Musculoskeletal Radiology

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105th Scientific Assembly and Annual Meeting
December 1–6 | McCormick Place, Chicago
Infected or Not? And by What? Challenging Cases of Musculoskeletal Infection Which Were Met During the Multidisciplinary Care Approach

All Day Room: MK Community, Learning Center Hardcopy Backboard

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TEACHING POINTS

Traditionally, the diagnosis of musculoskeletal infection is not challenging; however, sometimes, some cases have confusing appearances which interfere with the suitable treatment planning for the patients. The purpose of the exhibit is to share the challenging cases and to help avoid the chance of misdiagnosis.

TABLE OF CONTENTS/OUTLINE

The cases will be presented in a quiz format. Key differential points of each case will be showed in the discussion section of each case. The cases which are included in this exhibit are 1. Vertebral osteomyelitis vs metastasis 2. Modic type I endplate change vs infectious spondylitis 3. Gout vs septic arthritis 4. Degenerative spondylosis vs infectious spondylitis 5. Neuropathic osteoarthropathy vs infectious spondylitis 6. Postoperative fluid collection vs Postop abscess 7. Pyogenic spondylitis vs tuberculous spondylitis 8. Muscle injury related hematoma vs intramuscular abscess 9. Postop change vs infectious spondylitis 10. Acute compression fracture vs infectious spondylitis

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TEACHING POINTS

• At our institution, MR examinations of the lumbar spine are interpreted by musculoskeletal radiologists. • MRI may show variable pathologies involving the lumbar neural structures including the distal spinal cord, conus medullaris, extramedullary space and nerves. • Musculoskeletal radiologists should be familiar with these neurologic pathologies which can clinically mimic skeletal pathologies.

TABLE OF CONTENTS/OUTLINE

In this exhibit, we present variable disease pathologies that we encountered in our practice and these included: 1- Cord and conus pathologies: a) Tumors of filum terminal: Malignant : Myxopapillary ependymoma Schwannoma Hemangioblastoma Metastases Benign: Lipoma of the filum Epidermoid/dermoid cyst b) Demyelinating disease: Multiple sclerosis Intrathecal methotrexate Guillain Barre c) Tethered cord 2- Nerve roots pathologies: a) Nerve sheath tumors b) Arachnoiditis c) Leptomeningeal metastatic spread d) Meningitis 3- CSF pathologies: a) Subdural hematoma 4- Dural pathologies: a) Epidural lipomatosis b) Meningioma c) Dural arteriovenous fistula

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Awards
Cum Laude

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TEACHING POINTS
1. The subscapularis (SSC) is the largest of the rotator cuffs. Diagnosis of SSC tendon abnormality may be overlooked on MRI and arthroscopy. An underdiagnosed SSC tendon tear may lead to persistent pain and weakness, and a suboptimal surgical outcome after the repair of coexisting supraspinatus or infraspinatus tears. 2. The complex footprint anatomy of the SSC is somewhat different than the other rotator cuff tendons. It consists of 5 components: 1) main tendinous insertion; 2) inferior muscular insertion; 3) superior tendinous slip; 4) medial capsuloligamentous insertion; 5) transverse humeral ligament 3. Understanding of the footprint anatomy of the SSC will enhance the detection of the tendon injury and interpretation of MRI. 4. The mechanism of SSC injury can be divided into five major categories: 1) combined tear with supraspinatus tear; 2) associated with injury of long head tendon of biceps, biceps pulley and rotator interval; 3) subcoracoid impingement; 4) acute rupture; 5) glenohumeral joint instability

TABLE OF CONTENTS/OUTLINE
1. Introduction - Brief review of anatomy, function and clinical importance of the SSC 2. Footprint anatomy - Illustrative review of 5 components with schematic drawings and MR images 3. Mechanism of injury - Brief review of SSC tear - Case-based review of SSC injury categorized by 5 mechanisms

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Arthroscopic Surgery of the Wrist: What Radiologists Should Know

All Day Room: MK Community, Learning Center Hardcopy Backboard

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TEACHING POINTS
Arthroscopic wrist surgery is increasingly performed for the diagnosis and treatment of pathologic conditions in the wrist. Radiologists must understand the basics of arthroscopic findings and surgical procedures in order to correlate with MRI findings and to communicate with orthopedic surgeons. The major teaching points of this exhibit are: 1. To review the basics of wrist arthroscopy. 2. To understand when and how arthroscopic diagnosis and procedures are performed.

TABLE OF CONTENTS/OUTLINE
1. Basic of wrist arthroscopy
   a. Indication and preoperative physical examination
   b. Patient positioning
   c. Placement of arthroscopic portals and basic views
2. Pathologic state and procedures
   a. Distal radioulnar joint instability - Triangular fibrocartilage complex (TFCC) injury: central disc and peripheral tear
   b. Intrinsic ligament injury
   c. Ulnar impaction syndrome
   d. Kienböck disease
3. Limitations of wrist MRI compared to arthroscopy and vice versa
4. Summary and Take-home messages

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Sports Hernia/Athletic Pubalgia and Beyond: Unravelling Groin Pain in Elite Athletes

All Day Room: MK Community, Learning Center Hardcopy Backboard

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TEACHING POINTS
1. To illustrate the anatomy of the groin. 2. To describe the imaging approach in an athlete with groin pain. 3. To review imaging features of the umbrella term that encompasses the term athletic pubalgia. 4. To illustrate the differential diagnosis of groin pain with emphasis on Magnetic resonance (MR) imaging.

TABLE OF CONTENTS/OUTLINE

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Occult Fractures: A Pictorial Review

All Day Room: MK Community, Learning Center Hardcopy Backboard

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TEACHING POINTS
CT and MR imaging are the methods of choice when we are dealing with clinical and radiological suspicion of an occult fracture. Early diagnosis avoids the complications involved. To show some of the most frequent fractures using CT and MRI that could not be detected in the conventional X-ray through an interactive poster format that contains a series of challenging cases and original drawing schemes. To review the different types of occult fractures by region and the most appropriate imaging modalities for its diagnosis.

TABLE OF CONTENTS/OUTLINE
The cases will be presented in a quiz format, showing the original radiographs and hiding the CT and MR images. • Introduction • Terminology • Clinical Findings • Diagnostic Imaging Methods • Challenging cases: • Shoulder • Elbow • Wrist and hand • Hip and Pelvis • Knee • Ankle and hindfoot • Summary

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Awards
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TEACHING POINTS
Rheumatoid arthritis (RA) and psoriatic arthritis (PsA) are both common chronic inflammatory diseases, and differentiation of these conditions can be challenging. RA is an autoimmune systemic inflammatory disease manifested by synovitis, whereas enthesitis is a manifestation of PsA. Differentiating RA from PsA at an early disease stage is important because differences in response to therapy translate into substantially different clinical outcomes. We present radiographic features in MRI and DE-CT as advanced imaging tools adding to typical classic imaging findings.

TABLE OF CONTENTS/OUTLINE
1. Pathophysiology of RA and PsA
2. Diagnostic strategy for hand small joints arthropathy
3. Typical imaging features - Xp, CT
4. Advanced imaging - Clinical importance of early detection - DE-CT and eMRI - Evaluation of response to treatment

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A Radiological Overview of Hip Arthroplasty: Practical Keys in the Assessment of Hip Replacement

All Day Room: MK Community, Learning Center Digital Education Exhibit

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TEACHING POINTS
- To know the different types of hip replacement
- To review the role of imaging techniques (plain radiograph, CT, MR, US, scintigraphy) in the evaluation of prostheses
- To understand usefulness and limitations of plain radiographs and CT in the evaluation of hip replacements, emphasizing useful parameters and illustrating image analysis and interpretation
- To become familiar with normal and abnormal postoperative imaging findings and signs of complications

TABLE OF CONTENTS/OUTLINE
We review imaging of hip replacement, highlighting key concepts perceived as important variables by the surgeon and correlating images with clinical considerations and functional outcomes. We present:
1. A review of types of replacement.
3. Imaging. Plain radiographs: - Technique and views. Standard image acquisition: beam and anatomical landmarks - Parameters that should be evaluated: description of the components, alignment relative to normal anatomic alignment.
4. Imaging. CT: -Technique. -Parameters that should be evaluated. - Imaging of complications: infection, polyethylene wear, aseptic loosening, osteolysis, periprosthetic and component fracture, evaluation of the adjacent soft tissues.

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TEACHING POINTS
1. To be familiarized with the various radiographic foot angle measurements to define and characterize foot alignment
2. To gain insight into the usefulness of relevant foot angle measurements and radiographic signs to identify acquired foot deformities in an adult
3. To improve the diagnostic interpretation of various adult foot deformities and characterization of the spectrum of deformity

TABLE OF CONTENTS/OUTLINE
• Detailed illustrations of commonly obtained radiographic foot angles
• Comprehensive review of relevant radiographic foot angle measurements and signs associated with various adult foot deformities

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Acetabular Fracture Classification Made Easy: The Use of 3D CT and Acetabular App

All Day Room: MK Community, Learning Center Digital Education Exhibit

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TEACHING POINTS
1. To be familiarized with the recently introduced acetabular app and how to use it to arrive at the correct Judet-Letournel classification
2. To improve the diagnostic interpretation and classification of complex acetabular fractures
3. To increase the confidence level in establishing an accurate classification of any acetabular fracture, with the use of a 3D model and the acetabular app

TABLE OF CONTENTS/OUTLINE
• Review the features and algorithm of the acetabular app • Illustrate the step-by-step approach to arriving at the correct acetabular fracture classification • Identify pitfalls to be aware of when using the acetabular app

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Osteomyelitis - A Common Disease with Many Faces
All Day Room: MK Community, Learning Center Digital Education Exhibit

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TEACHING POINTS
Review the pathophysiology, terminology and classifications of osteomyelitis. Describe the widespread radiological presentation of osteomyelitis. Learn keys imaging features in each modality.

TABLE OF CONTENTS/OUTLINE
The manifestation of osteomyelitis is radiologically widespread. The presentation is multifactorial depending on the chronicity, patient age, pathogens, with a variety of mimicker making the diagnosis challenging. We review basic concepts including the pathophysiology, classification, and terminology. Using multiples modalities, including plain film, CT, US, and MR we illustrate the spectrum of manifestation from acute to chronic. We emphasize subtle changes allowing the differentiation of each phase. We describe expected post-surgical changes and worrisome signs suggesting of recurrence. We elaborate on current imaging protocol in challenging cases including the presence of metal implants and usage of metal suppression sequences or nuclear imaging (such as WBC and sulfur colloid scintigraphy). We review briefly subtypes including CRMO and SAPHO. Finally, we summaries with a table illustrating the most relevant signs according to each modality. Cases include acute, subacute and chronic osteomyelitis, sclerosing osteomyelitis, CRMO, SAPHO, neuropathic arthropathy, stress injuries, primary tumor (Ewing, multiple myeloma, osteosarcoma), LCH and metastasis.

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**TEACHING POINTS**

To review the approach of examination, anatomy and common lesions of meniscus in ultrasound as well as ultrasound guided meniscus interventions.

**TABLE OF CONTENTS/OUTLINE**

1. Approach of examination of meniscus by ultrasound. 2. Anatomy of meniscus horn on sagittal plane and meniscus body on coronal plane. Ultrasound anatomy of meniscus on axial plane. 3. Appearance of common meniscus lesions on ultrasound. 4. Indications and contraindications of ultrasound guided interventions. 5. Role of various injectants in meniscus tears and parameniscus cysts.

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Orthopaedic Clinical Examination Signs and What it Means for Radiologists

All Day Room: MK Community, Learning Center Digital Education Exhibit

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TEACHING POINTS
1. To gain awareness and understanding from a radiologists' perspective on the common clinical signs and examinations used by orthopaedic surgeons.
2. To correlate the elicited pathology with imaging findings on various musculoskeletal imaging modalities.

TABLE OF CONTENTS/OUTLINE
Various orthopaedic clinical tests will be discussed with a simple diagram illustrating how the test is performed, relevant imaging findings for its corresponding pathologies will be showcased. The clinical tests are divided according to different joints as detailed below.

Shoulder: Wrightington posterior instability test, Apprehension test, Relocation test, O'Brien's test, Scarf test, Speed's test, Spurling's test, Lhermitte's test and several shoulder arthroscopic signs.
Elbow: Hoffman's test, Cozen's test, Maudsley's test, Mill's test, Milking manoeuvre, Push up test.
Hand: Hueston's table top test, Ulnar grind test, Durkin's test, De Quervain's test.
Hip: Ober's test, C-sign, Psoas provocation test.
Knee: McMurray's test, Anterior draw test, Patellar grind test.
Ankle and Foot: Silverskiold test, Single and double heel test.

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The Nuts and Bolts: What the Radiologist Needs to Know about the Imaging Appearance of Orthopedic Procedures

All Day Room: MK Community, Learning Center Digital Education Exhibit

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TEACHING POINTS
1. Recognize common orthopedic hardware appearances throughout the body by radiographic appearance. 2. Recognize less commonly encountered orthopedic hardware and post-procedural appearances throughout the body by radiographic appearance.

TABLE OF CONTENTS/OUTLINE

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Anatomy, Biomechanics, Imaging and Pathologies of the Acromioclavicular Joint

All Day Room: MK Community, Learning Center Digital Education Exhibit

Awards
Magna Cum Laude
Identified for Radiographics

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TEACHING POINTS
- Acromioclavicular joint is the 'forgotten' joint of the shoulder, with shoulder pain often being attributed to the glenohumeral articulation and rotator cuff tendons
- Acromioclavicular joint pathology can be divided into traumatic and non-traumatic etiologies
- Awareness of anatomy, common pathologies, imaging, treatment and complications is essential in meaningful evaluation of this typically neglected joint

TABLE OF CONTENTS/OUTLINE
DEVELOPMENT Congenital variations Ossification centers Os acromiale syndrome ANATOMY Dynamic stabilizers Deltoid muscle Trapezius muscle Static stabilizers Acromioclavicular ligament Coracoclavicular ligament Coracoacromial ligament Joint capsule BIOMECHANICS AND PHYSIOLOGY Axes of movement and related structures Vertical axis Anteroposterior axis Longitudinal axis TRAUMATIC PATHOLOGY Grading Pre-operative and post-operative imaging Treatment NONTRAUMATIC PATHOLOGY Distal clavicular osteolysis Osteoarthritis Septic arthritis

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Adult Bone Marrow Disorders
All Day Room: MK Community, Learning Center Digital Education Exhibit

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TEACHING POINTS
The purpose of this exhibit is: 1. To review the normal bone marrow pattern on the axial and appendicular skeleton and their variants. 2. To demonstrate the most frequent changes in the bone marrow MRI signal found in routine exams and how to differentiate benign changes from malignancies.

TABLE OF CONTENTS/OUTLINE
Introduction presenting the normal bone marrow composition at different stages of life and the main differences between the axial and appendicular skeleton. Discuss the main pathologies that can alter the bone marrow signal in adults, including normal variants, medullary conversion/reconversion, systemic and neoplastic diseases, as well as the expected MRI pattern changes in each one of them. Objectively outline how radiologists should approach a focal or diffuse signal change in the bone marrow and how to make the main differential diagnoses, focusing on the differentiation between lesions of benign etiology and suspicious lesions for neoplastic involvement. Provide didactic and illustrative cases in a challenging format to test and consolidate the acquired knowledge. Conclusions. Bibliographical references.

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Dark Lesions of the Talus

All Day Room: MK Community, Learning Center Digital Education Exhibit

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TEACHING POINTS
To elucidate the concept of containment (nonshoulder) and noncontainment (shoulder) of osteochondral injuries and their associations with prognosis and therapeutic success. Didactic and illustrative review of Tram track and mirror-image injuries.

TABLE OF CONTENTS/OUTLINE
To discuss the etiology and classification of osteochondral lesions of the talus focusing on the concept of fragment contention, tram track and mirror image lesions. Provide schematic figures and cases to represent the concept of this presentation.

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TEACHING POINTS
- The synovium is a tissue that lines the synovial joints, bursae, and tendon sheaths. Synovial processes may present as a sequela of localized disease or a systemic disorder that can lead to irreversible joint damage and bone erosion if diagnosis is delayed. There are characteristic imaging findings to be aware of to aid in accurate diagnosis.
- Synovial Osteochondromatosis will demonstrate cartilaginous nodules within the synovium. Calcified bodies are pathognomonic. Pigmented villonodular synovitis classically demonstrates synovial hemorrhage.
- Amyloid arthropathy results from B2-microglobulin deposition, commonly in patients undergoing long-term dialysis.
- Lipoma arborescens is rare, but classically appears as a frondlike masses in the joint space that follow fat signal on all MRI sequences.
- Silicone synovitis is a nonseptic arthropathy resulting from chronic foreign body, most commonly carpal implants.

TABLE OF CONTENTS/OUTLINE
- Inflammatory Arthropathies
  - Rheumatoid Arthropathy
  - Juvenile Idiopathic Arthropathy
- Metabolic Diseases
  - Calcium Pyrophosphate Dihydrate Disease
  - Gout
  - Hydroxyapatite
  - Amyloid
- Neoplastic Diseases
  - Synovial Osteochondromatosis
  - Giant Cell Tumor/Pigmented Villonodular Synovitis
- Miscellaneous Diseases
  - Lipoma Arborescens
  - Particle Disease
  - Septic Joint

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Awards
Cum Laude

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TEACHING POINTS

Skeletal dysplasias encompass a heterogeneous group of over 400 disorders. They are individually rare, but collectively rather common with approximate incidence of 1/5000. Thus, radiologists occasionally encounter skeletal dysplasias in daily practice. Most skeletal dysplasias have identifiable pathognomonic pattern of skeletal changes, and the diagnosis mostly rests on pattern recognition approach. It is not difficult for radiologists to become familiar with the key radiological findings. The purpose of this exhibit is 1) to demonstrate key radiological findings and pathognomonic patterns of common skeletal dysplasias and 2) to review their clinical and genetic features that radiologists should be aware so as to participate in multidisciplinary patient care.

TABLE OF CONTENTS/OUTLINE

- Introduction
- Approach to skeletal dysplasias
- Thanatophoric dysplasia
- Achondroplasia
- Multiple epiphyseal dysplasias
- Diastrophic dysplasia
- Spondyloepiphyseal dysplasia congenita
- Achondrogenesis (1A, 1B, 2)
- Skeletal ciliopathies
- Acromelic dysplasia
- Osteopetrosis
- Pyknodysostosis
- Osteopoikilosis
- Melorheostosis
- Pyle disease
- Pachydermoperiostosis
- Osteogenesis imperfecta
- Cleidocranial dysplasia
- Nail patella syndrome
- Hereditary rickets
- Hypothyroidism
- Multiple exostoses
- Enchondromatosis
- Fibrous dysplasia (McCune-Albright syndrome)

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DISH, Ankylosing Spondylitis, and Spondyloarthrosis: What’s the Difference?

All Day Room: MK Community, Learning Center Digital Education Exhibit

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TEACHING POINTS
The purpose of this exhibit is: 1. To present the most typical clinical and radiological findings of Ankylosing Spondylitis, Diffuse Idiopathic Skeletal Hyperostosis and Spondyloarthrosis. 2. To define the major tips to differentiate the three entities, including some other differential diagnoses. 3. To discuss the importance of the correct diagnosis, especially because of new therapeutic possibilities with TNF alfa for the patients with ankylosing spondylitis.

TABLE OF CONTENTS/OUTLINE
Introduction reviewing the major clinical and epidemiological characteristics of Diffuse Idiopathic Skeletal Hyperostosis (DISH), Ankylosing Spondylitis (AS) and Osteoarthritis (OA). Present the typical radiological features of each pathology, focused on the spine but also discussing sacroiliac, peripheral joints and the enthesis, including the fact that some of them can overlap in more than one disease. Demonstrate how to differentiate the 'flowing' ossifications on DISH from the syndesmophytes on AS and the osteophytes on OA and how the associated features can help us lead to the right diagnosis. Briefly illustrate the most common differential diagnosis, like other spondyloarthritides. Provide didactic and illustrative cases in a challenging format to test and consolidate the acquired knowledge. Conclusions. Bibliographical references.

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TEACHING POINTS
* Discuss the main findings and population at risk for stress fractures in the upper extremity
* Present typical fracture sites and correlate with the most commonly associated sports modalities
* Review cases that are not related to sport injuries and typical findings that can help distinguish them from pathological fractures
* Revise and explain the different terminology among fractures due to stress, fatigue, insufficiency and others, that may lead to miscommunication

TABLE OF CONTENTS/OUTLINE
* Introduction of the theme beginning with the differentiation of the nomenclatures associated with atraumatic fractures, including stress, insufficiency, fatigue, atypical and pathologic fractures
* Presentation of the epidemiology, risk factors, commonly affected sites, and main associated causes
* Discussion of the main imaging modalities used in the diagnosis, with presentation of MRI cases
* How to differentiate stress from pathological fractures through evaluation of bone marrow involvement in T1 and muscle edema
* Provide an algorithm of the diagnostic modalities accordingly to the findings and chronology of the lesion
* Conclusions
* Bibliographical references

Printed on: 01/19/20
Practical Approach to Degenerative Spine: What the Surgeons Want to Know

All Day Room: MK Community, Learning Center Digital Education Exhibit

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TEACHING POINTS
Illustrate the critical aspects of degenerative spine disease that will affect surgical management. Eliminate verbose lists of findings that do not impact clinical decision making. Develop structured, succinct reporting of degenerative lumbar spine disease.

TABLE OF CONTENTS/OUTLINE
Background
* Back pain is the leading cause of disability
* Number of MRI and surgeries are on the rise
* High variability of MRI interpretations
Review of Nomenclature
Level by level findings to include
* Neural foraminal stenosis grading
* Lateral recess stenosis grading
* Spinal canal stenosis grading
* Causes and focal areas mass effect: Central zone, subarticular zone, foraminal zone, extra-foraminal zone
Level by level findings to exclude
* Broad based disc bulge
* Ligamentum flavum thickening
* Facet hypertrophy
Ways of generating concise reports
* Table format grading
* What not to do: lengthy, verbose reports with irrelevant material
Sample a lengthy and verbose lumbar spine MRI report condensed into a more structured and relevant report.

Conclusions
* MRI reports are valuable to a clinician when a structured format is used with succinct, clinically relevant findings.

Printed on: 01/19/20
The Biceps Brachii: What Should it Look Like and How Do We Know When Something is Wrong?

All Day Room: MK Community, Learning Center Digital Education Exhibit

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TEACHING POINTS
The long head of the biceps tendon may be associated with superior labral, biceps pulley, chondral and subscapularis tendon pathology. MRI can diagnose biceps chondromalacia. The distal biceps tendon can be separated into short and long components and tears can be partial or complete with retraction associated with tears of the lacertus fibrosis. Commonly performed surgical procedures for the biceps tendon include biceps tenotomy and tenodesis proximally and tendon repair distally. It is important to be familiar with the normal and abnormal appearance of these post-operative states to avoid misdiagnoses.

TABLE OF CONTENTS/OUTLINE
1. Normal anatomy of the proximal and distal biceps brachii including the biceps pulley
2. Clinical exam findings related to proximal biceps and superior labral injury and distal biceps injury
3. Pathology of the proximal long head of the biceps tendon: SLAP lesions, tendinosis, tenosynovitis, split tears, rupture, subluxations, dislocations and biceps chondromalacia as seen with MRI/MRA with arthroscopic correlation when available
4. Pathology of the distal biceps tendon as seen with MRI and ultrasound
5. Proximal biceps surgeries with multimodality imaging findings of the post-operative state
6. Distal biceps surgeries with multimodality imaging findings of the post-operative state

Printed on: 01/19/20
Current and Emerging Concepts in the Diagnosis and Treatment of Facet Joint Pain

All Day Room: MK Community, Learning Center Digital Education Exhibit

FDA Discussions may include off-label uses.

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TEACHING POINTS

1. Clinical diagnosis of facetogenic back/neck pain is challenging with confirmation requiring comparative medial branch blocks. 2. Non-anatomic imaging biomarker-directed treatment of facetogenic pain is being investigated and has potential to drastically change treatment. 3. Current treatments for facetogenic pain have a subgroup of patients with poor response. 4. New potential treatments are being investigated, including MRI-guided focused ultrasound and regenerative medicine techniques.

TABLE OF CONTENTS/OUTLINE

1. Facetogenic pain: considerations of inflammatory arthropathy versus osteoarthritis 2. Similarities, differences, and significance of perfacet bone scan activity, T2 hyperintensity, gadolinium enhancement, and FDG activity 3. Significance of the retrodural space of Okada and posterior ligamentous complex inflammatory syndrome 4. Emerging MRI techniques (e.g. ZTE, T1 rho) 5. Special considerations in the cervical spine (C1-C2 joint, whiplash, inflammatory arthropathy) 6. Special considerations in the thoracic spine (proximity to the costovertebral/transverse joints) 8. Introduction to the potential role of serum biomarkers. 9. Emerging interventional treatment strategies including modified approaches to radiofrequency ablation, MRI-guided focused ultrasound, and regenerative medicine.

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MK119-ED-X

Traumatic Injuries of the Spine: Surgical or Conservative Management?

All Day Room: MK Community, Learning Center Digital Education Exhibit

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TEACHING POINTS

The purpose of this exhibit is: ? To review the anatomy of the spine and the typical mechanisms of trauma. ? Review the TLICS classification for thoracolumbar injuries and specific classifications for the cervical spine. ? Differentiate surgical traumatic vertebral injuries from non-surgical and correlate with intraoperative images; ? Illustrate the main determinants for surgical treatment in each segment of the spine.

TABLE OF CONTENTS/OUTLINE

• Review of basic anatomy of the spine • Overview of typical mechanisms of trauma • Thoracolumbar spine: the TLICS classification • Compressive fracture of thoracolumbar spine • Burst fracture of thoracolumbar spine • Rotation mechanism of fracture of thoracolumbar spine • Distraction fracture of the thoracolumbar spine. • Special types of cervical spine fractures.

Printed on: 01/19/20
MR Features of the Traumatic Injury of the Triangular Fibrocartilage Complex (TFCC): A Refinement and Supplement to the Palmer Classification

All Day Room: MK Community, Learning Center Digital Education Exhibit

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TEACHING POINTS
This educational presentation will illustrate the following: 1. The refinement and supplement of the traumatic Palmer classification of the triangular fibrocartilage complex (TFCC) injury; 2. The utility of indirect MR arthrography (MRAr) in Palmer 1B injury; 3. The refinement of Palmer 1D injury and the MR imaging features; 4. The bucket-handle tear of the TFCC which has rarely been reported.

TABLE OF CONTENTS/OUTLINE
1. Introduction and background on the traumatic injury of the triangular fibrocartilage complex (TFCC) and the injury classification.
2. The chart and pictures illustrate the refinement and supplement of the traumatic Palmer classification of the triangular fibrocartilage complex (TFCC) injury. 3. Demonstration of the utility of indirect MR arthrography (MRAr) in Palmer 1B injury. 4. Illustration the refined Palmer 1D injury and the MRI characteristics. 5. Explanation of the bucket-handle tear of the TFCC.

Printed on: 01/19/20
Ultrasound of the Hamstring Complex - A Primer for the Sports Radiologist

All Day Room: MK Community, Learning Center Digital Education Exhibit

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TEACHING POINTS
Due to anatomical complexity, ultrasound examination of the hamstring muscles is challenging which can lead to diagnostic uncertainty. As such, there is under-confidence in the technique with a subsequent tendency to favour MRI evaluation. This can delay diagnosis and potential intervention. This exhibit aims to review anatomical landmarks of the posterior thigh on ultrasound with a direct comparison with the corresponding MRI appearances with which many radiologists may be more familiar. Identification of these key landmarks can help distinguish between the individual structures that form the hamstring complex and as such improve diagnostic accuracy and confidence. Ultimately, this can improve the time and sensitivity of identifying injuries, monitor progress and help identify suitable candidates for potential intervention.

TABLE OF CONTENTS/OUTLINE
An ultrasound image at a specific level of the hamstring complex will be displayed beside an MRI image at the same level from the same individual. This will be replicated to demonstrate key ultrasonographic anatomical landmarks, including: - Hyperechoic Triangle of Cohen - Ischial tuberosity insertions - 'Tadpole' appearance of the Semimembranosus tendon - Intramuscular fascial membrane that identifies semitendinosus - Long head of biceps femoris insertion onto the short head fascia

Printed on: 01/19/20
Stick to the Ribs: Imaging of Traumatic Rib Fractures, Complications, and Mimics

All Day Room: MK Community, Learning Center Digital Education Exhibit

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TEACHING POINTS
1. To review rib development, anatomy, and physiology of respiration.
2. To discuss the roles of different imaging modalities and patterns of search used in diagnosis of rib fractures.
3. To describe rib fracture types with close attention to those commonly missed.
4. To illustrate the benign and malignant mimics of rib fractures.
5. To recognize the most common complications of traumatic rib injury, and review posttreatment imaging.

TABLE OF CONTENTS/OUTLINE
Rib development, anatomy and respiration physiology Algorithm for imaging evaluation of rib fractures, CT search approach Role of coronal imaging Role of sagittal imaging Review of rib injury patterns - Buckle fractures - Stress fractures - Nondisplaced and displaced fractures - Costochondral injury - Pathologic rib fractures - Segmental rib fractures and flail chest Nontraumatic rib fracture mimics - Benign entities - Malignant lesions Complications of rib injury - Pulmonary contusion and laceration - Pneumothorax - Hemothorax - Extrapeural hematoma - Vascular injury Subacute and chronic rib trauma complications Rib fracture management and posttreatment imaging

Printed on: 01/19/20
Chip on Your Shoulder? A Resident’s Primer for Understanding Positioning and Relevant Anatomy in Shoulder Radiography

All Day Room: MK Community, Learning Center Digital Education Exhibit

Awards
Certificate of Merit

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TEACHING POINTS
Shoulder radiographs are commonly performed during evaluation of both acute and chronic pain. Familiarity with the proper patient positioning used in shoulder radiography is important to the radiologist for quality control. A thorough understanding of the anatomy of the shoulder on radiographic views is needed for accurate image assessment.

TABLE OF CONTENTS/OUTLINE
The purpose of this educational exhibit is review proper patient positioning for routine shoulder radiographs and emphasize the relevant anatomy on these views to ensure accurate image assessment. The target audience for this presentation is radiology residents and radiology trainees. Review the general anatomy of the shoulder with multiple modalities. Describe common radiographic views of the shoulder obtained in practice and the necessary patient positioning for each view. Highlight the relevant osseous anatomy on each of the different shoulder views. Shoulder radiographic views discussed will include: internal and external rotation AP, Grashey, outlet, axillary, Stryker notch and Velpeau. Illustrative normal and abnormal cases will be provided. Shoulder radiographs are common examinations. Familiarity with proper patient positioning and the relevant anatomy displayed on different views of the shoulder is important for accurate image interpretation.

Printed on: 01/19/20
TEACHING POINTS

Describe normal tibial anatomy in concordance with tibial eminence fractures in pediatric patients utilizing the Meyers and McKeever Classification System. Review typical imaging characteristics to classify the type of tibial eminence fracture through various imaging modalities including plain radiograph, CT, and MRI. Demonstrate importance of classification system on treatment and post treatment outcomes.

TABLE OF CONTENTS/OUTLINE

Tibial eminence fractures in the pediatric population present in numerous ways and can range in severity. The Meyers and McKeever Classification plays a vital role in categorizing various radiological findings of fractures involving the tibial eminence through differing imaging modalities to assess severity of the injury as well as aid in possible therapeutic intervention. Upon review of our presentation, the reader will be able to confidently identify normal anatomy and differentiate various tibial eminence fractures through differing imaging modalities and determine possible intervention and post treatment outcomes in patients approaching skeletal maturity. 1. Normal radiological features of tibial anatomy. 2. Demonstrate tibial eminence fractures utilizing the Meyers and McKeever Classification. 3. Discuss impact of classification system on assessing severity of injury, possible intervention, and post treatment outcomes.

Printed on: 01/19/20
Arthritis is generally used as disease that affects joint causing pain and stiffness. We reviewed the stepwise approach to variable arthritis based on imaging for radiologists. 1. To suggest stepwise approach to arthritis based on imaging, mainly radiography. 2. To demonstrate the characteristic imaging findings of each arthritis.

**TABLE OF CONTENTS/OUTLINE**

Introduction - What is the 'arthritis'? - Approach to 'arthritis' by diagram

Step 1: Number of joint involvement
- Multiple (more than 1) --> Go to step 2
- Single: Septic arthritis, Pigmented villonodular synovitis (PVNS), Primary synovial chondromatosis

Step 2: Characteristics
- Erosive: Rheumatoid arthritis, Hemophilic arthropathy, Amyloid arthropathy
- Productive: Osteoarthritis, Hemochromatosis
- Mixed: Seronegative spondyloarthropathy, Crystal deposition disease --> Go to step 3

Step 3: Symmetric joint involvement
- Symmetric: Ankylosing spondylolysis, Inflammatory bowel disease related arthritis
- Asymmetric: Psoriatic arthritis, Reactive arthritis, Gout, CPPD

Step 4: Ancillary features?
- Adjacent soft tissue density, periostitis, bone density

Step 5: Location

Summary
Bone Tumors and Tumor-Like Lesions on CT: A Primer for the Emergency Radiologist

All Day Room: MK Community, Learning Center Digital Education Exhibit

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TEACHING POINTS
1. Up to 80% of bone tumors can be diagnosed based on CT appearance and patient age alone. 2. Tumor aggressiveness, matrix, and location are the most important CT features to narrowing a differential diagnosis for a bone tumor. 3. CT is superior to MRI for characterization of mineralized matrix (chondroid and osteoid), but inferior for non-mineralized matrix. 4. Recommendations for further imaging (e.g. MRI) or orthopaedic oncology consult should be based on the radiologists' differential diagnosis, which is guided by the principles stated above. 5. Be aware of the "don't touch" lesions that one can confidently diagnose on CT and obviate unnecessary biopsy and orthopaedic oncology consult.

TABLE OF CONTENTS/OUTLINE
- Overview of bone tumors and tissues of origin
- Imaging diagnostic approach to bone tumors identified on CT
- Review of common bone tumors by tissue of origin (e.g. chondroid) with clinical pearls for management/triage in the Emergency Department (e.g., when to recommend orthopaedic consult and when to recommend follow-up imaging at what intervals)
- Case-Based Review of bone tumors with focus on management and triage

Printed on: 01/19/20
EXTRASKELETAL EWING SARCOMA: SITES OF OCCURRENCE AND IMAGING FEATURES

All Day Room: MK Community, Learning Center Digital Education Exhibit

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TEACHING POINTS
1. To present the distinct epidemiology, characteristics, and distribution of extraskeletal Ewing sarcoma with regard to the osseous Ewing's sarcoma. 2. To present common and uncommon sites of occurrence of extraskeletal Ewing sarcoma using multi-modality imaging.

TABLE OF CONTENTS/OUTLINE
The educational exhibit has two sections. The first section briefly reviews the classification and molecular basis, epidemiology, imaging characteristics, main differential diagnoses, prognosis, and treatment of extraskeletal Ewing sarcoma. The second section focuses on the imaging of extraskeletal Ewing sarcoma occurring at various anatomical sites based on radiography, ultrasound, CT, MR, SPECT/CT, and PET/CT. These presented anatomical sites, involving all the organ systems, encompass the skull base, cerebellum, lung, axilla, stomach, subcutaneous region, paralumbar region, kidney, adrenal gland, ureter, pelvis, prostate, inguinal region, and upper and lower extremities.

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Dual-Energy CT: Painting the Horizon of Musculoskeletal Imaging

All Day Room: MK Community, Learning Center Digital Education Exhibit

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Diagnostic Centres

TEACHING POINTS

The objectives are to discuss dual-energy CT (DECT) as a problem-solving tool in musculoskeletal imaging. There will be a focus on how to apply DECT concepts to add valuable information in routine clinical scenarios. Upcoming applications will be highlighted with reference to the current literature.

TABLE OF CONTENTS/OUTLINE

A. Introduction of DECT concepts
B. Applications of DECT for Gout diagnosis and management: in addition to helping in uncertain diagnostic scenarios, DECT has the potential to guide management by tracking resolution of gouty tophi. Detection of bone marrow edema: increased confidence in detecting subtle fractures. Assessment of collagenous structures: this upcoming application may offer added value in visualizing tendons, ligaments, menisci, and discs. Metal artifact reduction: improved image quality may salvage non-diagnostic studies. Infectious and inflammatory conditions: DECT can highlight edema and inflammatory lesions found in rheumatoid arthritis, psoriatic arthritis, and osteomyelitis. Malignancy: facilitated detection of metastases and multiple myeloma.

Printed on: 01/19/20
Musculoskeletal System Involvement by Opportunistic Infections: More Common than Recognized

Awards
Certificate of Merit

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TEACHING POINTS

The purpose of this exhibit is: 1. To present definitions of Opportunistic Infection noting differences over time and geographic location. 2. To present imaging examples of infectious musculoskeletal system involvement including cellulitis, fasciitis, myositis, osteomyelitis, and septic arthritis. 3. To present imaging findings that suggest specific cultural or serological tests should be performed. 4. To present categories of at-risk patients, including those with HIV infection, congenital deficiencies in immune function, patients being treated with immune regulating medications for neoplasia or other inflammatory diseases and patients with unusual infections but no known immune defect.

