



ZACHARY CLARK
RADIOLOGY
RESEARCH
SYMPOSIUM
APRIL 27, 2024



Department of Radiology
UNIVERSITY OF WISCONSIN
SCHOOL OF MEDICINE AND PUBLIC HEALTH

PROGRAM

8:00 – 8:30am:	Continental Breakfast in Atrium
8:30 – 8:45am:	Welcome & Introduction <i>Scott Reeder, MD, PhD, Department of Radiology Chair</i> <i>Andrew Ross, MD, MPH, Presenter of Lovell Scholars</i> <i>Allison Grayev, MD, Co-Moderator</i> <i>Giuseppe Toia, MD, Co-Moderator</i>
8:45 – 10:15am:	Oral Presentations
10:15 – 10:45am:	Electronic Exhibits Viewing
10:45 – 11:45am:	Keynote: “Mentorship, Sponsorship, and Coaching: My Secrets to Success in Imaging Informatics.” <i>Tessa Cook, MD, PhD, University of Pennsylvania</i>
11:45am – Noon:	Recognitions & Concluding Remarks

KEYNOTE

TESSA COOK, MD, PhD



The esteemed radiologist and informaticist **Tessa Cook, MD, PhD** will present the keynote address “Mentorship, Sponsorship, and Coaching: My Secrets to Success in Imaging Informatics.”

Dr. Cook is an associate professor of radiology at the University of Pennsylvania and holds numerous leadership positions, including director of the 3-D and Advanced Imaging Laboratory and director of the Center for Practice Transformation in Radiology.

Her current research endeavors are focused on imaging and clinical informatics, workflow optimization, innovation and practice transformation, patient-centered care, follow-up monitoring, and artificial intelligence in radiology.

JUDGES

Each year, faculty members volunteer to evaluate the oral presentations and electronic exhibits showcased at our symposium. We want to thank them for the time and thought they give to this endeavor.

Judges for Oral Presentations

Edward Lawrence, MD, PhD

Prashant Nagpal, MD

Timothy Ziemlewicz, MD

Judges for Electronic Exhibits

Teresa (Tess) Chapman, MD

Andrew (Drew) Ross, MD, MPH

Michael Veronesi, MD, PhD

AUDIENCE FEEDBACK

Provide your assessment, comments and questions on individual oral presentations and electronic exhibits. Presenters will receive this input and you can include your name if you wish to be contacted by them.

ORAL PRESENTATIONS

1. Review details in this program
2. Listen to presentations
3. Submit feedback and questions at go.wisc.edu/zcrrsoralfeedback

ELECTRONIC EXHIBITS

1. Review details in this program
2. Review the exhibits in the atrium or log into the Intranet and [view PDFs](#)
3. Submit feedback and questions at go.wisc.edu/ZCRRSexhibitfeedback



Madeline Jentink, DO

Level: Resident

Faculty Mentor: Fred Lee, MD

Title: Hydrodissection: The Usual, The Unusual, and The Crazy

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Ece Meram, MD

Level: Resident

Faculty Mentor: John Swietlik, MD

Title: Can Portal Venous Interventions Help with Refractory Chylous Ascites or Chylothorax?

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Vyshnavi Reddy, MD

Level: Resident

Faculty Mentor: Sandip Biswal, MD

Title: Light 'Em Up! Early Experience Utilizing 18F-FDG PET/MRI to Pinpoint Pain Generators in Patients with Diagnostically Challenging Chronic Pain

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Erik Winterholler, MD

Level: Resident

Faculty Mentor: Timothy Ziemlewicz, MD

Title: Reduction of Respiratory Motion Effect in Liver Histotripsy by Use of High Frequency Jet Ventilation

Summary on Page 13



Stephen Polanski, MD

Level: Fellow

Faculty Mentor: J Louis Hinshaw, MD

Title: Pilot Study Evaluating the Efficacy of Organ Displacement Using Hydrogel, Outside of Prostate Radiation

Summary on Page 14



Leslie Nelson, DO

Level: Fellow

Faculty Mentor: Elizabeth Sadowski, MD

Title: The Impact of MRI after Ultrasound on Patient Management using the O-RADS Risk Score

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Karla Wetley, MD

Level: Fellow

Faculty Mentor: Andrew Ross, MD

Title: Translating Musculoskeletal MRI Reports into Patient-friendly Summaries Using ChatGPT

Summary on Page 16



Allison Couillard, MD

Level: Resident

Faculty Mentor: Fred Lee, MD

Title: Renal Bleeding Events with Histotripsy versus Cryoablation in a Porcine Model

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Leslie Nelson, DO

Level: Fellow

Faculty Mentor: Perry Pickhardt, MD

Title: Longitudinal Intra-patient Changes in CT Body Composition Measures Associated with Semaglutide Use

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Vansh Jain

Level: Medical Student

Faculty Mentor: Mark Kleedehn, MD and Erica Knavel Koepsel, MD

Title: A Large Single-Institution Review of Bard Denali IVC Filter Complication Rates

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Peter Cormier, MD

Level: Fellow

Faculty Mentor: Kenneth Lee, MD, MBA

Title: Where does it hurt? Variability in Location of Edema Relative to MRI Compatible Pain Marker in Collegiate Football Players with Hamstring Strain Injury

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Emily Kruger, MD

Level: Resident

Faculty Mentors: Maria Daniela Martin Rother, MD; Jeffrey Kanne, MD; Brian Mullan, MD

Title: Phantoms of the Thorax

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Kyle Lacy, MD

Level: Fellow

Faculty Mentors: Mitchell Daun, MD; Andrew Ross, MD

Title: Evaluating the Effectiveness of a Resident-Generated Musculoskeletal Anatomy Study Guide in Enhancing Radiology Resident Confidence and Proficiency in Interpreting Musculoskeletal MRI

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Leslie Nelson, DO

Level: Fellow

Faculty Mentor: Perry Pickhardt, MD

Title: Spectrum of Heterotopic & Ectopic Splenic Conditions

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Jacob McCallum, DO

Level: Fellow

Faculty Mentor: Andrew Ross, MD

Title: AI Chatbot Utility in Answering Patient Questions about Procedures

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Alexander Moeller, MD

Level: Resident

Faculty Mentor: Tabassum Kennedy, MD

Title: Sinus Tumors – What the Tumor Board Wants to Know

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Faculty Mentor: John Symanski, MD

Title: Spotlight on Musculoskeletal Lymphoma: A Radiological Exploration of an Uncommon Entity

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Faculty Mentor: Perry Pickhardt, MD

Title: Fully Automated CT Imaging Biomarkers of Bone, Muscle, and Fat: Correcting for the Effect of Intravenous Contrast during Angiographic Phase

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Faculty Mentor: Perry Pickhardt, MD

Title: Comparing Automated Abdominal and Thoracic Aortic Agatston Measurements Derived from a Deep Learning-Based Model

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Katharine Molinarolo, MD

Level: Fellow

Faculty Mentor: Perry Pickhardt, MD

Title: Signet Ring Cell Adenocarcinoma of the GI Tract: Tour of Common and Uncommon Appearances from the Esophagus to Rectum

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Jessica Perry, MD

Level: Resident

Faculty Mentor: Joseph Tang, MD

Title: Atraumatic Non-Degenerative Back Pain: Missed Opportunities in Diagnosis

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Elliott Russell, MD

Level: Resident

Faculty Mentor: John Swietlik, MD

Title: Let Me Show You The Way: How Electromagnetic Navigation Systems Can Improve Your Practice

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Alankrit Shatadal, BS, BA

Level: Medical Student

Faculty Mentor: Allison Grayev, MD

Title: A Picture is Worth a Thousand Words: Correlating Description of Calcifications on Non Contrast Head CT with Final Diagnosis

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Anna Sorensen, MD

Level: Resident

Faculty Mentor: Fred Lee, MD

Title: Real-Time Electromagnetic CT Navigation (E-CTN) for Percutaneous Needle Placement

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Annie Zlevor

Level: Medical Student

Faculty Mentor: Fred Lee, MD

Title: CT-guided Percutaneous Interventions: Reduction of Metal Needle-Tip Artifact with Low Atomic Number Materials in Phantom and Porcine Models

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THANKS

The symposium would not be possible without the committee. The department appreciates their dedication to creating this event to highlight the accomplishments of our fellows, residents and medical students.

Symposium Committee

Brenna Burke, *Communications Specialist*

Camille Endres, MBA, *Chief Administrative Officer*

Sarah Fallon, *Event Manager*

Whitney Hanson Larson, *Event Coordinator*

Anna Hildebrandt, *Communications Manager*

Tabby Kennedy, MD, *Vice Chair of Communications*

Frank Korosec, PhD, *Interim Vice Chair of Research*

Scott Reeder, MD, PhD, *Department Chair*

Maggi Schrader, *GME Program Manager*

Katie Yang, *Assistant Director of Education*

HONORING ZACHARY CLARK



This symposium honors the memory of **Zachary Clark, MD**, a former radiology resident known for his excellent clinician skills, kindness, and enthusiasm for research. Neuroradiology was his primary focus, especially cerebrovascular disease research.

