*Presenter*) Nothing to Disclose

**LEARNING OBJECTIVES**

1) Understand the current process of how reimbursement for new procedures and technology is obtained from CPT code development, valuation and coverage. 2) Using Lung Cancer Screening as an example, the participants will become familiar with the specific processes for obtaining coverage for new screening programs in the public and private sectors and how a myriad of governmental agencies and other policymaking groups are involved in determining which new procedures are covered. 3) Understand how obtaining coverage will bring this new technology to the mainstream. 4) Interactive techniques will be used to engage the audience in the consideration of strategic partnerships between industry, clinical research, governmental agencies and third party payors.

**URL****Handout:Pamela Kassing**

[http://abstract.rsna.org/uploads/2015/14000570/RSNA2015-PPT\\_slides\\_MOB\\_11-23\\_final.pptx](http://abstract.rsna.org/uploads/2015/14000570/RSNA2015-PPT_slides_MOB_11-23_final.pptx)

**Handout:Ezequiel Silva**

[http://abstract.rsna.org/uploads/2015/14000570/Lung\\_Cancer\\_Screening\\_speaker\\_notes.docx](http://abstract.rsna.org/uploads/2015/14000570/Lung_Cancer_Screening_speaker_notes.docx)

## Hepatocellular Carcinoma in the Cirrhotic Liver and LI-RADS (An Interactive Session)

Tuesday, Dec. 1 4:30PM - 6:00PM Location: S402AB



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

### Participants

### Sub-Events

#### RC429A LI-RADS Overview, Current Status, and Future Directions

### Participants

Cynthia S. Santillan, MD, San Diego, CA, (csantillan@mail.ucsd.edu) (*Presenter*) Consultant, Robarts Clinical Trials Research Group

### LEARNING OBJECTIVES

1) To teach participants how to apply the Liver Imaging Reporting and Data System (LI-RADS) to their interpretation of imaging studies for the evaluation of hepatocellular carcinoma in at-risk patients. 2) To inform radiologists about the various online resources available via the ACR LI-RADS website, including an atlas, lexicon, reporting templates, and flashcards. 3) To update radiologists about future content in LI-RADS, including ultrasound and treatment response assessment guidelines.

### ABSTRACT

#### RC429B LI-RADS Imaging Features: What's the Evidence?

### Participants

An Tang, MD, Montreal, QC (*Presenter*) Speaker, Boehringer Ingelheim GmbH; Speaker, Siemens AG, ; Advisory Board, Imagia

### LEARNING OBJECTIVES

1) To review the major and ancillary CT and MRI features used in LI-RADS categorization for assessment of hepatocellular carcinoma (HCC). 2) To highlight the scientific literature supporting the major imaging features and criteria. 3) To summarize the evidence supporting ancillary features.

### ABSTRACT

The Liver Imaging Reporting and Data System (LI-RADS) relies on major and ancillary CT and MRI features to categorize observations for assessment of hepatocellular carcinoma (HCC). The major features include arterial phase enhancement, diameter, "washout" appearance, "capsule" appearance and threshold growth. In this course, we will discuss the scientific literature supporting the major imaging features. This will include estimates of diagnostic performance, and intra- and inter-reader agreement. LI-RADS also includes ancillary imaging features that modify the likelihood of HCC. We will provide a brief overview of the evidence supporting these ancillary features.

#### RC429C LI-RADS and Hepatobiliary Agents

### Participants

Kathryn J. Fowler, MD, Chesterfield, MO (*Presenter*) Research support, Bracco Group

### LEARNING OBJECTIVES

1) To provide an overview of LI-RADS content that refers to hepatobiliary contrast agents. 2) To review the ancillary features that are described with hepatobiliary contrast agents. 3) To present case examples to illustrate the role of hepatobiliary contrast agents in the diagnosis of hepatocellular carcinoma.

### ABSTRACT

Hepatobiliary contrast agents are routinely used in practice for diagnosing and staging HCC. Despite the potential diagnostic benefits, the role of hepatobiliary phase imaging has not been well defined in diagnostic algorithms. LI-RADS provides information on the use of these agents, their role in diagnosis, and potential pitfalls. The aim of this presentation is to provide an overview of hepatobiliary content included in the current version of LI-RADS.

#### RC429D LI-RADS LR-5 versus LR-M

### Participants

Thomas A. Hope, MD, San Francisco, CA, (thomas.hope@ucsf.edu) (*Presenter*) Advisory Committee, Guerbet SA; Research Grant, General Electric Company

### LEARNING OBJECTIVES

1) Understand the LR-M categorization and its role in LI-RADS. 2) Review imaging features that suggest LR-M. 3) Apply LI-RADS categorizations in cases of LR-5 and LR-M.