TABLE OF CONTENTS/OUTLINE

Introduction: Scope of the problem worldwide
Definition of Opportunistic Infection
Review of basic immune system function
Categories of Patient involvement
Regions of Musculoskeletal system involvement
Table 1: Specific infections expected based on immune deficit
Table 2: Regions of Involvement by Opportunistic Microorganisms

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MK130-ED-X

Posterolateral Rotatory Instability of the Elbow Joint: What Are the Imaging Features?
All Day Room: Mk Community, Learning Center Digital Education Exhibit

Participants
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TEACHING POINTS
- To recognize the different patterns of ligamentous and bony injuries associated with posterior elbow dislocation/subluxation.
- To recognize the imaging features of posterolateral rotatory instability of the elbow joint.
- To understand importance of the different grading systems used, in terms of elbow joint stability and further management decisions.

TABLE OF CONTENTS/OUTLINE
Elbow joint dislocation is the 2nd most common type of joint dislocation in adults. Various terms are used to describe injuries associated with posterolateral instability and elbow joint subluxation/dislocation (like circle of Horii, the terrible triad and the O'Driscoll staging). Incorrect diagnosis or management can result into joint instability and accelerated osteoarthritis. The aim of the presentation is to highlight the imaging findings in posterolateral rotatory instability of the elbow joint. We will emphasize the O'Driscoll staging and highlight the role of Mason-Johnston and the O'Driscoll classifications for radial head and olecranon fractures respectively. Subtle signs indicating instability (like the drop sign and Osborne-Cotterill lesions) will be demonstrated. MRI images will be used to clarify the different soft tissue/ligamentous injuries. There will be a few examples of post-operative images and complications.

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Imaging Findings of Osteomyelitis: Update on Diagnosis

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TEACHING POINTS
To revise the physiopathology and imaging findings of osteomyelitis with different imaging modalities. To discuss the differential entities that can mimic acute and chronic osteomyelitis, focusing on diagnostic pearls and potential pitfalls to make a correct diagnosis. To describe the role and potential limitations of imaging in the evaluation of diabetic foot.

TABLE OF CONTENTS/OUTLINE

Printed on: 01/19/20
Conventional Radiology in Peripheral Arthritis: What the Radiologist Needs to Know

All Day Room: MK Community, Learning Center Digital Education Exhibit

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TEACHING POINTS
1. To provide an educational and pictorial review of the peripheral arthritis based on radiological imaging features, emphasizing its anatomical distribution. 2. To classify peripheral arthritis using clinical and radiological criteria.

TABLE OF CONTENTS/OUTLINE
Multiparametric MR Imaging of Soft-Tissue Lesions: A Review

All Day Room: Mk Community, Learning Center Digital Education Exhibit

FDA  Discussions may include off-label uses.

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TEACHING POINTS
1. To describe usefulness of a combination of conventional and multiparametric MR imaging including diffusion-weighted (DW) imaging, perfusion imaging (Dynamic contrast-enhanced MR and Time-resolved MRA), chemical shift image, and magnetization transfer (MT) contrast image for better soft-tissue lesion characterization and treatment response assessment.
2. To learn pitfalls in DW imaging technique and interpretation.

TABLE OF CONTENTS/OUTLINE
• Multiparametric MR imaging protocol at 3T
• Semiquantitative and quantitative parameters- ADC- Time-Signal intensity curve- DCE parameters (Ktrans, Ve, Kep, Vp) - MT ratio
• ROI techniques on ADC map - Mean ADC vs Minimum ADC
• Clinical cases which allow specific diagnosis adding multiparametric MR imaging
• Potential challenges of multiparametric MR imaging in soft-tissue lesions

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CT Imaging of the Tendon with Model-based Iterative Reconstruction: Can it be Completely Visualized?

All Day Room: MK Community, Learning Center Digital Education Exhibit

Awards
Certificate of Merit

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TEACHING POINTS
Highly informative in identifying the relative positions of a tendon and a bone and understanding the whole picture of the tendon, CT-based tendon imaging is considered helpful in assisting with surgery. With this technology, however, hand tendons can be difficult to recognize because their small CT numbers cause low contrast with the surrounding structures. This exhibit aims to present a method for improving CT imaging of hand tendons by optimizing the tube voltage and using model-based iterative reconstruction (MBIR). Increasing the tube voltage improved contrast with the surrounding structures, and MBIR helped recognize a low-contrast tendon by reducing noise without compromising spatial resolution. In a visual evaluation, MBIR was superior to other techniques in the score of obtained images, for both flexor and extensor tendons. (p<0.05).

TABLE OF CONTENTS/OUTLINE
A: Anatomy of Tendons
B: CT Imaging Conditions - Relationship between Tube Voltage and the CT Number of a Tendon - Relationship between the Reconstruction Technique and VR Images of a Tendon
C: Standardization of Image Reconstruction
D: Clinical Case Presentation

Printed on: 01/19/20
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TEACHING POINTS
To discuss stress fracture and its subtypes. To discuss the pathophysiology, risk factors, and imaging findings (radiographs, CT, MRI and bone scintigraphy) of stress fractures. To discuss commonly used severity classification systems and their role in the management of stress fractures. To discuss general management algorithm of patients with stress fractures.

TABLE OF CONTENTS/OUTLINE
INTRODUCTION & DEFINITIONS: PATHOPHYSIOLOGY & RISK FACTORS: DIAGNOSIS: Plain Radiographs CT Scan, MRI, and Bone Scan CLINICAL CLASSIFICATION: High-Risk Fractures Low-Risk Fractures SEVERITY CLASSIFICATIONS: Arendt and Griffiths Classification Fredericson Classification systems Zwas Bone Scintigraphy Classification MANAGEMENT: DIFFERENTIAL DIAGNOSIS: SUMMARY:

Printed on: 01/19/20
Epiphyseal Lesions: Beyond the Tip of the Iceberg

All Day Room: MK Community, Learning Center Digital Education Exhibit

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TEACHING POINTS
The purpose of this exhibit is: 1. To review the normal ossification and its implication in the semiology of epiphyseal lesions.2. To discuss the common and rare differential diagnosis of epiphyseal lesions.3. To make the radiologist familiarized with the epiphyseal anatomy and the physiology of these lesions, essencial aspects for an accurate diagnosis.

TABLE OF CONTENTS/OUTLINE

Printed on: 01/19/20
Imaging Findings of Septic Arthritis: Update on Diagnosis

Awards
Certificate of Merit

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TEACHING POINTS
To revise the physiopathology and imaging findings of septic arthritis with different imaging modalities. To discuss the differential entities that can mimic septic arthritis, focusing on diagnostic pearls and potential pitfalls to make a correct diagnosis.

TABLE OF CONTENTS/OUTLINE

Printed on: 01/19/20
Chronic Distal Radio Ulnar Instability: A New Diagnostic Sign with MR Arthrography

All Day Room: MK Community, Learning Center Digital Education Exhibit

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TEACHING POINTS
The objective is to present a new imagological sign in the diagnosis of the distal radio ulnar dorsal instability. MR arthrography can detect the anatomical rupture of the dorsal superficial fascicle of the TFCC that results in dorsal DRUJ instability.

TABLE OF CONTENTS/OUTLINE
Peripheral TFCC ruptures result in clinically distal radio-ulnar instability. According to Zancolli’s classification, traumatic tears can also present with the rupture of the dorsal superficial insertion of the TFCC. The rupture of the dorsal superficial portion of the TFCC is sufficient to create dorsal DRUJ instability. The dorsal superficial portion of the TFCC has two anatomical insertions in the distal ulna; one on the radial border of the sixth compartment (Point A) and the other on the floor of the sixth compartment (Point B). Arthrography, has indirectly shown the tear of these two dorsal superficial insertions. The purpose of this work is to present a new imaging sign by MR arthrography showing the rupture of the superficial dorsal portion of the TFCC (Point A) in the radial border of the sixth compartment in patients who clinically presented dorsal radio-ulnar instability. The importance of this sign by MR arthrography, is that it allows the diagnosis of lesions not evidenced by arthroscopy through usual radiocarpal portals.

Printed on: 01/19/20
Glenoid Bone Stock and Version: A Practical Guide for a Radiologist on How to Measure and Why it’s Important

All Day Room: MK Community, Learning Center Digital Education Exhibit

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Identified for RadioGraphics

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TEACHING POINTS
•Shoulder osteoarthritis (OA) is a source of high morbidity. •Utilization of various surgical techniques has increased in an effort to reduce morbidity. •Unfortunately, the rate of premature loosening of components and recurrent prosthetic humeral head subluxation is significant and reduces the effectiveness of shoulder arthroplasty. •High grade rotator cuff muscle fatty infiltration has been correlated with more severe modified Walch classification subtype, increased joint line medialization and increasing retroversion. •Glenoid version is also a significant factor in determining surgical strategies and predicting operative outcomes.

TABLE OF CONTENTS/OUTLINE
•Normal shoulder anatomy •Overview of shoulder OA and associated medical costs •Surgical management of shoulder OA •Walch classification •Goutallier classification of rotator cuff fatty degeneration •Measurement methods on 3D CT and 3D MRI including Friedman and Paleoglenoid lines •Role in shoulder replacement/ humeral malalignment / association with rotator cuff tendon pathology, muscle fatty infiltration and replacement •Association of glenoid biconcavity and post-operative complications •Association of rotator cuff muscle fatty infiltration and postoperative outcomes •Relationship between glenoid bone stock and severity of rotator cuff tendon tears, rotator cuff muscle fatty infiltration and atrophy

Printed on: 01/19/20
**Fats are All Around: Liposarcomas in Usual and Unusual Locations**

All Day Room: MK Community, Learning Center Digital Education Exhibit

**Awards**
**Certificate of Merit**

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**TEACHING POINTS**
1. Discuss clinical features and pathogenesis of liposarcoma. 2. Review liposarcoma subtypes and imaging characteristics for each subtypes. 3. Identify liposarcomas originating in unusual locations. 3. Explain role of radiologist in follow up of diagnosed liposarcoma.

**TABLE OF CONTENTS/OUTLINE**
1) Liposarcoma background and pathogenesis 2) Imaging findings and pathology of different subtypes of liposarcoma: well-differentiated, dedifferentiated, myxoid and pleomorphic. 3) Imaging findings of liposarcomas in unusual locations. 4) Treatment and follow up of liposarcoma: metastasis, recurrence, and RECIST criteria.

Printed on: 01/19/20
Lumbar Spinal Surgery Mishaps: A Pictorial Review

All Day Room: MK Community, Learning Center Digital Education Exhibit

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TEACHING POINTS
Different aetiologies of back pain after spinal surgery exist and vary depending on the time elapsed after surgery. Postoperative imaging is crucial as some findings need urgent surgical treatment. The choice of the imaging technique varies depending on the suspected aetiology.

TABLE OF CONTENTS/OUTLINE
Spine surgery for pain treatment is a common procedure. However, pain persistence, recurrence or different type of pain appearance is frequently reported. Postoperative imaging with X-ray, CT and/or MRI should be used to look for causes of this unwanted result. Aetiologies are different depending on the chronology of the pain in relation to the surgical procedure: Pain persistence or new type of pain just after surgery: - Epidural hematoma - Infection - Gossypiboma - Hardware misplacement - Wrong level surgery, residual disc herniation - Pseudomeningocele Pain recurrence or new type of pain some time after surgery: - Fibrosis - Sterile arachnoiditis or radiculitis, siderosis - Recurrent disc herniation - Fusion failure: o Orthopedic hardware rupture o Orthopedic hardware loosening and mobilisation o Lack of osseous fusion with pseudoarthrosis - Accelerated degenerative changes.

Printed on: 01/19/20
Coronal Oblique MRI for Optimal Assessment of the Anterior Cruciate Ligament: Not Everything that Matters is the ACL

Participants
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TEACHING POINTS
1. To perform a practical review of the coronal oblique sequence (COS) on MRI of the knee, frequently used to evaluate the double bundle anatomy of the anterior cruciate ligament (ACL). 2. To emphasize that, although the COS is performed to improve the assessment of the ACL, it can also be used to characterize other structures and injuries. 3. To propose three (3) main areas of interest to evaluate in COS (zones I, II and III) with a checklist technique. 4. To show some sample cases of the pathology detected in each zone based on our experience.

TABLE OF CONTENTS/OUTLINE
1. COS on MRI of the knee. How and why. Technique and utility. Normal anatomy of this non-orthogonal sequence. 2. Practical interpretation of COS, beyond the ACL fibers. Delimitation of the areas of interest with their main structures to be evaluated (zones I, II, and III). Checklist. Sample cases of different injuries in each zone. 3. Conclusion. 4. References.

Printed on: 01/19/20
Imaging Characteristics of Hibernomas

All Day Room: MK Community, Learning Center Digital Education Exhibit

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TEACHING POINTS
Teaching Points: 1. Review the natural history of hibernomas. 2. Review imaging characteristics of hibernomas. 3. Demonstrate imaging similarities and differences between hibernomas and different soft tissue malignancies.

TABLE OF CONTENTS/OUTLINE

Printed on: 01/19/20
Interpreting Expected Periprosthetic Imaging Findings, Complications, and Failure Mimics

Awards
Certificate of Merit

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TEACHING POINTS

After reviewing this educational case-based review, the learner will be able to:
- List indications for joint replacement
- Identify common types of joint prostheses
- Describe individual prosthetic components
- Recognize common prosthetic failure mechanisms
- Describe imaging findings of prosthetic failures
- Describe techniques for imaging joint prostheses

TABLE OF CONTENTS/OUTLINE

Introduction/Objectives Indications for prostheses Osteoarthritis, inflammatory joint, dysplasia, avascular necrosis, trauma, tumor, pain Common types of prostheses Hip, shoulder, knee, small joints Non-cemented vs cemented Polyethylene spacer vs metal on metal Tumor arthroplasty Failures Stress shielding Loosening, including subsidence and bead shedding Dislocation and polyethylene displacement Polyethylene wear and particle disease Malplacement Component failure Infection Tumor recurrence Heterotopic ossification Mimics Residual cystic change and cavities mimicking loosening Medullary plug/stopper mimicking loosening Residual osteophytes mimicking fracture Vascular channels mimicking fracture Hardware imaging techniques

Printed on: 01/19/20
Osteochondromyxoma: "Carney Bone Tumor": What We Know and What We Learned

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TEACHING POINTS
- Osteochondromyxoma is an extremely rare bone tumor but associated with Carney complex and constitutes as one of its 11 diagnostic criteria. Using case-based review to describe imaging findings of osteochondromyxoma on different imaging modalities including radiograph, CT, MRI and bone scan. Demonstrate imaging findings of osteochondromyxoma at typical sites of nasal bones and long bones and unusual sites of ribs, phalanges and pelvis. Stress the imaging value at early detection, differential diagnosis and follow up studies.

TABLE OF CONTENTS/OUTLINE
- Introduction
- Definition of Carney complex
- Diagnostic criteria of Carney complex
- Imaging features of osteochondromyxoma of 3 patients with established diagnosis of Carney complex
- Radiograph CT
- MRI
- Bone scan
- Osteochondromyxoma involvement
- Sinus and nasal bone
- Long bone
- Rib
- Phalanges
- Pelvis
- Roles of imaging examination
- Early detection
- differential diagnosis
- Longitudinal imaging follow-up of osteochondromyxoma
- How to monitor treatment
- What complication to look for with ongoing treatment

Printed on: 01/19/20
MK147-ED-X

Reporting Hand and Wrist Ganglion Cysts: What are the Orthopedists Expecting?

All Day Room: MK Community, Learning Center Digital Education Exhibit

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TEACHING POINTS
• To review the epidemiology of ganglion cysts including the main differential diagnoses. • To describe the key imaging findings of ganglion cysts specially in MRI and the difference between focal and eccentric types. • To recognize the importance of the radiologist's report in the approach and selection of the surgical technique. • To propose an approach to the appropriate evaluation of ganglion cysts with the key points that the orthopedist need to know in order to select the correct treatment.

TABLE OF CONTENTS/OUTLINE
• Introduction • Ganglion cysts: Clinical key • Ganglion cysts: Epidemiology • Ganglion cysts: Focal • Ganglion cysts: Eccentric • Ganglion cysts: Surgical approach • Ganglion cysts: Orthopedists key points • Ganglion cysts: Main differential diagnosis • Conclusions

Printed on: 01/19/20
Ultrasound of the Inguinocrural Region: A Step-by-Step Guide with Emphasis on Anatomical and Surgical Correlations

All Day Room: MK Community, Learning Center Digital Education Exhibit

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TEACHING POINTS
To present a practical step-by-step guide for the assessment of the Inguinocrural region and its most common pathology. To review ultrasound anatomy with emphasis on anatomical correlations (cadaveric, surgical, laparoscopic), illustrated and with dynamic videos. To present the imaging findings of most common pathological conditions.

TABLE OF CONTENTS/OUTLINE
We provide a guide for the ultrasound examination of the inguinocrural region based on anatomical dissections, laparoscopic and surgical correlation. We will graphical and dynamic videos illustrations. We further provide clear anatomical limits for the classification of hernias, identification of muscular, articular pathology and postsurgical evaluation. The analysis of each sector will include the following considerations: Anatomy, ultrasound technique, special maneuvers, differential diagnoses, how to avoid false positives or negatives, limits of the method and when to request complementary studies will be evaluated.

Printed on: 01/19/20
Am I/Am I Not a Sarcoma? Pseudosarcomatous Soft Tissue Lesions - Rad-Path Correlation

All Day Room: MK Community, Learning Center Digital Education Exhibit

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TEACHING POINTS

Pseudosarcomatous soft tissue lesions can be often very challenging to diagnose in a timely matter because of their non-specific morphology, varied clinical presentation, similarity to malignant lesions & often have extended differential diagnosis histologically. For a radiologist, getting more acquainted with these lesions is important to improve accuracy of interpretation of findings, avoid misdiagnosis as well as unnecessary radical surgery. For a pathologist it can be very challenging to identify the pathology from the sample obtained if it was inadequate from curetting or small biopsies. Newer immunostains and genetic markers could sometimes help in diagnosis however their final interpretation still depends on clinical presentation, accurate radiological impressions and histopathologic appearance. This educational exhibit is our attempt to provide an integrated educational resource on Pseudosarcomatous soft tissue lesions for pathologists, radiologists and surgeons.

TABLE OF CONTENTS/OUTLINE

Review of various Pseudosarcomatous lesions and the challenges they pose in diagnosis. Highlight typical and atypical imaging findings & pathologists approach. Analysis of rad - path correlation to improve accuracy of diagnosis.

Printed on: 01/19/20
Growth Plate Injuries Around the Shoulder

All Day Room: MK Community, Learning Center Digital Education Exhibit

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TEACHING POINTS
1. Normal growth plates may be mistaken for fractures, and fractures may be mistaken for normal growth plates 2. MRI often reveals unsuspected growth plate injuries in young athletes with shoulder pain

TABLE OF CONTENTS/OUTLINE
Anatomy of growth plates around the shoulder Humerus: little leaguer's shoulder and lesser tuberosity avulsion Glenoid: Subcoracoid and coracoid tip fractures Clavicle: Distal clavicle growth plate injury mimicking AC separation Follow-up: What are outcomes after growth plate injury in the shoulder?

Printed on: 01/19/20
Spondylodiscitis or Type I Discogenic End Plate Changes: A Resident Primer

All Day Room: MK Community, Learning Center Digital Education Exhibit

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TEACHING POINTS
Early spondylodiscitis can be insidious in onset and challenging to differentiate from vertebral end plate changes. The implications of missing the diagnosis of spondylodiscitis, or misdiagnosing degenerative vertebral end plate changes as spondylodiscitis, could be disastrous for the patient. Spondylodiscitis often requires tissue for diagnosis, and treatment may involve extensive spinal surgery. Degenerative vertebral end plate change in comparison is treated symptomatically. By the end of this exhibit the learner will be able to accurately differentiate between spondylodiscitis and degenerative vertebral end plate change.

TABLE OF CONTENTS/OUTLINE
Spondylodiscitis or Type I Discogenic End Plate Changes: A Resident Primer
Purpose:
1.) Review the pathophysiology of spondylodiscitis and discogenic end plate changes.
2.) Review the imaging findings typical of spondylodiscitis and discogenic end plate changes.
3.) Provide a case based review.

Table of Contents/Outline:
Vertebral anatomy - Osseous and articular - Vascular
Pathogenesis of spondylodiscitis - Route of spread - Common organisms
Pathogenesis of discogenic vertebral endplate change
Common imaging in spondylodiscitis - CR - CT - MRI
Common imaging in discogenic vertebral endplate change - CR - CT - MRI
Case based review

Printed on: 01/19/20
Orthopedic Surgical Emergencies: Review for the Radiology Resident on Call

All Day Room: MK Community, Learning Center Digital Education Exhibit

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TEACHING POINTS
To discuss key and characteristic findings and basic patient management of orthopedic surgical emergencies, such as bleeding pelvic fractures, lisfranc fractures, femoral neck fractures, knee dislocations, fractures with vascular injuries, necrotizing fasciitis, among others. The educational exhibit is geared towards radiology residents on call, but also serves as a review for more experienced radiologists.

TABLE OF CONTENTS/OUTLINE
Certain fractures and their associated complications are considered surgical emergencies given the high morbidity if untreated in a timely fashion. Awareness of the radiologic appearance of such conditions allows immediate notification to the orthopedic surgeon for prompt and proper management. Characteristics findings on multiple imaging modalities will be discussed on these emergent pathologies, including bleeding pelvic fractures, femoral neck fracture in a young patient, fractures with vascular injury, knee dislocations, posterior sternoclavicular dislocation, scapulothoracic dissociation, hip fractures in the elderly patient, open fractures, compartment syndrome, fat embolism, necrotizing fasciitis, pediatric supracondylar fractures and lisfranc fractures. Appropriate pathology classification, basic patient management and mimickers of these conditions will be presented using a quiz format.

Printed on: 01/19/20
Foreign Body Multimodality Imaging: New Insights Into Old Challenges

All Day Room: MK Community, Learning Center Digital Education Exhibit

Awards
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TEACHING POINTS
Foreign body (FB) may be of any material, such as glass, wood and metal chips, which are the most commonly found. When retained in soft tissues may lead to complications like edema, cellulitis and abscess formation. Glass FB is always radiopaque and radiographic detectability of glass pieces is more dependent on its size, with high accuracy if larger than 2 mm. Ultrasonography (US) is a very elucidative choice exam for both radiolucent and radiopaque fragments. Posterior acoustic shadowing is always present. Reverberation artifact is produced by smooth and flat surfaces encountered in metal and glass. The granuloma pattern increases the US sensibility to detect FB and indicates its deep location. Computed tomography (CT) can also be used to diagnose retained FB that is radiolucent such as wood and plastic. FB demonstrates different imaging characteristics at MRI that is also performed to determine the degree of inflammation or associated damage to structures such as ligaments or tendons. An organizational chart based on the radiographic behavior of the materials and multimodality images features may reduce reconvocations and complications.

TABLE OF CONTENTS/OUTLINE
Common types of foreign bodies. Patterns of tissue response. Multimodality imaging as a tool for the radiologist. Organizational chart

Printed on: 01/19/20
Imaging Characteristics of Sacral and Presacral Lesions: A Simplified Classification and Approach

All Day Room: MK Community, Learning Center Digital Education Exhibit

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TEACHING POINTS
1. Describe the clinical spectrum of common and uncommon lesions arising from the presacral and sacral space. 2. Discuss imaging features (CT and MRI) to differentiate the described lesions and classification. 3. Develop a differential diagnosis for sacral and presacral lesions.

TABLE OF CONTENTS/OUTLINE
Sacral and presacral lesions organized into categories by tissue of origin: developmental, osseous, hematologic, neurogenic, infectious/inflammatory, and miscellaneous. Dedicated focus on several important lesions from each of the above categories which will include: a brief overview of epidemiology, clinical reliance, anatomy; MRI and/or CT imaging characteristics; and differential considerations. A brief list of examples (one example from each category): O Chordoma (developmental) O Neurofibroma (neurogenic) O Osteoblastoma (osseous) O Sacroilitis (infectious/inflammatory) O Chloroma (hematologic) O Retroperitoneal fibromatosis (miscellaneous) SUMMARY The sacrum and presacral space are anatomically complex and can give rise to multiple lesions of various origins. Integrating the relevant clinical information, with the available imaging findings can lead to the formation of a focused and/or specific differential diagnosis.

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MK157-ED-X

MR Imaging in Complications of Total Knee Arthroplasty

All Day Room: MK Community, Learning Center Digital Education Exhibit

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TEACHING POINTS

1) Review MRI techniques to evaluate total knee arthroplasty. 2) Review how MRI with metal suppression allows to evaluate the periprosthetic soft tissue and bone and provides useful information for clinical management in painful total knee arthroplasty.

TABLE OF CONTENTS/OUTLINE

1) MRI techniques to reduce metallic artifacts: imaging factors and sequences. 2) Implant integration and osteolysis in femoral, tibial and patellar prosthetic components. 3) Wear-induced synovitis. 4) Assessment of different patterns of synovitis. 5) Assessment of suspected total knee arthroplasty infection. 6) Assessment of bone marrow abnormalities. 7) Rotational malalignment of implant components 8) Hoffa’s fat pad arthrofibrosis, chunk syndrome and diffuse arthrofibrosis. 9) Periarticular complications: quadriceps and patellar tendon abnormalities, surrounding muscle and ligaments, periarticular fluid collections. 10) Proximal tibiofibular joint complications. 11) Nerve entrapment.

Printed on: 01/19/20
Way to Approach Wrist Instability: Tips for Radiology Residents

All Day Room: MK Community, Learning Center Digital Education Exhibit

FDI Discussions may include off-label uses.

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TEACHING POINTS
Normal wrist anatomy How to evaluate axis and stability of wrist Wrist instability ; classification & perilunate instability

TABLE OF CONTENTS/OUTLINE
Basic anatomy of wrist Evaluation of wrist on radiography Carpal instability - anatomical classification / pattern classification / perilunate instability Summary

Printed on: 01/19/20
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Certificate of Merit

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TEACHING POINTS
1. Review techniques to optimize MR imaging of the hip based on the clinical indication
2. Review the normal osseous, soft tissue, and labral variants that may mimic pathology
3. Review the terminology of labral tears with an emphasis on potential pitfalls

TABLE OF CONTENTS/OUTLINE
1. Optimize the Protocol
   1.1. Large Field of View
   1.2. Small Field of View - Imaging Planes, MR Arthrography
2. Identify Normal Variants
   2.1. Osseous Variants - Os Acetabuli, Synovial Herniation Pit, Supra-acetabular Fossa, Superior Acetabular Notch, Stellate Crease, Tubular Tracking
   2.2. Soft Tissue Variants - Iliopsoas Bursa, Variants of the Iliopsoas Tendon Complex, Obturator Externus Bursa, Ligamentum Teres, Plicae and Pectinofoveal Fold
   2.3. Labral Variants - Perilabral Recess, Transverse Ligament-Labral Junction Sulcus, Sublabral Cleft, Sublabral Recess
3. Accurately Describe Labral Tears
   3.1. Location - Anterior/Superior
   3.2. Extent - Clockface
   3.3. Description - intrasubstance, detachment, paralabral cysts
   3.4. Labral Variants vs. Labral Tears

Printed on: 01/19/20
MRI in Cervical Spine Trauma: What the Spine Surgeon Needs to Know

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TEACHING POINTS

1. In patients who sustained trauma to the cervical spine, we delineate three groups (as stated in the table of contents) who warrants further evaluation using MRI. 2. To illustrate the utility of MRI as they pertain to each of three groups, and to review the systematic approach and common pathologies seen in MR evaluation of the cervical spine in acute trauma. 3. To provide real-life examples of how MRI changed management outcome in cervical spine trauma in each of the three groups.

TABLE OF CONTENTS/OUTLINE

1) Review of indications for cervical spine injuries that further evaluation with MRI. a) Category A: Unstable injuries found on CT: for preoperative planning, prognosis, and for spinal cord evaluation. b) Category B: Stable injuries found on CT: to evaluate for ligamentous injuries, and to further assess for instability. c) Category C: Normal CT in symptomatic or in obtunded patients: to evaluate for CT-occult injuries such as isolated ligamentous injury, intervertebral disc injury, or an occult hematoma. 2) Review of traumatic cervical injuries: a) Intramedullary injuries. b) Intradural extramedullary injuries. c) Epidural injuries. d) Ligamentous injuries involving the ALL, PLL, ligamentum flavum, and interspinous ligaments. e) Vertebral bodies injuries. f) Posterior elements injuries.

Printed on: 01/19/20
Demystifying the Lateral Radiographs of the Adult Hip

Awards
Certificate of Merit

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TEACHING POINTS
The purpose of this exhibit is to review four different radiographic projections of the hip: The off-lateral, Lauenstein, Dunn and cross-table lateral views. To briefly review the radiological positioning. To explain radiological anatomy. To review the strengths, weaknesses, and common clinical indications of every radiograph.

TABLE OF CONTENTS/OUTLINE
Method: CT was performed on cadavers in every radiographic position and multiplanar reformats are used to explain radiological anatomy. Four lateral radiographic projections of the hip: Off-lateral view (Lequesne’s), Lauenstein, Dunn (and variants) and cross-table lateral view (Arcelin). For every radiographic projection: Radiographic position, Radiographic anatomy, Strengths and weaknesses, Common clinical indications.

Printed on: 01/19/20
IgG4-Related Spine Involvement - What We Know and What We Learned

All Day Room: MK Community, Learning Center Digital Education Exhibit

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TEACHING POINTS
- IgG4-related disease is an immune-mediated and fibroinflammatory condition with multiply organs involved, however, the involvement of spine is rare. Using case-based review to describe imaging findings of IgG4-related spine involvement on different imaging modalities including CT and MRI. Compare imaging findings of IgG4-related spine involvement on CT and MRI. Stress the imaging value at early detection, differential diagnosis and follow up studies.

TABLE OF CONTENTS/OUTLINE
- Introduction
  - Definition of IgG4-related disease
  - Organ involvement of IgG4-related disease
- Imaging features of IgG4-related spine involvement of 2 patients with established diagnosis of IgG4-related disease
- CT o MRI
- Roles of imaging examination
- Early detection
- Differential diagnosis
- Longitudinal imaging follow-up of IgG4-related spine involvement
- How to monitor treatment
- What complication to look for with ongoing treatment

Printed on: 01/19/20
MR Imaging of Glomangioma - Usual and Unusual: It's Not Just the Diagnosis of Fingertip

All Day Room: MK Community, Learning Center Digital Education Exhibit

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TEACHING POINTS

1. To discuss common locations of glomangioma2. To discuss uncommon locations of glomangioma3. To discuss MRI features for diagnosis of glomangioma4. To emphasize importance of detail history and clinical presentation5. To shows pitfalls in diagnosis and importance of post contrast MR study

TABLE OF CONTENTS/OUTLINE

• When to suspect glomangioma • MR protocol for imaging of glomus tumor• Common location of glomus tumor and its MR appearance • Unusual locations of glomus tumors and sample cases• Importance of post contrast MR imaging in diagnosis of glomangioma• Differential diagnosis of glomangioma and sample cases

Printed on: 01/19/20
Malignant Soft Tissue Sarcomas: Imaging Spectrum with Histopathological Correlation

All Day Room: M.K Community, Learning Center Digital Education Exhibit

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TEACHING POINTS
Imaging spectrum of soft tissue sarcomas and predict histopathological subtype, based on characteristic features. Imaging pointers to differentiate from Soft tissue sarcoma from mimickers like myositis ossificans, soft tissue hepatoma, myo-cysticercosis.

TABLE OF CONTENTS/OUTLINE
Enlisting WHO classification of soft tissue masses. Characteristic imaging features of Soft tissue sarcomas Discussing tumour mimics and tips to differentiate these lesions.

Printed on: 01/19/20
Shoulder Arthroplasties and their Complications: What the Radiologist Should Know

All Day Room: MK Community, Learning Center Digital Education Exhibit

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TEACHING POINTS
To familiarize the radiologist with the three main types of shoulder arthroplasty that he may encounter, each implanted in specific clinical situations: reverse shoulder arthroplasty, total shoulder arthroplasty and partial shoulder joint replacement. To know the various radiological tools available for the exploration of shoulder prostheses and their indications. To recognize the complications common to all types of shoulder prosthesis and the specific complications of each arthroplasty.

TABLE OF CONTENTS/OUTLINE
Introduction. Normal aspects of different shoulder prostheses: reverse shoulder arthroplasty (RSA), total shoulder arthroplasty (TSA), partial shoulder joint replacement. Imaging tools for exploration of shoulder prostheses in radiology: standard radiography, ultrasound, computed tomography, magnetic resonance imaging. Common complications to all shoulder prostheses: infection, stress shielding and periprosthetic fractures, humeral component loosening, heterotopic ossification, implant failure, nerve injury. Specific complications of different shoulder prostheses: instability following RSA, scapular notching (RSA), scapular spine and acromion fractures (RSA), glenoid component loosening (TSA), rotator cuff tear (TSA), progressive wear of the glenoid (partial joint replacement). Conclusion.

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Awards
Certificate of Merit

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TEACHING POINTS
After viewing this presentation, readers will have a better understanding for the role of ultrasound imaging in the evaluation of hand and wrist pathology in the acute setting such as within the Emergency Department or Urgent Care Clinic. Proper scanning technique and exam considerations for imaging will be reviewed, as well as various imaging examples of common acute hand and wrist pathologies. Both ultrasound and graphic images will be provided with MRI/Radiographic correlation, as well as a review of the relevant anatomy.

TABLE OF CONTENTS/OUTLINE
Ultrasound evaluation of Hand and Wrist Injuries and Pathology: Indications, Utility with other modalities, Limitations of Ultrasound Exam Technique: Patient positioning, Ultrasound machine settings, Relevant artifacts and imaging considerations Hand and Wrist Acute Pathology: Fracture, Flexor and Extensor Tendon Rupture, Foreign Body, Infection (Cellulitis, Abscess, Septic Joint/Effusion), Ligamentous Injury (Ulnar Collateral Ligament Disruption/Stener Lesion), Triangular Fibrocartilage Complex Injury, Neuropathies (Carpal Tunnel, Ganglion Cyst with compression of nerves) Opportunity for Intervention: Joint Aspiration

Printed on: 01/19/20
TEACHING POINTS

Tubercular arthropathy can affect any joint but is commonly seen in hip, knee, ankle, sacroiliac, sternoclavicular, shoulder, elbow & wrist. Usually monoarticular. It can mimic other infective arthritis and noninfectious etiology like metabolic/immunologic. Radiograph is the primary modality while MRI helps in diagnosis & also useful in assessing associated abnormalities. Radiologists must be familiar with the imaging findings to reach to a conclusion as treatment option varies as per etiology.

TABLE OF CONTENTS/OUTLINE

Tuberculous arthropathy is common cause of infectious arthritis in developing countries. A pathological joint lesion where the exact diagnosis is equivocal, tubercular origin should be considered. Plain films are reliable to detect and follow up of treatment. A triad of radiologic abnormalities (Phemister’s triad) include peri-articular osteoporosis; peripherally located osseous erosion & gradual reduction of the joint space. MRI can assess associated abnormalities such as osteomyelitis, myositis, cellulitis, para-articular abscess, tenosynovitis, bursitis & sinus tracts. T1 hyperintense signal is sensitive while contrast enhanced image is a shot in the arm. The differentials include rheumatoid arthritis, septic arthritis, ankylosing spondylitis, osteoarthritis, synovial osteochondromatosis, pigmented villonodular synovitis, gout & haemophilic arthropathy.
Imaging of Giant Cell Tumor Treated with Denosumab

All Day Room: MK Community, Learning Center Digital Education Exhibit

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TEACHING POINTS
The purpose of this exhibit is: 1. To review the mechanism of action, indications, and evidence for the use of Denosumab for Giant cell tumor. 2. To illustrate the complications. 3. To discuss appearances of successful treatment, the stationary course of the disease and local tumor progression on imaging follow-up. 4. Case illustration using different imaging modalities with emphasis on PET-CT role for disease activity assessment.

TABLE OF CONTENTS/OUTLINE
1. Define Denosumab. 2. Current indications. 3. Contraindications and side effect. 4. The basic principle of Denosumab mechanism of action on Giant cell tumor. 5. Illustrate in a case-based format the initial imaging work up for a variety of case with GCT at a different site on an involvement 6. Imaging follow-up as regards to: a. Appearances of successful treatment. b. Appearances of progression.

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MK171-ED-X

Holes, Lumps, and Bumps of the Calvarium

All Day Room: MK Community, Learning Center Digital Education Exhibit

Awards
Identified for RadioGraphics

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TEACHING POINTS

Following completion of this presentation, the reader will be able to: Categorize calvarial lesions based on underlying pathology Describe imaging features of each entity on radiographs, CT and MRI Approach calvarial lesions using various imaging characteristics such as lesion site, size, multiplicity, pattern of bone destruction, margins, periosteal reaction, local extension, and type of matrix to provide the proper diagnostic considerations

TABLE OF CONTENTS/OUTLINE


Printed on: 01/19/20
Soft Tissue Sarcomas: Radiopathologic Correlation

All Day Room: MK Community, Learning Center Digital Education Exhibit

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TEACHING POINTS

1. Review the common and uncommon soft tissue sarcomas with emphasis on 2013 World Health Organization (WHO) classification of soft tissue sarcomas.
2. Review the imaging findings of soft tissue sarcomas with pathologic and molecular biology correlation.
3. Discuss the role of radiologist in clinical management.