In the spirit of his passion for research, we dedicate this symposium to Dr. Zachary Clark.

ORAL PRESENTATIONS



Madeline Jentink, DO

Level: Resident

Faculty Mentor: Fred Lee, MD

Previous Presentation: Spectrum 2024

Hydrodissection: The Usual, The Unusual, and The Crazy

Citation: Jentink MS, Lee Jr. FT, Swietlik JF, Laeseke PF, Hinsaw JL, Stratchko LM, Knavel Koepsel EM, Ziemlewicz TJ. Hydrodissection: The Usual, The Unusual, and The Crazy. Presented at Spectrum 2024, Miami, FL. January 12, 2024.

Category of Submission: Ablative Therapy

Purpose: Percutaneous thermal ablation can lead to unintended injuries if the ablation zone extends into an adjacent vulnerable structure such as bowel. Thus, selection of candidates for thermal ablation historically involved a careful evaluation of structures adjacent to the planned ablation zone with many patients denied treatment. The discovery of hydrodissection increased the number of patients eligible for thermal ablation, particularly for the liver and kidney. During hydrodissection, fluid is used to dissect a plane between the target and adjacent at-risk tissue in order to allow for a safe window for ablation. Selection of a specific hydrodissection fluid is dependent on the thermal ablation modality, location of the tumor, and image guidance technique. Artificial ascites is a subtype of hydrodissection where fluid is instilled into the peritoneum, providing separation of peritoneal target structures (generally the liver) from adjacent at-risk tissues such as bowel. A side-benefit of artificial ascites is better ultrasound visualization of many liver tumors due to caudal displacement of the liver and a better ultrasound window created by the injected fluid. The purpose of this review is to explore the various ways in which hydrodissection can be used to facilitate thermal ablation.

Materials and Methods: A thermal ablation database (1994-2023) was searched for cases that were performed with hydrodissection and artificial ascites. Representative examples of hydrodissection used to aid in the radiofrequency, microwave, and cryoablation treatment of liver, kidney, retroperitoneal, chest, extremities, and pelvic tumors were collected.

Results: Hydrodissection can be safely used with cryoablation, radiofrequency ablation and microwave ablation for treatment of tumors throughout the body. Peritoneal and retroperitoneal hydrodissection are the most common ways the technique is used at our institution for ablation of solid tumors within the abdomen. Peritoneal artificial ascites is commonly performed in two ways: Direct stick into the peritoneum vs. Seldinger technique for placement of a peritoneal sheath. Less commonly employed uses of hydrodissection will be highlighted, including hydrodissection for treatment of tumors of the musculoskeletal system, mediastinum, pleural space, and pelvis.

Conclusion: Hydrodissection is a powerful tool that enables the treatment of a large number of tumors by percutaneous radiofrequency, microwave, or cryoablation which would otherwise not be feasible or safe.

ORAL PRESENTATIONS



Ece Meram, MD

Level: Resident

Faculty Mentor: John Swietlik, MD

Previous Presentation: Society of Interventional Radiology

Can Portal Venous Interventions Help with Refractory Chylous Ascites or Chylothorax?

Citation: Meram E, Ozkan O, Woods MA, Monroe E, Swietlik J. Can portal venous interventions help with refractory chylous ascites or chylothorax? SIR Annual Meeting, 2024.

Purpose: Chylous fluid accumulation in the setting of portal hypertension remains rare (< 1%). The data on endovascular decompressive interventions for refractory cases, such as TIPS and portal venous recanalization, is limited. This study aimed to investigate if portal venous interventions can decrease the volume of refractory chylous ascites or chylothorax.

Materials and Methods: An IRB-approved single-center retrospective review identified patients from 2011 to 2022 who underwent portal interventions, including TIPS and portal angioplasty/stenting. Ten patients were identified who underwent a portal intervention for documented chylous ascites (n=8) or chylothorax (n=2) by fluid analysis. Median triglyceride level in body fluids was 155 mg/dL. Portal interventions included TIPS placement in 8 patients (2 of which with thrombectomy), and portal vein angioplasty and stenting in 2 patients. Technical success, procedural details, adverse events, and clinical success were recorded. Descriptive statistics and paired t-tests were used for analysis.

Results: The technical success of portal interventions was 100%. The initial mean portal pressure gradient was 15 mmHg. Post-intervention mean portal pressure gradient was 7.1 mmHg, with a mean decrease of 7.9 mmHg. All patients (10/10) had decreased chylous fluid volume post-intervention with approximately 64% reduction in mean centesis volume (p=0.001). In 5 patients (50%), complete resolution of the chylous fluid was achieved within 30 days of the intervention. The median time to last fluid removal (i.e. paracentesis or thoracentesis) after portal intervention was 54 days. No moderate or severe procedural adverse events occurred. Five out of 8 patients developed medically manageable hepatic encephalopathy following TIPS placement.

Conclusion: In the setting of refractory chylous ascites or chylothorax associated with elevated portal venous pressures, decompressive portal interventions are safe and clinically effective.

ORAL PRESENTATIONS



Vyshnavi Reddy, MD

Level: Resident

Faculty Mentor: Sandip Biswal, MD

Previous Presentation: Society of Skeletal Radiology

Light 'Em Up! Early Experience Utilizing 18F-FDG PET/MRI to Pinpoint Pain Generators in Patients with Diagnostically Challenging Chronic Pain

Citation: Reddy V, van der Heijden RA, Pirasteh A, Biswal S. Light 'Em Up! Early Experience Utilizing 18F-FDG PET/MRI to Pinpoint Pain Generators in Patients with Diagnostically Challenging Chronic Pain. Annual SSR Meeting, Live, March 2-6, 2024.

Purpose: Chronic pain is now the number one reason for medical visits and a major driver of the opioid epidemic. Oftentimes, patients with chronic pain exhaust standard treatment options with little symptomatic relief due to our inability to precisely identify pain generators. 18F-FDG PET/MRI provides a highly sensitive method to identify sites of active inflammation. Our goal is to determine whether 18F-FDG PET/MRI can improve outcomes in patients with challenging pain conditions.

Materials and Methods: Six patients, whose source of chronic pain was unclear, were referred for 18F-FDG PET/MR imaging by their physicians. Potential pain generators were identified as increased FDG uptake on PET and/or T2 abnormalities on MRI. The patients were then followed to determine if their referring physicians altered their management based on the imaging findings.

Results: Six patients with spinal pain had 18F-FDG PET/MRI results that directly impacted management after reviewing the results with their referring physicians. In five out of six cases, a diagnostic injection at a new site was attempted or recommended. In one case, surgery was recommended. Patient number two, for example, had chronic thoracolumbar pain following a history of T11-12 discitis/osteomyelitis. The neurosurgeon was unsure on how to proceed given the possibility of recurrent infection. PET/MRI revealed metabolic/stress changes at the T12 pedicle likely due to altered biomechanics and importantly confirmed no recurrent infection. Surgery was offered to the patient. Patient number four had lower back pain initially attributed to Bertolotti's disease, but 18F-FDG PET/MRI demonstrated increased FDG uptake in both sacroiliac joints (red arrows) consistent with sacroiliitis and a lack of uptake at the pseudo-articulation (green arrow). Bilateral SI joint injections were performed with excellent symptomatic relief.

Conclusion: In our early experience, 18F-FDG PET/MRI can be helpful in identifying challenging pain generators and is preliminarily altering management by providing favorable outcomes to individuals suffering from chronic pain.

ORAL PRESENTATIONS



Erik Winterholler, MD

Level: Resident

Faculty Mentor: Timothy Ziemlewicz, MD

Previous Presentation: Spectrum 2024

Reduction of Respiratory Motion Effect in Liver Histotripsy by Use of High Frequency Jet Ventilation

Citation: Winterholler JE, Kisting MA, Falk KL, Kisting AL, Jentink MS, White JK, Lubner MG, Laeseke PF, Stratchko LM, Knavel-Koepsel EM, Swietlik JF, Hinshaw JL, Ferreira TH, Mao L, McCormick T, Cui M, Lee FT, Ziemlewicz TJ. Reduction of Respiratory Motion Effect in Liver Histotripsy by use of High Frequency Jet Ventilation. Presented at Spectrum 2024, Miami, FL. January 11, 2024.