### ABSTRACT

In at patients at risk for hepatocellular carcinoma (HCC), the diagnosis of malignancies other than HCC can be difficult. LI-RADS provides a categorization (LR-M), which should be used to indicate lesions that may represent malignancies other than HCC. In this

course, we will review the LI-RADS categorization LR-M and its relationship to LR-5. We will discuss findings that suggest LR-M and provide case examples where the diagnosis of LR-M and LR-5 should be made. We will also discuss how a LR-M categorization may affect clinical decision making.

RCA35

## Creating, Storing, and Sharing Teaching Files Using RSNA's MIRC® (Hands-on)

Tuesday, Dec. 1 4:30PM - 6:00PM Location: S401AB



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

### Participants

Krishna Juluru, MD, New York, NY (*Moderator*) Nothing to Disclose

Omer A. Awan, MD, Baltimore, MD (*Presenter*) Nothing to Disclose

### LEARNING OBJECTIVES

1) Learn how easy it is to install the new and improved RSNA teaching file software with the one-click installer. 2) Learn how to create, organize, and share teaching files, create conference documents and save interesting cases for yourself, your group or your department.

**Quantitative Imaging Mini-Course: Statistical Analysis/Metrology Issue**

Tuesday, Dec. 1 4:30PM - 6:00PM Location: S403B



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

**Participants**

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

**Sub-Events****RC425A The Role of Metrology in Quantitative Imaging****Participants**

Hyung J. Kim, PhD, Los Angeles, CA, (gracekim@mednet.ucla.edu) (*Presenter*) Nothing to Disclose

**LEARNING OBJECTIVES**

1) Understand the role of QI and its intended application. 2) Understand how to apply a study design for developing, evaluating, and validating a measurement of QI in a targeted population.

**ABSTRACT**

Many applications of using quantitative imaging biomarkers (QIB) have been reported in numerous scientific domains. Challenges are to obtain a universally consistent terminology or methods in reporting measurement variation of QIB under the various circumstances of scanners, readers, and software. Understanding variation of "measureland" (The quantity intended to be measured (VIM clause 2.3)) in radiological imaging is critical to set a clinically meaningful benchmark of a QI. To estimate a variation of measureland, the study design is a critical basis for developing, evaluating, and validating a QIB using a standard variation metric. Reporting an estimated measurement universally is an initialized step for combining the knowledge across studies and centers as part of evaluation and validation by an independent party. We will discuss the procedure starting from research question, study design, and the corresponding statistical methods toward development, evaluation, and validation of a measurement of QIB in a targeted population.

**RC425B Methods for Technical Performance Assessment: What to Assess and How****Participants**

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

**LEARNING OBJECTIVES**

1) Understand how to apply bias/linearity, repeatability and reproducibility analyses in characterizing the technical performance of a quantitative imaging metric. 2) Understand how technical performance can affect the utility of a quantitative imaging biomarker or Radiomic signature.

**ABSTRACT**

Developments in extracting biological information from medical images have given rise to a number of proposed quantitative imaging biomarkers (QIBs) and the field of Radiomics. Critical to these research areas is the establishment of accurate and reproducible quantitative imaging (QI) metrics and the establishment of appropriate and widely accepted assessment methods. In this section of the refresher course, we will update the audience on the latest recommendations for assessing the technical performance of individual QI metrics. We will also present an example case in which we assess the technical performance of a lung nodule volume estimation tool.

**RC425C Statistical Methods and Principles for Algorithm Comparison Assessment****Participants**

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

**LEARNING OBJECTIVES**

1) Understand objectives of algorithm comparison studies and study design principles. 2) Understand methods for testing hypotheses, estimating performance, and producing descriptive summaries for algorithm comparison. 3) Observe illustrations of how the methods are applied to real data.

**Handout:Gene Pennello**

[http://abstract.rsna.org/uploads/2015/15003205/Gene RSNA 2015 Talk 2015 12 01.pdf](http://abstract.rsna.org/uploads/2015/15003205/Gene%20RSNA%202015%20Talk%202015%2012%2001.pdf)



RC411

## Update on Radionuclide Therapies

Tuesday, Dec. 1 4:30PM - 6:00PM Location: S504CD



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

### Participants

### Sub-Events

#### RC411A New Guidelines for I-131 Therapy of Thyroid Cancer

##### Participants

Don C. Yoo, MD, Providence, RI (*Presenter*) Nothing to Disclose

##### LEARNING OBJECTIVES

1) Describe why thyroid cancer is increasing. 2) Review guidelines for the use of I-131 in the treatment of thyroid cancer. 3) Review the controversies in thyroid cancer treatment.