TABLE OF CONTENTS/OUTLINE

Soft tissue sarcomas are a rare diverse group of malignancies that account for approximately 1% of adult malignancies. Of these sarcomas, 40% occur in the torso. Pleomorphic undifferentiated sarcoma, liposarcoma, leiomyosarcoma, myxofibrosarcoma and synovial sarcoma constitute 75% of these sarcomas and these, along with more uncommon sarcomas will be reviewed with emphasis on 2013 World Health Organization (WHO) classification. In this exhibit the imaging as well as histopathologic findings of various soft tissue sarcomas will be demonstrated with biomarker correlation. Given the rarity and heterogeneous nature, these tumors are generally managed in tertiary care hospitals by a sarcoma tumor board comprised of an oncologist, surgical oncologist, pathologist and radiologist. The clinical outcomes are improving due to rapid advances in the understanding of soft tissue sarcomas. We will therefore also demonstrate the imaging features of treatment response and disease recurrence of various soft tissue sarcomas.

Printed on: 01/19/20
**Ultrasound Evaluation of Soft Tissues Masses: Forget the MRI!**

**All Day Room: MK Community, Learning Center Digital Education Exhibit**

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**TEACHING POINTS**

1. Although MRI is typically the go-to study for soft tissue masses, ultrasound is playing an increasingly important role in this field.
2. Ultrasound's lower cost compared to MRI and widespread availability make it ideal for evaluation of soft tissue lesions. In addition, interaction with the patient at the time of imaging can both provide useful information to the radiologist as well as allow the radiologist to discuss findings with the patient.
3. Many lesions have typical or pathognomonic appearances on ultrasound, and recognition of the imaging features can often lead to the diagnosis and prevent further work-up.
4. Color Doppler and dynamic ultrasound are important components of the assessment of soft tissue masses.

**TABLE OF CONTENTS/OUTLINE**


Printed on: 01/19/20
Keep Track of the Moving Parts: Dynamic Ultrasound of Musculoskeletal Pathology

All Day Room: MK Community, Learning Center Digital Education Exhibit

Awards
Certificate of Merit

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TEACHING POINTS

1. Dynamic ultrasound evaluation of the musculoskeletal system is crucial for the diagnosis of a variety of pathologic conditions. Dynamic maneuvers can directly visualize pathology not visible with other imaging modalities (such as impingement and abnormal tendon motion).
2. Appropriate use of dynamic imaging can also aid in the correct diagnosis of other entities (including diagnosis of masses and visualization of joint pathology).

TABLE OF CONTENTS/OUTLINE

1. Impingement:
   a. Subacromial impingement
   b. Hardware impinging on adjacent structures
2. Abnormal tendon motion:
   a. Extensor carpi ulnaris dislocation
   b. Peroneal tendon intrasheath subluxation/dislocation
   c. Trigger finger
3. Tendon tears:
   a. Differentiation of partial-thickness and full-thickness tears
4. Ligamentous pathology:
   a. Laxity
   b. Partial and full-thickness tear
5. Nerve pathology:
   a. Ulnar nerve instability
   b. Abnormal motion of the median nerve
6. Joint pathology:
   a. Differentiation of joint effusion from synovitis
   b. Improved visualization of effusion
   c. Plantar plate tear
7. Snapping:
   a. Iliopsoas snapping
   b. Iliotibial band snapping
8. Diagnosis of masses and differentiation from other pathology:
   a. Lipoma (compressibility)
   b. Giant cell tumor of tendon sheath
   c. Morton neuroma versus intermetatarsal bursitis

Printed on: 01/19/20
Differential Diagnosis of T2 Hypointense Lesions in Musculoskeletal MRI

All Day Room: Mk Community, Learning Center Digital Education Exhibit

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TEACHING POINTS
The purpose of this exhibit is to: 1. Illustrate varying characteristics of T2 hypointensity found in musculoskeletal lesions. 2. Review the pathophysiology which results in these MRI characteristics. 3. Discuss how knowledge of these lesions and their characteristic imaging findings can lead to the correct diagnosis.

TABLE OF CONTENTS/OUTLINE
I. Flowing blood or blood products: -Hematoma -Hemarthrosis -Aneurysm -Endometriosis II. Calcifications: -Hydroxyapatite deposition disease -Tumoral calcinosis -Heterotopic ossification -Phleboliths in hemangioma -Chondral bodies -Chondrocalcinosis III. Fibrous/collagenous: -Fibromyxoma -Fibromatosis (superficial and deep) -Collagenous fibroma -Tenosynovial giant cell tumor -Peripheral nerve sheath tumor (target sign) IV. Crystalline: -Gout -Amyloidosis Conclusions: Most soft tissue masses are predominantly T2 hyperintense on MRI; the pattern and extent of T2 hypointensity yields important clues as to the nature of the underlying lesion. This exhibit reviews the characteristic features of these lesions and demonstrates their appearance on MRI to aid the radiologist in making the correct diagnosis.

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Update on the Role of Imaging in Recent Guidelines for Multiple Myeloma Management

All Day Room: MK Community, Learning Center Digital Education Exhibit

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TEACHING POINTS
1. To understand the evolution of diagnosis and treatment of multiple myeloma
2. To understand recent international guidelines
3. To review the role of whole-body MRI and PET/CT

TABLE OF CONTENTS/OUTLINE
1. Evolving concept of plasma cell dyscrasia and multiple myeloma - Disease Entity: Monoclonal gammopathy of undetermined significance (MGUS), Smoldering multiple myeloma (SMM), Multiple myeloma (MM), Solitary plasmacytoma (SP), and POEMS syndrome - Myeloma-defining events and diagnostic criteria
3. Guidelines of the International Myeloma Working Group (IMWG)
   - For the use of whole-body MRI
   - For the use of FDG-PET/CT
4. Role of WB-MRI and WB-DWI - Diagnosis and Staging - Treatment response assessment

Printed on: 01/19/20
MK177-ED-X

It's All in the Wrist: The Classification, Repair, and Postoperative Appearance of Intrinsic Wrist Ligament Tears

All Day Room: MK Community, Learning Center Digital Education Exhibit

Awards
Certificate of Merit

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TEACHING POINTS
Promptly diagnosed and treated intrinsic ligamentous injuries have a good healing potential, while delays in treatment have a poor healing potential. Undiagnosed injuries lead to carpal instability and arthritis, therefore prompt recognition is essential to good outcomes. Surgical treatment is based on a combination of clinical examination, imaging findings, and arthroscopic findings. MRI findings correlate with arthroscopic findings and can allow for surgical planning without the need for a diagnostic arthroscopy. Knowledge of the different surgical repairs and their imaging appearance allows the radiologist to accurately assess the postoperative wrist.

TABLE OF CONTENTS/OUTLINE

Printed on: 01/19/20
Sesamoid Fractures: An Overlooked Cause of Pain

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TEACHING POINTS
This exhibit will provide the learner with knowledge of the pathology and common imaging characteristics of sesamoid fractures. The learner will also obtain an appreciation for normal anatomic variants and mimicking pathology, which can demonstrate similar imaging findings to fractures.

TABLE OF CONTENTS/OUTLINE
The presentation will begin by discussing the definition of sesamoid bones, their function, and the mechanism of how they fracture. Afterwards, multiple patient cases will be presented, which include fractures of the patella, fabella, os peroneum, hallucis and pollicis sesamoids. These will be showcased using various imaging modalities such as radiography, MRI and ultrasound. Some anatomic variants will also be discussed which can have similar imaging characteristics to fractures, such as a bipartite patella and hallucis sesamoids. Finally, mimicking pathologies such as Gamekeeper thumb and hallux sesamoiditis will be reviewed.

Printed on: 01/19/20
Lumbar Spine MRI: A Resident’s Primer for Common and Uncommon Causes of Lumbar Pain

All Day Room: MK Community, Learning Center Digital Education Exhibit

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TEACHING POINTS
After reviewing this exhibit, the learner should understand the anatomy of the intervertebral disc. They should be able to understand and describe the different types of lumbar disc bulges, herniation, and annular fissures using the standard nomenclature. Additionally, the learner should be able to identify some of the atypical causes of axial and radicular back pain with a focus on modifications to one’s search pattern to allow appropriate diagnosis and treatment.

TABLE OF CONTENTS/OUTLINE
1. Common causes of axial and radicular back pain. Review lumbar disc anatomy and appropriate nomenclature for disc herniation, disc bulge, and annular fissures. 2. Uncommon causes of axial and radicular back pain. Review synovial facet cyst, extra-foraminal disc protrusions, sacral insufficiency fractures, Bertolotti’s syndrome, Bastrup’s disease, and pedicle stress injuries with a focus on improving search pattern, guiding appropriate treatment, and image guided treatments.

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TEACHING POINTS
Differentiation of physiological and pathological marrow based on pattern of signal intensity at different regions of a bone in various MRI sequences. Specific MRI based sequence approach to assess bone marrow abnormalities. Focal or diffuse physiological marrow alteration can mimic pathology and radiologists must be aware of their differentiation. Post therapy marrow alteration should not be read as pathological.

TABLE OF CONTENTS/OUTLINE
The signal intensities in bone marrow are determined by the proportion of its constituents such as water and fat, artifacts induced by bony trabeculae and uptake of contrast media. Appearances of bone marrow on MRI sequences depend on distribution of red and yellow marrow and density of trabeculae which vary with age, gender and anatomical regions. An algorithm based approach can be followed while interpreting marrow abnormalities on MRI sequences. First stop: T1 sequence. Pattern of involvement can be classified into increase or decrease in signal intensity, which can be further divided into a focal or a diffuse type. Second stop: T2 sequence & STIR. Third stop: contrast enhanced sequences which show abnormal enhancement of areas of neoplastic infiltration. Other advanced techniques: chemical shift imaging, diffusion weighted imaging, proton MR spectroscopy and combined MR and PET imaging among others.
Teaching Points

Rib stress fractures are rare injuries with subtle radiographic findings. Rib stress injuries and fractures are not sport specific but they can vary in location depending on the sport. MRI is a useful imaging modality in patients with suspect rib stress injuries with normal radiographs. MRI should be considered in collegiate athletes due to radiation dose with CT and nuclear medicine bone scans to evaluate for stress fracture.

Table of Contents/Outline

- Pathogenesis of rib stress fractures
- Utility of radiography
- Sensitivity of initial and followup radiography
- MRI evaluation of rib stress fractures
- Varies based on age of injury
- Case studies: Female collegiate golfer, right hand dominate college baseball player, collegiate basketball player

Conclusion
Myositis Ossificans: Multimodality Imaging Keys for the General Radiologist

All Day Room: MK Community, Learning Center Digital Education Exhibit

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TEACHING POINTS
After reviewing this exhibit, the reader should be able to: Understand the pathophysiology of myositis ossificans. Recognize the advantages and limitations of each imaging modality in the diagnosis of the disease. Properly describe the findings in the studies performed to patients affected by this pathologic condition.

TABLE OF CONTENTS/OUTLINE
Brief description of the pathology, including epidemiology and clinical presentation, which will largely help in the differential diagnosis. Pathophysiology of the disease, that closely relates to the imaging findings and will help the reader to better understand them. Review of imaging findings in myositis ossificans, with emphasis on the key points that will allow us to identify the disease and make the correct diagnosis. Pros and cons for each imaging modality (plain film, computed tomography, magnetic resonance, nuclear medicine) are also discussed. We provide representative examples for each imaging modality from patients assessed in our center.

Conclusions

Printed on: 01/19/20
The Role of Image in Bone Tumors with Chondroid Matrix: A Pictorial Review with Pathological Correlation

All Day Room: MK Community, Learning Center Digital Education Exhibit

Awards
Certificate of Merit

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TEACHING POINTS

- Review the spectrum of chondroid matrix lesions.
- Present the different techniques (plain x-ray, Computed Tomography -CT-, Magnetic Resonance imaging -MRI- and PET/CT) available for their study.
- Discuss the image findings useful to distinguish benign from malignant lesions.

TABLE OF CONTENTS/OUTLINE

1. Background: Chondroid lesions are frequent incidental findings on musculoskeletal studies. Despite chondroid matrix is usually not difficult to recognize, differentiating benign from malignant lesions can be a real challenge both radiographically and pathologically.
2. Review of pathological anatomy and chondroid tumors classification.
3. Evaluation of the most representative cases collected in our centers (preferable with histopathological studies).
4. Conclusions: Distinguishing between benign and malignant chondroid lesions can be a challenge. Imaging techniques play an important role in their differentiation although in many cases histology is required for a definitive diagnosis.

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Incidentally Speaking: Incidental but Important Extraskeletal Findings on Routine Musculoskeletal Imaging

All Day Room: MK Community, Learning Center Digital Education Exhibit

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TEACHING POINTS
1. Imaging of the musculoskeletal system often includes substantial visualization of extraskeletal soft tissues and organs in the field of view. This is particularly significant when imaging the spine and hips. 2. Occasionally the source of patient’s symptoms can be found by carefully assessing the tissues adjacent to the joint or spine. 3. Both benign and malignant processes can be detected incidentally when imaging the musculoskeletal system. 4. Additional dedicated imaging of the area of suspected abnormality is often required to help determine if the abnormality is benign or malignant. 5. Incidentally detecting malignant processes within the field of view can enable earlier treatment and may reduce morbidity and mortality. 6. Always scrutinize scout images provided on musculoskeletal exams to screen for incidental abnormalities.

TABLE OF CONTENTS/OUTLINE
1. Incidental malignant processes detected within the field of view on musculoskeletal examinations. 2. Incidental benign processes detected within the field of view on musculoskeletal examinations. 3. Potential sources of symptoms within the field of view but outside of the imaged joint or spine. 4. Incidental findings discovered on scout images.

Printed on: 01/19/20
Patients with ankle-foot tumors present a non-specific clinical manifestation. MRI provides the tissue information that allows differential diagnosis and the definitive diagnosis. An analysis was made of the tumors found in ultrasound and ankle-foot MRI carried out in our center with the anatomopathological diagnosis of solid tumors using FNB or surgical excision. The masses that affect the joints or periarticular tissues have been classified into: 1. Lesions of synovial origin: synovial cysts, ganglions, bursitis, synovial osteochondromatosis, villonodular synovitis and rheumatoid arthritis. 2. Vascular lesions such as angiomas or angioleiomyomas. 3. Deposit diseases. 4. Tumors: including lipomas, neurogenic tumors, synovial sarcomas. 5. Pseudotumoral lesions such as accessory soleus, Achilles tendonitis, plantar fibromatosis, postoperative granulomas or foreign body, peroneal tendinosis, extensors and tibial tendons, osseous exostosis or plantar papilloma. Conclusions We should be familiar with the radiological characteristics of the articular and peri-articular tumors, especially with the characteristics in ultrasound and MRI that guide the diagnosis of benignity and malignancy.

TABLE OF CONTENTS/OUTLINE

Introduction Findings in radiography, ultrasound and MRI characteristics of solid knee tumors. Conclusions

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TEACHING POINTS
The purpose of this exhibit is:
- To describe basic topics that should be evaluated on every CT exam report of a total knee arthroplasty.
- To identify normal and pathological findings on a knee arthroplasty through CT scan by giving examples of the daily routine.
- To help the general radiologist how to provide the orthopedic surgeon with relevant information following a knee arthroplasty through a structured report.

TABLE OF CONTENTS/OUTLINE
- Provide a concise and simple scheme of the parameters to be analyzed on following a knee arthroplasty: alignment of femoral and tibial components, component size matched to the knee, rotation, patellar assessment, joint line height, shape of polyethylene components.
- Illustrate features related to main complications or failure: periprosthetic lucencies, sclerosis or bone proliferation, and component failure or fracture.
- Present useful and relevant findings via a structured report: osteolysis, periprosthetic fracture, polyethylene wear, angle of rotation for femoral component, angle of rotation for tibial component, angle between tibial component anatomic axis of the tibia, distance between inferior edge of the patella and superior polyethylene surface.
- Didactic and illustrative cases to test and consolidate the acquired knowledge.
A Practical Guide to Interpret MRI Features of New Bone Formation in Axial Spondyloarthritis

All Day Room: MK Community, Learning Center Digital Education Exhibit

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TEACHING POINTS
The purpose of this exhibit is: 1. To review the different types of new bone formation detectable on MRI, per anatomical region of the axial skeleton. 2. To review their value in diagnosis and follow-up of axial spondyloarthritis. 3. To learn how to integrate these features in the overall assessment of an MRI examination for axial spondyloarthritis.

TABLE OF CONTENTS/OUTLINE
1. Background 2. MRI features of new bone formation in the sacroiliac joints 2.1 Intra-articular high signal intensity on T1-weighted MR images 2.2 Ankylosis of the sacroiliac joints 3. MRI features of new bone formation in the spine 3.1 Discal high signal intensity on T1-weighted MR images 3.2 Syndesmophytes 3.3 Vertebral corner bridging 3.4 Transdiscal ankylosis 3.5 Ankylosis of the intervertebral synovial joints 4. MRI features of new bone formation in the sternum 5. Pitfalls in MR imaging-diagnosis 5.1 Diffuse idiopathic skeletal hyperostosis 5.2 Congenital vertebral fusion 5.3 Acquired vertebral fusion 6. Conclusions

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Awards
Cum Laude

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TEACHING POINTS
1. Review glenoid-sided challenges in light of the three types of shoulder arthroplasty
2. Summarize the morphologic changes at the glenoid which often accompany the need for arthroplasty
3. Describe the surgical maneuvers used to compensate for glenoid bone loss

TABLE OF CONTENTS/OUTLINE
Types of shoulder arthroplasty
Total arthroplasty
Hemiarthroplasty
Reverse arthroplasty
Challenge of limited glenoid bone stock, and early glenoid component failure
Morphologic changes at the glenoid in osteoarthritis
Osteophytes
Posterior thinning
Retroversion
Biconcavity
Subchondral bone quality
Surgical maneuvers used to compensate for glenoid morphology changes
Reaming
Bone graft
Augmented glenoid component

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Artifacts in Musculoskeletal Magnetic Resonance Imaging (MRI)

All Day Room: MK Community, Learning Center Digital Education Exhibit

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TEACHING POINTS
- Evaluate the most frequent artifacts in Magnetic Resonance Imaging of the musculoskeletal system - Introduce to the physical bases of these artifacts related to MRI technique - Propose solutions to avoid or minimize these errors

TABLE OF CONTENTS/OUTLINE

Printed on: 01/19/20
Measurements and Assessment of the Hip and the Lower Limbs from Youth to Old Age - What Every Resident Should Know

All Day Room: MK Community, Learning Center Digital Education Exhibit

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TEACHING POINTS

1. The lower limbs and hip measurements have great importance to evaluate the proper balance of the locomotor system and the pathological implications. 2. To illustrate the measurements used in the evaluation of the lower limbs and the hip, explaining clearly the anatomical landmarks. 3. Specify the average values in all measurements of the lower limbs and the hip. 4. Instruct the resident on the adequate interpretation of the abnormalities in the measures included in this presentation and the correlation with their respective pathology.

TABLE OF CONTENTS/OUTLINE

I. Introduction
II. LOWER LIMBS
   a. The standard measurement of alignment and angles of the lower limb
   b. Assessing the alignment and angles of the lower limb
   c. Assessing leg length discrepancy
III. HIP
   a. Lines and measurements in the evaluation of the hip
   b. Correlation with hip pathologies from youth to old age
IV. Conclusions

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TEACHING POINTS

After completing this educational exhibit, the learner will be able to: 1. Understand the physiology of fluorodeoxyglucose (18F-FDG) uptake by tissues following intravenous injection 2. Explain why non-neoplastic and neoplastic processes can share imaging characteristics on PET/CT 3. Differentiate non-malignant and malignant processes by correlating PET data with information from the localization CT 4. Recognize non-malignant musculoskeletal entities which display 18F-FDG avidity and can mimic malignancy

TABLE OF CONTENTS/OUTLINE

1. Introduction/Background 2. Review of physiologic principles of PET/CT imaging 3. Practical tips for differentiating non-malignant and malignant processes on PET/CT 4. Case-based review of commonly encountered non-malignant musculoskeletal entities that can mimic malignancy on PET/CT: • Benign neoplasms o Pigmented villonodular synovitis o Fibrous dysplasia o Bone island o Elastofibroma dorsi • Soft tissue abnormalities o Bursitis o Tendinopathy o Infection o Brown fat o Myositis ossificans • Osseous abnormalities o Tug lesion/enthesopathy o Fracture o Osteomyelitis • Periarticular abnormalities o Synovitis o Osteoarthritis o Inflammatory/erosive arthritis • Post-procedural o Ligament and tendon reconstruction/repair o Particle disease o Adverse local tissue reaction o Bone/bone marrow biopsy o Bone graft harvest

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Only the Wearer Knows Where the Shoe Pinches: Essential of Metatarsalgia

All Day Room: MK Community, Learning Center Digital Education Exhibit

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TEACHING POINTS
Metatarsalgia is the most frequent cause of foot pain and a thorough understanding of its multivariate etiology, presentations and pathogenesis is of utmost importance. In an attempt to guide and start the diagnostic thought among the various causes of metatarsalgia, at first, this condition was classified through a flowchart in its primary, secondary and iatrogenic causes. A schematic drawing divided the possible causes of metatarsalgia according to the anatomical regions, and a diagram along with imaging exams illustrated the presentation of the leading etiologies on MRI.

TABLE OF CONTENTS/OUTLINE
Epidemiology and pathophysiology of metatarsalgia; Flowchart with the main causes; Present the sites of involvement in a schematic drawing; Evaluate the main magnetic resonance features through a diagram and illustrations; Highlights of the most representative findings that should be observed and reported; Summary and conclusion.

Printed on: 01/19/20
The Spinopelvic Relationship Made Simple: What The Hip Arthroplasty Surgeon Wants to Know to Prevent Instability in High-Risk Patients

All Day Room: MK Community, Learning Center Digital Education Exhibit

Awards
Certificate of Merit

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TEACHING POINTS
1. There is a dynamic relationship between spinal mobility, pelvic tilt, and stability of total hip arthroplasty (THA). 2. Specifically, patients with decreased spinal mobility and sagittal spinal deformity, have increased risk for instability and need for revision surgery. 3. Radiologists interpreting imaging for THA surgeons must be familiar with the terminology and imaging of spinopelvic parameters & normal spinopelvic motion. 4. The surgeon will want to know these parameters as measured on hip/pelvis & lumbar spine radiographs & CT, to appropriately plan for surgery. 5. Systematic preoperative image interpretation, combined with standardized clinical protocols, can reduce risk of dislocation for high-risk patients (e.g., at our institution, <1% risk compared to historical rates of 10%).

TABLE OF CONTENTS/OUTLINE
• Epidemiology of spinopelvic deformity • Biomechanical relationship to instability after THA • Review of spinopelvic parameter terminology with attention to potentially confusing or misused terms (e.g., Sacral slope, Pelvic incidence) • Overview of imaging modalities and measurements made for spinopelvic parameters with emphasis on information the surgeon wants to know (and why!) • Presentation of novel standardized system for radiologic assessment of high-risk patients planning to undergo THA and clinical results of this system

Printed on: 01/19/20
'Straight from the Shoulder': A Bare Bones Approach to Shoulder Instability

All Day Room: MK Community, Learning Center Digital Education Exhibit

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**TEACHING POINTS**
The learner will be able to: 1. Understand functional anatomy and relevant biomechanics of the shoulder joint 2. Recognize the contribution of core soft tissue support to maintain stability 3. Discern various patterns of instability and their subtypes 4. Visualize imaging features of the most common lesions resulting in instability 5. Learn management strategies and treatment options

**TABLE OF CONTENTS/OUTLINE**

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Adult Spinal Deformity: Demystifying the Sagittal Curves and Parameters

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TEACHING POINTS
1. Understand the radiographic assessment of adult spinal deformity (ASD) and the major causes for morbidity. 2. Learn the sagittal compensation maneuvers. 3. Highlight the concepts behind regional and global spinal alignment. 4. Describe how to assess cervical, thoracic, and spinopelvic parameters.

TABLE OF CONTENTS/OUTLINE
Acquired sagittal spine malalignment is the strongest predictor of associated pain and morbidity in the adult population. Surgical intervention aimed to correct spinal alignment based on sagittal parameters is associated with a significant improvement in quality of life in adults. Given this, it is important for the radiologist to have a keen understanding of the sagittal parameters that influence surgical intervention. The following outline will be presented. 1. Intro: Achieving balance and horizontal gaze, Compensation maneuvers 2. Regional curves: Cervical lordosis, Thoracic kyphosis, Lumbar lordosis (LL) 3. Pelvic parameters: Sacral slope (SS), Pelvic incidence (PI), Pelvic tilt (PT) 4. Spino pelvic parameters: PI to LL mismatch, T1 spinopelvic inclination, T1-Pelvis angle (TPA), Sagittal vertical axis 5. Cervical and thoracic parameters: Regional C0-C2 angle, Regional C2-C7 angle, Global C1-C7 angle, Cervical tilting, Thoracic inlet angle T1 slope

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What Sport Did That? Review of Radiological Diagnosis Involving Sports Names

All Day Room: MK Community, Learning Center Digital Education Exhibit

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TEACHING POINTS
Review various imaging findings/diagnosis with sports related names across radiographs, CT and MR. Describe the etiology and mechanisms of injury for these diagnosis as it relates to sports injuries. Provide clinical implications for each of the diagnosis and provide relevant radiological information that is needed to ensure communication to the clinicians for proper management.

TABLE OF CONTENTS/OVERSEVIEW
The cases will be presented in a quiz format followed by discussion of key imaging characteristics of each diagnosis. The specific cases with original imaging includes: Golfers elbow Tennis elbow Gamekeeper's thumb (skier's thumb) Snowboarder's fracture (lateral talar process fracture) Boxers fracture Runner's knee Topics for discussions for each diagnosis includes: Clinical presentation and relevant information Mechanisms of action of the Injury Relevant imaging findings on radiographs, CT, or MRI Treatment implications

Printed on: 01/19/20
Pre-Surgical Radiographic Evaluation of Adult Spinal Deformity: A Current Review

All Day Room: MK Community, Learning Center Digital Education Exhibit

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TEACHING POINTS
1. Spinal deformities and their accompanied spinopelvic abnormalities have a major impact (60-70%) on the aging population. In comparison to coronal spinal deformities, studies suggest that sagittal spinal deformities in the adult have greater implications on patient morbidity. 2. The Scoliosis Research Society (SRS)-Schwab classification modifiers have been shown to be adequate for sagittal plane correction; however, implant related complications remain high with many patients requiring revision surgery. 3. In order to optimize correction, anatomic variability must be taken into account. To achieve this, implementation of the pelvic-incidence-based proportional method of analyzing the sagittal plane, using the global alignment and proportion (GAP) score, should be considered to minimize the need for mechanical revision.

TABLE OF CONTENTS/OUTLINE
1. Describe the SRS-Schwab classification of adult spinal deformity and its limitations. 2. Define the GAP score to include defining relative pelvic version, relative lumbar lordosis, lordosis distribution index and relative spinopelvic alignment. 3. Provide a systematic algorithmic approach for analyzing and reporting adult spinal deformity to the surgeon, to assist in patient management.

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Imaging of Spinal Accessory Nerve Injury

All Day Room: MK Community, Learning Center Digital Education Exhibit

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TEACHING POINTS
The purpose of this exhibit is to: 1. Review the anatomy of the spinal accessory nerve and illustrate how it is susceptible to iatrogenic injury in the posterior cervical triangle. 2. Show imaging findings in cases of surgically confirmed spinal accessory nerve injury with correlation to EMG and intraoperative photos. 3. Explain how early diagnosis of a transected spinal accessory nerve could lead to a change in management.

TABLE OF CONTENTS/OUTLINE
Spinal accessory nerve background- anatomy, function, clinical presentation of injury, and treatment of injury. Review of imaging findings of spinal accessory nerve injury. Sample cases with correlation to clinical findings, EMG, and intraoperative photographs.

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Stress MRI of Lumbar Spine: Does it Help?

All Day Room: Mk Community, Learning Center Digital Education Exhibit

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TEACHING POINTS
To discuss indications for stress MRI of lumbar spine
Technique of stress MRI of lumbar spine
To evaluate changes in spinal canal after application of stress in selective patients

TABLE OF CONTENTS/OUTLINE
Introduction of stress MRI
Biomechanics of stress MRI of lumbar spine
Apparatus of stress MRI
Technique of stress MRI - how to perform
Various changes in MRI of lumbar spine seen after application of stress
Evaluation of lumbar canal diameter with and without application of stress
Sample cases showing importance of stress MRI of lumbar spine

Printed on: 01/19/20
Imaging Features of Intravascular Papillary Endothelial Hyperplasia (Masson’s Tumor) - Pathologic Correlation and Differential Diagnosis

All Day Room: MK Community, Learning Center Digital Education Exhibit

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TEACHING POINTS
To explain and review the physiopathology of the intravascular papillary endothelial hyperplasia (IPETH). To describe ultrasound (US) and magnetic resonance imaging (MRI) features of intravascular papillary endothelial hyperplasia with radiologic pathology correlation. To identify findings differentiating IPETH from other subcutaneous lesions.

TABLE OF CONTENTS/OUTLINE

Printed on: 01/19/20
Elbow US: When Can Its Diagnostic Reliability Be Equal to MRI?

All Day Room: MK Community, Learning Center Digital Education Exhibit

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TEACHING POINTS
- to review the anatomy and scanning technique of Elbow: anatomical variants and the effects of anisotropy - establish the pathological conditions in which the ultrasound is as useful as MRI in the diagnosis

TABLE OF CONTENTS/OUTLINE
Ultrasound of the elbow is particularly indicated in patients with symptoms addressed to a specific area. Is especially useful in the evaluation of tendon, in which the MRI and because the direction of the tendon will be subject to the effects of anisotropy. Also will allow us to perform a dynamic study and obtain images of the full course of the tendons in different planes. There were selected 310 patients with elbow complaints and evaluated by standardized ultrasound. The following compartments and structures were systematically analyzed: - Anterior compartment: Anterior joint recess, distal brachialis muscle and distal biceps muscle - Lateral compartment: Common extensor tendon, lateral collateral lig. complex, annular recess and radial nerve - Medial compartment: Common flexor tendon and anterior band of the UCL - Posterior compartment: Distal triceps tendon, olecranon bursa, posterior recess and ulnar nerve. Us is a very effective method of imaging the elbow, especially in cases with suspected tendon pathology. Is a priority to know the technique, normal us anatomy and appearances of pathologic.

Printed on: 01/19/20
Can Peri-Implant Lucency be Normal In Hip Arthroplasties?

All Day Room: MK Community, Learning Center Digital Education Exhibit

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**TEACHING POINTS**
Total hip arthroplasty is one of the most commonly reported studies. Radiograph is the best initial imaging modality for postoperative follow up to identify complications. Radiolucencies can be deceptive and normal in some implant designs and it could be abnormal in others. There is limited information in the literature to tease out normal vs abnormal radiolucent findings in and around the hip arthroplasty implants. This exhibit is our attempt to make radiologists more aware of different causes for normal as well as abnormal lucencies in Total Hip Arthroplasty patients.

**TABLE OF CONTENTS/OUTLINE**
Various types of hip arthroplasty fixation, designs, assembly First line Imaging modality and protocols to identify complications What is radiolucency around hip implants? Types, classifications, zones. Which could be Normal vs Abnormal lucencies in cemented vs cementless total hip arthroplasties, unipolar vs bipolar implants, fully porous coated vs partially coated implant designs. What should be taken into consideration to differentiate normal from abnormal. Various other reasons for lucencies around the hip joint and what should a radiologist be cognizant about so as to avoid missing important study findings that could save the patient and the surgeon from an impending disaster complication or put patient through an unnecessary surgical procedure.

Printed on: 01/19/20
Is Metallosis and Trunnionosis Around Hip Arthroplasty Implants the Same?

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Awards
Certificate of Merit

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TEACHING POINTS

Metal poisoning is a condition in which debris from metallic implants shed from the artificial hips, build up in soft tissue and leak into the bloodstream, manifesting as depression, suicidal tendencies and psychosis. Great controversy exists regarding the evaluation, radiological interpretation and therapeutic approach in patients with hip pain with mental health changes. These factors emphasize the importance of imaging of hip arthroplasty to identify clues for the origin of metal debris which could seriously impact morbidity and mortality. Imaging is used in symptomatic hip prosthesis and as a screening tool in the asymptomatic prosthesis for exclusion of infection and aseptic loosening as a cause of symptoms, assessment of component positioning, and identification of solid or fluid-filled pseudotumors. Various types of metal debris associated reactions like Metallosis, Trunnionosis, Pseudotumor and ALVAL(Aseptic Lymphocyte-dominated Vasculitis-Associated Lesion) can be identified on imaging and help surgeons in making educated decisions to improve success of the surgery and overall prognosis.

TABLE OF CONTENTS/OUTLINE

- Define metal poisoning
- Discuss and differentiate types of Metal Debris associated reactions
- Interpretation of early imaging findings and its impact on patient morbidity and mortality

Printed on: 01/19/20
TEACHING POINTS: 1. To familiarise the reader with various types of avulsion fractures of the knee on imaging 2. To know the underlying structure injured in an avulsion fracture and also, discuss other frequently associated soft tissue injuries, neurovascular injuries which are easily identified on MRI, not seen on radiographs.

TABLE OF CONTENTS/OUTLINE: 2000 knee radiographs and MRIs were reviewed between 2016 to 2019 which revealed 10 various patterns of avulsion injuries on imaging which are as follows- Segond fracture, Reverse segond fracture, ACL avulsion fracture, PCL avulsion fracture, Arcuate complex avulsion fracture, Iliotibial band avulsion fracture, Biceps femoris tendon avulsion fracture, Quadriceps tendon avulsion fracture, Proximal and distal patellar tendon avulsion fractures. A variety of avulsion fractures can occur which have a subtle appearance on conventional radiology. Therefore MRI are helpful and can provide additional information for adequately defining the extent of damage. In this exhibit, we describe the various Avulsion fractures around the knee and its associated abnormality.
Comparison of Radial Plane MRI and Arthroscopic Findings in Glenoid Labral Tear: Possibility of Non-Contrast Radial Plane T2-Weighted Image

All Day Room: MK Community, Learning Center Digital Education Exhibit

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TEACHING POINTS
1. Diagnostic imaging of glenoid labral tear: Characteristics of MR Arthrography
2. Labrum imaging with non-contrast radial plane on T2-weighted image
3. Clinical cases of glenoid labral tear on findings of radial MRI T2-weighted image and arthroscopy

TABLE OF CONTENTS/OUTLINE
1. Anatomy of glenoid labrum
2. Characteristic of MR Arthrography
3. Imaging technique of non-contrast radial plane T2-weighted image
4. Comparison of radial plane MRI and arthroscopic findings
5. Summary

Printed on: 01/19/20
For Every Bone Aggression, There is a Periosteal Reaction

All Day Room: MK Community, Learning Center Digital Education Exhibit

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TEACHING POINTS
The purpose of this exhibit is: 1. As the finding of periosteal reaction presents high frequency rate in the performed exams done at our service, even in several kinds of illness. 2. To demonstrate how this finding, periosteal reaction, could be a clue to detect bone lesions and to contribute to find the diagnosis.

TABLE OF CONTENTS/OUTLINE
3.1 - These slides will present a sample of how the periosteum can react as each type of aggression it suffer and some examples: - Where is periosteum - indicated by arrows - Periosteal tumor reaction: chondroma and Nora lesion were the examples used in the slides. However, our work will describe another malignant and metastasis tumors. - Inflammatory and infectious: finding that could bring some clues to interpret malignant and benign reactions. - Pediatrics and adult trauma, including impaction: to encounter the finding that differ lesions and exceptal developmental outcomes according to age. - Miscellaneous: hematological diseases, periosteal reaction on tenossynovitis.

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TEACHING POINTS

- to review the sonographic anatomy and scanning technique knee. Understanding of the anatomy, scanning technique and appearance of pathological conditions is essential for proper interpretation of US findings.
- to describe those pathological conditions in which ultrasound (US) has a similar or even higher sensitivity and specificity than MRI. One particular advantage US offers is the ability to perform a dynamic study and also allows us to make instant contralateral comparison when the abnormalities are confusing.
- US has a similar diagnostic capacity to MRI in the pathology of the tendons and bursae of the anterior compartment, specially in pediatric population.