Purpose: Histotripsy is a non-invasive, non-thermal, non-ionizing treatment modality which is currently being investigated in human clinical trials for use in the liver and kidney. Because it is externally applied, histotripsy is subject to respiratory motion effects, such as elongation of the treatment zone with diaphragm excursion. High frequency jet ventilation (HFJV) utilizes small tidal volumes and high respiratory rates to reduce respiratory motion effects, and thereby has the potential to decrease elongation of the treatment zone and off-target treatment, improving accuracy of histotripsy.

Materials and Methods: Six swine underwent hepatic histotripsy treatment in each median lobe, once with HFJV and once with conventional ventilation (CV) under one treatment session. Laterality was randomized. The swine were maintained under anesthesia and underwent a post-procedure abdomen MRI with contrast. Following MRI, the swine underwent necropsy and liver harvest. Measurements were then taken from MRI in the anteroposterior, transverse, and craniocaudal dimensions. Histopathologic analysis was performed to measure the transition zone between normal and completely treated tissue at the cranial, caudal, anterior, posterior, right, and left periphery of the treatment zone. Biostatistical analysis was performed using R.

Results: The craniocaudal measurement of histotripsy treatment zones was significantly shorter in the HFJV group compared to the CV group (27.8 mm HFJV, 32.3 mm CV, $p=0.04$). The craniocaudal measurement on post-procedural MRI is thought to be the most accurate proxy for measuring respiratory motion effect. Anteroposterior (32 mm HFJV, 28.3 mm CV, $p=0.285$) and transverse dimensions (27 mm HFJV, 27.8 mm CV, $p=0.685$) were not significantly different between groups. Transitional zones, or the distance between normal and completely treated tissue, were significantly shorter at the cranial margin in the HFJV group when compared to the CV group (4 mm HFJV, 8.2 mm CV, $p=0.018$). Anterior (3.8 mm HFJV, 8.5 mm CV, $p=0.054$) and posterior (4 mm HFJV, 6.3 mm CV, $p=0.078$) transition zones were borderline significantly lower. The caudal (3.3 mm HFJV, 6.2 mm CV, $p=0.271$), left (4.2 mm HFJV, 5.8 mm CV, $p=0.12$), and right (5.2 mm HFJV, 6.5 mm CV, $p=0.825$) transition zone measurements were not significantly different between the two groups.

Conclusions: High frequency jet ventilation reduces cranio-caudal treatment zone length and transition zone elongation seen with conventional ventilation. As such, it has the capacity to improve the precision of histotripsy as a treatment modality in solid intra-abdominal organs.

ORAL PRESENTATIONS



Stephen Polanski, MD

Level: Fellow

Faculty Mentor: J Louis Hinshaw, MD

Previous Presentation: Society of Abdominal Radiology

Pilot Study Evaluating the Efficacy of Organ Displacement Using Hydrogel, Outside of Prostate Radiation

Citation: Polanski S, Lee F, Ziemlewicz T, Morris Z, Morris B, Basree M, Cooley G, Glide-Hurst C, & Hinshaw JL. Pilot study evaluating the efficacy of organ displacement using hydrogel, outside of prostate radiation. Annual SAR Meeting, oral presentation, April 14-19, 2024

Purpose: Approximately 2/3 cancer patients receive radiation therapy. Radiation is delivered such that a planning target volume (PTV) receives as much of the prescription dose as possible. However, tumor proximity to nearby normal structures, termed organs at risk (OARs), may require PTV under dosing to maintain safety. In men with prostate cancer, injection of hydrogel is standardly performed to create separation between the rectum and prostate prior to radiation therapy. The purpose of the study is to assess the efficacy of hydrogel displacement of OARs from tumor in other disease sites, with the goal of increasing PTV coverage by the prescribed radiotherapy dose.

Materials and Methods: Image-guided placement of hydrogel between the target tumor and adjacent OAR was performed in 8 patients (6 CT-guided, 2 US-guided). Mean patient age was 67 (range 52-76). PTVs were single lesions of primary or metastatic disease located in the chest, abdomen, pelvis, and extremity. The displaced OARs included bowel, bladder, and nerve. Four of 8 patients had pre-injection radiation planning. All patients had post-injection radiation planning within 19 days of injection. Percent increase in PTV was calculated in the 4 patients who had pre and post-injection planning.

Results: 87.5% (7/8) of procedures were technically successful with the separation between the tumor and OAR increasing from an average of 0.01 cm prior to injection to 1.04 cm post injection (p-value = 0.0001, range 0.9-1.2 cm) with one injection being considered unsuccessful (0.2 cm separation). In the 4 patients that had pre- and post-injection data there was an increase in the percent of PTV covered by the prescription dose, increasing from mean of 57% (range 23-80%) to 78% (range 53-100%), with an average increase of 48% (range 7.1-128%). The average percent of PTV covered by prescription dose for all patients after injection was 86% (53-100%). There was one minor adverse event, pain that resolved without intervention.

Conclusion: This study demonstrates that hydrogel injection can be safely and efficaciously applied in non-prostate anatomic locations, providing increased PTV coverage by prescription dose radiotherapy. Further study in a larger prospective trial is warranted.

ORAL PRESENTATIONS



Leslie Nelson, DO

Level: Fellow

Faculty Mentor: Elizabeth Sadowski, MD

Previous Presentation: Society of Abdominal Radiology

The Impact of MRI after Ultrasound on Patient Management using the O-RADS Risk Score

Citation: Neslon LW, Hetzel S, Reinhold C, Barroihet L, Sadowski E. The Impact of MRI after Ultrasound on Patient Management using the O-RADS Risk Score. Annual Society of Abdominal Radiology Meeting, April 14-19, 2024.

Purpose: Pre-treatment imaging can be used to determine if an adnexal lesion should be referred to gynecologic oncology or if the lesion can be followed or referred to a general gynecologist. This study assesses how many patients were treated appropriately based on clinical assessment and initial imaging with and without O-RADS scoring.

Materials and Methods: This single-site, IRB-approved study reviewed patients with adnexal lesions who underwent US followed by MRI prior to clinical management. Investigators blinded to the final outcome scored the lesions using the O-RADS US and MRI risk assessment. Final outcome was determined by pathology or adequate imaging follow-up. Clinical management, including surgery with a general gynecologist versus a gynecologic oncologist was recorded. Appropriate management was deemed appropriate if a benign lesion was treated by a general gynecologist or followed and if a malignant lesion was treated by a gynecologic oncologist. The original imaging and management were compared to the potential management based on the US and MRI O-RADS scores. O-RADS US and MRI score 4 were used as the threshold for referring to gynecologic oncology. Rates of appropriate management were compared using McNemar's test.

Results: 211 patients were reviewed, 16 were excluded for insufficient follow-up. In 195 patients, there were 180 benign and 15 malignant lesions. In patients with benign outcomes, 88% (159/180) were treated appropriately based on the original imaging and management, compared with 77% (139/180) based on the O-RADS US score alone and 94% (169/180) based on the O-RADS MRI score. In patients with malignant outcomes, 80% (12/15) were treated appropriately based on original imaging and management, compared with 80% (12/15) based on the O-RADS US score and 93% (14/15) based on the O-RADS MRI score. There was a statistically significant increase in appropriate management with the inclusion of the O-RADS MRI score after US ($p < 0.0001$)

Conclusions: This study demonstrates that a significantly increased number of patients were treated appropriately when the O-RADS MRI scoring was added to ultrasound. Using the O-RADS MRI score decreased the number of benign lesions and increased the number of malignant lesions referred to gynecologic oncologists.

ORAL PRESENTATIONS



Karla Wetley, MD

Level: Fellow

Faculty Mentor: Andrew Ross, MD

Previous Presentation: Society of Skeletal Radiology

Translating Musculoskeletal MRI Reports into Patient-friendly Summaries Using ChatGPT

Citation: Kuckelman IJ, Wetley K, Yi PH, Ross AB. Translating musculoskeletal radiology reports into patient-friendly summaries using ChatGPT-4. *Skeletal Radiol.* 2024 Jan 25. doi: 10.1007/s00256-024-04599-2. Epub ahead of print. PMID: 38270616. Annual SSR Meeting, oral presentation, Mar 2-6, 2024.

Purpose: Radiology reports are meant to convey information to other health care providers. However, patients also have access to these reports via the Electronic Health Record (EHR). The goal of this study is to determine whether ChatGPT can generate accurate and complete layperson summaries of musculoskeletal (MSK) magnetic resonance imaging (MRI) reports that patients can understand.

Materials and Methods: This HIPAA-compliant, retrospective study was performed under a waiver of informed consent from the IRB. We searched PACS to find 60 consecutive MRI reports (20 shoulders, 20 lumbar spines, and 20 knees) performed between 7/1/2022-7/5/2022, which were deidentified and submitted to ChatGPT with the prompt "Produce an organized and concise layperson summary of the findings of the following radiology report. Target a reading level of 8-9th grade and word count <300 words." Two independent readers then scored the ChatGPT summaries against the original reports using a 3-point scale for both accuracy and completeness. Descriptive statistics and inter-rater agreement were calculated.