##### ABSTRACT

The purpose of this educational activity is to review the reasons why the incidence of thyroid cancer has risen so rapidly over the last 40 years and discuss the role of radioiodine ablation in patients with thyroid cancer. Issues that will be discussed include controversies in the extent of thyroid surgery and the appropriate use of radioiodine ablation in patients with thyroid cancer which is controversial in low risk and intermediate risk patients. The incidence of thyroid cancer in the United States has almost tripled since the early 1970s with unchanged mortality principally due to overdiagnosis. The extent of surgery performed for thyroid cancer is controversial especially in small cancers but only patients with complete thyroidectomy are candidates for radioiodine ablation. Recently lower doses of I-131 have been shown to be effective for radioiodine ablation of remnant thyroid tissue after thyroidectomy. High risk patients will benefit from radioiodine ablation with decreased recurrence and improved mortality. Radioiodine ablation in low risk patients is very controversial and has not been shown to improve mortality.

#### RC411B Ra-223 Therapy for Bone Metastases

##### Participants

Eric M. Rohren, MD, PhD, Houston, TX (*Presenter*) Nothing to Disclose

##### LEARNING OBJECTIVES

Radium-223 is a recently approved therapy for patients with metastatic prostate cancer to bone. The use of radium-223 is increasing worldwide, and new applications are being evaluated. The objectives of this presentation are: 1) Review the chemistry and mechanism of action of Ra-223. 2) Understand the approved indications for Ra-223. 3) Illustrate the techniques and procedures for radium administration using a case-based approach.

##### ABSTRACT

Radium-223 is an alpha-emitting radiopharmaceutical approved for use in men with castration-resistant prostate carcinoma. The use of radium in a clinical setting will be discussed, including the rationale, patient eligibility, administration, and follow-up, as well as radiation safety precautions and handling. Illustrative cases will be presented.

##### Honored Educators

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

Eric M. Rohren, MD, PhD - 2015 Honored Educator

#### RC411C Hepatic Artery Infusion Therapy with Y90 Microspheres

##### Participants

Charles Y. Kim, MD, Durham, NC, ([charles.kim@duke.edu](mailto:charles.kim@duke.edu)) (*Presenter*) Research Grant, Galil Medical Ltd; Consultant, Kimberly-Clark Corporation; Consultant, Cryolife, Inc

##### LEARNING OBJECTIVES

1) Review range of malignancies treated with Y90 microsphere infusion. 2) Discuss the types of Y90 therapy and dosimetric considerations. 3) Describe the procedures and technical steps involved in Y90 therapy. 4) Recognize pertinent scintigraphic findings associated with Y90 therapy.

##### ABSTRACT

Intra-arterial Yttrium-90 (Y90) therapy is an important treatment modality for a variety of hepatic tumors. While numerous types of embolotherapies are employed by interventional radiologists for treatment of cancer, Y90 therapy is unique in its multimodality and multi-procedural nature. Not only does this treatment effect rely on deposited ionizing radiation therapy, but scintigraphic imaging is also an integral component of treatment. Two types of Y90 therapies are available, made by two different manufacturers. The

differences between the two types are subtle, but there are differences in administration and manufacturer-recommended dosimetric calculation. These various differences will be highlighted. Y90 therapy is comprised of several steps and is frequently subclassified into a "planning" phase and "treatment" phase. In the planning phase, detailed angiographic imaging is performed to delineate arterial anatomy , determine tumoral distributions, and redistribute vascular flow if indicated. Scintigraphic imaging is an integral component of this planning phase, in order to help identify angiographically occult arterial anomalies, confirm appropriate infusion site, and to quantify the hepatopulmonary shunt fraction. From this information, as well as other factors, the appropriate treatment doses can be determined. In the treatment phase(s), the Y90 dose is administered to the appropriate portions of the liver with subsequent scintigraphic imaging for confirmation.

MSRO39

## **BOOST: CNS-eContouring**

Tuesday, Dec. 1 4:45PM - 6:00PM Location: S104B



AMA PRA Category 1 Credits <sup>™</sup>: 1.25  
ARRT Category A+ Credits: 1.50

### **Participants**

Jonathan P. Knisely, MD, Lake Success, NY (*Presenter*) Travel support, Elekta AB; Travel support, BrainLAB AG; Speaker, BrainLAB AG; Travel support, Cyber Medical Corporation Limited  
Jesty R. Abraham, DO, Philadelphia, PA (*Presenter*) Nothing to Disclose

### **LEARNING OBJECTIVES**

1) Define normal anatomy in the CNS. 2) Define and contour the GTV/CTV for Glioma. 3) Define and contour the GTV/CTV for CNS tumors.

### **ABSTRACT**

The safe and successful treatment of brain tumors is depending upon accurately and reliability being able to identify normal CNS anatomy, and regions of gross tumor and regions at risk. This course will teach participants to identify normal anatomy and define the GTV and CTV for brain tumors.