TABLE OF CONTENTS/OUTLINE

We review US and MRI studies performed in 413 patients with symptoms referred to a specific knee area; those patients with diffuse or meniscal symptoms were excluded. We describe the sonographic appearance of the four anatomic compartments in which knee is divided: anterior, medial, lateral and posterior. We explain how to perform a dynamic US study (with active and passive mobilization) and to obtain images of the full course of the tendons in different planes. Illustrative examples of main tendinous diseases are shown. We emphasize the advantages of US exam compared to MRI.
Update on Knowledges and MRI Scan Techniques for Diagnosing Injury of Ankle Ligaments

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TEACHING POINTS
1. Anatomy of lateral ankle ligaments The lateral ankle ligaments consist of the anterior talofibular ligament (ATFL), the posterior talofibular ligament (PTFL), and the calcaneofibular ligament (CFL). The CFL runs deep in the peroneal muscle tendons. Morphology of CFL changes in different ankle positions due to the influence of the peroneal muscle tendons. Understanding the course of intact ligament is necessary to interpret injured ligament on MRI.
2. Injury of lateral ankle ligaments Severe cases in which both the ATFL and the CFL are torn often transition to chronic ankle instability, which is known to occur in about 20% of cases according to recent reports.
3. Clinical use of 3D MRI It is important to evaluate the remaining ligament using 3D T2 fast spin echo sequence for decision of surgical technique which included ligament repair and reconstruction.

TABLE OF CONTENTS/OUTLINE
1. Anatomy of lateral ankle ligaments
2. Morphological change of the calcaneofibular ligament in different ankle positions
3. 3D MRI of acute ankle sprain; The imaging findings in time-dependent change
4. 3D MRI of chronic ankle instability
5. Summary
The Achilles Tendon Pathologies: Case-based Pictorial Review

All Day Room: MK Community, Learning Center Digital Education Exhibit

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TEACHING POINTS
- To review the anatomy of Achilles tendon (AT), paying special consideration to vascular supply and biomechanical forces.
- To discuss the spectrum of AT pathologies including tendenosis (hypoxic, mucoid, lipoid, and calcified) and paratendonitis.
- To illustrate the different imaging findings of AT pathologies.
- To review types of AT tears, imaging findings, and Kuwada classification.
- Mimics of AT tears including plantar muscle injury and Haglund’s disease.

TABLE OF CONTENTS/OUTLINE
- General introduction.
- Anatomy and vascular supply of the AT.
- Imaging techniques.
- AT Tendonosis and paratendonitis pathology, subtypes, and imaging findings.
- Kuwada classification of AT tears.
- AT tear mimickers including Haglund’s disease and plantar muscle injury.
- Management of AT pathologies and tears.
- Post-surgical imaging.

Printed on: 01/19/20
Fluoroscopically Guided Facet Joint Steroid Injection-Related Adverse Events: What the Spine Intervention Radiologist Need to be Concerned

All Day Room: MK Community, Learning Center Digital Education Exhibit

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TEACHING POINTS
Epidural steroid injections and facet joint injections are the two most commonly used approaches in spine interventions for pain management. Even though facet joint injections is effective and could be an alternative to epidural injection for the patients at risk of bleeding, complications of facet joint injection have not been reported systematically. Spine intervention radiologist should be aware of possible adverse events and their severity in order to perform facet joint injection in high risk patients. Review anatomy and trajectory of facet joint injection for safe approach and analyze the incidence and type facet joint injection related adverse events.

TABLE OF CONTENTS/OUTLINE

Printed on: 01/19/20
Diffuse bone marrow signal abnormality is an often encountered incidental finding on MRI studies and can pose a diagnostic nightmare for even the most experienced radiologists. They can occur as a result of a wide range of both malignant and benign processes, meaning that differentiating between them is important in order to be able to recommend appropriate further management for the patient and set in motion an appropriate investigation pathway. We present a pictorial quiz composed of a wide range of well selected cases, of varying complexity, collected from a university teaching hospital and aim to: - Demonstrate important, interesting and unusual imaging appearances. - Discuss key learning points, further imaging and differential diagnostic considerations, including imaging pitfalls. - Help participants create a robust systematic approach to reporting similar cases, in order to optimise their diagnostic accuracy and streamline patient pathways.

TABLE OF CONTENTS/OUTLINE

Amongst many others our cases include: Widespread Metastases Myeloma Leukemia Myelofibrosis Mastocytosis Sickle Cell Disease GCSF (EPO) use Oncogenic osteomalacia Chronic diseases leading to marrow reconversion, including chronic liver disease. Recurrent transfusion related bone marrow iron deposition.
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TEACHING POINTS
1. To understand various imaging modalities useful in diagnosis of rib lesions. 2. Illustrate the key findings and teaching points for a variety of rib osseous lesions. 3. Review the benign and malignant rib lesions in different imaging modalities. 4. Demonstrate important rib lesions that can mimic malignancy i.e. granulomatous infection and fracture callus. 5. To correlate the imaging findings with histopathological diagnosis.

TABLE OF CONTENTS/OUTLINE
Radiological approach to assessing rib lesions Case scenarios in quiz format demonstrating imaging features of different rib pathologies including: A. Fibrous Dysplasia B. Enchondroma C. Chondrosarcoma D. Metastases (Sclerotic/Lytic/Mixed) E. Multiple myeloma F. Ewing Sarcoma G. Giant Cell tumor H. Brown Tumor (Osteitis Fibrosa Cystica) I. TB (Granulomatous infection mimicking malignancy) J. Fracture callus (lesion mimic on MRI)

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Computed Tomography Evaluation of Imaging Findings of Fibrodysplasia Ossificans Progressiva (FOP)

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TEACHING POINTS
The purpose of this exhibit is: To review key concepts about FOP, such as epidemiology, clinical features and management. To gain an awareness of the main imaging findings and associated malformations; To emphasize the role of analysis and report standardization to evaluate the disease progression throughout the years.

TABLE OF CONTENTS/OUTLINE
1) FOP: Epidemiology, Clinical features, management. 2) CT exam protocol: Hints and tips of 3D Reconstruction images; Exam analysis and report standardization; 3) Illustrative cases: Clinical features and past medical history; Imaging findings spectrum; Analysis of control exams to assess disease progression or stability after treatment and/or surgical procedures; 4) Discussion about the decisive role of radiologist in early detection of suspicious findings of FOP. 5) Discussion about the low dose CT as a standard imaging exam of FOP, for global disease analysis and progression assessment.

Printed on: 01/19/20
Avoid Getting Rocked by Heavy Metal: A Practical Guide of Radiological Findings After Arthroplasties

All Day Room: MK Community, Learning Center Digital Education Exhibit

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TEACHING POINTS
- Review the main techniques and criteria for an adequate evaluation by imaging methods for hip and knee prostheses;
- Highlight the most common complications after hip and knee arthroplasties that must be recognized by the radiologist with illustrated cases of our Musculoskeletal Radiology Department;
- Propose a well-defined and directed model of radiological report containing the key elements needed by orthopedists for manage a correct treatment of arthroplasties complications.

TABLE OF CONTENTS/OUTLINE
- INTRODUCTION: Anatomical aspects involved in arthroplasties; Techniques and materials commonly used in this surgical approach and its imaging features;
- NORMAL IMAGING ASPECTS OF PROSTHESES;
- COMPLICATIONS AFTER ARTHROPLASTY: Clinical cases illustrating the spectrum of common and uncommon complications after arthroplasty in different imaging methods (CT, MR, CR and US). Displacement; Prosthesis fracture; Infection; Metallosis; Mechanical lesions; Other lesions.
- BRIEF CLUES TO CORRECTLY REPORT RELEVANT INFORMATIONS FOR THERAPEUTIC PLANNING.

Printed on: 01/19/20
Imaging Features of Chronic Kidney Disease Mineral and Bone Disorders (CKD-MBD)

All Day Room: MK Community, Learning Center Digital Education Exhibit

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TEACHING POINTS
This exhibit aims to: - Review the pathophysiology of CKD-MBD - Discuss musculoskeletal manifestations of CKD - Describe and facilitate the recognition of imaging features of CKD-MBD in most imaging modalities

TABLE OF CONTENTS/OUTLINE
- Introduction
- CKD and Bone Metabolism Disorders
- Secondary Hyperparathyroidism
- Subperiosteal resorption
- Subchondral resorption
- Subligamentous resorption
- Trabecular resorption
- Osteoclastoma
- Periosteal neostosis
- Osteosclerosis
- Gout
- Soft-tissue and vascular calcifications
- Superscan
- Osteomalacia
- Diffuse demineralization
- Insufficiency fractures
- Pseudofractures/Looser's Zones
- Metaphyseal flaring
- Acetabular protrusion
- Treatment-related Manifestations
- Aluminium toxicity
- Amyloidosis
- Destructive Spondyloarthropathy
- Hemodialysis-related erosive arthropathy
- Tendon Rupture
- Avascular necrosis
- Infection
- Neoplasm
- Conclusion

Printed on: 01/19/20
The Fist Bump: Evaluation and Review of Hand Nodules with Ultrasound

All Day Room: MK Community, Learning Center Digital Education Exhibit

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TEACHING POINTS

1. To review the differential of the most common benign and malignant nodules of the hand.
2. To discuss the benefits and drawbacks of different imaging modalities in the assessment of hand nodules, with ultrasound proposed as the preferred first line modality.
3. To outline appropriate ultrasound technique and give a protocol for dynamic evaluation when investigating such lesions.
4. To review the imaging features, with figures, of each entity outlined in the differential.

TABLE OF CONTENTS/OUTLINE


Printed on: 01/19/20
Imaging Pitfalls Unique to the Developing Pediatric Ankle

All Day Room: MK Community, Learning Center Digital Education Exhibit

Awards
Certificate of Merit
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TEACHING POINTS
1. Highlight normal radiographic and MRI findings in the skeletally immature ankle that may be misinterpreted as abnormal 2. Provide pearls to aid in accurate imaging interpretation

TABLE OF CONTENTS/OUTLINE

Printed on: 01/19/20
Knee MRI in the Pediatric Population: What Your Resident Should Know

All Day Room: MK Community, Learning Center Digital Education Exhibit

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TEACHING POINTS

- To review the normal anatomy of the pediatric knee on MRI
- To classify the different pediatric knee injuries according to their age demographic
- To correlate the different knee injuries with their corresponding causes
- To revise the characteristic imaging findings of the most typical pediatric knee injuries on MRI

TABLE OF CONTENTS/OUTLINE

- Introduction
- MRI protocols
- Pediatric knee injuries
  - Bone and cartilage: Physeal fractures, Premature physeal closure
  - Avulsion fractures, Osteochondral injuries, Osteochondritis dissecans
  - Extensor mechanism: Traumatic patellar luxation, Osgood–Schlatter
  - Menisci: Meniscal tears, Discoid menisci, Osteochondritis dissecans
  - Ligaments: tears and injuries, Joint effusion, Popliteal cysts, Sinovitis, Others
  - Tumors: Malignant, Osteosarcoma, Benign, Osteochondroma, Osteochondromatosis, Cortical fibrous defect, Non-ossifying fibroma
  - Cortical desmoid, Sclerosing bone displasia, Pigmented villonodular sinovitis, Incidental findings
- Conclusion
- References

Printed on: 01/19/20
MRI of the Wrist: Top 20 Diagnosis - A Primer for Residents

All Day Room: MK Community, Learning Center Digital Education Exhibit

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TEACHING POINTS
1. Comprehensive review of the normal anatomy and biomechanics of the wrist. 2. Case based review of common wrist pathologies. 3. To describe the spectrum of imaging findings of these wrist pathologies with emphasis on what the orthopedic surgeon wants to know.

TABLE OF CONTENTS/OUTLINE
1. Technical aspects - Commonly performed sequences and imaging planes. 2. Review of normal anatomy. 3. Case based review of common wrist pathologies. 4. Review of salient imaging findings of these pathologies. 5. Emphasis on information useful for orthopedic surgeons.

Printed on: 01/19/20
Beauty and the Botched: Sonographic and MR Findings of Cosmetic Injections Gone Wrong

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TEACHING POINTS
1. To correlate and review the imaging appearance of common body augmentation injections across several imaging modalities including ultrasound, MR, CT, and radiograph.
2. To review common complications of body augmentation injections and the imaging appearance of these complications.
3. To illustrate how specialized MR sequences can be used to identify injected materials and review the MR physics basis for the sequences.
4. To introduce treatments available for symptomatic lesions.
5. To emphasize the importance of radiologists in making these diagnoses, since these procedures are often not mentioned by patients clinically.

TABLE OF CONTENTS/OUTLINE
Introduction
Commonly Used Cosmetic Injectable Fluids
Common Injection Sites
Natural History of the Injections and Associated Complications
Radiograph and CT imaging Findings
Ultrasound Findings
MR Findings on Commonly Used Sequences
MR Findings with Specialized Sequences
MR Physics of Injectable fluid and Specialized Sequences
Appearance of Patients’ Findings in Multiple Modalities
Treatments available for Symptomatic Lesions
Importance of the Radiologist’s Role in Making the Diagnosis
Conclusion

Printed on: 01/19/20
Diagnostic Imaging in QSS: Challenges in Definitive Diagnosis

All Day Room: MK Community, Learning Center Digital Education Exhibit

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TEACHING POINTS

- Discuss algorithm of diagnostic imaging for neurogenic and vascular QSS
- Discuss the typical need for >1 diagnostic imaging study, due to weak sensitivity and specificity

TABLE OF CONTENTS/OUTLINE

Overview of Quadrilateral space syndrome (QSS): - Rare disorder characterized by axillary nerve and posterior humeral circumflex artery (PHCA) compression (neurogenic and vascular forms) - Differential diagnosis: Rotator cuff injuries, referred pain syndromes, cervical spine pathologies, and labral injuries - Diagnostic algorithm for neurogenic and vascular QSS forms - Determine pre-test probability: overhead throw athlete, age <40 yrs - If patient meets risk factors and demonstrates positive QSS symptoms, proceed with diagnostic imaging: DSA, CTA, MRA, US, EMG - Multiple imaging modalities typically needed because of low sensitivity and/or specificity of tests: - In one controlled study, 80% of asymptomatic controls demonstrated PHCA occlusion in arteriography - MRI: denervation of axillary nerve-supplied muscles can lead to atrophy detectable on MRI, but these findings are nonspecific

Printed on: 01/19/20
Difficult Water Imaging? An Easy and Practical Guide of Diffusion-Weighted Imaging for Radiologists

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Certificate of Merit

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TEACHING POINTS
Diffusion weighted imaging (DWI) is one of the more commonly used functional techniques in MRI. In this exhibit, we explain the basic physics of DWI and provide practical examples of problem-solving imaging of soft tissues, bones, and nerves.

TABLE OF CONTENTS/OPTLINE
Review basic physics of DWI: Brownian motion Basic DWI echo-planar spin-echo (EPI) sequence Technical considerations (fat suppression, timing, plane, scan strength, parallel imaging, multi-shot EPI vs single-shot EPI) The b-value and its effect on images Understanding the apparent diffusion coefficient (ADC) Artifacts Clinical applications of DWI imaging: Rules and pitfalls of ADC measurements for lesion characterization and response assessment Difference between yellow marrow, red marrow, and infiltrated marrow Whole-body marrow survey and infection Neuromuscular disease Imaging pitfalls (lipoma, hemorrhage, fibrosis)

Printed on: 01/19/20
The Iliopsoas: A Review of Iliopsoas Compartment Anatomy and Pathology

All Day Room: MK Community, Learning Center Digital Education Exhibit

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TEACHING POINTS
- Review anatomy and biomechanical function of the iliopsoas compartment musculature.
- Describe the spectrum of pathology affecting the iliopsoas compartment, including the multimodality imaging features of each condition.

TABLE OF CONTENTS/OUTLINE
Multimodality (CT, MRI, Ultrasound) imaging review with illustrations:
A. Normal anatomy and biomechanical function of the Iliopsoas compartment.
B. Infectious/inflammatory processes: Primary infection vs. TB/Pyogenic abscesses from vertebral osteomyelitis, pancreatitis, diverticulitis, pyelonephritis.
C. Hemorrhage
D. Neoplasms - malignant metastatic vs. primary tumor (liposarcoma, leiomyosarcoma, hemangiopericytoma) vs. benign (neurofibroma, lipoma).
E. Musculoskeletal - Tendinopathy/tears, bursitis, impingement.
F. Ultrasound: Iliopsoas bursitis - including iliopsoas bursal injection technique.
G. Snapping hip syndrome.
H. Summary.

Printed on: 01/19/20
TEACHING POINTS

Prepare the radiologist to search and value musculoskeletal findings in computed tomography (CT) and magnetic resonance imaging (MRI) exams. Propose a didactical classification. Exhibit a pool of significant diseases that should be reported by general radiologist.

TABLE OF CONTENTS/OUTLINE


Printed on: 01/19/20
Psoriatic Onycho Pachydermo Periostitis ('Popp') lesion is a recently described and rare musculoskeletal manifestation of psoriasis, frequently associated with cutaneous adnexa disease. The diagnosis of the condition relied until few years ago just on a clinical basis. Recently described MR imaging features (keypoints) increased diagnostic accuracy. MRI examinations also contribute to exclude close mimickers, such as osteomyelitis. Findings like a conspicuous bone marrow edema, disproportionate the surrounding soft tissue, thickening of the nail bed and bone irregularity at tendon insertions are some of its main imaging pitfalls. Directed-guided ultrasound also have an important role identifying tenosinovitis with an accentuated thickening and vascularization of the nail bed.

TABLE OF CONTENTS/OUTLINE

1. Brief review of the main musculoskeletal involvement on psoriasis. 2. POPP lesions: from histology to imaging characteristics on ultrasound, CT and MR. 3. Pitfalls concerning the entity: the nail involvement. 4. The close mimickers: osteomyelitis and rheumatoid arthritis. What could guide us through the differential? 5. Cases from our experience, including ectoscopy, 'before and after', and advanced MR imaging such as perfusion TIC highlighting the contribution of radiology on early diagnosis.
The Diabetic Foot: Soft Tissue and Osseous Changes and the Role of the Radiologist in Determining Management

All Day Room: MK Community, Learning Center Digital Education Exhibit

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TEACHING POINTS
The diabetic foot is a significant source of morbidity in the United States. Diabetic patients who develop foot ulcers approximately 15% will develop osteomyelitis. Imaging findings can help guide clinical management of patients, and will be demonstrated in this exhibit. The radiology report, while mostly helpful, can sometimes limit the clinicians in their options for management. Correct use of terminology may prevent inappropriate intervention.

TABLE OF CONTENTS/OUTLINE
The goals of this exhibit are to provide an imaging review of the diabetic foot with associated complications and demonstrate appropriate and inappropriate use of terminology that can affect management. We will describe the well-known as well as under-recognized soft tissue and osseous imaging findings of the diabetic foot. For example, we will include heel pad thinning, adventitial bursae, synovial diverticulae, tendinosis/tenosynovitis, plantar fascial thickening and bowing, as well as soft tissue ulcers, abscesses, and fasciitis. Osseous findings will include Charcot foot, osteomyelitis and other less well-known sequelae including calcaneal insufficiency avulsion fractures (CIAF) and second metatarsal head insufficiency fractures. Finally, algorithms outlining the correct approach to imaging interpretation and use of appropriate terminology will be provided.

Printed on: 01/19/20
The Orthopedic Approach to Radiographic Evaluation of Acetabular Fractures

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TEACHING POINTS
1. Learn anatomic landmarks that are important in acetabular fractures
2. Understand updated methodology for radiographic interpretation of acetabular fractures
3. Become familiar with algorithm that can be applied when interpreting acetabular radiographs in order to provide useful information to the Orthopedic Surgeon.

TABLE OF CONTENTS/OUTLINE
1. Anatomy
   a. Radiographs
   b. CT
2. Algorithm for radiographic evaluation of acetabular fractures based on Letournel Classification
3. Application of the Algorithm in a quiz format. The list of cases includes:
   a. Transverse plus posterior wall fracture
   b. Transverse fracture
   c. Anterior column fracture
   d. Posterior column plus posterior wall fracture
   e. Posterior column fracture
   f. Posterior wall fracture
   g. Anterior wall fracture
   h. T-type fracture
   i. Anterior column Posterior hemitransverse fracture

Printed on: 01/19/20
Achitions of the Hip Joint Capsule

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TEACHING POINTS

1. Understand the anatomical and functional concepts of the hip joint capsule. 2. To recognize the image patterns of the different pathologies that affect the hip joint capsule including the inflammatory, traumatic, degenerative, infectious, post-surgical, among others causes. 3. Emphasize the key concepts and imaging characteristics for the differential diagnoses of hip joint capsule lesions.

TABLE OF CONTENTS/OUTLINE

INTRODUCTION - Concept and anatomical revision of the hip joint capsule. AFFECTIONS OF THE HIP JOINT CAPSULE. Case-based review of the main affections of the hip joint capsule: - Adhesive capsulitis. - Post-traumatic changes: capsule stretch, ligament rupture. - Degenerative changes: ligament degeneration. - Inflammatory changes: Deposition of crystals; Polymyalgia rheumatica. - Infectious changes. - Paraneoplastic changes - Postoperative changes. DIDACTICS - Cases to illustrate and solidify the concepts

Printed on: 01/19/20
Musculoskeletal Tuberculosis: A Practical Guide for Residents

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TEACHING POINTS
Familiarity to the musculoskeletal tuberculosis is of paramount importance for the radiologist since these lesions are infrequently seen on daily practice. Upon completing this exhibit, the learner will be able to: 1. Properly recognize and describe the common sites of disease in musculoskeletal tuberculosis. 2. Review the role of each diagnostic imaging modalities. 3. Describe the findings and appearance of common complications of musculoskeletal tuberculosis.

TABLE OF CONTENTS/OUTLINE
1. Get an overview about the physiopathology and clinical presentation about the musculoskeletal tuberculosis and bone involvement / tuberculosis arthritis. 2. General features of 'Tuberculosis' in musculoskeletal radiology, including the cases. 3. Correlate the pathologic findings in each imaging modalities (x-ray, CT and MRI). 4. Final review with all cases disposed by little images for rapid consult.

Printed on: 01/19/20
Keep It Moving: Spondylosis and Posterior Spinal Motion Preserving Surgeries

All Day Room: MK Community, Learning Center Digital Education Exhibit

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TEACHING POINTS
1. Understand the indications for the different types of posterior spinal motion preserving surgeries
2. Recognize the expected postsurgical appearance of the various types of posterior spinal motion preserving surgeries on imaging
3. Accurately evaluate complications of posterior spinal motion preserving hardware on postsurgical imaging

TABLE OF CONTENTS/OUTLINE
1. Laminoplasty: Indications/contraindications, mechanics, preoperative imaging evaluation, hardware design, postoperative imaging evaluation, complications and outcomes
   A. Open door technique and variations
   B. French door technique and variations
2. Dynamic posterior stabilization: Indications/contraindications, mechanics, preoperative imaging evaluation, hardware design, FDA approval status, postoperative imaging appearance, complications and outcomes
   A. Interspinous spacers: X-Stop, Wallis, Coflex, DIAM
   B. Posterior dynamic stabilization devices: Graf artificial ligament system, Dynesys, Stabilimax NZ, IsoBar, Dynamic Soft Stabilization System
3. Facet replacement implants: Indications/contraindications, mechanics, preoperative imaging evaluation, hardware design, FDA approval status, postoperative imaging appearance, complications and outcomes

Printed on: 01/19/20
Pediatric Soft Tissue Tumors and Tumor-Like Conditions: Focused Imaging Overview with Pathologic Correlation

All Day Room: MK Community, Learning Center Digital Education Exhibit

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TEACHING POINTS
After reviewing this exhibit, the learner will be able to:

i. Recognize the discriminatory radiologic features that help separate benign from malignant pediatric soft tissue lesions.

ii. Identify imaging features that result in a focused differential diagnosis for benign and soft tissue pediatric tumors.

iii. Recognize the histopathologic correlation associated with the common pediatric soft tissue lesions presented

TABLE OF CONTENTS/OUTLINE

* Tumor-like conditions:
  * Hematoma
  * Abscess
  * Myositis ossificans
  * Cysts
  * Fibromatosis

* Vascular lesions:
  * Hemangioma
  * Venous, capillary, and lymphatic malformation
  * Arteriovenous fistula
  * Arteriovenous malformation

* Neurogenic lesions:
  * Neurofibroma
  * Schwannoma

* Fat-containing lesions:
  * Lipoma
  * Lipoblastoma
  * Liposarcoma

* Sarcoma:
  * Rhabdomyosarcoma
  * Synovial sarcoma
  * Fibrosarcoma
  * Epithelioid sarcoma
  * Alveolar soft part sarcoma
  * Malignant peripheral nerve sheath tumor
  * Ewing sarcoma

Summary/Conclusion

Printed on: 01/19/20
Chronic Nonbacterial Osteomyelitis (CNO), also known as Chronic Recurrent Multifocal Osteomyelitis (CRMO), is a noninfectious autoinflammatory disorder, occurring primarily in children and adolescents, characterized by episodic musculoskeletal pain with a protracted course. Traditionally, CNO is a diagnosis of exclusion and commonly requires bone biopsy in order to rule out infection and malignancy. However, bone biopsies may be avoided, according to some authors, when there are characteristic features, such as multifocal bone lesions at typical sites, absence of constitutional symptoms and no signs of infection in laboratory test results.

Characteristic disease presentation includes bilateral lytic lesions with surrounding sclerosis in long bones metaphysis (especially in the lower extremity), clavicles and vertebral bodies. In contrast, single lesion, diaphyseal involvement and synovitis are unusual findings. Whole-body MRI (WB-MRI) is the study of choice, since it is valuable in the identification of multifocal symptomatic and asymptomatic lesions, thus helping to establish the diagnosis and serving as a baseline exam for disease response evaluation.

TABLE OF CONTENTS/OUTLINE


Printed on: 01/19/20
"Why Is It Hot?": Recognizing Benign Osseous Findings that Can Have Uptake on Nuclear Medicine Exams

All Day Room: MK Community, Learning Center Digital Education Exhibit

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Certificate of Merit

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TEACHING POINTS

Nuclear medicine exams may find incidental osseous lesions or may be part of the evaluation of an unknown osseous finding. Positive findings on these exams may be interpreted as a sign of a malignant osseous lesion. However, many benign osseous findings can have uptake on bone scan or PET.

TABLE OF CONTENTS/OUTLINE

1. Objective: Review benign osseous lesions that may have uptake on bone scan or PET. Benign osseous lesions that typically require no further evaluation: a. These lesions may be found incidentally and have characteristic appearance on radiographs or MRI. PET or bone scan findings may prompt further work-up, including biopsy. Understanding the potential appearance of these lesions on PET or bone scan can help avoid unnecessary procedures or further imaging. i. Enchondroma ii. Fibrous Dysplasia iii. Vertebral Hemangioma iv. Non-ossifying fibroma v. Schmorl's node vi. Osteonecrosis vii. Paget's disease
2. Benign osseous lesions that typically need further management: a. These lesions may have bone scan or PET as part of the work-up. Recognizing the potential appearance of these primary bone lesions on nuclear medicine exams can help guide the work-up of that osseous lesion. i. Osteoid osteoma ii. Eosinophilic granuloma iii. Aneurysmal bone cyst iv. Chondromyxoid fibroma v. Giant cell Tumor vi. Infection

Printed on: 01/19/20
The Postoperative Spine: A Basic Understanding of Spine Surgical Procedures

All Day Room: MK Community, Learning Center Digital Education Exhibit

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TEACHING POINTS
Upon completing this exhibit, the learner will be able to: 1 - Evaluate postoperative spine imaging and create effective reports to guide the spine surgeon in patient management. 2 - Differentiate normal findings from abnormal findings in the postoperative spine. 3 - Properly recognize and describe some of the more common surgical techniques as well as the hardware involved in these procedures. 4 - Identify the location and integrity of surgical implants.

TABLE OF CONTENTS/OUTLINE
A - Suggested MRI protocol for the postoperative spine, as performed in our institution. B - General features of surgical techniques of the spine on CT and MRI, including decompressive procedures, stabilization and fusion surgeries, and additional procedures, such as vertebral body replacement (corpectomy) and disc arthroplasty. C - Epidural fibrosis and hardware-related complications: implant malpositioning, implant loosening, and implant fracture.

Printed on: 01/19/20
How to Differentiate Malignant from Benign Vertebral Fractures?

All Day Room: Mk Community, Learning Center Digital Education Exhibit

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TEACHING POINTS
Compressive vertebral fractures are common in elderly patients, even without trauma. Osteoporosis is the main cause of fracture in this age group, accounting for 1.5 million fractures, about half of them in the vertebral body. On the other hand, in patients under 50 y.o., trauma is the main cause of vertebral compression fracture. Indeed, the spine accounts for 39% of all bone metastases, which can result in a pathological fracture. Differentiation between benign from malignant vertebral fractures can be a diagnostic challenge, especially in older patients, implying changes in staging, treatment and prognosis. The purpose of this exhibit is: - To discuss and illustrate the characteristics that help us differentiate benign from malignant fractures in the main imaging methods - CT, MR, PET / CT. - To illustrate the main pitfalls and keep in mind the major differential diagnosis.

TABLE OF CONTENTS/OUTLINE
A) INTRODUCTION • EPIDEMIOLOGY B) MORPHOLOGY • LOCATION AND NUMBER OF LESIONS • POSTERIOR ELEMENTS INVOLVEMENT • PARAVERTEBRAL OR EPIDURAL EXTENSION • ASPECT OF POSTERIOR VERTEBRAL CONTOUR C) MR • SIGNAL INTENSITY • ENHANCEMENT PATTERNS AND FLUID SIGN • DIFFUSION • CHEMICAL SHIFT D) CT • PUZZLE SIGN • INTRAVERTEBRAL VACUUM PHENOMENON E) PET/CT F) PITFALLS • MULTIPLE MYELOMA • PAGET DISEASE G) CONCLUSIONS

Printed on: 01/19/20
Normal Anatomy and Traumatic Lesions Secondary to the Sprain of the Midtarsal Articular Complex (Chopart): MRI Findings

All Day Room: MK Community, Learning Center Digital Education Exhibit

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TEACHING POINTS
- Correlate the normal anatomy with the ligament lesions secondary to Chopart's joint sprains.
- To demonstrate some variations of ligament injuries of Chopart's joint secondary to ankle sprain.
- List the MRI imaging findings of Chopart joint injuries

TABLE OF CONTENTS/OUTLINE
1 - MRI findings 2 - Talonavicular and calcaneocuboid joints 3 - Ligaments of the Chopart joint 4 - Dorsal talonavicular ligament 5 - Bifurcate ligament 6 - Dorsal calcaneocuboid ligament 7 - Short and long plantar ligaments 8 - Spring ligament complex 9 - Correlation between normal anatomy and traumatic lesions 10 - Ligament lesions secondary to Chopart's joint sprains

Printed on: 01/19/20
Unstable Shoulders: Radiologic Review of Shoulder Labral Tears

All Day Room: MK Community, Learning Center Digital Education Exhibit

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Certificate of Merit

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TEACHING POINTS

Demonstrate relevant MRI anatomy and conventional radiological description of the glenoid labrum. Present different types of glenoid labral tears and imaging characteristics on MRI. Provide the clinical aspects of each type of labral tear, such as mechanism of action, clinical presentation, and the clinical consequences as they relate to orthopedic management. Identify pitfalls in anatomic variants which may mimic labral tears and that radiologists should watch out for when relevant.

TABLE OF CONTENTS/OUTLINE

Topics for discussion and review of original images for each specific topic include: Clinical presentation and relevant information on the Injury MR imaging findings and pitfalls Treatment options from orthopedic standpoint Specific topics with original images include: Relevant MRI anatomy and conventional radiological descriptions SLAP tears and brief overview of subtypes Classic Bankart Reverse Bankart Perthes Lesion Anterior Labral Periosteal Sleeve Avulsion (ALPSA) Glenolabral Articular Disruption (GLAD)

Printed on: 01/19/20
MK241-ED-X

Guidebook for Upper and Lower Extremities Fractures Classifications

All Day Room: MK Community, Learning Center Digital Education Exhibit

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TEACHING POINTS

The purpose of this exhibit is: 1. To be a guide for radiologists to report the main features of a extremity fracture; 2. To illustrate the main determinants that will implicate in surgical treatment and/or prognostic in each fracture.

TABLE OF CONTENTS/OUTLINE


Printed on: 01/19/20
Kick off at Your Own Risk! Case-based Review of Pediatric Sports Injuries of the Lower Extremity

All Day Room: MK Community, Learning Center Digital Education Exhibit

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TEACHING POINTS
Children are not tiny adults. Discuss mechanism of action and clinical presentation of a variety of pediatric sports injuries. Discuss relevant anatomy and imaging characteristics on radiographs, ultrasound, CT and MR. Recognizing potential complications and treatment implications of various pediatric injuries.

TABLE OF CONTENTS/OUTLINE
Topics for discussion and review of original images for each specific topic include: Clinical presentation and epidemiology
Mechanisms of action for various injuries
Imaging findings and pitfalls across multiple modalities
Potential complications and treatment options/implications.
Specific topics with original images include:
Avulsion of the pelvic apophyses
Ligamentous injuries of the knee
Meniscal tears
Stress fractures
Osteochondritis dissecans of the knee
Osgood-Schlatter Disease
Sinding-Larsen-Johansson Syndrome
Transient dislocation of the patella
Patellar sleeve avulsion

Printed on: 01/19/20
Deciphering Surface Bone Lesions

All Day Room: Mk Community, Learning Center Digital Education Exhibit

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TEACHING POINTS
- Benign lesions such as infection, stress fracture, and aneurysmal bone cysts can have aggressive imaging appearances on radiographs and cross sectional imaging, mimicking a malignant process - Surface lesions can be challenging to diagnose and often necessitate biopsy, though characteristics such as location, matrix (osteooid or chondroid) or dominant cell type (lipomatous or fibrous), and post-traumatic history can provide clues as to the most likely diagnosis

TABLE OF CONTENTS/OUTLINE
Overview of surface lesion types - Imaging features - Osteoid forming lesions - Chondroid forming - Mixed bag (including post-traumatic, mimics, and rare entities)

Printed on: 01/19/20
Get the 411 on NF1: Musculoskeletal Findings in Patients with Neurofibromatosis Type I

All Day Room: MK Community, Learning Center Digital Education Exhibit

Awards
Cum Laude

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TEACHING POINTS

1. Review the epidemiology and pathophysiology of neurofibromatosis type 1.
2. Review the diagnostic criteria for neurofibromatosis type 1.
3. Discuss the imaging characteristics of the different types of neurofibromas.
4. Discuss the imaging characteristics of malignant peripheral nerve sheath tumors with an emphasis on findings suspicious for malignant transformation of a known neurofibroma.
5. Review osseous abnormalities associated with neurofibromatosis type 1.

TABLE OF CONTENTS/OUTLINE

1. Introduction
   A. Epidemiology and pathophysiology
   B. Diagnostic criteria
2. Soft tissue abnormalities
   A. Neurofibromas
      i. Localized
      ii. Diffuse
      iii. Plexiform
   B. Malignant peripheral nerve sheath tumors
3. Osseous abnormalities
   A. Calvarial and skull base defects
   B. Kyphoscoliosis
   C. Posterior vertebral body scalloping
   D. Protrusio acetabula, osteoporotic changes
   E. Tibial dysplasia, periosteal dysplasia
   H. Nonossifying fibromas
4. Conclusion and summary

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Beyond 'Prosthesis in Situ' - A Radiological Review of Normal Appearances and Complications of Orthopaedic Implants

All Day Room: MK Community, Learning Center Digital Education Exhibit

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TEACHING POINTS
1. To give a pictorial review of the normal imaging appearances of some of the important orthopedic implants.
2. To develop a structured approach for evaluation of the post operative radiographs.
3. To review the radiographic findings and relevance of identifying the associated complications.

TABLE OF CONTENTS/OUTLINE
I) Normal imaging anatomy of important orthopaedic implants-a) Hip.b) Knee.c) Foot and ankle implants.d) Shoulder.e) Forearm and wrist.f) Spinal
II) Approach to post-operative imaging of-a) Hip.b) Knee.c) Foot and ankle implants.d) Shoulder.e) Forearm and wrist.f) Spinal
III) Review of important complications associated with orthopaedic implants.
IV) Relevance of early diagnosis and pitfalls in reporting post-operative imaging studies.

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TEACHING POINTS
• To review and to illustrate the anatomy of anterolateral ligament (ALL) in magnetic resonance imaging (MRI); • To demonstrate the main possible lesions of the ALL, emphasizing its importance in clinical practice.

TABLE OF CONTENTS/OUTLINE
• ALL characterization at MRI exam: - Normal anatomy; - Main anatomical landmarks in axial and coronal planes; - Differentiation from adjacent structures; • ALL function in the knee; • ALL injuries on MRI exams (acute partial or complete lesions, chronic healed lesions, related avulsions and associated alterations); • Clinical correlation; • Sample cases and mimics.
Imaging Evaluation of Inferior Extremities Fractures: Correlation between Dual Energy Computed Tomography and Magnetic Resonance in Bone Marrow Edema Detection

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TEACHING POINTS
Understand physical principles of Dual Energy Computed Tomography (DECT) and its use in bone marrow evaluation. Understand physical principles of Magnetic Resonance (MR) and its use in bone marrow evaluation. Comprehend indications of each diagnostic method in trauma cases. Describe MRI and DECT limitations in fracture diagnosis. Comparison between DECT and MR in inferior extremities fractures, considering MRI as the gold standard. Know the impact of DECT as a new validated tool on trauma complementary evaluation.