Conclusions: Overall ratings for accuracy and completeness of the AI-generated layperson report summaries were high, illustrating the potential for generative AI, such as ChatGPT, to automate the production of patient-friendly summaries for MSK MRI reports. Inter-rater agreement was low, however, which may have been due to differences in the rater's level of training, and the subjective nature of assessing summary quality.

ORAL PRESENTATIONS



Allison Couillard, MD

Level: Resident

Faculty Mentor: Fred Lee, MD

Previous Presentation: Spectrum 2024

Renal Bleeding Events with Histotripsy vs. Cryoablation in a Porcine Survival Model

Citation: Couillard AB, Kisting M, Zlevor AM, Mauch S, Knott EA, Ziemlewicz TJ, Hinshaw JL, Laeseke PF, Knavel-Koepsel E, and Lee FT. Renal bleeding events with histotripsy vs. cryoablation in a porcine survival model. Spectrum Meeting, January 11-14, 2024

Purpose: To compare the incidence of bleeding events in normal pig kidneys treated with histotripsy, histotripsy plus anticoagulation, and cryoablation.

Materials and Methods: A total of 26 female non-tumor bearing swine (mean weight= 52.5 kg) were divided into three renal treatment groups: Histotripsy (n=9), Histotripsy+anticoagulation (n=8), and percutaneous cryoablation (n=9). The anticoagulation group received warfarin (initial daily dose=0.08 mg/kg starting 5 days pretreatment) to a target prothrombin time (PT) of 30%–50% above baseline. A planned 2–3 cm diameter treatment was performed in the lower pole of the kidney under ultrasound (histotripsy) or ultrasound and computed tomography (CT) guidance (cryoablation). Cryoablation was performed with the animal in a prone or lateral decubitus position with two cryoablation probes (10–5–10 min freeze/thaw). All treatments were immediately followed by contrast-enhanced CT (CECT) and blood serum analysis. The anticoagulation group was observed for 7 days while continuing Warfarin, followed by repeat CECT and blood draws and then necropsy. The remaining animals underwent repeat CECT and lab draws with necropsy at day 7 (n=6 total, histotripsy n=3, cryoablation n=3) or continued survival to day 30 (n = 6). Animal welfare, treatment zone appearance, procedure-related adverse events, and histopathology of the treatment zones and surrounding tissues were assessed.

Results: No clinically significant bleeding events occurred during the follow-up period. There was no death, disability, change in behavior, or sign of distress during or after treatment with histotripsy. At treatment, 62.5% (5/8) animals were therapeutically anticoagulated and all 8 animals reached therapeutic levels by the time of necropsy (two animals were suprathreshold). There was a statistically significant difference in development of perirenal hematomas between groups (χ^2 test, $p < 0.01$). In the histotripsy group, 17.6% (3/17) had perinephric hematomas on CT at day 7 with an average volume of 3.3 cm³, 66.7% (2/3) of these were in the anticoagulated group. All cryoablation cases (9/9) had an immediate post-procedure perirenal hematoma on CT with mean volume of 22.2 cm³ and active arterial extravasation in 4/9 (44%) animals. In the histotripsy group, 23.5% (4/17) of animals developed hematuria and resolved within 3 days. There were no incidence of active arterial extravasation in the histotripsy group. In the cryoablation group, 44% (4/9) had active arterial extravasation on immediate post-procedure imaging, but none were symptomatic or required further intervention. On pathology the treatment zones for both groups were predominantly acellular consistent with prior descriptions.

Conclusions: The incidence of bleeding events including perirenal hematoma formation and active arterial extravasation was higher in the cryoablation vs. histotripsy groups; however, none that bled after cryoablation required intervention or demonstrated signs of distress. Anticoagulation does not appear to increase the risk of bleeding after histotripsy.

ORAL PRESENTATIONS



Leslie Nelson, DO

Level: Fellow

Faculty Mentor: Perry Pickhardt, MD

Previous Presentation: Society of Abdominal Radiology

Longitudinal Intra-patient Changes in CT Body Composition Measures Associated with Semaglutide Use

Citation: Nelson LW, Pickhardt SG, Blake MG, Perez AA, Summers RM, Garrett JW, Pickhard PJ. Longitudinal Intra-patient Changes in CT Body Composition Measures Associated with Semaglutide Use. Annual Society of Abdominal Radiology Meeting. April 14-19, 2024.

Purpose: Semaglutide is a glucagon-like peptide-1 (GLP-1) receptor agonist indicated for the treatment of type 2 diabetes mellitus and obesity in adults. Although weight loss and improved diabetic control have been documented in clinical trials, little is known regarding potential changes in visceral body composition measures. We utilized fully-automated CT-based AI biomarker tools to assess for changes before and after initiation of this medication.

Materials and Methods: An EMR search at our institution identified all adults in whom semaglutide had been prescribed and initiated. After excluding patients without an available abdominal CT within 5 years of starting semaglutide, and without at least one post-semaglutide abdominal CT, a final cohort of 212 patients was derived (mean age, 61 years when semaglutide started; 127F/85M). Validated CT-based AI biomarker measures assessing skeletal muscle, visceral (VAT) and subcutaneous (SAT) fat, liver, kidney, BMD (L1 HU), and aortic calcium were derived. Patients were divided into those who lost (n=73) or gained (n=37) at least 5 pounds on average at the time of their post-semaglutide CT scans (the remaining patients had < 5-lb average weight change).

Results: The weight-loss cohort (mean, -12.1 lbs; Δ BMI=-3.0) showed a mean -9.0% decrease in liver volume (-233.4 ml) and -9.7% decrease in L3 muscle area (-15.7 cm²), whereas the weight-gain cohort (mean, +10.5 lbs; Δ BMI=+2.6) showed +10.7% and +8.1% mean increases in these measures (+249.9 ml and +15.7 cm²), respectively (p < 0.001). Similar but less significant opposing trends were seen in mean liver HU (+11.8% vs -4.4%), kidney volume (-1.4% vs +2.2%), and BMD (+6.1% vs -3.5%), whereas aortic Agatston score increased in both cohorts (+6.5% vs +11.1%). As expected, mean decreases in VAT area (-10.6%) and SAT area (-11.7%) were associated with weight loss, whereas mean increases were seen with weight gain (+5.4% and +8.0%, respectively; p < 0.001).

Conclusions: We observed opposing longitudinal changes in CT body composition measures for liver, muscle, fat, kidney, and bone among patients who either lost or gained weight after starting semaglutide, which presumably correlates with the degree of diabetic control. Further investigation is warranted.

ORAL PRESENTATIONS



Vansh Jain

Level: Medical Student

Faculty Mentor: Mark Kleedehn, MD and Erica Knavel Koepsel, MD

Previous Presentation: Society of Interventional Radiology

A Large Single-Institution Review of Bard Denali IVC Filter Complication Rates

Citation: Jain VS, Johnstad CM, Ferrer SM, Knavel Koepsel EM, Kleedehn MG. A Large Single-Institution Review of Bard Denali IVC Filter Complication Rates. SIR 2024 Annual Meeting, Salt Lake City, UT, March 23-28, 2024

Purpose: To evaluate Denali IVC filter (Bard Peripheral Vascular, Inc.) complication rates using a large, multi-year database of patients.

Materials and Methods: 508 Denali IVC filters were placed from 2015 through 2022. Retrospective chart review collected information on patient demographics, filter indication, thrombotic events, filter-related complications, and retrieval information.

Results: 500 unique patients had Denali filters placed (207 female, 293 male, mean age 61.0 ± 14.6). Filter indications included venous thromboembolism with contraindication to therapeutic anticoagulation in 378 cases (74.7%), surgical prophylaxis in 56 cases (11.1%), anticoagulation failure in 43 cases (8.5%), and other reasons in 29 cases (5.8%). 284 (55.8%) filters were retrieved at our institution, 159 (31.4%) were permanent, 21 (4.1%) were retrieved at an outside hospital, 27 (5.3%) had known IVC filter follow up at an outside hospital, and 17 (3.3%) were lost to follow up. When retrieval was attempted at our institution, initial retrieval was successful in 275 cases (96.8%) while 7 additional cases had successful retrieval on a second attempt, retrieval success was 99.3% overall. Initial retrieval venogram showed clot in filter in 18 cases (6.3%) and an occluded cava in 13 cases (4.6%). 75 patients who did not have filter retrieval at our institution had contrast enhanced imaging following filter placement: 7/75 (9.3%) had thrombus within the filter, 5/75 (6.7%) had caval thrombosis or occlusion, 2/75 (2.7%) had severe caval stenosis, and 1/75 (1.3%) had new nonocclusive caval thrombus. Among all cases, no filter breakage or clinically significant extravascular strut penetration was reported. The only filter migration was a suprarenal filter that tilted when tines descended into the renal veins.

Conclusion: Denali IVC filters have a higher rate of caval thrombosis than reported for other filter brands {1}. However, they have a high retrieval success rate and low rates of migration, breakage, and clinically significant strut migration.

References: 1. Xiao N, Karp J, Lewandowski R, Cuttica M, Schimmel D, Martin K, Desai KR. Inferior Vena Cava Thrombosis Risk in 1582 Patients with Inferior Vena Cava Filters. *Radiology*. 2022 May;303(2):300-302. doi: 10.1148/radiol.211169. Epub 2022 Feb 8. PMID: 35133197.

ELECTRONIC EXHIBITS



Peter Cormier, MD

Level: Fellow

Faculty Mentor: Kenneth Lee, MD, MBA

Previous Presentation: Society of Skeletal Radiology

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Where does it hurt? Variability in Location of Edema Relative to MRI Compatible Pain Marker in Collegiate Football Players with Hamstring Strain Injury

Citation: Where does it hurt? Variability in Location of Edema Relative to MRI Compatible Pain Marker in Collegiate Football Players with Hamstring Strain Injury. Cormier P, Ito N, Blemker S, Opar D, DuCharme O, Riem L, Heiderscheit B, Lee K. Society of Skeletal Radiology Annual Meeting, San Juan, Puerto Rico, March 2024.

Purpose: To determine if the patient-determined site of maximum pain corresponds to the location of maximum edema on MRI after acute hamstring strain injuries (HSI) in NCAA Division I football players.

Materials and Methods: MRI examinations were obtained from 18 collegiate football players (age, 20 ± 2 years), 3.5 (range: 1-7) days after HSI. MR images were captured after placement of a vitamin E capsule (VitE) over the athletes' self-identified site of maximum pain. Edema volumes were quantified by auto-segmentation algorithms applied to axial T2 images (Springbok Analytics, Charlottesville, VA) (Figure 1). The edema center of mass (COM) and VitE locations relative to the image reference were calculated in the Z (superior to inferior) and X (medial to lateral) coordinates, as well as the resultant vector ZX. Absolute and relative agreement between the edema COM and VitE were compared using Bland-Altman analysis and Pearson correlation coefficients.

Results: Edema COM and VitE showed agreement with minimal bias, with 94% of data points presenting within the limits of agreement for all three directions (Figure 2). The mean absolute differences in agreement in each direction were 4.5 ± 4.0 cm (Z), 2.4 ± 2.2 cm (X), and 4.3 ± 3.7 cm (ZX). Edema COM and VitE showed strong correlation in all three directions [Z ($R = 0.82$, $p < 0.001$); X ($R = 0.98$, $p < 0.001$); ZX ($R = 0.89$, $p < 0.001$)].

Conclusion: Self-identified location of maximum pain strongly correlated with the MRI determined site of maximum edema obtained acutely after HSIs in collegiate football players. However, the mean absolute differences accounted for approximately 10% of the length of the typical hamstring myotendinous unit, which ranges from 39 to 42cm. This location difference can be substantial and indicates limitations in determining the involved muscle from a pain-based physical examination. Additionally, the location difference suggests other potential regional pain influencers, such as the sciatic nerve, may be involved.

ELECTRONIC EXHIBITS



Emily Kruger, MD

Level: Resident

Faculty Mentors: Maria Daniela Martin Rother, MD; Jeffrey Kanne, MD; Brian Mullan, MD

Previous Presentation: Society of Thoracic Radiology

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Phantoms of the Thorax

Citation: Kruger EC, Martin D, Kanne JP, Mullan B. Phantoms of the Thorax. Annual STR Meeting, February 24-28, 2024.

Background Information: Benign processes and anatomic variants can be confused with disease on chest CT. Misdiagnosis can lead to unnecessary further evaluation. Awareness of common pitfalls on chest CT is essential for accurate interpretation.

Educational Goals/Teaching Points:

- Tracheal diverticula can be confused with pneumomediastinum. These are benign structures occurring in a predictable location right posterolateral to the trachea and are typically asymptomatic.
- Hemostatic gauze such as Surgicel can mimic abscesses. Surgicel will typically have higher attenuation than gas, ranging from -104 to -458 HU, and gas pockets will be uniform unlike in an abscess.
- Mediastinal fat necrosis can be confused with lymphadenopathy or malignancy. Fat necrosis is typically well circumscribed and round with fat attenuation and adjacent inflammatory changes and resolves spontaneously.
- Intralobar sequestration can be confused with malignancy. Systemic arterial supply, lack of airway connection, and adjacent abnormal lung can help establish the diagnosis.
- Ductus diverticulum can be confused with aortic pseudoaneurysm. The diverticulum has smooth margins and obtuse angles with the aortic wall whereas pseudoaneurysms typically have acute angles and irregular margins.
- Flow artifacts from physiologic or adjacent pathologic processes can mimic thrombi on contrast-enhanced CT, especially with rapid acquisitions. Flow artifacts typically have indistinct margins and resolve on delayed imaging.

Conclusion: Awareness of common diagnostic pitfalls on chest CT can help establish a correct diagnosis and avoid unnecessary and potentially invasive evaluation.

ELECTRONIC EXHIBITS



Kyle Lacy, MD

Level: Fellow

Faculty Mentors: Mitchell Daun, MD; Andrew Ross, MD

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Evaluating the Effectiveness of a Resident-Generated Musculoskeletal Anatomy Study Guide in Enhancing Radiology Resident Confidence and Proficiency in Interpreting Musculoskeletal MRI

Citation: Lacy K, Daun M, Ross A, Viers C. Evaluating the Effectiveness of a Resident-Generated Musculoskeletal Anatomy Study Guide in Enhancing Radiology Resident Confidence and Proficiency in Interpreting Musculoskeletal MRI. 2023.

Purpose: As the complexity of musculoskeletal MRI continues to evolve, ensuring the proficiency of radiology residents becomes increasingly crucial. This study aims to assess the effectiveness of a novel, resident-generated musculoskeletal anatomy study guide in enhancing resident confidence and competency in interpreting musculoskeletal MRI.

Methods and Materials: A pre- and post-rotation survey-based study was conducted among radiology residents who completed a musculoskeletal rotation. Prior to the rotation, residents completed a survey assessing their confidence and understanding of musculoskeletal MRI anatomy. Additionally a focused quiz on MSK MRI anatomy was administered. During the rotation, they utilized the resident-generated study guide both for self-study and in focused teaching sessions with MSK faculty. Post-rotation, the same residents completed a follow-up survey to measure changes in confidence and proficiency, and to gather feedback on the guide's usefulness. The anatomy quiz was retaken to assess learning.

Results: To date 4 residents have completed the pre- and post-education survey. Average self-assessed proficiency improved from 3.4 to 6.3 while confidence scores also increased from 4.0 to 6.0. Data collection is ongoing with 32 more residents scheduled to utilize the study guide over the remainder of the academic year.

Conclusion: A resident-created study guide is anticipated to be effective at improving resident confidence and knowledge of MSK MRI anatomy. This type of study guide can help focus resident self-directed learning and provide structure for teaching sessions with faculty.

ELECTRONIC EXHIBITS



Leslie Nelson, DO

Level: Fellow

Faculty Mentor: Perry Pickhardt, MD

Previous Presentation: Radiological Society of North America

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Spectrum of Heterotopic & Ectopic Splenic Conditions

Citation: LW Nelson, SM Bugenhagen, MG Lubner, S Bhalla, PJ Pickhardt. Annual RSNA Meeting 2023.

A spectrum of heterotopic and ectopic splenic conditions may be encountered in clinical practice as incidental asymptomatic detection or symptomatic diagnosis. The radiologist needs to be aware of these conditions and their imaging characteristics to provide a prompt correct diagnosis and avoid misdiagnosing as neoplasm or lymphadenopathy.

Having a strong knowledge of the embryologic development of the spleen improves the understanding of the pathophysiologic basis of these conditions. Splenic-specific imaging techniques, such as ^{99m}Tc-labeled denatured erythrocytes scintigraphy, ^{99m}Tc sulfur colloid liver-spleen scintigraphy, and MR with ferumoxytol IV contrast, can also be used to confirm the presence or absence of splenic tissue. Heterotopic splenic conditions include splenules and splenogonadal fusion (discontinuous and continuous forms). The heterotopic splenic conditions are caused by incomplete fusion of the splenic primordia (splenule) and abnormal fusion of the gonadal and splenic tissue (splenogonadal fusion). The ectopic splenic conditions arise in patients with prior splenic injury (splenosis), laxity of maldevelopment of the splenic ligaments (wandering spleen), and patients with Heterotaxy syndrome (polysplenia and asplenia). Additionally, the heterotopic and ectopic splenic conditions can also present with complications, including vascular torsion and rupture.