TABLE OF CONTENTS/OUTLINE
INTRODUCTION-Definition of DECT and its current applications
EPIDEMIOLOGY-Epidemiology of inferior members fractures
ANATOMICAL CONCEPTS-Brief description of inferior members anatomy
PHYSICAL CONCEPTS OF DECT-Equipment characterization - Image acquisition and postprocessing - Information obtained using DECT when compared to single energy CT - Bone marrow edema characterization (physical principles and imaging features) - DECT limitations
PHYSICAL CONCEPTS OF MR-T1WI and T2WI fat-suppressed image: acquisition and post processing - Bone marrow edema characterization (physical principles and imaging features) and additional findings in trauma
MR limitations
COMPARING DECT AND MR IN BONE MARROW DETECTION: INTERACTIVE CASE-BASED DIDACTICS-Sample MRI cases to illustrate and solidify new concepts.
Stop Hiding Behind Impression: Complex Acetabular Fracture as Above

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TEACHING POINTS
1. Review standard radiographic projections of the pelvis and emphasize anatomic landmarks utilized to aid in identifying and classifying acetabular fractures. 2. Review Judet and Letournel acetabular fracture classification system, supplemented with rare variants. 3. Discuss a reading algorithm when presented with a radiograph and/or CT of the pelvis as evaluation, detection of all pertinent findings, and accurate classification can be challenging. 4. To discuss the role of imaging in the clinical management and surgical planning as well as post-surgical healing.

TABLE OF CONTENTS/OUTLINE

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Iliotibial Tract Anatomy: Functions and Its Pathologies

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TEACHING POINTS
Teaching points The proximal origin of iliotibial tract is the result of three fascias fusion at the greater trochanter level. They are superficial, intermediate and deep layers. Distally, the iliotibial tract has five insertions, one of those is the Gerdy's tubercle. The capsular-osseous insertion has a synergistic movement with the ACL. Therefore, it is affected when the ACL suffered a tear. A reproducible aggravating factor to iliotibial band friction syndrome is running downhill. Iliotibial tract injury could be a cause of ACL torn and patellar dislocation.

TABLE OF CONTENTS/OUTLINE
Table of contents/ Outline The iliotibial tract (IT) is a strong band which extend from the ilium to the knee along the lateral side of the thigh. It contributes with many functions to the body such as extension, abduction and rotation of the hip, standing, anterolateral and lateral stability of the knee. Because of its extension and functions, different etiologic pathologies could be affect it. A detailed anatomic review might give the key to an accurate diagnosis. Pathologies will be described: proximal iliotibial band syndrome, Morel-Lavallée lesions, external snapping hip syndrome, iliotibial band friction syndrome, traumatic tears, isolated IT injury, iliotibial insertional tendinosis and peritendinitis, avulsion fractures at Gerdy's tubercle.

Printed on: 01/19/20
Death is Not in the Air: Imaging Review of Necrotizing Fasciitis (NF)

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TEACHING POINTS

Necrotizing Fasciitis (NF) is a rapidly progressive and potentially fatal infectious disease involving the soft tissues deep to the muscular fascia. Radiologists should be aware of the hallmark imaging findings typical of NF as well as the strengths and limitations of each modality. CT is considered the modality of choice due to widespread availability and fast acquisition time. Radiologists need to educate themselves and others, that in most cases the diagnosis of NF is suggested without the presence of soft tissue gas. Imaging is crucial to assess extent of disease/margins, aid in surgical planning and evaluation of potential complications. In septic deteriorating patients, treatment should not be delayed by imaging.

TABLE OF CONTENTS/OUTLINE


Printed on: 01/19/20
What Every Radiologist Should Know about Assessing Lower Limb Length Discrepancy

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TEACHING POINTS

1. To review the measurements used to evaluate the asymmetry of the lower limbs 2. To Identify the compensatory anomalies and the imbalance associated with the asymmetry of the lower extremities. 3. To know the radiological follow-up and the different methods of conservative and surgical treatment.

TABLE OF CONTENTS/OFFLINE


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Problem Solved: Integral Applications of Musculoskeletal Sonography

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Discussions may include off-label uses.

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TEACHING POINTS
Radiographs, MRI, and CT are most commonly ordered to evaluate musculoskeletal pain or postoperative complications, however ultrasound is also a valuable tool.

TABLE OF CONTENTS/OUTLINE
1. Objective: a. Musculoskeletal ultrasound is valuable with advantages including Doppler, fine spatial resolution, and targeted dynamic imaging. 2. Postoperative complication of distal radius fracture ORIF a. Radiographs for pain demonstrate no correlate. b. Ultrasound reveals protrusion of a screw beyond the dorsal radial cortex. 3. Patient with multiple hereditary exostosis with thigh fullness and tightness a. No radiographic correlate. b. CT reveals a nonenhancing soft tissue mass intimate with the lesser trochanteric osteochondroma. c. MRI confirms soft tissue mass contiguous with the lesser trochanteric osteochondroma. d. Ultrasound demonstrates a fluid collection with internal echoes. Doppler confirms a yin-yang and to-and-fro pattern consistent with pseudoaneurysm. 4. Ultrasound boasts better tissue spatial resolution for a singular, specific indication a. Linear increased echogenicity at the outer surface of hyaline cartilage paralleling the articular surface is consistent with monosodium urate crystal deposition in gout. b. CPPD crystals aggregate in the middle layer of hyaline articular cartilage and are non-linear and irregular.

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Skeletal Involvement in Gaucher’s Disease: From Macrophage to Bone

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TEACHING POINTS
- Conceptualizing Gaucher's disease
- Review the pathophysiology of skeletal involvement
- Discuss the main findings involving the skeletal system in the imaging examinations, as well as their complications

TABLE OF CONTENTS/OUTLINE
Introduction
Epidemiology
Review of the pathophysiology of skeletal involvement in Gaucher's disease
- Accumulation of glucosylceramide in macrophages (Gaucher cells)
- Infiltration of Gaucher cells in bone marrow
- Chronic stimulation of the immune system leading to significant impairment in osteoblast proliferation
- Vascular compression due to the accumulation of Gaucher cells leading to necrotic complications
Characteristics in imaging examinations, including radiography, computed tomography and magnetic resonance imaging
- Infiltration of bone marrow
- Erlenmeyer flask deformity
- Osteopenia
- Bone infarction
- Avascular necrosis
- Fractures
- Osteolytic lesions
- Bone growth retardation

Conclusions

Printed on: 01/19/20
Radiologists as Detectives: Demystifying the Mystery of the Primary Bone Tumor - Is it Benign or Malignant? Using Radiographs

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TEACHING POINTS
The aim of this review is to discuss approach to diagnosis of bone tumors on radiography with clues. - To discuss the role of radiologist in deciding- Is the lesion benign or malignant?, Is there a need for further imaging (CT / MRI / PET) ?, Is there a need for biopsy?. - The importance of reporting checklist and use of clinico-radiological approach in diagnosis. - To discuss the signs of malignancy.

TABLE OF CONTENTS/OUTLINE
Retrospective and Prospective analysis of radiographs from 2015 to 2019 were studied. Radiographs are primary investigation done in musculoskeletal imaging and diagnosis of bone lesion being a tumour or not begins here. A combined clinico-radiological approach is needed to arrive at right diagnosis. Seven clues are 1.Age 2.Location 3.Lytic or Sclerotic 4.Zone of Transition 5.Matrix 6.Pattern of bone destruction 7.Periosteal Reaction. Teaching pearl is "BONE" B: Best initial imaging modality O: Optimum in a resource poor country like India N: Need for further imaging. If yes, which one? E: Eliminate unnecessary biopsies by correctly studying Radiographs!

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A Comprehensive Review of Diabetic Foot Complications

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TEACHING POINTS
1. To illustrate the different imaging findings of diabetic foot complications. 2. To describe different scenarios, that involve the soft tissue, bone, and their combination, which help taking treatment decisions. 3. To describe the key findings that best delimitate areas of septic inflammation and make easier planning surgical decisions.

TABLE OF CONTENTS/OUTLINE
Diabetic foot complications are related with increased mortality and morbidity of diabetic population. Foot ulcers lead to infection of bone, articulations, muscular, tendinous and other soft tissue structures. Soft tissue involvement cause amputations in patients with diabetes, increasing the mortality range from 39% to 80% at 5 years. Radiology has an important role making the diagnosis of these complications and help planning the posterior treatment (e.g. antibiotics, surgical debridement and amputation). We retrospectively evaluated 47 cases with amputation caused by osteomyelitis, diagnosed in a tertiary-level healthcare hospital, and reviewed also soft tissue complications, with microbiology confirmation and intraoperative correlation. We describe the findings that best correlate with osteomyelitis, soft tissue infection, their combination, the postsurgical imaging findings that correlate with recurrence and describe different scenarios that lead to different treatment.

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Image of Musculoskeletal Fungal Infections: Educational Review Based on Cases

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TEACHING POINTS
1. Review epidemiology, clinical aspects and involvement spectrum of musculoskeletal fungal infection. 2. Discuss common and uncommon findings of fungal infections on different image methods (CR, US, TC, MRI and PET-CT), with illustrated cases of our Musculoskeletal Radiology Department. 3. Highlight the main differential diagnosis. 4. Discuss the use of interventional radiology on the diagnosis and identification of the microorganism.

TABLE OF CONTENTS/OUTLINE
Introduction: epidemiology, risk factors and clinical of fungal infections. Review cases of fungal infections: review classical, common and uncommon findings. Discuss image aspects in the subcutaneous tissue, tendons, muscle and bones. Differential diagnosis: brief review of main differential diagnosis. Red flags: when we should think about fungal infection. Diagnosis and treatment: brief discuss on the use and accuracy of interventional radiology for diagnosis. The use of image to evaluate treatment response.

Printed on: 01/19/20
Anatomical Variation in the Ankle and Foot: Potential Inductors of Pathology

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TEACHING POINTS
Learn which are the most common anatomical variations in the ankle and foot. Recognize anatomical variants that may be a source of pathology and the challenges in differential diagnosis

TABLE OF CONTENTS/OUTLINE
Accessory anatomical structures in the ankle and foot usually represent incidental imaging findings; however, they may also eventually represent a source of pathology, such as painful syndromes, degenerative changes, be the subject of overuse and trauma or appear as masses and cause compression syndromes or impingement. This review aims to describe and illustrate the imaging findings related to the presence of accessory ossicles and muscles in the ankle and foot through different techniques, with special attention on those variants that associate factors of clinical relevance or that would trigger challenges in the differential diagnosis.

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Multimodality Imaging Evaluation of Musculoskeletal Chest Pain

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TEACHING POINTS
Chest pain is a common complaint in the emergency room, accounting for 1-2% of medical visits. It is important to exclude potentially fatal causes, such as cardiac ischemic disease. Musculoskeletal causes account for the largest proportion of these cases, reaching 36% in some studies, and imaging exams play a predominant role. Chest pain due to musculoskeletal causes is frequent in all age groups and may have degenerative, inflammatory, traumatic, infectious and neoplastic etiologies. The purpose of this study is to:- Recognize the anatomy of healthy thoracic wall- Discuss the different musculoskeletal chest pain etiologies- Illustrate imaging findings through sample cases- Propose a systematic approach to image interpretation.

TABLE OF CONTENTS/OUTLINE
INTRODUCTION-Anatomy: bones, ligaments, muscles and biomechanics of the thoracic wall.MUSCULOSKELETAL CHEST PAIN DIFFERENTIAL DIAGNOSIS-Degenerative-Inflammatory---Costochondritis, SAPHO syndrome, rheumatoid arthritis, ankylosing spondylitis, systemic lupus erythematosus.-Trauma-Infection---Septic arthritis, osteomyelitis.-NeoplasticIMAGING INTERPRETATION-Systematic approach to evaluate image exams-Template reporting systemINTERACTIVE CASE-BASED DIDACTICS- Sample cases to illustrate and solidify the concepts

Printed on: 01/19/20
Common Metallic Orthopedic Hardware Found on Knee X-Rays: What the Radiologist Needs to Know

All Day Room: MK Community, Learning Center Digital Education Exhibit

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TEACHING POINTS
Knee surgery has evolved strongly in the last decades and different devices or orthopedic implants are used in clinical practice, either with the objective of reconstructing structures or replacing joint surfaces. Imaging examinations are fundamental in assessing the integrity and positioning of devices, with simple radiography having a prominent role, with low cost and wide availability. Our goal is to illustrate the most common orthopedics hardware that can be found on knee x-rays. Illustrative images of knee x-rays were selected to exemplify and review details of the most common orthopedic hardware that can be found in radiological practice, such as: various types of plates and screws, endobuttons, anchors, Kirschner wires, arthroplasties, among others. The knowledge of the most common orthopedic hardware allows the radiologist to establish a precise diagnosis and actively contribute with the orthopedic surgeon in the management of clinical cases.

TABLE OF CONTENTS/OUTLINE
'Watch Your Step': Ankle Ligament Injuries - Understanding the Biomechanics of Trauma Until the Surgery

All Day Room: MK Community, Learning Center Digital Education Exhibit

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TEACHING POINTS
Ankle ligament injuries are among the most commonly seen pathologies in the clinical practice of orthopedic traumatology. Through this pictorial essay will be made a review about the ankle ligament injury, in a didactic and illustrative way, we will review the anatomical concepts and the imaging findings of trauma and after surgical procedures. The purpose of this exhibition is to: - To review the normal anatomy ankle ligaments. - To discuss and illustrate the injury mechanism of ankle ligament sprain and the associated lesions. - To describe the clinical presentation and imaging findings of ankle ligament injuries. - Highlight the ankle ligaments postoperative imaging findings.

TABLE OF CONTENTS/OUTLINE
INTRODUCTION - Ankle ligaments injuries epidemiology and importance ANATOMICAL CONCEPTS - Ligaments o Lateral complex o Medial complex o Spring complex o Syndesmosis IMAGING TECHNIQUES - Imaging techniques acquisition and protocol - What to look on each sequence ANKLE LIGAMENT INJURY - Trauma biomechanics - Clinical features and associated lesions - Imaging findings and what report - Surgical indications and postoperative imaging findings INTERACTIVE CASE-BASED DIDACTICS - Sample cases to illustrate and solidify the concepts

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Ultrasound of the Post-Operative Rotator Cuff: A Minefield of Artifacts with Nuggets of Gold

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TEACHING POINTS

1. Describe the ultrasound appearances of the rotator cuff in post-operative setting. Brief discussion of the type of rotator cuff repair and the type of arthoplasty will precede the illustrations of the sonographic appearances.
2. Placement of orthopedic hardware and sutures/anchors during surgery gives rise to unique pitfalls for interpretation of the sonographic images. These will be discussed with help of examples.

TABLE OF CONTENTS/OUTLINE

1. Introduction to Musculoskeletal ultrasound with emphasis on its strengths and weaknesses. 2. Discussion of various types of operative procedures performed on the shoulder. 3. Discussion of various expected post-operative sonographic appearances. 4. Illustrative cases with discussion of abnormalities. 5. List of pitfalls encountered during the above exams and how to identify them. 6. Summarization of important teaching points.

Printed on: 01/19/20
Unexpected Imaging Findings on Bone Densitometry: Why the Radiologist Needs to Be Ever Observant

All Day Room: MK Community, Learning Center Digital Education Exhibit

Awards
Certificate of Merit

Participants
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TEACHING POINTS
1. Although less discrete compared to diagnostic modalities, a variety of clinically important pathologies may be initially detected on low-resolution DEXA images including metastases and fractures. 2. When in or overlying the bone, many high-density surgical devices can lead to erroneous bone mineral density measurements and the interpreting physician must be vigilant for these processes to avoid interpretation error. 3. When encountering unexpected incidental findings on low-resolution DEXA images, appropriate follow-up imaging should be recommended to confirm the diagnosis and guide management.

TABLE OF CONTENTS/OUTLINE
I. Introduction
II. Incidental bone lesions
   A. Benign - Bone island
   B. Malignant - Metastases
III. Compression fractures
IV. Surgical devices
   A. Determining if affecting BMD measurement
   B. Excluding level(s) of the lumbar spine for BMD analysis
   C. Examples
   1. Spinal fusion
   2. G-J tube
   3. Ureteral Stent
   4. Aorto-Iliac Graft
V. Extra-osseous Pathology
A. Gallstones
VI. Conclusion

Printed on: 01/19/20
Lending a Hand: Ultrasound Evaluation of Hand and Wrist Pathology

All Day Room: MK Community, Learning Center Digital Education Exhibit

Participants
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TEACHING POINTS
The purpose of this exhibit is to: 1. Emphasize the importance of ultrasound evaluation of the hand and wrist by focusing on clinically relevant anatomy and why ultrasound is particularly useful in these areas. 2. Identify urgent and emergent findings in the hand and wrist that directly improves patient care and selection for emergent surgical interventions. 3. Review common, and uncommon, entities that ultrasound can be particularly helpful in diagnosing.

TABLE OF CONTENTS/OUTLINE
Brief overview of normal soft tissue anatomy of the hand and wrist that are particularly well-evaluated under ultrasound. Common injury patterns presenting to the ED in which ultrasound can be helpful. Common soft tissue lesions in the extremity that are evaluated nicely under ultrasound. Limitations of ultrasound evaluation of the hand and wrist.

Printed on: 01/19/20
Sternalclavicular Joint Pathologies
All Day Room: MK Community, Learning Center Digital Education Exhibit

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TEACHING POINTS
• To revise anatomy of sternoclavicular joint along with variants.
• Technical aspects of imaging, taking into consideration the institutional protocol.
• To categorize common and uncommon pathologies specifically involving the sternoclavicular joint.
• To discuss common clinical presentation and the radiologic features associated with different pathologies.
• To correlate radiological features with histopathological counterparts.

TABLE OF CONTENTS/OUTLINE
• Anatomy of sternoclavicular joint.
• Imaging protocol
• Pathologies involving sternoclavicular joint.
• Common clinical presentation and radiologic features associated with different pathologies.
  a. Traumatic pathologies
  b. Infective pathologies
  c. Inflammatory conditions
  d. Degenerative osteoarthritis
  e. Miscellaneous conditions - SAPHO, Condensing Osteitis, Friedrich's disease

Printed on: 01/19/20
Handbook of 3D Printing for Tibial Plateau Fracture Sequelae Surgery

All Day Room: MK Community, Learning Center Digital Education Exhibit

Participants

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TEACHING POINTS

Learning objectives: 1. To review the principles of 3D printing, technical aspects and segmentation tools 2. To review the application of 3D printing models for preoperative planning and intraoperative use in tibial plateau fractures.

TABLE OF CONTENTS/OUTLINE

Background With the appearance of 3D printing the generation of 3D models for pre operative planning has been growing exponentially. In this education exhibit, we are going to discuss the applications of these models in tibial plateau fractures procedures. Findings and procedure details The following learning points will be discussed with real cases and pre-surgical models:

1. Anatomy of proximal tibia. 2. Types of tibial plateau fractures 3. Printing procedures and material a- CT and MR acquisition and post processing 4. STL archive post processing; improving the printing. 5. Discuss benefits of pre operative planning with 3D printing models a- cost, time and surgical planning Conclusion 3D printing models are a novel and potentially useful technique available for treatment planning. In tibial plateau fractures the use of 3D models helps classify complex fractures and pre select the appropriate plates and screws, simulating the surgical procedure, in order to reduce surgical time and blood loss, as well as improving the patient-doctor communication.

Printed on: 01/19/20
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TEACHING POINTS
1. Describe the synovium and relevant joint anatomy. 2. Discuss the spectrum of synovial pathologies affecting the knee. 3. Emphasize the key imaging findings to arrive at the right diagnosis.

TABLE OF CONTENTS/OUTLINE
500 MRI studies evaluated from 2016 to 2018, revealed 10 different synovial pathologies which are as follows: • Inflammatory: Lipoma arborescens, Pigmented villonodular synovitis, Juvenile rheumatoid arthritis, rheumatoid arthritis • Degenerative: Synovial chondromatosis, Primary and secondary Synovial osteochondromatosis, secondary Lipoma arborescens • Infective: Tubercular arthritis, Septic arthritis • Vascular: Synovial hemangioma • Miscellaneous: Cyclops lesion, Reactive synovitis,
The Magnet is Sometimes "Off" - Practical Strategies for Optimizing Challenging Musculoskeletal MR Imaging

All Day Room: MK Community, Learning Center Digital Education Exhibit

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TEACHING POINTS
MSK MRI presents several unique challenges. We highlight the five most common MSK MRI challenges and provide practical strategies on scanning these challenging cases: 1) Off-Center imaging, 2) Patient motion, 3) Metal imaging, 4) Small FOV imaging, and 5) Scan angles and slice positioning.

TABLE OF CONTENTS/OUTLINE
Off ISO imaging - Fat suppression at off isocenter; Patient positioning superman vs arm down; Optimized imaging using STIR, PD with fat suppression and Dixon Patient Motion - Creative patient positioning and immobilization; Imaging optimization (phase and frequency encode direction) and radial k-space sampling (PROPELLER, BLADE); Fast scan techniques to decrease patient motion
Imaging metal - Effect of field strength and scan parameters (bandwidth, echo train length, STIR) on susceptibility artifact; Optimized imaging using metal artifact reduction sequences (VAT, MAVRIC, SEMAC) Small FOV - Effect of coverage and resolution on SNR; Optimal choice of coil based on anatomy of interest; Effect of field strength and scan parameters (slice thickness, bandwidth, image filters) Scan angles and slice positioning - scan angles for unique clinical indications (aberr view, tendon view); Patient immobilization and positioning tricks to maximizing patient comfort; Scan orientation, imaging plane and slice prescription setup tips

Printed on: 01/19/20
Utility of CT Dual Energy in the Musculoskeletal System: Current Applications

All Day Room: MK Community, Learning Center Digital Education Exhibit

Participants
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TEACHING POINTS
The goal of this presentation includes: 1. Brief technical explanation of CT dual-energy. 2. Applications of CT dual-energy technology as it relates to the musculoskeletal system and disease process.

TABLE OF CONTENTS/OUTLINE
Brief technical explanation of CT dual-energy. Applications of CT dual-energy technology in improving diagnostic sensitive and specificity as it relates musculoskeletal disease processes. Cases of how the application of CT dual-energy helped in the evaluation of musculoskeletal disorders while decreasing radiation dose. Future applications.

Printed on: 01/19/20
Gamuts in Advanced MRI for Soft Tissue Lesions Assessment: The Added Value of Functional Imaging

All Day Room: Mk Community, Learning Center Digital Education Exhibit

Awards
Magna Cum Laude

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TEACHING POINTS
1. Review the physical basis of Diffusion Weighted Imaging (DWI), Dynamic Contrast Enhanced MRI and MR H1 Spectroscopy (MRS) and their technical adjustment for soft tissue lesions evaluation. 2. Perform diagnosis aided lists including the main patterns of physiopathological aspects derived from DWI, DCE and H1MRS techniques for soft tissue lesions assessment. 3. Show potential applications of these Gamuts in diverse clinical scenarios.

TABLE OF CONTENTS/OUTLINE

Printed on: 01/19/20
Tibial Plateau Fractures Beyond Schatzker: What the Surgeon Wants to Know

All Day Room: MK Community, Learning Center Digital Education Exhibit

Awards
Cum Laude
Identified for RadioGraphics

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TEACHING POINTS
To understand the emerging concept of the proximal tibia as a three-column structure and how it differs from traditional Schatzker classification To review the three-column concept, fracture morphology, relevant soft tissue structures and joint congruity that matter to the surgeon when predicting outcomes and plan management. To be able to identify findings indicating a fracture-dislocation rather than just a tibial plateau fracture and the increased concern of neurovascular injury

TABLE OF CONTENTS/OUTLINE
Review the history of tibial plateau fracture classification Illustrate and review the concept of the tibial plateau as a 3-column structure and importance of correctly describing fracture morphology Illustrate examples of tibial plateau fractures highlighting important differences between 3-column and Schatzker terminology (Ex: Zero-column fracture - Schatzker Type III; One-column (lateral column) fracture - Schatzker Types I and II; Two-column (lateral and posterior column) fracture - not included in Schatzker classification; Two-column fracture (medial and posterior column) fracture - Schatzker Type IV; Three-column fracture - Schatzker Type V or Type VI Illustrate and review the indications for surgical treatment and examples of the important soft tissue structures that may affect clinical management

Printed on: 01/19/20
Current MR Imaging Assessment of the Knee after Anterior Cruciate Ligament Reconstruction in Adults

All Day Room: MK Community, Learning Center Digital Education Exhibit

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TEACHING POINTS
1. To describe current types of ACL reconstruction techniques.
2. To describe imaging findings of current types of ACL reconstruction techniques and complications.
3. To describe how to assess intraarticular structures at risks in follow-up imaging after ACL reconstruction.

TABLE OF CONTENTS/OUTLINE
1. Types of ACL graft reconstructions: augmentation, single bundle ACL graft, doubled-bundle ACL graft reconstruction.
2. Biology of signal changes in ACL grafts after surgery: Detached against non-detached grafts.
4. Intraarticular structures at risk after ACL reconstruction: Assessment of meniscus, cartilage and arthroscopically-treated osteochondral lesions associated to original ACL injury: High resolution and functional imaging.

Printed on: 01/19/20
Typical and Atypical Musculoskeletal Findings in the Abdominal Radiologist Practice: A Pearl Guide

All Day Room: MK Community, Learning Center Digital Education Exhibit

Participants
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TEACHING POINTS
Review the anatomy and biomechanical of the musculoskeletal structures included in the abdomen an pelvis exams. Recognize which are the normal and abnormal finding in bones, joints, and muscles according to the age. To describe and illustrate the main aspects of musculoskeletal diseases that can be found incidentally or not in abdominal exams, and should be correctly diagnosed.

TABLE OF CONTENTS/OUTLINE
The commonest and most important musculoskeletal diseases found on abdominal exams and its main locations will be divided into six categories: infectious, miscellaneous, tumors, traumatic/degenerative, inflammatory/vascular. All boxes in blue will show information about epidemiology, clinical manifestations, diagnosis, and treatment. All boxes in black will provide data about imaging patterns of musculoskeletal pathologies that can be seen in abdominal exams. According to the location and category, the diseases will be demonstrated with a didactic way (Iliopsoas abscess, spondylodiscitis, extramedullary hematopoeisis, tailgut cyst, Paget disease, chordoma, metastasis, chondrosarcoma, spondylolysis, insufficiency fracture, ankylosing spondylitis, femoral head osteonecrosis, and others.

Printed on: 01/19/20
MK277-ED-X

Radiographic Findings of Complications that Result in Prosthesis Failure Following Total Knee Arthroplasty

All Day Room: MK Community, Learning Center Digital Education Exhibit

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TEACHING POINTS

Learning objectives: To understand the range of complications associated with prosthesis failure following total knee arthroplasty. To identify the key radiographic features of these complications.

TABLE OF CONTENTS/OUTLINE

Total knee arthroplasty is a common surgical procedure. It is a safe and effective procedure that improves function and quality of life in patients with severe arthritis. Complications can result in prosthesis failure and it is important that radiologists be aware of the imaging features to accurately diagnose these complications. Our case series includes a range of periprosthetic fractures including post-traumatic displaced and undisplaced supracondylar fractures, post-traumatic proximal tibial fractures and intra-operative patellar fracture. We also present a range of examples of prosthesis loosening, including periprosthetic lucency at both the femoral and tibial components with and without component migration and subsidence, osteolysis complicated by proximal tibial periprosthetic fracture and periprosthetic infection. Lastly we present 2 cases related to polyethylene liner complication; the first demonstrates polyethylene bearing displacement and the second demonstrates polyethylene wear with resulting metallosis.

Printed on: 01/19/20
Fibro-osseous Tumors of Bone and Their Mimickers: Clinical, Imaging, and Pathologic Features

All Day Room: MK Community, Learning Center Digital Education Exhibit

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TEACHING POINTS
To learn the epidemiology, clinical presentation, typical location, and imaging and pathologic features of fibroosseous tumors of bone. To discuss the approaches of differentiating fibroosseous tumors of bone from their mimickers.

TABLE OF CONTENTS/OUTLINE
Epidemiology, clinical presentation, and typical locations of fibroosseous tumors of bone. Histopathologic findings of fibroosseous tumors of bone and related samples. Imaging findings of fibroosseous tumors of bone and related samples. Diagnostic strategy and points in differentiating fibroosseous tumors of bone from their mimickers.

Printed on: 01/19/20
Metaphyseal Lesions - How Well Do You Know It? Take a Quiz!

All Day Room: MK Community, Learning Center Digital Education Exhibit

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TEACHING POINTS
The purpose of this exhibit is to expose radiologists to a series of challenging metaphyseal cases in order to help improve the radiologist’s diagnostic knowledge when facing such cases. Summarize the metaphyseal anatomy and its imaging features in quiz format.

TABLE OF CONTENTS/OUTLINE
Describe the broad differential diagnosis for lesions that occur in the metaphysis. Recognize the entities that are highly characteristic of or specific to each metaphyseal lesion. Characteristic imaging findings of metaphyseal lesions: Metaphysical Chondro dysplasia, Rickets, Idiopathic metaphyseal sclerosis, Blount’s disease, Progressive diaphyseal Dysplasia, Maffucci’s Syndrome, Congenital Syphilis, Chondrodysplasia punctata, Chondro-Myxoid Fibroma, Cortical Osteo-fibrous Dysplasia, Mesenchymal Hamartoma.

Printed on: 01/19/20
Ultrasound Evaluation of the Painful and Swollen Leg: Please Think Beyond Deep Vein Thrombosis or Baker's Cyst!

All Day Room: MK Community, Learning Center Digital Education Exhibit

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TEACHING POINTS
• To recognize the clinical relevance of the correct and timely diagnosis of the painful and swelling leg. • To classify through a pictorial review the different disorders which may cause swelling and leg pain according to their etiology: vascular conditions, musculoskeletal and inflammatory conditions of the skin and soft tissue. • To recognize the advantages of Doppler and musculoskeletal ultrasound as a practical, low-cost and available method capable to diagnose the most frequent etiologies of the painful and swollen leg; it also allows guidance of injection therapies. • To propose an ultrasound diagnostic protocol that allows the detection or exclusion of deep vein thrombosis and ensures the diagnosis of other causal pathologies.

TABLE OF CONTENTS/OUTLINE
- Clinical and epidemiological relevance of patients with a painful swollen leg. - A pictorial review of the differential diagnosis of patients with painful swollen leg: vascular conditions, musculoskeletal and inflammatory conditions of the skin and soft tissue. - Ultrasound evaluation of the painful and swollen leg: Doppler and musculoskeletal approach. - Ultrasound diagnostic protocol: Technique considerations, pearls and pitfalls.

Printed on: 01/19/20
Sacral Osteoarticular Lesions: What the Radiologist Should Know

All Day Room: MK Community, Learning Center Digital Education Exhibit

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TEACHING POINTS
- To review normal sacral anatomy
- To familiarize with the multimodality imaging approach to study sacral lesions
- To provide an overview of its main pathologic entities

TABLE OF CONTENTS/OUTLINE
The sacrum, due to its anatomic location, is a structure that presents itself to the attention of multiple medical specialists as well as imaging generalists and subspecialists. A wide variety of disease processes can involve the sacrum either focally or as part of a systemic process. A multimodality approach including plain radiographs, computed tomography (CT) and magnetic resonance (MR) is necessary for proper study of the sacrum. This review aims to provide a comprehensive review of potential pathologic conditions involving the sacrum, which include:
- Congenital disorders
- Sacral tumours
- Infectious lesions
- Non-infectious arthropaties
- Sacral fractures
Knowledge of these abnormalities and familiarity with the imaging of these processes will allow radiologists of all subspecialties to contribute to the diagnosis and management of sacral disorders.

Printed on: 01/19/20
An Open and Closed Book Review of Skeletal Tumors of the Pelvis

All Day Room: MK Community, Learning Center Digital Education Exhibit

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**TEACHING POINTS**
Bone tumors are a relatively infrequent finding in Radiology. The ability to provide a meaningful differential diagnosis to the clinician is a critical component of MSK Radiology. This project will provide a full discussion of common and uncommon skeletal tumors involving the pelvis. The primary teaching point will explore and discuss the techniques to narrow the differential diagnosis of pelvic bone tumors. Additionally, pearls and pitfalls when encountering an incidental pelvic skeletal lesion on routine imaging will be reviewed.

**TABLE OF CONTENTS/OUTLINE**

Printed on: 01/19/20
**Awards**

**Certificate of Merit**

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**TEACHING POINTS**

1. To recognize the relevant anatomy and etiology of various tendon snapping phenomena.  
2. To acquire imaging techniques and detect findings in a variety of snapping tendon conditions.  
3. To learn provocative manoeuvres for eliciting snapping during dynamic ultrasound.

**TABLE OF CONTENTS/OUTLINE**

Pathophysiology of snapping tendons  
Review of sonographic imaging findings for snapping tendons  
Sample cases including multiple sites with a variety of causes (eg. TFL, ECU, sartorius, etc) - Predominantly presented in video format  
Future directions and summary

Printed on: 01/19/20
Awards
Certificate of Merit

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TEACHING POINTS
Percutaneous spinal procedures are widely practiced around the world for various interventions. Nevertheless, technical details of vertebral, discal or discovertebral approaches at the different vertebral levels are poorly described however they require great precision and a good understanding of vertebral anatomy and fluoroscopic images. The aim of this poster is: - to explain the vertebral, discal and disco vertebral approach to perform vertebroplasty, vertebral biopsy, disco vertebral biopsy, nucleotomy... - to explain how to direct the needle into the vertebrae using the bevel and how to use a curved needle for the lower lumbar disc approaches - to explain the main errors in spinal approach and know how to recognize them

TABLE OF CONTENTS/OUTLINE

Printed on: 01/19/20
Value-Added 'Opportunistic' CT: State-of-the-Art Insights into Bone, Muscle, and Fat

Awards
Certificate of Merit

Participants
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TEACHING POINTS
1) Discuss proposed CT-based definitions of osteoporosis, sarcopenia, and adiposity. 2) Review the potential for clinical impact when using routine CT to screen for osteoporosis, sarcopenia, and adiposity. 3) Highlight practical pearls and pitfalls for diagnostic imagers using opportunistic CT.

TABLE OF CONTENTS/OUTLINE

Printed on: 01/19/20
MK286-ED-X

Ultrashort Echo Time (UTE) Imaging: Review of Technique and Musculoskeletal Applications with Examples of Utility in the Knee

All Day Room: MK Community, Learning Center Digital Education Exhibit

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TEACHING POINTS
The purpose of this exhibit is to: Explain the MRI physics and reconstruction techniques for the UTE sequence Review the potential musculoskeletal applications for the UTE sequence Present imaging examples of utility of the UTE sequence in the knee

TABLE OF CONTENTS/OUTLINE
1. UTE sequence and reconstruction pipeline
2. UTE musculoskeletal applications
   Deep calcified layer of articular cartilage
   Cortical bone ultrastructure and porosity
   Meniscus ultrastructure and quantification of meniscal calcification and subclinical degeneration
   Tendon and ligament microarchitecture and collagen remodeling assessment
   Enthesis evaluation
   Intervertebral disc cartilaginous endplate (CEP) evaluation
   Soft tissue calcifications, including calcified arterial plaques
   Bone CT-like images and 3D reconstruction using zero echo time (ZTE) technique
3. Imaging examples of knee pathology highlighting the utility of the UTE sequence compared to routine fast spin echo (FSE) sequences will be provided

Printed on: 01/19/20
Awards
Certificate of Merit

Participants
Ashley L. Arnaud, MD, Temple, TX (Presenter) Nothing to Disclose
Ricardo D. Garza-Gongora, MD, Temple, TX (Abstract Co-Author) Nothing to Disclose
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TEACHING POINTS
Detail the anatomic structures attaching to the ulnar styloid and the TFCC. Describe types of ulnar styloid fracture and complications, including nonunion. Detail imaging findings of ulnar-sided wrist impaction syndromes. Discuss Palmer classification of TFCC tears with a focus on Types 1B-1D. Describe extensor carpi ulnaris tendon (ECU) tendon subsheath anatomy and three common patterns of ECU tendon sheath pathology resulting in ulnar sided wrist pain.

TABLE OF CONTENTS/OUTLINE
Ulnar styloid and TFCC anatomy
TFCC proper
Ulnotriquetral ligament
Ulnolunate ligament
Ulnar collateral ligament
Meniscus homologue
Extensor carpi ulnaris tendon sheath
Ulnar Styloid fractures, nonunion
Ulnotriquetral Impaction Syndrome
Ulnar Impingement Syndrome
Ulnocarpal Impaction Syndrome
Ulnar Styloid Impaction Syndrome
Hamatolunate Impingement Syndrome
Palmer Classification of Traumatic Tears
Type 1A: Central perforation
Type 1B: Base of ulna avulsion
Type 1C: Peripheral volar ligament avulsion
Type 1D: radial avulsion
Extensor Carpi Ulnaris Subsheath Anatomy
Characteristic Patterns of Injury of the ECU Subsheath
ECU Tendon Dislocation
Ulnar-sided Rupture
Radial-sided rupture

Printed on: 01/19/20
Are Enough Capsular Variants in the Shoulder? A Review and Current Concepts

All Day Room: MK Community, Learning Center Digital Education Exhibit

Awards
Identified for RadioGraphics

Participants
Alexeys Perez, MD, Caracas, Venezuela (Presenter) Nothing to Disclose
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TEACHING POINTS
Review the broad spectrum of capsular and ligamentary variants of the shoulder using Arthro MRI with arthroscopic correlation as well as the possible pathological implication of these variants. Provide a better understanding of capsular variants to avoid misinterpreting as pathological findings.