ELECTRONIC EXHIBITS



Jacob McCallum, DO

Level: Fellow

Faculty Mentor: Andrew Ross, MD

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AI Chatbot Utility in Answering Patient Questions about Procedures

Citation: McCallum JT, Ross AB, Kuckelman IJ. AI chatbot utility in answering patient questions about procedures. Annual AUR Meeting, April 2-5, 2024.

Purpose: To evaluate the accuracy and completeness of AI chatbot responses to commonly asked questions from patients about 3 representative radiologic procedures ranging from less complex to more complex.

Materials and Methods: Our group developed 10 common patient type questions for three common radiologic procedures varying in degree of complexity (Ultrasound guided glenohumeral steroid injection, Fluoroscopic guided vertebroplasty, Fluoroscopic guided epidural steroid injection) and input the questions into the Microsoft Bing chatbot in two trials across three different response type settings; "More Creative", "More Balanced", and "More Precise" response types available with the Bing AI chatbot. These were also input approximately 5 days apart to simulate natural temporal variance in AI chatbot response. A single reviewer (Fellowship level musculoskeletal radiologist) compared the varying responses provided by the chatbot to a gold standard resource – radiologyinfo.org– and rated them for both accuracy and completeness. A scale of 1-3 was utilized; 1 being incorrect/incomplete and potentially harmful, 2 being mostly correct/complete and unlikely to cause confusion or harm, and 3 being entirely correct/complete. Descriptive statistics were calculated. Differences in accuracy and completeness rating were compared by chatbot settings and exam with a Pearson Chi squared test.

Results: Of the 180 responses 143 were rated as "entirely correct", 36 were rated as "mostly correct" and only 1 was rated as "inaccurate". Of the 180 responses, 116 were rated as "complete", 42 were rated as "mostly complete", and 22 were rated as "incomplete". Accuracy was significantly better when using the "creative" setting with a Pearson chi squared of 47.28. Accuracy did not vary significantly by exam type. Completeness was significantly lower for the more complex exams (vertebroplasty and epidural steroid injection) with a Pearson Chi Squared of 14.6. Completeness was significantly better using the "creative" setting with a Pearson Chi Squared of 127.9

Conclusion: Our study shows that the Microsoft Bing Chatbot has potential as a tool useful in educating patients prior to radiologic procedures; however, may be less complete and accurate with varying degrees of case complexity and response type setting. Directing patients to this online resource or potentially incorporating this resource into preprocedural discussions could be a cost-effective and efficient way for both health systems and providers to prepare patients for procedures, improve patient understanding allowing them to ask questions in a low-pressure setting, and hopefully reduce patient anxiety related to procedures while improve the patients in hospital experience. Limitations of the study include potential variability in responses based on question phrasing, timing of questioning, persistent lack of understanding of information provided to patients, and overall omission of information not elicited from the chatbot by patients. Additional potential draw backs are the use of AI chatbots reducing the overall human interaction of patients with their providers leading to a weaker patient physician relationship.

ELECTRONIC EXHIBITS



Alexander Moeller, MD

Level: Resident

Faculty Mentor: Tabassum Kennedy, MD

Previous Presentation: Radiological Society of North America

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Sinus Tumors – What the Tumor Board Wants to Know

Citation: Alex Moeller, MD, Greg Avey, MD, Ian Koszewski, MD, Adam Burr, MD, Justine Y. Bruce, MD, Marin McDonald, MD, PhD, Tabby A. Kennedy, MD. Sinus Tumors – What the Tumor Board Wants to Know. RSNA 2023.

Teaching Points:

1. Understand the general treatment considerations of sinonasal tumors.
2. Describe relevant imaging findings of sinonasal tumors that would impact treatment decisions.
3. Identify resources for staging sinonasal tumors.

Outline:

1. Overview
 - a. Sinonasal tumor classification based on cell of origin
 - b. Sites of disease
 - c. Role of imaging
 - d. AJCC 8th Edition staging overview
2. Treatment of Sinonasal Tumors
 - a. What the endonasal surgeon wants to know
 - b. What the medical oncologist wants to know
 - c. What the radiation oncologist wants to know
3. Differential Diagnosis and Case Examples
 - a. Sinonasal Undifferentiated Carcinoma
 - b. Olfactory neuroblastoma
 - c. Squamous cell carcinoma
 - d. NUT carcinoma
 - e. Inverted papilloma
 - f. Metastatic disease
4. Summary of Tumor Treatment Strategies

Conclusion: Sinonasal tumors have a variety of imaging presentations and characteristics that are important to highlight for the clinical team. These findings will impact treatment decisions and help guide patient management.

ELECTRONIC EXHIBITS



Alexander Moeller, MD

Level: Resident

Faculty Mentor: John Symanski, MD

Previous Presentation: Radiological Society of North America

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Spotlight on Musculoskeletal Lymphoma: A Radiological Exploration of an Uncommon Entity

Citation: Sleeth C, Moeller A, Gaskin C, Symanski J, Davis K, Kresse M. Spotlight on Musculoskeletal Lymphoma: A Radiological Exploration of an Uncommon Entity. RSNA 2023.

Teaching Points:

1. Radiology plays a central role in the diagnosis of musculoskeletal lymphoma.
2. Musculoskeletal lymphoma can present with different patterns.
3. Lymphoma involving the muscle, skin, and bones can occur at nearly every age and may present with atypical features that can distinguish it from other entities.

Outline:

1. Introduction
 - a. Overview of musculoskeletal lymphoma
 - b. Importance of radiology in diagnosis
2. Imaging Modalities for Musculoskeletal Lymphoma
 - a. Radiography
 - b. Ultrasound (US)
 - c. Computed Tomography (CT)
 - d. Positron Emission Tomography (PET)
 - e. Magnetic Resonance Imaging (MRI)
3. Imaging Features and Patterns of Musculoskeletal Lymphoma
 - a. Osseous lymphoma
 1. Lytic Pattern
 2. Sclerotic Pattern
 3. "Near Normal" Radiographic Findings
 - b. Soft tissue lymphoma
 - c. Trans-spatial lymphoma
4. Differential Diagnosis
 - a. Other primary bone and soft tissue neoplasms
 - b. Metastatic lesions
 - c. Inflammatory and infectious conditions

Conclusion:

1. Primary musculoskeletal lymphoma is an uncommon entity with various imaging presentations
2. Radiographically, osseous lymphoma most commonly presents as a lytic lesion
3. Lymphoma should be considered with radiographically normal lesions demonstrating osseous and soft tissue components on advanced imaging modalities.
4. Large trans-spatial lesions should invoke lymphoma, especially when anatomic structures are invaded and infiltrated.
5. PET can assess for multifocal lesions and monitor treatment response.

ELECTRONIC EXHIBITS



Alexander Moeller, MD

Level: Resident

Faculty Mentor: Perry Pickhardt, MD

Previous Presentation: Society for Advanced Body Imaging

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Fully Automated CT Imaging Biomarkers of Bone, Muscle, and Fat: Correcting for the Effect of Intravenous Contrast during Angiographic Phase

Citation: Moeller AR. Garrett J. Summers R. Pickhardt P. Fully Automated CT Imaging Biomarkers of Bone, Muscle, and Fat: Correcting for the Effect of Intravenous Contrast during Angiographic Phase. SABI Annual Meeting October 2023.

Purpose: To determine and correct for the effect of intravenous (IV) contrast on automated body composition measures between non-contrast and angiographic phase exams.

Materials and Methods: We identified a single center retrospective cohort of 1255 patients (mean age 72.3 years, \pm 14.0; 769 men, 485 women) that underwent routine CT angiography protocol of the chest/abdomen/pelvis. Multiphasic CT protocol consisted of pre-contrast and arterial phases. Fully automated CT-based algorithms for quantifying bone mineral density (BMD, L1 trabecular HU), muscle area and density (L3-level mean area and HU), and fat (L1-level visceral and subcutaneous mean area, HU, and V/S ratio) were applied to pre-contrast and arterial phases. Patients who had a failed biomarker measure on pre- and/or post-contrast studies were excluded from analysis of that biomarker, but remained included for analysis of other successfully measured biomarkers. Effects of IV contrast upon these body composition measures were analyzed. Descriptive analyses were performed for the pre- and post-contrast biomarker measurements as well as change between the two. Linear least-squares regression analysis was performed to compare pre- and post-contrast results.