TABLE OF CONTENTS/OUTLINE
MK290-ED-X

What the Radiologist Needs to Know About Posterior Tibial Tendon Dysfunction and How to Help the Orthopedic Surgeons

All Day Room: MK Community, Learning Center Digital Education Exhibit

Participants
Vanessa M. Medina, MD, Temple, TX (Presenter) Nothing to Disclose
Jared B. Com, MD, Temple, TX (Abstract Co-Author) Nothing to Disclose
Ricardo D. Garza-Gongora, MD, Temple, TX (Abstract Co-Author) Nothing to Disclose

TEACHING POINTS
Understand basic anatomy and how to diagnose posterior tibial tendon dysfunction based on radiographic and MRI findings. Use MRI findings in order to apply appropriate grading schemes to help the orthopedic surgeon.

TABLE OF CONTENTS/OUTLINE
Detail anatomy and biomechanical properties of the posterior tibial tendon and regional hindfoot stabilizers. Discuss radiographic features and measurements indicative of posterior tibial tendon dysfunction (PTTD) and resultant medial longitudinal arch collapse. Highlight clinical and radiographic classification schemes for PTTD. Emphasize useful imaging parameters for surgical management stratification, treatment options and surgical techniques.

Printed on: 01/19/20
Acromioclavicular Joint and Distal Clavicular Third: Multimodality Approach, Treatment, and Complications

All Day Room: MK Community, Learning Center Digital Education Exhibit

Participants
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TEACHING POINTS
Describe the anatomy and function of the acromio clavicular joint (ACJ)
Review the wide spectrum of the ACJ pathology
Multimodality assessment for evaluating ACJ disorders
Assessment of distal third clavicle fractures
Describe the most common surgical procedures and their complications for the treatment of ACJ disorders and for distal third clavicle fractures.

TABLE OF CONTENTS/OUTLINE
Acromio clavicular normal anatomy
Acromio clavicular dislocation: classification, multimodality approach, most common surgical techniques and complications
Distal clavicular osteolysis: imaging, treatment and surgical complications
Distal third clavicle fractures: classification, treatment, and surgical complications
Acromio clavicular arthrosis
Miscellaneous: Ganglion, Geyser phenomenon, Cristal arthropathy, infection

Printed on: 01/19/20
Fast Musculoskeletal MRI: What the Radiologist Needs to Know

All Day Room: Mk Community, Learning Center Digital Education Exhibit

Awards
Cum Laude

Participants
Robert D. Boutin, MD, Davis, CA (Presenter) Nothing to Disclose
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Abhijit J. Chaudhari, PhD, Sacramento, CA (Abstract Co-Author) Nothing to Disclose
Feliks Kogan, PhD, Stanford, CA (Abstract Co-Author) Research Grant, General Electric Company
Brent Foster, Sacramento, CA (Abstract Co-Author) Nothing to Disclose
Valentina Mazzoli, MSc, Amsterdam, Netherlands (Abstract Co-Author) Nothing to Disclose
Garry E. Gold, MD, Stanford, CA (Abstract Co-Author) Research support, General Electric Company

TEACHING POINTS
[1.] Fast MRI pulse sequences with short acquisition times (< 30 sec) can be added to typical musculoskeletal MRI exams, thus enabling dynamic assessment. [2.] 3D volumetric datasets enable '4D MRI' during voluntary provocative maneuvers that are personalized to reproduce patient symptoms (e.g., active motion, isometric muscle contraction). [3.] High temporal resolution (< 500 ms/slice) MRI is associated with diminished in-plane spatial resolution compared to routine clinical scans, and always should be employed as a supplement to static MRI protocols using a high-spatial resolution technique.

TABLE OF CONTENTS/OUTLINE
[1] OVERVIEW OF FAST MRI: [A] Terminology ('real-time', 'cine', 'dynamic', 'active'); [B] Fast imaging comparisons: MRI vs. CT vs. sonography; [C] MRI resolution trade-offs (spatial vs. contrast vs. temporal); [D] Active MRI: General indications & contraindications; [II] TECHNICAL CONSIDERATIONS: [A] Set-up: Coils & other equipment; [B] Pulse sequences (2D vs. 3D vs. 4D); [C] Post-processing options (e.g., autosegmentation, kinematic models); [III] SPECIFIC EXAMS: [A] Spine (flexion/extension); [B] TMJ (disc); [C] Shoulder (instability); [D] Elbow (loose body); [E] Wrist (midcarpal instability, DRUJ); [F] Hip (FAI); [G] Knee (patellar maltracking); [H] Ankle (impegment); [I] Muscle (hernia); [IV] CONCLUSIONS

Printed on: 01/19/20
Juvenile Osteochondritis Dissecans Versus Normal Variants of Ossification in the Knee in Children: Key Points to Correct Assessment

All Day Room: NA Digital Education Exhibit

Participants
Nicolas Garcia, MD, Santiago, Chile (Presenter) Nothing to Disclose
Gonzalo Delgado, Santiago, Chile (Abstract Co-Author) Nothing to Disclose
Gonzalo E. Corral, MD, Vitacura, Chile (Abstract Co-Author) Nothing to Disclose
Macarena Nieto, Santiago, Chile (Abstract Co-Author) Nothing to Disclose
Julio Rosales, Santiago, Chile (Abstract Co-Author) Nothing to Disclose
Marco Antonio Verdugo, Santiago, Chile (Abstract Co-Author) Nothing to Disclose

TEACHING POINTS
- With advancing age the signal intensity in the posterior femoral condyles increases and becomes progressively more focal, in a normal age-related variation process.
- Compromise of intercondylar central zone of femoral condyle is more common in OCD, whereas posterior and inferocentral site is frequent in normal variants.
- Early stages of juvenile OCD lesions show disruption of the overlying normal thin hyperintense secondary physis on water-weighted MRI sequences.
- Accessory ossification centers, spiculations, and lack of bone marrow edema are features of normal variants.
- Intact overlying cartilage is a key feature to describe in doubtful cases, because probably they will be managed conservatively with MRI periodic controls, even in OCD or normal variants.

TABLE OF CONTENTS/OUTLINE
1. Distal femoral epiphyseal ossification in children: Normal MRI appearance
3. Early stage OCD versus normal variants: a. Location: is it important? b. MRI configuration of osteochondral defect in distal femoral epiphyses: Could it guide us to OCD or normal variants?
4. How to report doubtful cases?
5. Summary

Printed on: 01/19/20
A Radiologist’s Guide to Musculoskeletal Measurements in Adults

All Day Room: MK Community, Learning Center Digital Education Exhibit

Participants
Wael Layouss, Paris, France (Presenter) Nothing to Disclose
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Marion Morel, Paris, France (Abstract Co-Author) Nothing to Disclose
Elisabeth Dion, MD, Paris, France (Abstract Co-Author) Nothing to Disclose

TEACHING POINTS
Describe the principal anatomical measurements and landmarks in musculoskeletal imaging in adults Illustrate easy and reproducible measurement methods using different imaging modalities Determine the normal values and their clinical significance

TABLE OF CONTENTS/OUTLINE
Spine measurements • Craniocervical junction: RX and CT scan • Cervical spine: RX and MRI • Lumbar Spine: RX, CT and MRI
Shoulder measurements • Elbow measurements • Wrist measurements • Pelvis measurements • Hip dysplasia • Femoral anteversion • Acetabular anteversion • Femoroacetabular impingement • Symphysis pubis • Knee measurements • Patellar instability: RX and MRI • Anterior cruciate ligament • Lower limb alignment • Foot measurements • Longitudinal arch • Hindfoot geometry • Hallux valgus

Printed on: 01/19/20
Patellofemoral Instability? What the Surgeon Wants to Know

All Day Room: MK Community, Learning Center Digital Education Exhibit

Participants
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TEACHING POINTS
1. To review the evaluation methods of the diagnostic procedures involved in the surgery-related diagnosis of Patellofemoral Instability. 2. To review the Patellofemoral Instability management workflow.

TABLE OF CONTENTS/OUTLINE
A. Clinical Progression B. Anatomical Factors C. Imaging Evaluation Method D. Patellofemoral Instability Management

Printed on: 01/19/20
Ankle Ultrasound: A Primer for Radiology Residents
All Day Room: MK Community, Learning Center Digital Education Exhibit

Participants
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TEACHING POINTS
This presentation aims to guide the radiologist to recognize relevant anatomical structures relevant in the evaluation of the ankle.

TABLE OF CONTENTS/OUTLINE
Introduction Anatomy Muscles Anatomy Ligaments and Tendons US evaluation Anterior Compartment Lateral Compartment Medial Compartment Posterior Compartment Conclusions

Printed on: 01/19/20
ED008-SU

Musculoskeletal Sunday Case of the Day

Sunday, Dec. 1 7:00AM - 11:59PM Room: Case of Day, Learning Center

AMA PRA Category 1 Credit ™: .50

Participants
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TEACHING POINTS
Participants will test their diagnostic skills and become familiar with the imaging findings of a variety of challenging and interesting musculoskeletal cases.

Printed on: 01/19/20
Participants
Karen C. Chen, MD, Providence, RI (Moderator) Nothing to Disclose
Ali Guermazi, MD, PhD, West Roxbury, MA (Moderator) Shareholder, Boston Imaging Core Lab, LLC; Research Consultant, Merck KGaA; Research Consultant, Roche, Inc; Research Consultant, TissueGene, Inc; Research Consultant, Galapagos, Inc; Research Consultant, AstraZeneca PLC; Research Consultant, Pfizer Inc

Sub-Events

SSA14-01 Diagnostic Accuracy of Dual-Layer Detector CT Using Calcium-Suppressed Images for the Detection of Bone Marrow Edema in Wrist

Participants
Ji-Eun Kim, MD, Seoul, Korea, Republic Of (Presenter) Nothing to Disclose
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Hyunjung Yeoh, BMedSc, Seoul, Korea, Republic Of (Abstract Co-Author) Nothing to Disclose

PURPOSE
To evaluate the performance of calcium suppressed images (CaSupp) obtained by dual-layer detector computed tomography (DLCT) for the detection of bone marrow edema (BME) in patients with wrist pain.

METHOD AND MATERIALS
We retrospectively analyzed 49 patients with wrist pain (44 distal radius fractures, 2 carpal bone fractures, 2 scaphoid nonunion advance collapses, 1 Kienböck disease), who underwent both DLCT and MRI. Two blinded and independent readers evaluated CaSupp images for evaluating BME by using color-coded maps. Using MRI images as the reference standard, the sensitivity and specificity of CaSupp images were analyzed for detecting BME of radius, ulna, and carpal bones.

RESULTS
On MRI, 44 distal radius and 30 distal ulna fractures were found. In detecting BME of radius and ulna, two readers showed 100% of agreement. When CaSupp images were compared with MRI images, sensitivity and specificity for detecting BME were both 100% for radius, and 88% and 87.5% for ulna, respectively. For carpal bone, BME was found in 8 of 44 radius fractures and 5 of patients with only carpal bone abnormalities on MRI. Those carpal bone BMEs were detected on CaSupp images with following diagnostic accuracy: sensitivity, 92.8% for reader 1 and 64.2% for reader 2; specificity, 88.5% in both readers. For detection of carpal bone BME, two readers showed moderate agreement (agreement 75.5%, kappa value 0.43).

CONCLUSION
CaSupp images reconstructed from DLCT enabled detection of BME in fractured distal radius and ulna with substantially high diagnostic accuracy when compared to MRI images. However, CaSupp demonstrated limited performance in visualization of BME of carpal bone pathologies.

CLINICAL RELEVANCE/APPLICATION
CaSupp images showed similar performance in visualization and detection of BME in wrist, including incomplete fracture compared with MRI. CaSupp images is expected to be a promising technique to demonstrate BME in wrist.

SSA14-02 3D UTE Bicomponent T2* Analysis of Cortical Bone using a Novel Soft–Hard Composite Excitation Pulse

Participants
Liang Li, San Diego, CA (Abstract Co-Author) Nothing to Disclose
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Zhao Wei, San Diego, CA (Abstract Co-Author) Nothing to Disclose
Eric Y. Chang, MD, San Diego, CA (Abstract Co-Author) Nothing to Disclose
To evaluate 3D UTE bi-component T2* analysis of cortical bone ex vivo and in vivo using a novel soft-hard composite excitation pulse on a 3T scanner.

**METHOD AND MATERIALS**

UTE bi-component T2* analysis has been used to quantify T2*s and relative fractions of bound water (BW) and pore water (PW) in cortical bone. However, chemical shift artifact and fat-water oscillation may significantly affect the quantification accuracy. Here a 3D UTE Cones sequence with a soft-hard composite pulse was developed on a 3T GE MR750 scanner, and compared with Cones imaging with a short rectangular pulse excitation and a conventional FatSat module, respectively. The sequences were applied to bovine bone samples (n=72) and tibial midshafts of volunteers (n=76). Bi-component T2* analyses were performed and results including T2* and fractions were compared.

**RESULTS**

Comparable fat suppression was achieved with the soft-hard composite pulse and the FatSat module. More robust bi-component T2* fitting was achieved with 3D UTE Cones imaging with the soft-hard composite pulse, which outperformed the short rectangular pulse with greatly reduced fat water oscillation and chemical shift artifacts especially for cortical bone imaging, as shown in Figure 1. The conventional FatSat module suppressed fat signal and related fat-water oscillation, however, the BW fraction was greatly reduced due to direct saturation. For bovine bone samples the mean BW fraction was 75.73±1.58% for the composite pulse and 52.9±27.8% for the hard pulse. For human tibial midshafts the BW fraction was 71.3±3.0% for the composite pulse and 34.7±1157.1% for the hard pulse. The short T2 signals of cortical bone in the UTE-Cones images with the soft-hard pulse excitation were much better preserved than those in the FatSat UTE-Cones images. Meanwhile, fat signals were greatly suppressed by the soft-hard composite pulse, leading to much improved T2* bi-component analysis of bound and pore water fractions.

**CONCLUSION**

The 3D UTE Cones sequence with a soft-hard composite pulse allows more robust volumetric mapping of bound and pore water T2*s and relative fractions in cortical bone.

**CLINICAL RELEVANCE/APPLICATION**

The 3D UTE Cones sequence with a soft-hard composite pulse allows more robust volumetric mapping of bound and pore water T2*s and relative fractions in cortical bone.

**SSA14-03 Differentiation of Myelodysplastic Syndrome from Aplastic Anemia Using Conventional Multiparametric MRI and Machine Learning**

**Sunday, Dec. 1 11:05AM - 11:15AM Room: E450B**

Participants:

Myuki Takasu, MD, Hiroshima, Japan (Presenter) Nothing to Disclose
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Kazuo Awai, MD, Hiroshima, Japan (Abstract Co-Author) Research Grant, Canon Medical Systems Corporation; Research Grant, Hitachi, Ltd; Research Grant, Fujitsu Limited; Research Grant, Bayer AG; Research Grant, DAIICHI SANKYO Group; Research Grant, Eisai Co, Ltd;
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**PURPOSE**

Distinguishing myelodysplastic syndromes (MDS) from aplastic anemia (AA) can be challenging because patients with these diseases share many clinical features, such as hypocellular bone marrow (BM). This research aimed to build an MRI-based predictive model to differentiate between these entities using a machine learning algorithm.

**METHOD AND MATERIALS**

Patients with histologically confirmed MDS (n=24) or AA (n=29) were retrospectively investigated. First, we used three machine-learning approaches including a logistic regression model for the classification task to differentiate the entities. We included mean ADC, indices calculated from the ADC histogram, perfusion indices, and fat fraction from ROIs within the BM of L1-L3, and whole blood test data, including the reticulocyte percentage, as inputs in the model. We used 10-fold cross-validation to prevent overfitting. Next, we compiled datasets of the lumbar MR images of T1WI. We fine-tuned a convolutional neural network (CNN) on our training dataset. The CNN with standard cross-entropy loss function and the Adam optimizer with an initial learning rate of 0.001 provided automated prediction of the diagnosis. Third, the diagnostic performances of a radiology fellow, experienced musculoskeletal radiologist, and senior hematologist with specific expertise in pancytopenia were calculated.

**RESULTS**

Of the 53 MRIs tested, the algorithm by conventional multiparametric MRI predicted diagnosis correctly by the logistic regression model with the highest accuracies of 77.4% for MDS and 77.4% for AA with a combination of features of age, fat fraction, and platelet count. The accuracy achieved by the CNN on random sampling with 90% of training set size and 50 iterations was 84.0% (Figure). In general, the misclassified results were caused by signal intensity and heterogeneity within the BM. The AUC (95%CI) for the CNN was 0.810. The fellow, radiologist, and hematologist showed 60%, 66%, and 66% accuracy, respectively.

**CONCLUSION**

The CNN provided better differentiation of MDS from AA than conventional multiparametric MRI or visual inspection by human observers. Age, fat fraction of lumbar BM, and platelet count in whole blood proved useful for differentiation of these two entities.
A machine learning algorithm proved effective for differentiating MDS from AA. Machine learning may help to improve prognosis through early and appropriate treatment.

**SSA14-04**  
**Quantitative Assessment of Bone Marrow Adipose Tissue after Roux-en-Y Gastric Bypass Surgery in Postmenopausal Women**  
Sunday, Dec. 1 11:15AM - 11:25AM Room: E450B

**Participants**  
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Nathalie Bravenboer, Amsterdam, Netherlands (Abstract Co-Author) Nothing to Disclose  
Peter Bisschop, Amsterdam, Netherlands (Abstract Co-Author) Nothing to Disclose

**PURPOSE**  
To determine the effect of laparoscopic Roux-en-Y gastric bypass surgery (RYGB) on quantitative assessment of bone marrow adipose tissue (BMAT) and volumetric bone mineral density (vBMD), in postmenopausal women. Bariatric surgery rates are rising as a consequence of the increase in obesity and its associated diseases. RYGB effectively reduces body weight and improves metabolic health, but is also associated with increased fracture risk. BMAT could be a possible mediator of the increased fracture risk following bariatric surgery, since high BMAT is associated with increased fracture risk.

**METHOD AND MATERIALS**  
The study was approved by the local medical ethics committee. We included 17 postmenopausal, non-diabetic obese women, scheduled for laparoscopic RYGB. We determined bone marrow fat signal fraction (BMAT) of L3-L5, measured by SE-Dixon Quantitative Chemical Shift Imaging and vBMD of L3-4, measured by QCT, before surgery and 3 and 12 months after surgery. Data were analyzed by linear mixed model.

**RESULTS**  
BMAT was negatively associated with vBMD at baseline (R²=0.41 p=0.005). Body weight decreased after surgery from 106±15 [baseline] to 91±13 [3 months] and 74±10 kg [12 months, p<0.001]. BMAT decreased after surgery from 52.4±8% [baseline] to 50.4±8% [3 months] and 46.7±7% [12 months, p=0.001]. vBMD decreased after surgery from 104±27 [baseline] to 95±21 [3 months, p=0.001] and 98±26 mg/cm³ [12 months, p=0.080]. Calcium and vitamin D did not change after surgery.

**CONCLUSION**  
We show a decrease in BMAT 12 months after RYGB and a decrease in vBMD 3 months after RYGB. As high BMAT is associated with increased risk of fractures, independently of BMD in some studies, quantitative assessment of BMAT could potentially be interesting as a new imaging biomarker for assessment for bone quality following RYGB.

**CLINICAL RELEVANCE/APPLICATION**  
Quantitative assessment of bone marrow adipose tissue by quantitative chemical shift imaging has potential as an imaging biomarker for bone quality after RYGB surgery.

**SSA14-05**  
**Improved Detection of Benign and Malignant Rib Lesions in the Routine CT Work-Up of Oncological Patients Using Automated Unfolded Rib Image Post-Processing**  
Sunday, Dec. 1 11:25AM - 11:35AM Room: E450B

**Participants**  
Kaspar Ekert, Tubinga, Germany (Presenter) Nothing to Disclose  
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Marius Horger, MD, Tuebingen, Germany (Abstract Co-Author) Nothing to Disclose

**PURPOSE**  
To evaluate the performance of automated CT post-processing software generating unfolded rib images for improved detection of both benign and malignant rib lesions during routine diagnostic work-up of oncological patients.

**METHOD AND MATERIALS**  
1008 in- and outpatients (63.66 ±14.25 years; range 18.67 to 95.67 years; 405 females and 603 males) undergoing chest-CT between 07/2018-1/2019 at our own institution were retrospectively evaluated. Patients underwent chest-CT alone or as part of a whole-body CT staging/restaging. The CT-protocol consisted of 120kV, 100 mAs, matrix 512x512, collimation 0.6mm, reconstructed section thickness 3mm and 1mm using a soft tissue spatial resolution kernel (130f) and a sharp kernel (B70f). Both transversal image data sets were used for "conventional" diagnosis including coronal reformates with 3mm slice thickness. 1mm slice thickness image data sets of all patients were additionally directed from the scanner to a computational server where they were automated post-processed to 3D unfolded ribs. The "unfolding" of the rib using the centreline as an axis allows a synchronous display and rotation of all ribs from 0 to 360°. The standard of reference was 18F-FDG-PET, Ga68-DOMITATE-PET/CT, bone scan or imaging follow-up (>6mo).

**RESULTS**  
From a total of 1008 evaluated patients 763 (73.02%) were hematooncologic patients. A total of 104 rib lesions were found by
transversal CT-image reading whereas the unfolded rib image reading detected 305 lesions. 89 were classified malignant and 202 were classified benign. Detection of malignant rib lesions proved significant both for <1cm diameter (p<0.02) and >1cm diameter (p=0.007). The sensitivity, specificity, PPV and NPV for detection of malignant rib lesions was 97.7%/98.5%/96.6%/99% for unfolding ribs and 76.4%/100/92.7%/90.5% for conventional (transversal) image reading. Detection of sclerotic rib lesions and lesions >1cm in diameter was significantly better (p<0.01) for the unfolding rib algorithm.

CONCLUSION

The 'unfolded rib' reformates are significantly superior for rib lesion detection compared to conventional transversal CT-scan reading and should be therefore used in all patients in particular in those with oncologic background.

CLINICAL RELEVANCE/APPLICATION

The 'unfolded rib' reformates are significantly superior for rib lesion detection and should be therefore used in all patients in particular in those with oncologic background.

SSA14-06  Convolutional Neural Networks versus Expert Radiologist Accuracy in Differentiating Benign and Malignant Soft Tissue Neoplasms

Sunday, Dec. 1 11:35AM - 11:45AM Room: E450B

Participants
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PURPOSE

To evaluate the accuracy of convolutional neural networks (CNNs) in differentiating pathologically-proven benign from malignant soft tissue musculoskeletal neoplasms as compared to that of experienced musculoskeletal radiologists.

METHOD AND MATERIALS

One hundred patients with histologically-confirmed soft tissue tumors were identified from the institutional medical record. T1W, fat-suppressed T2W (fsT2W), fat-suppressed T1W pre- (T1-Pre) and post-contrast (T1-Post) MR images were used to train four CNNs, each using data from one sequence. A fifth CNN was created using data from one sequence. A fifth CNN was created using all imaging sequences in combination. For image preprocessing, volumetric regions of interest (ROIs) corresponding to tumor boundaries were segmented on Horos software. PyOsirix was used to export images and ROI masks for later analyses. Patches of 201 x 201 pixels were generated in each tumor ROI. Five-hundred patches per MR sequence were selected from each of the 100 patients, with 60 patients chosen for testing, 10 for validation, and 30 (50% benign) for independent testing. The training and validation studies were used to optimize an Inception V4 CNN with 201 layers, constructed in Tensorflow. Tumors in the testing set were classified as benign or malignant using the CNN.

RESULTS

Each radiologist attained an accuracy of 0.66. The five CNNs achieved the following accuracies and AUCs, respectively: 0.69, 0.70 (T1W); 0.74, 0.80 (T1-Pre) 0.78, 0.76 (T1-Post); 0.70, 0.70 (fsT2W); 0.80, 0.82 (combined CNN). No significant difference was found between the accuracy of the combined CNN model and either radiologist (p>0.05). False positive rate for malignancy was significantly higher in both radiologists as compared to the combined CNN (p<0.05).

CONCLUSION

CNNs differentiate benign versus malignant soft tissue neoplasms with moderate accuracy using individual MR sequences and good accuracy using the full conventional MR imaging protocol. Overall accuracy is similar to expert radiologist interpretation.

CLINICAL RELEVANCE/APPLICATION

Machine learning approaches could serve as a valuable adjunct to clinical practice for physicians and non-musculoskeletal fellowship trained radiologists.

SSA14-07  Qualitative Evaluation of MRI Features of Lipoma and Atypical Lipomatous Tumors: Results from a Multi-Center Study

Sunday, Dec. 1 11:45AM - 11:55AM Room: E450B

Participants
Andrew Wong, MD, MS, Sacramento, CA (Presenter) Nothing to Disclose
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Thomas M. Link, MD, PhD, San Francisco, CA (Abstract Co-Author) Research Grant, General Electric Company; Research Consultant,
Morphologic changes in ASPS lesions at 3-months are strong predictors of durable response; while in isolated cases early and

CONCLUSION
associated with lesion non-progression (p=0.04, 0.04, and 0.03, respectively).

volume (p=0.003 and 0.0003, respectively). Of textural features, only decreases in kurtosis, entropy, and skewness were
follow-up was highly associated with non-progressive disease (p=0.0004, Wilcoxon rank-sum), as were decreases in short axis and
progressed by at least 20%. Decrease in Dmax at 3-month
received axitinib and pembrolizumab combination therapy. Target lesions were chosen according to RECIST 1.1 guidelines. All target
This IRB-approved study included 28 lesions in 10 subjects with ASPS enrolled in a prospective phase 2 clinical trial. Patients
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PURPOSE
The purpose of this study was to: (a) evaluate MRI qualitative features that differentiate benign lipomas (BL) from atypical

METHOD AND MATERIALS
This retrospective multicenter study recruited a total of 247 (136 females) subjects (median age:59 years; range:23-92). All
subjects underwent presurgical contrast-enhanced MRI. MRI was centrally read by a board-certified radiologist for site, depth
(superficial/deep), architectural complexity, level of fat suppression, enhancement and septa. Significant features in univariate
analysis were further studied using a logistic regression model with 1000-samples bootstrapped 95% confidence interval (CI). The
radiologist's impression was recorded as BL or ALT. A 4-point scale (1-4) reflecting the diagnostic confidence was also used, with 4
being the highest level of confidence. Histopathology (including MDM2) was used as the diagnostic reference standard.

RESULTS
71 ALTs were pathologically verified. Subjects with ALTs were significantly older (61±13 vs. 56±12yr) and presented with pain or
discomfort. Multiple features were significantly associated with the pathologic diagnosis in univariate analysis, but in multivariate
analysis only large tumor size (OR=1.08, 95%CI:1.01-1.16), deep location (OR=4.31, 95%CI:1.02-18.33), proximal lower limb
location (OR=5.97, 95%CI:2.12-16.82), incomplete fat saturation (OR=3.28, 95%CI:1.14-9.49), and increased architectural
complexity (OR=9.44, 95%CI:3.51-25.44) were independent predictors of ALT. Overall radiologist impression was 80% sensitive
(95%CI:69-89%) and 79% specific (95%CI:72-85%). 8/97 cases with a confidence score of 4 and 9/64 cases with a confidence
score of 3 were misdiagnosed. Radiologist confidence score inversely correlated with the proportion of misdiagnosis (p<0.05).

CONCLUSION
The MRI features tumor size, depth, location, fat saturation and architectural complexity were independent predictors of ALT.
Though these features may help in the differentiation of lipomatous lesions, several cases were misdiagnosed even when the
radiologist expressed a high level of diagnostic confidence.

CLINICAL RELEVANCE/APPLICATION
MRI features can help differentiating lipomatous lesions, however, even when the radiologist’s confidence level is high, several
cases were misdiagnosed. Clinician should be aware of the limitations of MRI features.

SSA14-08 CT Radiomics in Alveolar Soft Part Sarcoma Response to Novel Immunotherapy Regimen
Sunday, Dec. 1 11:55AM - 12:05PM Room: E450B

Participants
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PURPOSE
Axitinib/pembrolizumab has recently shown superior efficacy compared to historical controls in the treatment of alveolar soft part
sarcoma (ASPS). We aimed to evaluate CT texture analysis of ASPS lesions treated with this novel immunotherapy regimen.

METHOD AND MATERIALS
This IRB-approved study included 28 lesions in 10 subjects with ASPS enrolled in a prospective phase 2 clinical trial. Patients
received axitinib and pembrolizumab combination therapy. Target lesions were chosen according to RECIST 1.1 guidelines. All target
lesions were segmented on portal-venous phase CT using mint Lesion 3.4, and the following radiomics features were extracted: long
axis, short axis, volume, entropy, kurtosis, skewness, mean of positive pixels (MPP), and uniformity of distribution of positive gray-
level pixel values (UPP). Results were compared to maximum diameters at the lesional level.

RESULTS
The 28 lesions were followed for mean of 13 months (range 3 to 27 months); this yielded a total of 152 distinct lesional timepoint
assessments. Baseline mean Dmax=2.6 cm, and volume=9.1 cc. Best individual lesion responses by Dmax were as follows: 5 lesions
disappeared, 13 decreased by at least 30%, 3 remained stable, and 7 progressed by at least 20%. Decrease in Dmax at 3-month
follow-up was highly associated with non-progressive disease (p=0.0004, Wilcoxon rank-sum), as were decreases in short axis and
volume (p=0.003 and 0.0003, respectively). Of textural features, only decreases in kurtosis, entropy, and skewness were
associated with lesion non-progression (p=0.04, 0.04, and 0.03, respectively).

CONCLUSION
Morphologic changes in ASPS lesions at 3-months are strong predictors of durable response; while in isolated cases early and
predictive changes in image textural parameters were observed, in general these parameters do not substantially improve response prediction over $D_{\text{max}}$ at the 3-month time-point.

**CLINICAL RELEVANCE/APPLICATION**

In ASPS treated with this immunotherapy-based regimen, one-dimensional assessments at 3 months are sufficient to predict durable lesion response.

**SSA14-09  Organ Dose and Total Effective Dose of Whole-Body CT in Multiple Myeloma Patients**  
Sunday, Dec. 1 12:05PM - 12:15PM Room: E450B

Participants  
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Kai Yang, PhD, Boston, MA (Abstract Co-Author) Nothing to Disclose  
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**PURPOSE**

Whole body low-dose CT (WBLDCT) plays an important role in the work-up of patients with plasma cell disorders and has recently been incorporated in the International Myeloma Working Group criteria for multiple myeloma (MM). However, data are lacking on the radiation exposure of such CTs. The purpose of this study was to evaluate organ dose and total effective dose of WBLDCT performed on different CT scanners in patients with MM and to compare it to the effective dose of a radiographic skeletal survey and typical diagnostic CTs. We hypothesized that the effective dose of WBLDCT would be lower than that of diagnostic CTs and higher than that of a skeletal survey.

**METHOD AND MATERIALS**

Our study was IRB approved and HIPAA compliant. We retrospectively analyzed data from 228 patients (47.4% females, mean age 67.9±10.4 years, mean weight 81.8±22.4 kg) who underwent WBLDCT for the work-up or surveillance of MM. Patients were scanned using one of our six multi-detector CT-scanners (Figure 1). Organ doses and total effective doses per scan were calculated using a commercially available dose management platform (Radimetrics, Bayer Healthcare, Leverkusen, Germany). The median effective dose was then compared to radiographic skeletal survey and representative diagnostic CTs performed in our institution.

**RESULTS**

The mean effective dose of our WBLDCT-protocol was 4.82 mSv. A significant higher effective dose was observed in females compared to males (4.95 mSv vs. 4.70 mSv, $P=0.002$). The mean organ dose ranged from 3.72 mSv (esophagus) to 13.09 mSv (skeleton). The mean effective dose varied amongst different CT-scanners (range 4.34-8.37 mSv) (Figure 1). The median effective dose of WBLDCT was more than twice the dose of a skeletal survey (4.82 vs 2.04 mSv), 23% higher than a diagnostic contrast-enhanced chest CT (3.9 mSv), 46% lower than a diagnostic contrast-enhanced abdomen/pelvis CT (9.0 mSv), and 45% lower than a lumbar spine CT (8.7 mSv).

**CONCLUSION**

WBLDCT in MM has a higher effective dose than a radiographic skeletal survey, but a lower effective dose than diagnostic CTs of the lumbar spine, abdomen and pelvis. This underlines the broad applicability of WBLDCT in the management of MM patients.

**CLINICAL RELEVANCE/APPLICATION**

The additional diagnostic value of low-dose whole-body CT in the management of MM patients outweighs the relatively limited additional radiation dose as compared to a radiographic skeletal survey.

Printed on: 01/19/20
**Purposes**

In the case of radiographically occult hip fractures, patients undergo further imaging, including additional CT or MRI. The purpose of our study is to develop an automated deep learning system (Deep Convolutional Neural Network: DCNN) for detecting hip fractures using CT or MRI as a gold standard, and to evaluate the diagnostic performance of 7 readers with and without DCNN.

**Method and Materials**

The study population consisted of 327 patients who underwent pelvic CT or MRI and were diagnosed as femoral fractures. Radiography was performed in all cases. All radiographs were manually checked and annotated by radiologists referring to CT or MRI for selecting ROI. At first, a DCNN with architecture of GoogleNet model was trained by 302 cases. The remaining 25 cases and 25 control subjects were used for the observer performance study and for the testing of DCNN. Seven readers of radiologists with 9, 13 and 24-year experience, an orthopedist with 22-year experience, a radiology trainee with 3-year experience, a general physician with 4-year experience and a senior resident took part in this study. A continuous rating scale was used to record each observer’s confidence level. Subsequently, each observer read the radiographs with the DCNN outputs and rated again. The observer performance was evaluated by using receiver operating characteristic (ROC) analysis. The area under each ROC curve (AUC) was used to compare in detecting fractures with and without the DCNN output.

**Results**

The AUCs of the 7 readers were 0.920, 0.886, 0.842, 0.839, 0.827, 0.810, and 0.698, respectively. The average AUC of the 7 observers was 0.832. The AUC of DCNN alone was 0.905. The AUCs of the 7 readers with DCNN outputs were 0.934, 0.928, 0.896, 0.866, 0.862, 0.841, and 0.800 respectively. The average AUC of the 7 readers with DCNN outputs was 0.876. The AUC of both experienced and less-experienced readers with DCNN output were higher than those without, respectively (p<0.05). The AUC of the 2 experienced readers with DCNN output exceeded the AUC of DCNN alone.

**Conclusion**

For detecting the hip fractures on radiographs, DCNN developed using CT or MRI as a gold standard by radiologists improved the diagnostic performance including the experienced readers.

**Clinical Relevance/Application**

For detecting the hip fractures on Xp, DCNN developed using the higher-level reference standards increased the efficiency of diagnosis. This methodology provides more accurate data labeling.
Ischiofemoral impingement (IFI) is associated with abnormalities of the quadratus femoris muscle and narrowing of the ischiofemoral (IF) and quadratus femoris (QF) spaces. The hip abductors play important roles in pelvic stability. We hypothesized that abductor insufficiency might be a contributing factor to the development of IFI. The purpose of our study was to assess hip abductor pathology in patients with IFI.

**METHOD AND MATERIALS**

The study was IRB approved and HIPAA compliant. The study group comprised 140 patients with IFI (mean age: 56±13 y, 130 f, 10 m) and 140 age and gender-matched controls without IFI. Two MSK radiologists performed measurements of IF and QF distances, assessed quadratus femoris muscle for edema and atrophy, and the integrity of the tensor fascia lata, gluteus medius and minimus tendons. IFI and control groups were compared with a two-tailed t-test or Fisher's exact test.

**RESULTS**

As expected, patients with IFI had decreased IF and QF distances (p<0.0001) compared to controls. All patients with IFI had abnormalities of the quadratus femoris muscle, whereas the QF muscle was normal in controls (p<0.0001). Patients with IFI had a higher prevalence of gluteal medius and minimus partial and full-thickness tears compared to controls (p=0.007). There were no tears of the tensor fascia lata in either group.

**CONCLUSION**

Abductor insufficiency might play a role in the pathophysiology of IFI in elderly patients. This emphasizes the need of abductor strengthening or repair in the treatment of IFI.

**CLINICAL RELEVANCE/APPLICATION**

Physical therapy focusing on abductor strengthening might become a first line non-invasive therapeutic approach to treat ischiofemoral impingement.

Greater trochanteric pain syndrome (GTPS) is a common cause of lateral hip pain. Repetitive friction between the greater trochanter (GT) and iliotibial band (ITB) is a proposed cause and thought to be related to altered ITB kinematics and gait patterns. The purpose of this study is to assess if the angle of the ITB as it passes from its iliac origin over the GT to its tibial insertion is associated with GTPS.

**METHOD AND MATERIALS**

Consecutive subjects with a clinical diagnosis of GTPS and MRI features consistent with GTPS (GT bursitis, gluteal tendinosis) were included. The angle subtended from the iliac origin of the ITB to the lateral femoral shaft with apex at the GT was recorded (iliac-trochanteric-shaft angle, ITS). The grade of GTB and gluteus minimus and medius tendinosis as well as the femoral neck-shaft angle (FNS), center edge angle (CEA) and patient demographics were recorded. Consecutive age and gender matched controls with hip MRI performed for indications other than GTPS and with an absence of radiological features of GTPS were identified and the ITS angle, FNS angle and CEA were recorded. Student's t-test was utilised to evaluate for differences between subjects and controls.

**RESULTS**

106 subject and 106 control exams were included (64% female, 36% male). Mean ages were similar (56.9 vs 55.3 yrs respectively, p 0.69). The mean and median ITS angles were 158.2/158° and 166.9/165° respectively (p 0.0001) with the difference significant for both males and females. No difference was observed in FNS angle (131.6 vs 131.8°, p 0.83) and CEA (34.7 vs 33.6°, p 0.21). In the subject cohort GTB was present in 84% (mild 58%, moderate 20%, severe 6%). Gluteus minimus tendinosis was present in 90% (mild 54%, moderate 32%, severe 4%) and gluteus medius tendinosis was present in 80% (mild 52%, moderate 24%, severe 4%) with an association between decreasing ITS angle and increasing grade of GTB and gluteal tendinosis.

**CONCLUSION**

Increasing acuity of the angle of the ITB from its origin as it crosses the GT represented by the ITS angle is associated with clinical and radiological GTPS likely as a result of altered kinematics and increased friction with the peritrochanteric structures associated with GTPS.
METHOD AND MATERIALS

Consecutive patients under 50 years old with clinical hip impingement and available MRI and/or CT of hip were included. Age matched controls with an absence of clinical hip impingement and labral tear on imaging were selected. Studies were reviewed by two MSK radiologists in consensus for AIIS and SS morphology as well as radiological features of hip impingement including rectus femoris origin pathology, periacetabular edema, femoroacetabular impingement (FAI) and acetabular labral tear. Exclusion criteria included fracture, osteoarthritis and active core injury.

RESULTS

60 subject and 40 control exams were included (62.5% male, 37.5% female). All patients had an MRI, 20% of patients also had a CT for review. Abnormal morphology of the AIIS (case vs controls: 55% vs 29.5%, p=0.04) and SS (55% vs 29.5%, p=0.05) was associated with EA-HI and labral tears. 42% had combined AIIS and SS impingement. AIIS or SS impingement coexisted with FAI in 32.5% of cases vs 12.5% of controls (p=0.02). There was a strong correlation between MRI and CT morphology classification (r=0.7).

CONCLUSION

AIIS and SS impingement are separate entities in close anatomic proximity which frequently coexist as causes of EA-HI. Distinct classification systems as well as a high index of suspicion and knowledge of normal AIIS and SS anatomy, variant morphology and pathology are crucial to accurately diagnose and treat EA-HI.

CLINICAL RELEVANCE/APPLICATION

AIIS and SS impingement are distinct causes of EA-HI. The approach to surgical management is different and a knowledge of normal and variant morphology is crucial to accurately guide intervention.
RESULTS
In SCFE hips the more proximal methods according to Lee et al. (mean femoral version, -19°±16°), Reikeras et al. (-15° ± 14°) yielded a higher prevalence of retroversion with 91%, 84% versus 47%, 60% compared to the more distal methods of Tomczak et al. (0°±13°) and Murphy et al. (-4°±16°), (all p <0.001). By contrast prevalence of retroversion was lower in the unaffected hips for the respective measurement methods (all p <0.001): Lee et al. 42% (2°±12°), Reikeras et al. 32% (5°±11°), Tomczak et al. 5% (18°±11°), Murphy et al. 4% (19°±13°).

CONCLUSION
Prevalence of femoral retroversion is high in SCFE and depends on the measurement method. Thus, to avoid errors in treatment planning a consistent measurement method including respective reference intervals should be used.

CLINICAL RELEVANCE/APPLICATION
Routine measurement of femoral version in SCFE could help surgeons to identify hips in which an additional femoral osteotomy is needed to correct a retroverted femur or whether cam correction alone is sufficient.

SSA15-06 MRI Assessment of Subspine Impingement: Features Beyond Anterior Inferior Iliac Spine Morphology

Sunday, Dec. 1 11:35AM - 11:45AM Room: E451A

Participants
Mohammad M. Samim, MD, MRCS, Yonkers, NY (Presenter) Nothing to Disclose
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Thomas Youm, New York, NY (Abstract Co-Author) Nothing to Disclose

PURPOSE
To assess the MRI features associated with subspine impingement (SSI) including the osseous morphology of the anterior inferior iliac spine (AIIS) and femoral cam and associated soft tissue injuries.

METHOD AND MATERIALS
We performed a retrospective study of symptomatic patients who underwent arthroscopic treatment for femoroacetabular impingement (FAI) between December 2014 and March 2017. A subset of patients who had clinical and intraoperative findings of SSI were selected as the SSI group and the rest made the FAI group. Patients included had preoperative MRI within 6 months from surgery. Preoperative MRI was assessed by two radiologists independently and blinded to clinical information for AIIS morphology, presence of distal cam (we defined it as bump more distal to the head neck junction), signs of impingement on the distal femoral neck including sclerosis, edema, or cystic changes of the femoral neck and femoral neck synovial edema, edema of the superior capsule and rectus femoris tendon (RFT) at the AIIS level, and presence and location of chondrolabral lesions. The inter-reader agreement was also assessed.

RESULTS
Total of 62 patients with FAI met the inclusion criteria. 20 patients out of 62 (32%) were also diagnosed with SSI. The mean time difference between the MRI and arthroscopy was 4.1 ± 1.8 months. Distal cam was present in 80% of patients with SSI and in 19% of patients with FAI (p<0.001). We found no significant difference in AIIS morphology variants between the two groups. There was statistically significant difference in presence of signs of impingement on the distal femoral neck (77% vs 18%) between SSI and FAI groups respectively (p<0.001). Superior capsular edema was present in 80% in SSI and 29% in FAI group (p<0.05). No significant difference was between two groups regarding RFT edema and presence or location of chondrolabral lesions. There was substantial agreement between readers for detecting distal cam (kappa=0.80) and anterior chondral lesions (kappa=0.62), and moderate agreement for signs of distal femoral neck impingement, anterior labral and superior chondral lesions.

CONCLUSION
Our study showed that in addition to osseous morphology, there are associated soft tissue injuries which can be utilized to improve the accuracy of SSI diagnosis.

CLINICAL RELEVANCE/APPLICATION
Several osseous and soft tissue pathologies can be used to enhance the accuracy of detecting SSI in patient with FAI.

SSA15-07 Ultra-low Dose CT of the Pelvis: Applying Tin Prefiltration to Achieve a Radiation Dose Equivalent or Lower Than Radiographs

Sunday, Dec. 1 11:45AM - 11:55AM Room: E451A

Participants
Christoph Stern, MD, Zurich, Switzerland (Presenter) Nothing to Disclose
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PURPOSE
The aim of this study was to develop an ultra-low dose pelvic CT protocol using tin prefiltration for spectral shaping of the x-ray beam to achieve a dose equivalent or lower than radiographs and to provide a virtual diagnostic radiograph.
METHOD AND MATERIALS

Three pelvic cadavers received standard pelvic radiographs and were repeatedly scanned on a 128-detector row CT scanner with identical pitch, slice thickness and iterative reconstruction strength: 1) conventional dose and reduced dose scan with tin prefiltration, both with automated tube voltage and current modulation; 2) successive tin prefiltered ultra-low dose scans with two dose equivalent protocols up to a maximum dose of a standard radiograph of the pelvis (0.44mSv) using a fixed tube voltage (Sn100kV and Sn140kV) and a fixed tube current (138-277mAs and 25-50mAs). Radiation dose was compared and virtual radiographs of CT data were computed using a customized cone-beam algorithm in Matlab (MathWorks). CT image quality was assessed quantitatively by signal- and contrast-to-noise ratio (SNR,CNR) and figure of merit (FOM) for CNR dose efficiency. On a 5-point scale CT images and virtual radiographs were rated qualitatively by two readers.

RESULTS

For each of the three cadavers no substantial difference was observed for SNR, CNR and FOM between ultra-low dose protocols. The ultra-low dose protocol with Sn140kV/50mAs that performed best in all 3 cadavers was chosen by consensus reading: overall image quality was rated good (mean 4.3 and 4.3, for reader 1 and 2 respectively), image noise weak to minimal (mean 4.0 and 4.7) and artifacts almost none (mean 4.7 and 4.7). Mean effective dose (0.36mSv) was substantially lower compared to conventional dose (mean 3.08mSv; -88% reduction) and reduced dose (1.88mSv; -81%) scans. Overall subjective image quality of the three virtual radiographs was rated excellent (mean 4.7 and 4.7).

CONCLUSION

We showed the feasibility of ultra-low dose pelvic CT scans of cadavers with tin prefiltration with a dose less than a conventional radiograph. The reconstructed virtual radiographs exhibited excellent image quality.

CLINICAL RELEVANCE/APPLICATION

Standard radiographs of the pelvis can be replaced by an ultra-low dose pelvic CT scan providing both cross-sectional information and a virtual radiograph with a dose below standard radiographs.

SSA15-08 Evaluation of Athletic Pubalgia in the Setting of Femoroacetabular Impingement

Sunday, Dec. 1 11:55AM - 12:05PM Room: E451A

Awards
Trainee Research Prize - Resident

Participants
Sowmya L. Varada, MD, New York, NY (Presenter) Nothing to Disclose
Matthew P. Moy, MD, New York, NY (Abstract Co-Author) Nothing to Disclose
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PURPOSE

To evaluate the incidence of athletic pubalgia in patients with femoroacetabular impingement (FAI) on MRI.

METHOD AND MATERIALS

An IRB approved retrospective search identified 134 patients (total 163 hips) with clinical or imaging diagnosis of femoroacetabular impingement (FAI) who had a hip MRI between January 2015 and July 2018. Patients who had prior hip surgery were excluded. Two fellowship trained musculoskeletal radiologists blindly reviewed all studies in consensus and evaluated for the presence of: acute/chronic osteitis pubis, adductor/abdominis rectus tendinosis and tear, and aponeurotic plate tear. Demographic data (age, sex, sports participation, and treatment) was obtained from the electronic medical record. Imaging data (femoral version, acetabular version, alpha angle, and lateral center edge angle) were obtained from reports or measured by a third blinded fellowship trained musculoskeletal radiologist. Statistics included t-test, chi-square test, and one-way ANOVA with significance set to p < 0.05.

RESULTS

Incidence of pubalgia findings: Aponeurotic tear (14%), adductor tendonosis (71%), adductor tendon tear (10%), abdominis rectus tendinosis (1%), abdominis rectus tendon tear (<1%), acute osteitis pubis (14%), chronic osteitis pubis (42%). Incidence of treated pubalgia findings: Aponeurotic tear 30% (7/23), adductor tendonosis 14% (16/115), adductor tear 71% (12/17), acute osteitis pubis 26% (5/19), and chronic osteitis pubis 7% (4/56). Demographic/imaging data compared with pubalgia findings: Male vs. Female: adductor tendon tears 14% (16/115) vs. 2% (1/48) (p = 0.024) and acute osteitis pubis 19% (17/90) vs. 5% (2/42) (p = 0.025). Sports participation vs. No history of sports: adductor tendon tears 20% (12/61) vs. 5% (5/102) (p = 0.003) and chronic osteitis pubis 56% (28/50) vs. 33% (28/84) (p = 0.010). Alpha angle > 60° vs. Alpha angle < 60°: Chronic osteitis pubis 50% (44/88) vs. 26% (12/46) (p = 0.008). All other differences in demographic and imaging data were not significant when assessed against the pubalgia findings.

CONCLUSION

There is a high incidence of athletic pubalgia in FAI patients with certain findings found more commonly in males, in those with prior sports participation, and in the presence of a cam lesion.

CLINICAL RELEVANCE/APPLICATION

Identification of co-existent pubalgia findings with FAI may alter patient management. Our results add to the growing theory that there is pathophysiologic interplay between the two processes.

SSA15-09 Musculoskeletal Keynote Speaker: Therapeutic Arthrogram of the Hip for Adhesive Capsulitis - An Innovative Treatment Procedure that Reduces Capsular Stiffness and Increases Muscle Activation
Participants
Anthony T. Mascia, MD, Toronto, ON (Presenter) Nothing to Disclose

Printed on: 01/19/20
PURPOSE

Osteoporosis is described as one of the radiographic signs of osteonecrosis of the femoral head (ONFH) in the early stage before femoral head collapse. However, no studies have demonstrated the decreased bone mineral density (BMD) of the necrotic area in pre-collapse ONFH probably because dual-energy X-ray absorptiometry (DXA) is inappropriate for the examination of the femoral head. The purpose of this study was to verify the utility of CT Hounsfield unit (HU) values for BMD of the femoral head, and to test the assumption of decreased HU values of the necrotic area in pre-collapse ONFH.

METHOD AND MATERIALS

A proximal one-third area of the coronal section through the anterior part of the femoral head was set as a region of interest (ROI) for the measurement of HU values. In each femoral head, average HU values of three ROIs on the serial CT slices was defined as the HU values of the femoral head. Firstly, the HU values of normal femoral heads in 101 control subjects were assessed for identifying relevant confounding factors. Next, in 25 of 101 control subjects who had undergone DXA around the same time, the correlation strength between BMD of the femoral neck on DXA and the HU values of the femoral head was verified. Finally, the HU values of femoral heads in pre-collapse ONFH subjects were compared with those in propensity-matched control subjects.

RESULTS

Based on the multivariate analysis, both age and BMI were identified as relevant confounding factors for the HU values of the femoral head. Age was negatively correlated with the HU values (p < 0.01), and BMI was positively correlated with the HU values (p < 0.01). As a result of correlated analysis, a strong correlation was found between BMD of the femoral neck on DXA and the HU values of the femoral head was verified. Finally, the HU values of femoral heads in pre-collapse ONFH subjects were compared with those in propensity-matched control subjects.

CONCLUSION

The HU values may be useful for the examination of BMD of the femoral head. The current propensity-matched study demonstrated no significant difference in the HU values between the necrotic area of asymptomatic pre-collapse ONFH and normal femoral head.

CLINICAL RELEVANCE/APPLICATION

The current study supports the opinion that bone resorption inhibitors including bisphosphonate is ineffective for preventing femoral head collapse of ONFH.
Rotator cuff tears (RCT) lead to muscle degeneration and atrophy which impacts clinical outcomes negatively. MRI studies have evaluated the 3D volume of the rotator cuff muscles. We sought to characterize supraspinatus muscle 3D shape alterations in patients with full-thickness RCT.

**METHOD AND MATERIALS**

Retrospective study in 47 patients with RCT (mean age, 57 years; range, 39-67 years) and 30 asymptomatic volunteers (mean age, 56 years; range, 35-64 years). RCT severity was graded according to the Patte classification. The entire supraspinatus muscle length was segmented on large field-of-view coronal oblique T1-weighted MR images by two independent readers using ITK-SNAP tool. Volume, length, surface area and surface-to-volume ratio (S/V) were computed in Matlab from the reconstructed 3D solid representation of the supraspinatus muscle. 3D shape statistical analysis was performed using SPHARM-PDM tool to precisely locate morphological changes between RCT and healthy supraspinatus muscles. ANOVA and a non-parametric permutation testing scheme with covariates (sex, height, weight) and correction for multiple comparisons, were applied to test for significant differences (p < 0.05) between patients, volunteers, and RCT severity subgroups as appropriate.

**RESULTS**

Interobserver reliability for the muscle semi-automated segmentation technique was excellent (ICC = 0.916). Supraspinatus mean volume and surface area were smaller in patients compared to volunteers, whereas mean S/V was greater (all, p < 0.001) and no difference in mean length was observed (p = 0.318). Similarly, as tendon tear size increased, supraspinatus mean volume and mean surface area decreased, and mean S/V increased significantly. However, there was no statistically significant difference in mean supraspinatus muscle length between volunteers and all RCT severity subgroups (p>0.05). Supraspinatus muscle group-wise shape analysis showed predominant muscle loss in the inferior myotendinous region and predominant muscle enlargement at the supero-medial, antero-lateral and postero-lateral regions of the muscle in patients compared to volunteers.

**CONCLUSION**

RCT lead to supraspinatus muscle size reduction and non-uniform 3D shape alterations with predominant muscle loss occurring at the myotendinous junction and asymmetrical enlargement of the muscle belly, whereas muscle length remains unchanged.

**CLINICAL RELEVANCE/APPLICATION**

3D shape analysis of the entire supraspinatus muscle length could provide a more precise evaluation of the muscular condition in RCT patients than current 2D assessment techniques, and contribute to improving care management in these patients.

**PURPOSE**

Low back pain (LBP) is one of the most common complaints in the US with imaging playing an important diagnostic role. We aim to describe the variability of both physician and patient factors that associate with guideline concordance for LBP image ordering.

**METHOD AND MATERIALS**

We performed retrospective review of 10,126 patients with LBP using the electronic clinical quality measure (eCQM 166v6) specification of the Center for Medicare and Medicaid’s Merit-Based Incentive Payment System from January 1 to December 31, 2017 at one large medical center. We selected the 5 most guideline concordant (GC) and 5 most guideline discordant (GD) outpatient sites of care, leaving a total of 3,306 patients. Sites with fewer than 100 patients were excluded. We evaluated differences in ordering physician medical specialty, patient demographics including age, race and gender, and healthcare insurance status.

**RESULTS**

Of the 3,306 (33%) records of 2017 LBP patient volume, GC sites had 776 (23%) patients and a concordance rate of 96%. GD sites had 2,530 (77%) patients and a concordance rate of 43%. GC sites were largely composed of internal medicine (65%) and physical medicine and rehabilitation physicians (29%). GD sites were predominately orthopedic surgery (71%) and rheumatology physicians (15%). Compared to GD sites, GC sites had more patients that were 40 years or older (51% vs 39%), male (50% vs. 42%), Black (29% vs. 9%) and publically insured (20% vs. 12%), and fewer that were White (45% vs. 63%) and Asian (7% vs. 14%).

**CONCLUSION**

Our results demonstrated that there are differences in guideline concordant and guideline discordant physician practices with regards to ordering physician medical specialty, patient age, patient gender, patient race, and patient insurance status.

**CLINICAL RELEVANCE/APPLICATION**

The differences identified can be used to direct efforts to improve the guideline concordance in LBP imaging. As LBP is common, these efforts have considerable potential to increase value-based care.
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PURPOSE

Compare MRI to an US scanning and reporting protocol for the detection of recurrent soft tissue sarcomas. Propose a risk profile system with recommendations for subsequent action and validate it using pathological and follow-up MRI data.

METHOD AND MATERIALS

Consecutive patients with previously resected soft tissue sarcomas of the extremities and trunk presenting for MRI surveillance were invited to participate. Blinded to clinical information, one radiologist scanned the surgical site. If a mass was detected, qualitative and quantitative data were recorded and used to create an US risk profile score. A second radiologist, blinded to US findings, independently determined if tumor was present on the same day MRI. Recurrent tumor was defined by positive histology. Negative was defined as either negative histology or no evidence of tumor at the next surveillance MRI.

RESULTS

Currently, follow-up information was available for 40% of cases. US and MRI had a sensitivity, specificity, PPV, NPV and accuracy of 0.88, 1.0, 1.0, 0.94 and 0.96 and 1.0, 0.87, 0.80, 1.0 and 0.91, respectively. There was excellent agreement between US and follow-up (ICC 0.91 p < 0.001) and good agreement between MRI and follow-up (ICC 0.83, p < 0.001). There was good agreement between US and MRI (ICC 0.75 p < 0.001). There was a strong positive correlation between the US total score and sonographically detected mass being malignant (r = 0.72, p = 0.02) and between the score and follow-up (r = 0.87, p < 0.001). A total score of 5.5 appears to be an optimal cut point. Internal flow, when present, was indicative of tumor. The only US false negative was a DFSP just below the skin.

CONCLUSION

In this ongoing pilot study, at this point, US was at least as accurate as MRI in the detection of recurrent soft tissue sarcomas. US performance would likely be improved further if the scanner was aware of tumor histology. While US performed well for high grade sarcomas, detection of ALT/WDL and DFSP can be challenging.

CLINICAL RELEVANCE/APPLICATION

US may perform similar to MRI in the detection of recurrent soft tissue sarcomas. As this patient population may require long term imaging, this finding would address the need to reduce cost and gadolinium exposure.


Station #5

Participants

Islam I. Fayed, MD,DO, Mount Sinai , NY (Presenter) Nothing to Disclose
Mathew S. Hensley, RT,MD, Port Jefferson, NY (Abstract Co-Author) Nothing to Disclose
Daichi Hayashi, MD,PhD, Stony Brook, NY (Abstract Co-Author) Nothing to Disclose

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TEACHING POINTS

To describe Thoracic outlet syndrome and its types as well as the role of dynamic imaging in diagnosing TOS To illustrate and discuss imaging finding is different types of TOS

TABLE OF CONTENTS/OUTLINE

1. Summary of the anatomy, pathophysiology, types and clinical features and the role of dynamic imaging in diagnosing TOS
2. Detailed imaging protocol, including patient positioning and preparation
3. Pictorial review of the TOS utilizing dynamic/stress MRI and MRA Types: (Vascular and Neurogenic) Vascular (arterial and/or venous) Compression by bone and soft tissue abnormalities; Axillary/subclavian vein thrombosis with collaterals development; Axillary/subclavian artery aneurysm or pseudoaneurysm; Arterial thrombus with distal emboli and enlarged collaterals; Fixed axillary/subclavian vessels stenosis at the site of dynamic narrowing; Axillary/subclavian vessels narrowing with abduction Neurogenic Compression by bone and soft tissue abnormalities; Loss of fat about brachial plexus with abduction; Edema in brachial plexus
4. Discuss alternative imaging modalities such as CT, ultrasound, and radiograph
5. Conclusion: Dynamic MRI/MRA may be helpful in informing the clinician as to the anatomic structures undergoing compression, the location of that compression, and the anatomic structures responsible for it

MK291-ED- SUA6 Postsurgical Imaging of the ACL: Everything You Always Wanted to Know But Were Afraid to Ask

Station #6

Participants

Ericka M. Leon, MD, Mexico City, Mexico (Presenter) Nothing to Disclose
Araceli S. Cabanillas, MD, Mexico, Mexico (Abstract Co-Author) Nothing to Disclose
Ricardo Salazar, MD, Mexico City , Mexico (Abstract Co-Author) Nothing to Disclose
TEACHING POINTS

Describe basic anatomy of the anterior cruciate ligament (ACL). Discuss reconstruction techniques and normal postoperative appearance/criteria. Review the functional classification of ACL postsurgical complications: decrease in the range of motion vs laxity. Recognize the role of the radiologist in the postsurgical follow-up.

TABLE OF CONTENTS/OUTLINE

A comprehensive review of the ACL reconstruction procedures:
- Autologous and grafts MRI appearances
- Femoral and tibial tunnel anatomy
A case-based review of main complications:
- Impingement, arthrofibrosis, intraarticular bodies, ganglion cysts
- Graft tearing, graft stretching

MK292-ED-SUA7  Metabolic and Endocrine Bone Disorders and Conditions: A Current, Comprehensive Review

Participants
Sirisha Koneru, DO, Mineola, NY (Presenter) Nothing to Disclose
Jawad Hussain, Mineola, NY (Abstract Co-Author) Nothing to Disclose
Jonathan A. Flug, MD, MBA, Phoenix, AZ (Abstract Co-Author) Nothing to Disclose
Douglas S. Katz, MD, Mineola, NY (Abstract Co-Author) Nothing to Disclose

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TEACHING POINTS

To discuss and refresh the concepts of various metabolic and endocrine disorders which can affect bone, to help radiologists identify and diagnose these conditions appropriately. To review the multi-modality imaging features of these disorders and conditions.

TABLE OF CONTENTS/OUTLINE

Pathophysiology of Vit D, Ca, Phosphorous, PTH, other metabolic diseases that affect bone, collagen, and cartilage, osteoporosis and types, transient osteoporosis of the hip, migratory osteoarthritis, rickets/osteomalacia, renal osteodystrophy, hyperparathyroidism, x-linked hypophosphatemic rickets, DEXA Screening, BMD and FRAX tool Biomarkers and proteomic analysis for OA. Review of current role of high-spatial resolution peripheral quantitative CT (HR-pQCT). Radiographic features of ossification disorders including heterotopic ossification, DISH, hypertrophic osteoarthropathy, and spondyloarthropathies. Stages of Paget's with radiographic correlation, review complications. Endocrine diseases affecting the bone-pituitary disorders, growth hormone abnormalities, and thyroid hormone disorders. Other diseases affecting the bone-Gaucher's, osteopikilosis, myelofibrosis, sickle cell anemia, heavy metal poisoning, chronic inflammatory and malabsorption disorders. Radiographic, CT, MRI & NM imaging features of diseases, with selective pathology correlation. Recent advances in diagnosis and management.

MK293-ED-SUA8  An Educational Approach to Dynamic Contrast-Enhanced MRI Techniques for Arthritis Assessment

Participants
Teodoro M. Noguerol, MD, Jaen, Spain (Presenter) Nothing to Disclose
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Marta Gomez Cabrera, MD, Cadiz, Spain (Abstract Co-Author) Nothing to Disclose
Rafael Barajasse, MD, Capital Federal, Argentina (Abstract Co-Author) Nothing to Disclose
Antonio Luna, MD, PhD, Jaen, Spain (Abstract Co-Author) Speaker, Canon Medical Systems Corporation; Speaker, Koninklijke Philips NV; Speaker, Siemens AG

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TEACHING POINTS

1. Review the physical basis and technical adjustments for DCE-MRI and T1 permeability sequences acquisition for joints assessment. 2. Explain, from an educational point of view, the biological meaning of parameters derived from DCE-MRI and T1 permeability acquisitions. 3. Show potential applications of DCE-MRI and T1 permeability sequences for arthritis evaluation in different clinical scenarios.

TABLE OF CONTENTS/OUTLINE

**Ultrasound Features of Sport-related Muscle Injuries of the Lower Limb**

**Station #9**

**Participants**
- Catherine Phan, MD, Paris, France (Presenter) Nothing to Disclose
- Anne Miquel, MD, Paris, France (Abstract Co-Author) Nothing to Disclose
- Michel D. Crema, MD, Brasilia, Brazil (Abstract Co-Author) Shareholder, Boston Imaging Core Lab, LLC
- Clement Cholet, MD, Paris, France (Abstract Co-Author) Nothing to Disclose
- Raissa Lotte, MD, Paris, France (Abstract Co-Author) Nothing to Disclose
- Caroline Cuau-Pailier, Paris, France (Abstract Co-Author) Nothing to Disclose
- Lionel Arrive, MD, Paris, France (Abstract Co-Author) Nothing to Disclose

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**TEACHING POINTS**

1. To understand how different types of muscle injuries relate to biomechanics, pathophysiology, and anatomy of the muscle
2. To describe the ultrasound findings using comprehensive grading system for intrinsic and extrinsic muscular lesions
3. To define sonographic features of chronic lesions after muscle trauma including fibrous scars, muscle hernias, and calcification
4. To emphasize what should not be missed for patient’s outcome

**TABLE OF CONTENTS/OUTLINE**

1. Echo-anatomy of lower limb muscles
2. Normal echotexture of the muscle, and the myoaponevrotic and myotendinous junctions
3. Durey and Rodineau grading system with corresponding sonographic cases
4. Sonographic cases of the most common pathologic findings for muscle injuries for the following muscle: rectus femoris, vastus lateralis, vastus medialis, vastus intermedius, adductor, hamstring lesion, tennis leg lesion, DOMS

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**Through Thick and Thin: Periosteal Reactions and Their Underlying Etiology**

**Station #10**

**Participants**
- Jonathan Barclay, MD, Los Angeles, CA (Presenter) Nothing to Disclose
- Leanne L. Seeger, MD, Los Angeles, CA (Abstract Co-Author) Nothing to Disclose
- Benjamin D. Levine, MD, Santa Monica, CA (Abstract Co-Author) Nothing to Disclose
- Kambiz Motamedi, MD, Los Angeles, CA (Abstract Co-Author) Nothing to Disclose

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**TEACHING POINTS**

1. General overview and pathophysiology of periosteal reactions
2. Differential Diagnosis for periosteal reaction
3. Review the types and various appearances of periosteal reaction
4. Determining benign vs. aggressive periosteal reaction (slow vs. fast)
5. Characteristics of periosteal reactions in specific diseases
6. Identifying complex (mixed) periosteal reaction

**TABLE OF CONTENTS/OUTLINE**

1. Overview of periosteal reaction
2. Differential diagnosis of periosteal reactions
3. Aggressive vs nonaggressive periosteal reactions
4. Examples of aggressive periosteal reactions
5. Examples of benign periosteal reactions

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**Osteochondral Lesions of the Talar Dome: An Up-To-Date Approach on Multimodality Imaging and Surgical Techniques**

**Station #11**

**Awards**
- Certificate of Merit

**Participants**
- Isabela A. da Cruz, MD, Sao Paulo, Brazil (Presenter) Nothing to Disclose
- Julio B. Guimaraes, MD, Sorocaba, Brazil (Abstract Co-Author) Nothing to Disclose
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- Bruno C. Carneiro, Sao Paulo, Brazil (Abstract Co-Author) Nothing to Disclose
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**TEACHING POINTS**

*The talus is a unique bone, with no tendon attachment and a distinct morphology and vascularization, supporting several times the weight of the body in a relatively small articular surface.*

*Talar dome is prone to osteochondral lesions (OCL) secondary to varianmorphologicalmechanisms, being the rotational trauma the most frequent causative factor, usually related to inversion stress of the foot.*

*We aim to review multimodality imaging approach: CR, CT, arthroCT, MRI, arthroMRI and quantitative MRI sequences.*

*The imaging findings must be well documented in order to allow therapeutical decision, and should include lesion size and depth,*
location, cartilage status, subchondral bone outline and edema, cystic and degenerative changes, as well as alignment and associated injuries.* New insights on arthroscopic surgery: what radiologists need to know.* Post-therapeutic imaging evaluation of OCL: what orthopedic surgeons want to know.

**TABLE OF CONTENTS/OUTLINE**

*Anatomy and vascularity*
*Mechanisms of injury and natural history of osteochondral lesions*
*Multimodality imaging approach and classification of distal tibial and talus OCL*
*MRI and arthroscopic correlation*
*Adapted algorithm from the International Consensus Meeting on Cartilage Repair of the Ankle - AOFAS 2017*
*Therapeutic options including orthobiologics*
*Post-treatment imaging evaluation*

Printed on: 01/19/20
**MKS-SUB**

**Musculoskeletal Sunday Poster Discussions**

Sunday, Dec. 1 1:00PM - 1:30PM Room: MK Community, Learning Center

**MK**

**AMA PRA Category 1 Credit ™: .50**

**FDA**

Discussions may include off-label uses.

**Participants**
Reto Sutter, MD, Zurich, Switzerland (Moderator) Nothing to Disclose

**Sub-Events**

**MK352-SD-SUB1**

**An Updated Classification of A Normal Manubriosternal Junction: A Human Cadaveric Study Correlating Magnetic Resonance Imaging and Computed Tomography**

Station #1

Participants
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**PURPOSE**

Until now, a normal manubriosternal junction (MSJ) was classified based on plain radiographs. To our best knowledge, there has been no studies correlating magnetic resonance (MR) imaging and computed tomography (CT) for the MSJ. Therefore, the aim of this study was to correlate the MR, CT, and the histologic features of the MSJ in non-arthritic cadavers and update the classification of a normal MSJ.

**METHOD AND MATERIALS**

Eleven human cadaveric MSJ specimens were used and scanned with MR imaging and CT at the same day. At first, two board-certified musculoskeletal radiologists and one board-certified pathologist evaluated whether 11 cadaveric MSJ specimens had normal MSJ or not using MR imaging, CT, and histology. And then, the two radiologists and one pathologist correlated the findings of MR imaging, CT, and histologic features with regard to the distribution of the cartilage (fibro-cartilage and hyaline cartilage), presence of the erosion-like change, cartilage fusion, and bony ankylosis. Also, the classification of a normal MSJ was updated by consensus.

**RESULTS**

Ten MSJ specimens were proved as normal MSJs and one was proved as an abnormal MSJ (metastasis). Among ten normal MSJs, five showed neither erosion-like changes nor ankylosis (type 1), three showed erosion-like changes without ankylosis (type 2), and two showed bony ankylosis (type 3). Among type 1 MSJs, two were entirely composed of hyaline cartilage by separation (type 1a) and three entirely composed of hyaline cartilage by fusion (type 1b). Among type 2 MSJs, one was composed of hyaline cartilage by small erosion-like changes due to the cartilage invagination (type 2a) and two were composed of fibro-cartilage bar by large central erosion-like change (type 2b). Two type 3 MSJ specimens showed one partial ankylosis with peripheral hyaline cartilage (type 3a) and one total ankylosis (type 3b).

**CONCLUSION**

The six types (three categories) of normal MSJs were determined based on MR imaging and CT using normal cadaveric MSJs. Erosion-like change and bony ankylosis are not always pathologic change and also can be seen on normal MSJs.

**CLINICAL RELEVANCE/APPLICATION**

Knowledge of the updated classification of normal MSJs may be important in order to reduce misdiagnosis of the normal finding as pathologic changes such as arthritis in the MSJ, and helpful to differentiate between normal and pathologic changes in the MSJ.
PURPOSE
To assess the diagnostic value of axial computer tomography (CT) images for distal tibiofibular syndesmosis injury (DTSI).

METHOD AND MATERIALS
With institutional review board approval, a total of forty-five patients (21 females, mean age 45 years) with DTSI were prospectively enrolled. All patients underwent unenhanced CT scans and magnetic resonance (MR) examinations of ankles. CT examination was performed on a 16-slice spiral CT scanner (SOMATOM emotion, Siemens Healthcare, Forchheim, Germany), scan parameters were: tube voltage, 130 kVp; tube current time product, 80 mAs; pitch, 1.05; slice collimation, 0.7 mm. MR images were acquired using a 3.0-T MR scanner (Verio, Siemens Healthcare, Erlangen, Germany) with an extremity coil positioned around ankles. Morphological parameters on axial CT images including tibiofibular clear space (TFCS), tibiofibular overlap (TFO), the ratio of TFCS to fibular width (TFCS/FW), TFO/FW, and the widths of anterior (AB) and posterior (CD) distal tibiofibular ligaments at the corresponding tibial tubercle were measured (Fig 1 and 2). MR results served as the gold standard for the extent of injured ligaments (1 = normal syndesmosis; 2 = thickened syndesmosis; 3 = partially ruptured syndesmosis; 4 = completely ruptured syndesmosis) (Fig 3 and 4). Receiver operating characteristic (ROC) analysis was performed to assess the diagnostic value of CT morphological parameters for DTSI. Correlation between CT measurements and MR grading for DTSI was analyzed by Spearman’s rank test.

RESULTS
A total of eighty injured ankles were analyzed, results of MR were shown in Table 1. The sensitivity, specificity, positive predictive value, negative predictive value and area under the curve (AUC) of each CT parameter were summarized in Table 2. TFO and TFO/FW had the highest diagnostic value for DTSI (AUC, 0.88 Vs 0.89, P>0.05) with cut-off values of 3.55 mm and 0.18, respectively (Fig 5). Combination of TFO/FW and CD was diagnostically valuable for DTSI (AUC, 0.68) (Fig 6). TFO, TFO/FW, and combination of TFO/FW and CD were correlated with syndesmotically injured (all P < 0.05) (Table 3).

CONCLUSION
Morphological parameters of TFO and TFO/FW on axial CT images are valuable for diagnosis of DTSI.

CLINICAL RELEVANCE/APPLICATION
Morphological parameters on axial CT images are useful for diagnosis of distal tibiofibular syndesmosis injuries compared with MRI.

Feasibility of Isotropic MAVRIC-SL with Spectral Bin Modulation for Metal Artifact Reduction at 3T MRI

PURPOSE
Spectral bin modulation, depending on spectral calibration scan, can allow a surgical prosthesis-dependent spectral bin reduction. To assess the clinical feasibility of isotropic acquisition of multi-acquisition variable resonance imaging combination slice selective (MAVRIC-SL) compared with MAVRIC-SL STIR (short tau inversion recovery) at 3T MRI.

METHOD AND MATERIALS
Both 1.3 mm isotropic MAVRIC-SL PD (proton density) and MAVRIC-SL STIR images were compared in 10 patients with surgical prostheses. For isotropic imaging review, multiplanar reformatted oblique images were generated and reviewed by musculoskeletal radiologist according to the prosthesis or structure of interest. For each patient, matched coronal images on isotropic MAVRIC-SL PD and MAVRIC-SL STIR were evaluated for qualitative and quantitative analysis. Overall metal artifact, noise, blurring, visualization of prosthetic margin and surrounding soft tissue were subjectively evaluated by using five-point scale. Quantitatively, the areas of metal artifact and peri-prosthetic lesions, if any, were measured. Additionally, the areas of each peri-prosthetic lesion were measured on corresponding axial and sagittal reconstructed images of isotropic MAVRIC-SL PD. Scan time were recorded in all image pairs. For statistical analyses, Paired Sample t-test was used to test for significance.