Results: Mean changes (95% CI) in L1-level BMD, L3-level muscle area and muscle HU, and V/S fat ratio were 22.4 HU (19.1 – 25.7), -3.8 cm² (-7.2 – -0.6), 6.6 HU (5.3 – 7.8), -0.1 (-0.2 – 0.1), respectively. Good linear correlation between pre- and post-contrast values was observed for all automated measures: BMD (pre=0.7 \times post + 8.66; $r^2=0.64$), muscle area (pre=1.01 \times post + 1.37; $r^2=0.96$), muscle HU (pre=0.96 \times post - 6.98; $r^2=0.93$), and V/S (pre=1.04 \times post + 0.1; $r^2=0.95$); $p < 0.001$ for all r^2 values.

Conclusion/Clinical Significance: Fully automated quantitative tissue measures of bone, muscle, and fat at arterial phase chest/abdomen/pelvis CT can be correlated with non-contrast equivalents using simple, linear relationships. These findings will facilitate evaluation of mixed CT cohorts involving larger patient populations and could greatly expand the potential for opportunistic screening.

ELECTRONIC EXHIBITS



Alexander Moeller, MD

Level: Resident

Faculty Mentor: Perry Pickhardt, MD

Previous Presentation: Society for Advanced Body Imaging

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Comparing Automated Abdominal and Thoracic Aortic Agatston Measurements Derived from a Deep Learning-Based Model

Citation: Moeller A. Garrett J. Lee M. Pickhardt P. Comparing Automated Abdominal and Thoracic Aortic Agatston Measurements Derived from a Deep Learning-Based Model. SABI Annual Meeting October 2023.

Purpose: Purpose: Aortic calcium is a marker of cardiovascular risk which can be quantified from CT scans using fully automated artificial intelligence (AI) tools. The purpose of this study is to compare fully automated CT-based measures of thoracic and abdominal aortic calcium (AoCa, Agatston [Ag] score) in patients undergoing unenhanced chest/abdomen/pelvis (CAP) CT imaging as part of a CT angiography (CTA) protocol.

Materials and Methods: In this single center retrospective study, we applied a previously validated fully automated deep learning algorithm to non-contrast CT examinations in patients undergoing CAP CTA to quantify aortic calcium for the total, thoracic, and abdominal aorta. Descriptive analyses were conducted to highlight sample characteristics. Wilcoxon signed-rank test was used to compare abdominal and thoracic AoCa. Abdominal and thoracic AoCa were grouped by Ag score (0, 1-399, >400) and analyzed. Descriptive analyses, Wilcoxon signed rank test, and Cohen's weighted Kappa analysis were performed to assess agreement between abdominal and thoracic AoCa measures.

Results: 1254 adult patients (mean age 73.4 years, \pm 14.0; 764 men:491women) underwent CTA from XX-XX. Mean Ag scores for the abdominal and thoracic aorta were 3328 (SD 4862) and 3987 (SD 4875), respectively. A significant difference was observed between the abdominal (median = 1283) and thoracic (median = 2302) AoCa ($p < 0.001$). Moderate reliability was observed between thoracic and abdominal AoCa scores with correlation coefficient of 0.646 (95% CI 0.616 – 0.680). Ordinal analysis of abdominal AoCa scores showed 11.8% ($n = 146$) had 0, 20.8% ($n = 257$) had 1-399, and 67.3% ($n = 830$) had >400. For thoracic AoCa, 5.8% ($n = 72$) had 0, 19.3% ($n = 239$) had 1-399, and 73.5% ($n = 922$) had >400. Significant differences were observed between median scores of abdominal and thoracic AoCa across groups ($p=XX$). There was agreement on category in 74.6% of cases. Overall interrater reliability was found to be $\kappa=0.546$ (95% CI, 0.503 – 0.589), $p < 0.001$. Fair-to-moderate agreement was observed across categories: $\kappa = 0.356$ (95% CI, 0.300 – 0.412) for 0, $\kappa = 0.303$ (95% CI, 0.248 – 0.359) for 1-399, and $\kappa = 0.566$ (95% CI, 0.510 – 0.622), ($p < 0.001$ for all).

Conclusion/Clinical Significance: Although there is an expected difference between fully automated measures of abdominal and thoracic AoCa, moderate categorical agreement exists. Further studies are warranted to compare predictive ability for CV outcomes.

ELECTRONIC EXHIBITS



Katharine Molinarolo, MD

Level: Fellow

Faculty Mentor: Perry Pickhardt, MD

Previous Presentation: Radiological Society of North America

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Signet Ring Cell Adenocarcinoma of the GI Tract: Tour of Common and Uncommon Appearances from the Esophagus to Rectum

Citation: Molinarolo KH, Sugi M, Lubner MC, Kim DH, Hartung MP, Matkowskyj KA, Pickhardt PJ. Signet Ring Cell Adenocarcinoma of the GI Tract: Tour of Common and Uncommon Appearances from the Esophagus to Rectum. RSNA Meeting, Educational Exhibit, November 26-30, 2023.

Teaching Points:

1. To describe the key epidemiological, clinical, radiological, and pathological features of signet ring cell adenocarcinomas of the GI tract.
2. To review the specific features of gastric, colorectal, esophageal, appendiceal, and pancreaticobiliary signet ring cancers, with radiologic-pathologic correlation.
3. To illustrate linitis plastica, scirrhous tumors, and the “malignant target sign” associated with these aggressive cancers.

Table of Contents/Outline:

- Signet ring cell adenocarcinomas of the GI tract o Histopathological definition
- Epidemiology and prognosis
- The malignant target sign - Clinical-Pathological-Radiological correlation
- Gastric signet ring cell adenocarcinoma (linitis plastica)
- Colorectal signet ring cell adenocarcinoma
- Esophageal signet ring cell adenocarcinoma
- Appendiceal signet ring cell adenocarcinoma
- Pancreaticobiliary signet ring cell adenocarcinoma
- Metastatic signet ring cell adenocarcinoma

ELECTRONIC EXHIBITS



Jessica Perry, MD

Level: Resident

Faculty Mentor: Joseph Tang, MD

Previous Presentation: Society of Skeletal Radiology

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Atraumatic Non-Degenerative Back Pain: Missed Opportunities in Diagnosis

Citation: Perry J, Laucis N, Anderson J, Tang J. Atraumatic Non-Degenerative Back Pain: Missed Opportunities in Diagnosis. Annual Society of Skeletal Radiology Meeting, March 2-6th, 2024.

Purpose: Atraumatic back pain is a common indication for spine imaging, and while most of these cases will exhibit degenerative disc/facet disease, it may not be the only cause of the patients' symptoms. Missed or delayed diagnoses may increase the likelihood of poor outcomes such as permanent neurologic deficits or delayed cancer treatment. For example, while dural arteriovenous fistulas (dAVFs) are the most common vascular malformation in the spine, up to 71% of patients are initially misdiagnosed (Zhang et al.). The aim of this presentation is to illustrate the myriad of important atraumatic etiologies for back pain outside of degenerative explanations with which radiologists must be familiar.

Materials and Methods: A literature review of non-degenerative causes of back pain was performed and representative examples were compiled from our institution's PACS. The patients' presenting symptoms, imaging findings, time to diagnosis, and outcomes were scrutinized to better understand how spine imaging played a part in their diagnosis and treatment. This exhibit will present a pictorial review of these cases.

Results: Atraumatic causes of back pain included vascular (dAVF), neoplastic (lymphoma, metastases, osteoid osteoma), infectious (tuberculosis, bacterial), and inflammatory (sarcoidosis) etiologies. Many of these entities required the radiologist to have a high level of suspicion to correctly interpret the imaging findings and propose the correct diagnosis -- especially in cases with concurrent degenerative changes.

Conclusion: Back pain is an exceedingly common indication for spine imaging and while many of these patients will display only degenerative findings, there are other considerations with the potential for high morbidity if the diagnosis is delayed. Familiarity with these less common diagnoses is crucial in order for the radiologist to recognize the imaging findings and propose the correct diagnosis.

ELECTRONIC EXHIBITS



Elliott Russell, MD

Level: Resident

Faculty Mentor: John Swietlik, MD

Previous Presentation: Society of Interventional Radiology

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Let Me Show You The Way: How Electromagnetic Navigation Systems Can Improve Your Practice

Citation: Russell, E., Vandevender, J., Woods, M., Swietlik, J. Let Me Show You The Way: How Electromagnetic Navigation Systems Can Improve Your Practice. Educational Exhibit, Society of Interventional Radiology Annual Meeting; March 25, 2024; Salt Lake City, Utah, USA.

Background: Percutaneous image guided interventions are quintessential to interventional radiology. Interventional applications of Computed Tomography, Ultrasonography, and Magnetic Resonance Imaging have distinct advantages as well as disadvantages. Electromagnetic navigation is a well-established technology that has been implemented in several fields (interventional radiology, interventional pulmonology). Organs/lesions that are historically deemed unreachable with no safe percutaneous window can be accessed with these systems. Use of these systems can lead to improved patient outcomes, including patient safety, radiation dose, and procedure time.

Procedure Details: EMN systems require previously acquired data (CT, MRI, or US) as an overlay. This data must be acquired with a fiducial in the field of view to correlate spatial position of an electromagnetic probe that the operator can manipulate. This allows for dynamic, off-axis reconstructed images to be reconstructed and displayed to the operator via a mobile screen. Guides and needle overlays are available and depict projected needle position. This is used to access lesions at oblique angles which would be otherwise difficult using CT or US guidance. It is important to remember that images are not real time, however Intermittent CT scans can be obtained to verify needle location.

Teaching Points:

- EMN systems are easy to implement, requiring minimal procedural modifications.
- EMN systems can be used to optimize technical success and increase the potential organs/lesions that are reachable.
- EMN systems might increase procedural confidence which could improve patient safety and reduce overall radiation dose.

ELECTRONIC EXHIBITS



Alankrit Shatadal, BS, BA

Level: Medical Student

Faculty Mentor: Allison Grayev, MD

Previous Presentation: Association of University Radiologists

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A Picture is Worth a Thousand Words: Correlating Description of Calcifications on Non Contrast Head CT with Final Diagnosis

Citation: Shatadal A, Li G, Grayev A. A Picture Is Worth a Thousand Words: Correlating Description of Calcifications on Non-Contrast Head CT with Final Diagnosis. Annual AUR Meeting, April 1-5, 2024.

Purpose: Intracranial calcifications are an extremely common finding on non-contrast head CT. There is a broad differential diagnosis, ranging from benign to malignant entities. Determining the etiology of these calcifications constitutes a key decision point in a patient's plan of care. In line with other calls to standardize the language used in radiology reports to aid communication between radiologists and referring physicians, we seek to discover if there is a potential lexicon to describe intracranial calcifications that would be more clear .

Materials and Methods: We performed a retrospective chart review of 858 patients who underwent noncontrast head CT [between x and x]. Patient reports were reviewed for descriptors of calcifications and we assessed for correlation between verbiage and final diagnosis. We grouped diagnoses into six categories - infectious, vascular, iatrogenic, congenital, post-inflammatory, and neoplastic and used 4 types of adjectives describing size, quantity, shape, and distribution. Chi-squared and G-tests were performed on both the full dataset as well as subgroups of patients by age group (19 and under, 20-74, and 75+).

Results: Analysis yielded significant correlations between quantity and diagnosis, distribution and diagnosis, size and diagnosis, as well as shape and diagnosis. Words describing quantity were most pronounced among reports describing infectious causes in the 20-74 age group and 75+ age group. Further analysis of words describing distribution of calcification demonstrated that iatrogenic cause reports mentioned marginal structures while reports of masses detailed internal calcification. Diagnosis of masses also used the word "large" significantly more often. Reports that did not provide a diagnostic category tended to use the words "tiny" or "small." Within the analysis of shape descriptions, infectious causes as well as masses had the most unique profiles, which are being further investigated to determine particular words for each category.

Conclusion: Our results show that in transcribing specific patterns seen on head CT, particular sets of words are used across multiple patients and radiologists to describe specific pathologies. This shows that there are connotations in the written language of radiology reports which could be clarified for use as tools by referring physicians to aid in interpretation of diagnostically challenging cases.

ELECTRONIC EXHIBITS



Anna Sorensen, MD

Level: Resident

Faculty Mentor: Fred Lee, MD

Previous Presentation: Society of Interventional Radiology

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Real-Time Electromagnetic CT Navigation (E-CTN) for Percutaneous Needle Placement

Citation: Sorensen AM, Zlevor AM, Kisting MA, Couillard AB, Ziemlewick TJ, Toia GV, Hinshaw JL, Woods M, Stratchko LM, Pickhardt PJ, Foltz ML, Peppler WW, Lee FT Jr., Knavel EM. Real-Time Electromagnetic CT Navigation (E-CTN) for Percutaneous Needle Placement: A How-to Pictorial Essay. Society of Interventional Radiology Annual Meeting, Oral Educational Exhibit, March 23-28, 2024.

Learning Objectives:

1. Review the equipment, procedural steps, and indications for percutaneous needle placement using electromagnetic CT navigation (E-CTN) using a pictorial case-based approach.
2. Outline the advantages of CTN.
3. Understand the disadvantages and pitfalls of CTN to avoid procedural error and ensure diagnostic adequacy.

Background: There is an increased demand for CT-guided procedures, sometimes in relatively challenging anatomic locations, highlighting the need for advanced techniques for needle placement. The recent introduction of several new CT navigation tools may help overcome some of the limitations of historical CT guidance techniques. CT navigation systems combine the advantages of conventional CT guidance and CT Fluoroscopy (CTF) for percutaneous needle placement. E-CTN systems specifically use a localization strategy placed on the patient and needle, combined with fiducials placed within the scan field to superimpose a known needle location onto a CT dataset. Advantages of E-CTN over conventional CT/CTF guidance include the ability to use virtually any puncture angle, with a recent report showing 50% of E-CTN procedures were performed at an angle greater than 10 degrees. E-CTN is also highly efficient due to the need for fewer average check scans when compared to conventional CT guidance (3 checks vs. 9). Despite the diagnostic-level images used for E-CTN, the mean reported effective radiation dose to the physician was very low compared to CTF (0.4 vs 1.2 microGy). Considerations when utilizing CTN include an initial learning curve, less accurate needle position if the needle bends or becomes displaced from the guide, or if the fiducial gets displaced or the patient changes position.

Clinical Findings/Procedural Details: This exhibit will include a pictorial review of how E-CTN is set-up, as well as utilize salient cases to highlight the advantages and indications of CTN for percutaneous needle placement. Important pitfalls and considerations will also be highlighted using a pictorial format to aid interventionalists in utilizing E-CTN.

Conclusions/Teaching Points: E-CTN affords the interventionalist many advantages; including real-time needle tracking using a contemporaneous high-quality CT dataset with the patient in the treatment position, reduced radiation to the physician, facilitation of procedures outside of the gantry plane, fewer helical scans during needle placement, and needle guidance based on diagnostic-quality CT datasets. An understanding of the disadvantages and considerations when using E-CTN will help the interventionalist avoid error and ensure diagnostic adequacy.

ELECTRONIC EXHIBITS



Annie Zlevor

Level: Medical Student

Faculty Mentor: Fred Lee, MD

Previous Presentation: Society of Interventional Radiology

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CT-guided Percutaneous Interventions: Reduction of Metal Needle-Tip Artifact with Low Atomic Number Materials in Phantom and Porcine Models

Citation: Zlevor AM, Versaggi L, Kisting MA, Couillard AB, Wagner M, Kisting A, Falk KL, White J, Kutlu A, Minesinger GM, Mao L, Hinshaw JL, Szczykutowicz T, Lee FT Jr. CT-guided Percutaneous Interventions: Reduction of Metal Needle-Tip Artifact with Low Atomic Number Materials in Phantom and Porcine Models. Society of Interventional Radiology, Salt Lake City, UT, March 2024.

Purpose: Needle tip artifact during CT-guided intervention is problematic because of potential obscuration of both the needle track and target. The purpose of this study is to determine if needle tip artifact can be reduced by replacing stainless steel stylets with lower atomic number materials.

Materials and Methods: A soft tissue-mimicking phantom and deceased porcine model (kidney, liver, and lung) were used to analyze CT beam hardening artifact with different stylet materials. Carbon fiber, aluminum, titanium, nitinol, stainless steel, copper, brass, and molybdenum were used in the phantom, and aluminum and stainless steel were used in the porcine model. Stylet atomic numbers (Z) ranged from 6 to 42 and sized to fit within a 17g introducer needle. CT scans were obtained at 120 kV and 140 kV (phantom) or 120 kV (porcine) at 2.5 mm slice thickness. Images were analyzed for artifact width, length, and intensity, and three blinded radiologists ranked the impact of artifact in the porcine model on a 1-5 scale (1=no artifact, 5=severe artifact).

Results: In the soft tissue phantom, artifact width increased with increasing Z-number, ($p=0.009$ for 120 kV; $p=0.007$ for 140 kV), and artifact intensity worsened ($p=0.001$ for 120 kV; $p<0.001$ for 140 kV). In the porcine model, aluminum had less artifact length and width, and increased HU, resulting in a less intense artifact, compared to stainless steel in all measurements in the kidneys, livers, and lungs ($p<0.05$), except for artifact width and length in the lung and needle width in the kidney ($p>0.05$). Blinded readers ranked the artifact from stainless steel stylet as significantly worse than aluminum ($p<0.005$, kappa=0.63).

Conclusion: Lower Z-number stylet materials substantially decreased metal artifact emanating from needle tips. Medical-grade aluminum replacement of stainless steel stylets may improve image quality and physician confidence during CT-guided percutaneous procedures.