RESULTS
Scan times of isotropic 3D imaging and one-plane imaging were not significantly different (p=0.107). With these 1.3 mm isotropic sliced imaging, overall metal artifact, blurring, and noise were reduced and visualization of prosthetic margin and surrounding soft tissue were improved on qualitative analysis. The measured area of peri-prosthetic lesion was increased approximately 33.6% (1.22 cm² vs. 1.63 cm²), compared with MAVRIC-SL STIR images. Four of those seven lesions were more clearly demonstrated in isotropic MAVRIC-SL PD images by utilizing the reconstructed axial and sagittal images.

CONCLUSION
Isotropic acquisition of MAVRIC-SL imaging is feasible for prosthesis and peri-prosthetic evaluation with spectral bin modulation. Isotropic MAVRIC-SL PD showed reduced metal artifact and enhanced lesion conspicuity due to thinner slice thickness and radiologist-defined multiplanar reconstruction images with comparable average scan time.

CLINICAL RELEVANCE/APPLICATION
Isotropic MAVRIC-SL with spectral bin modulation can be utilized as 1.3 mm isotropic acquisition with acceptable scan time.

3D Morphometric Characterization of Femoral Cam Lesion Extent

PURPOSE
To study the 3D morphometric characterization of femoral cam lesion extent.

METHOD AND MATERIALS
A total of ninety-five patients (50 females) with femoral cam lesion were included. CT examination was performed on a 16-slice spiral CT scanner (SOMATOM emotion, Siemens Healthcare, Forchheim, Germany), scan parameters were: tube voltage, 130 kVp; tube current time product, 80 mAs; pitch, 1.05; slice collimation, 0.7 mm. CT images were acquired in axial, coronal, sagittal, and oblique planes. The measured parameters were: cam lesion length, cam lesion anterior-posterior width, cam lesion anteroposterior tilt angle, and cam lesion abaxial tilt angle. The measured areas of cam lesion were compared with normal contralateral side. The measured areas of cam lesion were correlated to the patient’s age. For statistical analysis, Paired Sample t-test was used for significant differences.

RESULTS
The mean cam lesion length was 2.8 ± 1.3 cm, the mean cam lesion anterior-posterior width was 1.5 ± 0.7 cm, the mean cam lesion anteroposterior tilt angle was 35 ± 10 degrees, and the mean cam lesion abaxial tilt angle was 25 ± 10 degrees. The measured areas of cam lesion were significantly different from normal contralateral side (p<0.05). The measured areas of cam lesion were positively correlated to patient’s age (p<0.05).

CONCLUSION
The 3D morphometric characterization of femoral cam lesion extent was feasible and showed significant differences from normal contralateral side. The measured areas of cam lesion were positively correlated to patient’s age. Further studies are needed to determine the clinical significance of these findings.

CLINICAL RELEVANCE/APPLICATION
The 3D morphometric characterization of femoral cam lesion extent can provide valuable information for surgical planning and treatment decision-making.
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PURPOSE
To quantify the radial and distal extent of femoral cam lesions in symptomatic femoroacetabular impingement (FAI) patients.

METHOD AND MATERIALS
An IRB approved retrospective search for preoperative hip CTs of FAI patients that underwent arthroscopic surgery from 7/1/2017-3/1/2019 yielded 81 hips (mean age 27 ± 9.4 years, M:F 51:30) after exclusion criteria (prior surgery before CT, n=12) were applied. Femur radial reconstructions were made in 1-hour increments over 360°. At each hour, the alpha angle (a) (abnormal defined as > 55°) and the distal extent of the cam (length from osseous extension outside the best fit circle to point of restoration of femoral neck concavity) were measured. Patient demographics and arthroscopic findings were obtained from the EMR. T-test, chi square, and logistic regression were performed with significance set to p < 0.05.

RESULTS
Cam lesions were classified based on radial extent of abnormal a: Type 1 (12:00-3:00) (47/81, 58%) and Type 2 (extension beyond 12:00-3:00) (34/81, 42%). Distal extent for Type 1 vs. Type 2: Mean distal extent (1.25 cm ± 0.45 vs. 1.59 cm ± 0.39) (p = 0.001). Percentage of cases with distal cam extension and normal a at a clock position (19% vs. 0%) (p = 0.029); the mean a was 48 ± 4.9 with a mean 1.9 hours of underestimated radial extent. Demographic and intraoperative findings for Type 1 vs. Type 2: Male sex (47% vs. 85%) (p < 0.001), BMI > 25 (25% vs. 62%) (p = 0.001), organized sports participation (71% vs. 43%) (p = 0.012), and cartilage damage at arthroscopy (34% vs. 67%) (p = 0.005). Differences in femoral version, acetabular version, LCEA, AIIS morphology, and labral tears at arthroscopy were not significant. Logistic regression showed likelihood of having a Type 2 lesion remains significantly increased (Odds ratio, 95% CI) with BMI > 25 (4.7, [1.6, 14.0]), male sex (4.8, [1.5, 15.8]), and organized sports (3.3, [1.1, 9.8]) when controlling for each other.

CONCLUSION
A cam lesion extending beyond 12:00-3:00 has more cartilage damage and is more likely seen in males, high BMI, and organized sports participation. Typical lesions isolated to 12:00-3:00 may often have a distal extent not captured by a criteria.

CLINICAL RELEVANCE/APPLICATION
Residual osseous deformity is the most common cause of failed FAI surgery. Improved preoperative recognition of radial and distal cam extent may allow for better localization and surgical outcomes.

Awards
Magna Cum Laude

Participants
Hanna Tomesen, MD, Darby, PA (Presenter) Nothing to Disclose
Malgorzata Goralczyk, MD, Philadelphia, PA (Abstract Co-Author) Nothing to Disclose
Oleg Teytelboym, MD, Philadelphia, PA (Abstract Co-Author) Nothing to Disclose

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TEACHING POINTS
1. To review the pathogenesis of the most common musculoskeletal complications of HIV infection and AIDS. 2. To illustrate the radiological findings of the infectious, inflammatory, and neoplastic complications affecting the musculoskeletal system in patients with HIV. 3. To describe the imaging appearance and significance of other miscellaneous musculoskeletal disorders affecting HIV/AIDS population, including those related to antiretroviral therapy.

TABLE OF CONTENTS/OUTLINE
TEACHING POINTS

After the exhibit the reader would be able to, • Identify anatomic structures of the shoulder in MRI • Learn the kinematics of throwing • Understand the anatomical adaptations of the shoulder in the throwing athlete • Review the MRI and MRI arthrogram techniques • Recognize the imaging features of the most common shoulder injuries in the throwing athlete

TABLE OF CONTENTS/OUTLINE

• Introduction • Kinematics of Throwing • Anatomical Adaptations • MRI and MRI arthrogram protocols • Pathological Conditions • Consequences of Adaptive External Rotations a. Glenohumeral internal rotation deficit (GIRD) b. Internal Impingement c. Rotator Cuff Tears d. Labral Tears (SLAP) • Anterior Shoulder Injuries a. Anterior Capsule Injury • Posterior Shoulder Injuries a. Bennett lesion • Overuse Injuries • Key Points

MK300-ED- SUB88 Traumatic Thoracolumbar Spine Injuries: How to Help the Spine Surgeon

Station #8

Participants
Silmara R. Coelho, Sao Paulo, Brazil (Abstract Co-Author) Nothing to Disclose
Julia E. Castro Anaya, MD, Sao Paulo, Brazil (Abstract Co-Author) Nothing to Disclose
Marlana D. Silva, MD, Sao Paulo, Brazil (Abstract Co-Author) Nothing to Disclose
Leonardo M. Sugawara SR, MD, Sao Paulo, Brazil (Abstract Co-Author) Nothing to Disclose
Fabiano N. Cardoso, MD, Sao Paulo, Brazil (Abstract Co-Author) Nothing to Disclose
Andre Y. Aihara, MD, Sao Paulo, Brazil (Presenter) Nothing to Disclose

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silmara.mc@gmail.com

TEACHING POINTS

• Mechanical stability is a critical factor for treatment decision making in patients with traumatic spinal injury. Stability of the spine is defined as the ability to prevent progressive deformity and the development of neurological injury, which depends on the integrity of the bone and ligament components. Injuries to one or both may result in instability of the spine requiring surgical stabilization. • Classification of vertebral fractures serves to facilitate communication and to develop optimal treatment protocols. Many classification systems were proposed, but none achieved universal adoption. The proposed systems have used several lesion characteristics as basis for classification, such as mechanism of inferred lesion, bone morphology, anatomical determinants of fracture stability and neurological status. • It is important, therefore, that radiologists are aware of the most important classifications of thoracolumbar spine lesions, since these conditions can be serious and potentially morbid and threatening, making a rapid and accurate diagnosis essential.

TABLE OF CONTENTS/OUTLINE

• Introduction: to review classifications of thoracolumbar fractures focusing in AO/TLICS (Thoracolumbar Injury Classification and Severity Scale). • Case-based review pictures and illustrating with some cases of our centre.

MK301-ED-SUB99 Make No Bones About: Quiz Based, Imaging of Vertebral Bone Tumors

Station #9

Participants
Suman T. Prabhakar, MBBS, MD, Bangalore, India (Presenter) Nothing to Disclose
Sunita P Kumaran, MD, Toronto, ON (Abstract Co-Author) Nothing to Disclose
Puneeth K. N, MD, Mumbai, India (Abstract Co-Author) Nothing to Disclose
Bharath B. Das, MD, MBBS, Bangalore, India (Abstract Co-Author) Nothing to Disclose
Prashanth Reddy, MBBS, MD, Bangalore, India (Abstract Co-Author) Nothing to Disclose
Bhavana Nagabhushana Reddy, MBBS, MD, Bengaluru, India (Abstract Co-Author) Nothing to Disclose
Jainesh V. Dodia, MBBS, MD, Bangalore, India (Abstract Co-Author) Nothing to Disclose
Sanjaya Viswantrd, MD, Bangalore, India (Abstract Co-Author) Nothing to Disclose

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sumanpt11@gmail.com

TEACHING POINTS

• To enlist the various spectrum of vertebral tumors based on multiplicity and location. • To discuss the key imaging findings of each with emphasis on associated complications and treatment response.

TABLE OF CONTENTS/OUTLINE

We review spectrum of spine tumors with discussion in a quiz based format based on benign vs malignant and common location. The presentation has 12 different bony spinal tumors with discussion in a quiz based format. • Each new case has a brief clinical history at the top of the slide. • All questions have only one correct answer among the choices provided and some others require textual responses. • The discussion of that pathological entity follows the slides with the questions. • The following spinal tumors are discussed: Benign: Hemangioma, Osteoid osteoma, Osteoblastoma, Giant cell tumor, Osteochondroma, Aneurysmal bone cyst, Eosinophilic granuloma Malignant: Metastases, Myeloma, Lymphoma, Chordoma, Chondrosarcoma Plain radiographs, CT and MR imaging are very useful in characterizing and making a diagnosis or to suggest alternative evaluation in cases when necessary. A good knowledge of their imaging features helps to arrive at a diagnosis or a set of close differentials.

MK297-ED-SUB10 MR Neurography Applied to Carpal Tunnel Release Surgery: How to Interpret and Surgical Implications

Station #10

Participants
Jonadab Dos Santos Silva, MS, Niteroi, Brazil (Abstract Co-Author) Nothing to Disclose
For information about this presentation, contact:
jonadabs@id.uff.br

TEACHING POINTS
This presentation aims to demonstrate: 1. How to define the most appropriate magnetic resonance imaging sequences for visualization of wrist structures for carpal tunnel syndrome decompressive surgery mapping 2. How to assess pathological alterations in the median nerve and surrounding structures in carpal tunnel syndrome 3. How to identify wrist anatomical structures 4. What to report when performing pre- and post-operative wrist imaging for carpal tunnel surgery or follow up

TABLE OF CONTENTS/OUTLINE
1. Magnetic resonance sequences to visualize wrist structures and their specificities a) T1 b) PSIF c) SPACE-STIR d) SPACE-DP-FS e) T2-TSE-FS 2. Interpreting an MR neurography in carpal tunnel syndrome 3. Reporting the findings for better surgical planning a) Median nerve pathological aspects b) Thenar motor branch exiting c) Surrounding anatomical structures 4. Advantages of pre-operative MR neurography in carpal tunnel syndrome surgery

Awards
Cum Laude

Participants
James V. Cortez, MD, Houston, TX (Presenter) Nothing to Disclose
Behrang Amini, MD, PhD, Houston, TX (Abstract Co-Author) Nothing to Disclose
Avneesh Chhabra, MD, Flowermound, TX (Abstract Co-Author) Consultant, ICON plc; Consultant, Treace Medical Inc; Author with royalties, Wolters Kluwer nv; Author with royalties, Jaypee Brothers Medical Publishers Ltd

For information about this presentation, contact:
JVCortez@mdanderson.org

TEACHING POINTS
Evaluating the lumbosacral plexus can be a daunting task. We aim to provide a well-rounded review of the lumbosacral plexus to help simplify the process.

TABLE OF CONTENTS/OUTLINE
At the conclusion of the presentation, the reader will be exposed to: Basic terminology regarding spinal nerves Differentiation between normal versus diseased nerves Nerve injury classification Additionally, the reader will be familiar with the origins, course, function, and examples of pathology of the nerves of the lumbosacral plexus. Examples of nerve pathology utilized for this presentation include: Oncologic (benign and malignant etiologies and radiation/chemotherapy induced injury) Injury and entrapment Polyneuropathies and mononeuropathies

Awards
Cum Laude

Participants
Carlos Felipe T. Lobo, MD, Sao Paulo, Brazil (Presenter) Nothing to Disclose
Marco Bianchi, Sao Paulo, Brazil (Abstract Co-Author) Nothing to Disclose
Renata V. Leao, Sao Paulo, Brazil (Abstract Co-Author) Nothing to Disclose
Camilo P. Helito, Sao Paulo, Brazil (Abstract Co-Author) Nothing to Disclose
Paulo Victor P. Helito, MD, Sao Paulo, Brazil (Abstract Co-Author) Nothing to Disclose

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carlosfelipet@hotmail.com

TEACHING POINTS
Review current understanding of the anatomy and the physiology of anterolateral ligament (ALL) of the knee, correlating with magnetic resonance imaging (MRI). Discuss and illustrate the association of ALL lesions and lesions of the anterior cruciate ligament (ACL), meniscus and other structures of the knee. Discuss and illustrate the adopted techniques for ALL reconstruction using MRI, computed tomography (CT) and conventional radiography.

TABLE OF CONTENTS/OUTLINE
INTRODUCTION Anatomy and physiology of ALL with MRI correlation. Tips to differentiate from other structures of the postero-lateral corner of the knee. ALL INJURIES Review didactic cases of ALL injuries. Discussion of the associated lesions of ACL, meniscus and other structures of the postero-lateral corner of the knee. RADIOLOGICAL IMAGING OF ALL RECONSTRUCTION Description of the most used and recent techniques. Illustration the post-operative findings using conventional radiography, CT and MRI.
Advanced Muscle Imaging: State of the Art

Sunday, Dec. 1 2:00PM - 3:30PM Room: E450A

RC104A Acute Muscle Injuries: MRI Protocol, Classification, and Prognosis

Participants
Robert D. Boutin, MD, Davis, CA (Director) Nothing to Disclose

LEARNING OBJECTIVES
1) Assess state-of-the-art imaging techniques for diagnosis of acute and chronic muscle derangements, with an emphasis on MRI, CT, and sonography.

Sub-Events

RC104A Acute Muscle Injuries: MRI Protocol, Classification, and Prognosis

Participants
James M. Linklater, MBBS, St Leonards, Australia (Presenter) Nothing to Disclose

For information about this presentation, contact:
JamesLinklater@casimaging.com

LEARNING OBJECTIVES
1) Define the musculo-tendinous anatomy of the hamstring, quadriceps, adductor and gastrocnemius-soleus muscle groups. 2) Define efficient, sensitive MRI protocols to assess for acute muscle injuries in the lower extremities. 3) Identify on imaging and classify patterns of injury to the hamstring, quadriceps, adductor and gastrocnemius-soleus muscle groups. 4) Understand classification and grading systems used in the evaluation of acute muscle injuries in the lower extremities and their potential value in determining prognosis regarding return to sport.

Active Handout: James MacPherson Linklater

RC104B Chronic Muscle Conditions: A Practical Approach

Participants
Robert D. Boutin, MD, Davis, CA (Presenter) Nothing to Disclose

LEARNING OBJECTIVES
1) Review chronic muscle derangements and apply knowledge using a case-based approach, with an emphasis on practical diagnostic patterns.

RC104C MRI versus Ultrasound of Muscle: Choosing When and How

Participants
Kambiz Motamedi, MD, Los Angeles, CA (Presenter) Nothing to Disclose

For information about this presentation, contact:
kmotamedi@mednet.ucla.edu

LEARNING OBJECTIVES
1) Identify the appropriate diagnostic imaging modality for common muscle pathologies. 2) Describe normal and abnormal ultrasound appearance of muscle. 3) Compare imaging characteristics of muscle pathology on MRI versus ultrasound.

Active Handout: Kambiz Motamedi

RC104D Muscle Ischemia, Infarction, and Compartment Syndrome

Participants
Michael D. Ringler, MD, Rochester, MN (Presenter) Nothing to Disclose

LEARNING OBJECTIVES
1) Recognize imaging findings associated with common clinical syndromes involving muscle ischemia, including compartment...
1) Recognize imaging findings associated with common clinical syndromes involving muscle ischemia, including compartment syndrome. 2) Differentiate appearance of irreversible myonecrosis from treatable ischemia. 3) Design an MR protocol for Chronic Exertional Compartment Syndrome.

**RC104E Imaging of Muscle Quality: Myosteatosis Revisited**

Participants
Leon Lenchik, MD, Winston-Salem, NC (Presenter) Nothing to Disclose

For information about this presentation, contact:
llenchik@wakehealth.edu

**LEARNING OBJECTIVES**

1) Discuss the imaging diagnosis of myosteatosis and its relation to muscle quality.

Printed on: 01/19/20
RC108

Imaging of Musculoskeletal Emergencies (Interactive Session)

Sunday, Dec. 1 2:00PM - 3:30PM Room: S406A

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

Participants
Manickam Kumaravel, MD, FRCR, Houston, TX (Moderator) Nothing to Disclose

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

Sub-Events
RC108A Hip

Participants
Manickam Kumaravel, MD, FRCR, Houston, TX (Presenter) Nothing to Disclose

For information about this presentation, contact:
manickam.kumaravel@uth.tmc.edu

LEARNING OBJECTIVES
1) Understand in depth the normal anatomy of hip. 2) Appreciate subtle and catastrophic patterns of the hip and peri-hip causes of pain. 3) Effectively utilize CT and MRI in problem solving patients with hip and peri-hip causes of pain. 4) Comprehend the clinical implications of hip pain presentations.

ABSTRACT
The learner will be exposed to a wide gamut of patients presenting to the emergency room with hip and peri-hip causes of pain. Injuries will be elucidated with plain radiography, CT and MRI.

RC108B Wrist

Participants
Claire K. Sandstrom, MD, Seattle, WA (Presenter) Spouse, Advisory Board, BTG International Ltd;

For information about this presentation, contact:
cks13@uw.edu

LEARNING OBJECTIVES
1) Review osseous and soft tissue emergencies of the wrist that may be encountered in the Emergency Department. 2) Describe appropriate imaging work-up of wrist emergencies.

RC108C Ankle and Foot

Participants
Adnan M. Sheikh, MD, Ottawa, ON (Presenter) Speaker, Siemens AG

For information about this presentation, contact:
asheikh@toh.ca

LEARNING OBJECTIVES
1) Review the imaging modalities to assess ankle and foot pathologies. 2) Understand the imaging features of common and uncommon ankle and foot injuries. 3) Develop strategies to reduce the possibility of a missed lesion on screening.

RC108D Shoulder

Participants
Jonathan A. Flug, MD, MBA, Phoenix, AZ (Presenter) Nothing to Disclose

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flug.jonathan@mayo.edu

LEARNING OBJECTIVES
1) Detect imaging abnormalities commonly seen in the shoulder in the emergency setting. 2) Identify commonly encountered
shoulder pathology in the emergency setting. 3) Recommend appropriate follow up for various findings in the shoulder in the emergency setting.

ABSTRACT
The shoulder is a commonly injured body part presenting in the emergency setting. For many injuries, x-ray imaging is the first line in diagnosis and these studies may reflect a significant proportion of the workflow of a radiologist in a general or subspecialty practice. However, these injuries are often missed or have a delay in diagnosis. The purpose of this course is to review normal anatomy in the shoulder as well as commonly encountered pathology to improve diagnosis and provide strategies when x-ray imaging cannot sufficiently establish a diagnosis.

Printed on: 01/19/20
Dynamic Musculoskeletal US: Clicks and Clunks of the Lower Extremity (Hands-on)

Sunday, Dec. 1 2:00PM - 3:30PM Room: E264

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

Participants
Viviane Khoury, MD, Philadelphia, PA (Presenter) Nothing to Disclose
Jon A. Jacobson, MD, Ann Arbor, MI (Presenter) Research Consultant, BioClinica, Inc; Advisory Board, Koninklijke Philips NV; Royalties, Reed Elsevier
David P. Fessell, MD, Ann Arbor, MI (Presenter) Nothing to Disclose
Ghiyath Habra, MD, Troy, MI (Presenter) Nothing to Disclose
Joseph H. Introcaso, MD, Neenah, WI (Presenter) Nothing to Disclose
Kenneth S. Lee, MD, Madison, WI (Presenter) Grant, General Electric Company; Grant, National Basketball Association; Grant, Johnson & Johnson; Research support, SuperSonic Imagine; Royalties, Reed Elsevier
Humberto G. Rosas, MD, Madison, WI (Presenter) Nothing to Disclose
Marnix T. van Holsbeeck, MD, Detroit, MI (Presenter) Stockholder, Koninklijke Philips NV; Stockholder, General Electric Company; Stockholder, MedEd3D;
Mark Cresswell, MBCh, Vancouver, BC (Presenter) Consultant, Koninklijke Philips NV
J. Antonio Bouffard, MD, Bloomfield Hills, MI (Presenter) Nothing to Disclose
Joseph G. Craig, MD, Ann Arbor, MI (Presenter) Nothing to Disclose
Robert R. Lopez, MD, Cornelius, NC (Presenter) Nothing to Disclose
Girish Gandikota, MBBS, Ann Arbor, MI (Presenter) Nothing to Disclose
Marcos L. Sampaio, MD, Ottawa, ON (Presenter) Nothing to Disclose
Andrew J. Grainger, MD, Leeds, United Kingdom (Presenter) Consultant, Leviecept Ltd; Director, The LivingCare Group;
Philippe A. Peetrons, MD, Brussels, Belgium (Presenter) Research Consultant, Canon Medical Systems Corporation
Carlo Martinoli, MD, Genova, Italy (Presenter) Speaker, Koninklijke Philips NV; Speaker, Canon Medical Systems Corporation;
Speaker, Novonordisk Pharmaceuticals; Speaker, Pfizer Inc; Speaker, Novartis AG; Speaker, Swedish Orphan Biovitrum AB
Etienne Cardinal, MD, Montreal, QC (Presenter) Nothing to Disclose

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LEARNING OBJECTIVES

1) Identify anatomic structures which can impinge or move abnormally in the lower extremity causing pain during normal range of motion. 2) Describe the ultrasound anatomy and scanning technique for a dynamic examination of these lesions. 3) Position patients optimally for the dynamic evaluation of the upper extremity respecting ergonomics.

ABSTRACT

This course will demonstrate standardized techniques of performing the dynamic examination of hip and ankle lesions that are only or best demonstrated dynamically. These include the snapping hip, peroneal tendon subluxation/dislocation, flexor hallucis longus impingement, and ankle ligament instability. In the first portion of the course, probe positioning will be demonstrated on a model patient with overhead projection during live scanning. In the second portion of the course, an international group of expert radiologists will assist participants in learning positioning and scanning of hip and ankle joint lesions described. An emphasis on dynamic maneuvers and ergonomic documentation of tissue dynamics will be taught. Participants will be encouraged to directly scan model patients.

Printed on: 01/19/20
PS12A  Report of the RSNA Research and Education Foundation

Participants
Thomas M. Grist, MD, Madison, WI (Presenter) Institutional research support, General Electric Company; Institutional research support, Bracco Group; Institutional research support, Siemens AG; Institutional research support, Hologic, Inc; Institutional research support, McKesson Corporation; Stockholder, Elucent; Stockholder, HistoSonics, Inc;

PS12B  Image Interpretation Session

Participants
Neil M. Rofsky, MD, Dallas, TX (Moderator) Advisory Board, InSightec Ltd; CME & Education Steering Committee, Medscape, LLC
Laura W. Bancroft, MD, Venice, FL (Presenter) Author with royalties, Wolters Kluwer nv; Editor, Thieme Medical Publishers, Inc;
Travel support, Thieme Medical Publishers, Inc;
Yoshimi Anzai, MD,MPH, Salt Lake City, UT (Presenter) Nothing to Disclose
Robert D. Boutin, MD, Davis, CA (Presenter) Nothing to Disclose
Govind B. Chavhan, MD, Toronto, ON (Presenter) Speaker, Bayer AG
Philippe A. Grenier, MD, Saint Cloud, France (Presenter) Nothing to Disclose
S. Nahum Goldberg, MD, Efrat, Israel (Presenter) Consultant, AngioDynamics, Inc; Consultant, Cosman Medical, Inc; Consultant, XACT Robotics;
Nicole M. Hindman, MD, New York, NY (Presenter) Nothing to Disclose
Jessica W. Leung, MD, Houston, TX (Presenter) Scientific Advisory Board, Subtle Medical
Don C. Yoo, MD, E Greenwich, RI (Presenter) Consultant, General Electric Company

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donyoo@brown.edu

LEARNING OBJECTIVES

1) Identify key abnormal findings on radiologic studies that are critical to making a specific diagnosis. 2) Construct a logical list of differential diagnoses based on the radiologic findings, focusing on the most probable differential diagnoses. 3) Determine which, if any, additional radiologic studies or procedures are needed in order to make a specific final diagnosis. 4) Choose the most likely diagnosis based on the clinical and the radiologic information.

Printed on: 01/19/20
ED008-MO

Musculoskeletal Monday Case of the Day

Monday, Dec. 2 7:00AM - 11:59PM Room: Case of Day, Learning Center

AMA PRA Category 1 Credit ™: .50

Participants
Daniel E. Wessell, MD, PhD, Ponte Vedra Beach, FL (Presenter) Nothing to Disclose
Nathan D. Cecava, MD, JBSA Lackland AFB, TX (Abstract Co-Author) Nothing to Disclose
Lance Edmonds, MD, Fairfield, CA (Abstract Co-Author) Nothing to Disclose
Mustafa M. Alikhan, MD, Kailua, HI (Abstract Co-Author) Nothing to Disclose
James H. Chang, MD, Dupont, WA (Abstract Co-Author) Nothing to Disclose
Mark D. Murphey, MD, Silver Spring, MD (Abstract Co-Author) Nothing to Disclose
Jacob R. Hansen, DO, Honolulu, HI (Abstract Co-Author) Nothing to Disclose
Andrew J. Degnan, MD, Philadelphia, PA (Abstract Co-Author) Nothing to Disclose
Tae H. Ro, MD, Fairfield, CA (Abstract Co-Author) Nothing to Disclose
Matthew Loewen, DO, Fircrest, WA (Abstract Co-Author) Nothing to Disclose
David J. Oettel, DO, Lackland, TX (Abstract Co-Author) Nothing to Disclose
Megan Dececchis, MD, Pensacola, FL (Abstract Co-Author) Nothing to Disclose
Joseph Salama, DO, MSc, Puyallup, WA (Abstract Co-Author) Nothing to Disclose
Richard Buck, MD, Tacoma, WA (Abstract Co-Author) Nothing to Disclose

TEACHING POINTS
Participants will test their diagnostic skills and become familiar with the imaging findings of a variety of challenging and interesting musculoskeletal cases.

Printed on: 01/19/20
Radiology Stranger Things: A Journey into the Upside Down (Case-based Competition)

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

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

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

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

Printed on: 01/19/20
RC204

Musculoskeletal Series: MRI of Ankle and Foot

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

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

Sub-Events

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

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

For information about this presentation, contact:
yuliavm@gmail.com

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

RC204-02 MRI of Ankle Instability

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

For information about this presentation, contact:
wpalmer@mgh.harvard.edu

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

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

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

For information about this presentation, contact:
william.walter@nyulangone.org

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

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

RESULTS
68 ankle MRIs were identified from a total of 374 MRIs (25 pediatric patients with average age 13.9 years, standard deviation 5.2 years; 43 adult patients with average age 38.9 years, standard deviation 19.2 years).

RC204

Musculoskeletal Series: MRI of Ankle and Foot

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

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

Sub-Events

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

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

For information about this presentation, contact:
yuliavm@gmail.com

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

RC204-02 MRI of Ankle Instability

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

For information about this presentation, contact:
wpalmer@mgh.harvard.edu

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

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

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

For information about this presentation, contact:
william.walter@nyulangone.org

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

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

RESULTS
68 ankle MRIs were identified from a total of 374 MRIs (25 pediatric patients with average age 13.9 years, standard deviation 5.2 years; 43 adult patients with average age 38.9 years, standard deviation 19.2 years).
To date, 68 ankle MRIs were identified from a total of 374 MRIs (25 pediatric patients with average age 13.9 years, standard deviation (SD)=2.2 years) with normal syndesmosis, and 20 pediatric (13.3 years, SD=1.7 years) and 23 adult (53.2, SD=12.1 years) cases with syndesmotic injuries). Fibrous and cambial periosteal layers were identified in all normal pediatric cases; normal ligaments were attached to tibial and fibular fibrous periosteum prior to full bony ossification. MRIs with syndesmotic ligamentous injury depicted stripping of tibial periosteum in 8/20 (40.0%) of pediatric and 1/23 (4.0%) of adult cases. 1/20 (5%) pediatric and 4/23 (17.4%) of adult cases with syndesmotic injuries demonstrated avulsion fractures.

**CONCLUSION**

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

**CLINICAL RELEVANCE/APPLICATION**

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

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

**Purpose**

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

**Method and Materials**

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

**Results**

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

**Conclusion**

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

**Clinical Relevance/Application**

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

### RC204-05  MRI of Ankle Impingement

**Learning Objectives**

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

**Participants**

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

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### RC204-06  MRI of the Midfoot

**Learning Objectives**

**Participants**

Hilary R. Unans, MD, Ardsley, NY (Presenter) Nothing to Disclose
1) Describe the normal MRI anatomy of the midfoot. 2) Discuss osseous abnormalities of the Chopart joint and Lisfranc joint complex. 3) Identify tendinous pathology of the midfoot.

Active Handout: Hilary Ruth Umans

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

Participants
Drew Gunio, MD, MS, New York, NY (Presenter) Nothing to Disclose
Carlos L. Benitez, MD, New York, NY (Abstract Co-Author) Nothing to Disclose

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

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

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

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

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

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

Participants
Saeed Jerban, PhD, San Diego, CA (Presenter) Nothing to Disclose
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Robert Sah, La Jolla, CA (Abstract Co-Author) Nothing to Disclose
Eric Y. Chang, MD, San Diego, CA (Abstract Co-Author) Nothing to Disclose
Darryl D’Lima, MD, PhD, La Jolla, CA (Abstract Co-Author) Research funded, Stryker Corporation; Consultant, Advanced Mechanical Technology, Inc; Research funded, ConforMIS, Inc; Consultant, Ossur HF; Officer and Stockholder, XpandOrtho, Inc
Jiang Du, PhD, San Diego, CA (Abstract Co-Author) Nothing to Disclose

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

METHOD AND MATERIALS
135 cortical bone strips (~4×2×40 mm3) were harvested from the tibial and femoral midshafts of 37 donors (61±24 yo). Specimens were scanned using a 1-inch diameter T/R birdcage coil on a 3T clinical scanner (MR750, GE). Ten sets of dual-echo 3D-UTE-Cones sequences with different echo time from 0.032ms to 24.0ms (TR=28ms, flip angle=10°, and 26 µs rectangular RF pulse) were performed for T2* bicomponent (2-com) and tricomponent (3-com) decay analyses. Other imaging parameters included: field of view=40×40mm2, matrix=160×160, slice-thickness=2mm, bandwidth=±62.5kHz. Specimens were later scanned using a Skyscan 1076 (Kontich, Belgium) µCT at 9 µm3 voxel size to measure bone porosity and bone mineral density (BMD). Finally, mechanical...
properties of the bone specimens (Young's modulus, yield stress, ultimate stress, and failure energy) were estimated using 4-point bending tests. Pearson's correlation coefficients were calculated between water fractions-estimated with 3-com and 2-com UTE-MRI T2* analyses-and μCT measures of porosity and BMD, as well as mechanical properties.

RESULTS

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

CONCLUSION

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

CLINICAL RELEVANCE/APPLICATION

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

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

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

PURPOSE

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

METHOD AND MATERIALS

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

RESULTS

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

CONCLUSION

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

CLINICAL RELEVANCE/APPLICATION

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

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

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

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

METHOD AND MATERIALS

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

RESULTS

At baseline, (T0) statistically significant differences were found in SWE velocity between the affected side and healthy side with higher value in healthy side with value equal to 3.8 (1.5; 5.1) ms-1 and 4.7 (4.07;7.04) ms-1 respectively (p=0.006; z=2.758), while no significant differences were found for strain ratio (p=0.656; z=0.445). One month after ESWT treatment (T1) the strain ratio of the affected side increased, with median value equal to 0.89 (0.3-1.5) at baseline to 1.16 (0.3-1.6) at 1 month and decreased at three months (T2) with median value equal to 0.82 (0.38-1.12). No statistically significant differences were found. Significant differences were found in shear wave velocity over time, with an increase of SWE velocity after shock-wave treatment (p=0.04; χ2=11.167), results showed significant differences from T0 to T2 with median value varying from 3.8 (1.5-5.1) ms-1 at baseline and 5.23 (4.55-6.74) ms-1 a three months after treatment ended respectively (p=0.003).

CONCLUSION

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

CLINICAL RELEVANCE/APPLICATION

US-elastography especially with shear wave may increase ultrasound accuracy for plantar fasciitis diagnosis and can be an important additional tool to evaluate ESWT efficacy.
RC217

Emerging Technology: 3D Joint MR Imaging

Monday, Dec. 2 8:30AM - 10:00AM Room: S504CD

Participants
Avneesh Chhabra, MD, Flowermound, TX (Moderator) Consultant, ICON plc; Consultant, Treace Medical Inc; Author with royalties, Wolters Kluwer nv; Author with royalties, Jaypee Brothers Medical Publishers Ltd

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LEARNING OBJECTIVES
1) Gain knowledge of techniques of optimal 3D isotropic MRI technique for joint and bone evaluation. 2) Learn how to create meniscus, cruciate and ankle ligament, and rotator cuff specific reconstructions using 3D MRI. 3) Learn 3D evaluation of internal joint derangements and their arthroscopy correlations. 4) Explain the advantages and drawbacks of 3D MSK MRI. 5) Describe new techniques to accelerate 3D MSK MRI. 6) Gain knowledge of the optimal 3D isotropic MRI technique for knee meniscus and bone evaluation. 7) Learn how to create meniscus and cruciate specific reconstructions using 3D MRI. 8) Learn how to evaluate meniscus tears and describe their longitudinal extent with arthroscopy correlations. 9) To apply current techniques and acquisition strategies for isotropic 3D MRI of the ankle joint. 10) To review the diagnostic performance and comparative accuracy of 3D MRI of the ankle joint. 11) To illustrate the strengths and limitations of 3D MRI of the ankle. 12) Define technical elements that allow acquisition of high resolution 3D MR images of the hip. 13) List common clinical indications for 3D MR imaging of the hip. 14) Explain differences between high resolution 3D MRI and conventional MR sequences to referring clinicians. 15) Discuss accuracy of 3D MRI of the hip as compared to conventional MR sequences and MR arthrogram. 16) List pitfalls and list measures to minimize artifacts in using high resolution 3D sequences of the hip. 17) Review the imaging and post-processing techniques used to create 3D MRI shoulder models. 18) Discuss the use of 3D MRI bone models in the evaluation of anterior shoulder instability patients. 19) Discuss the use of 3D soft tissue models in the MRI evaluation of rotator cuff tendon tears.

Sub-Events

RC217A  Fast 3D Imaging: Emerging Techniques to Accelerate 3D Acquisitions

Participants
Naveen Subhas, MD, Shaker Heights, OH (Presenter) Research support, Siemens AG

LEARNING OBJECTIVES
1) Explain the advantages and drawbacks of 3D MSK MRI. 2) Describe new techniques to accelerate 3D MSK MRI.

RC217B  3D MR Imaging of Knee Joint

Participants
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LEARNING OBJECTIVES
1) Gain knowledge of the optimal 3D isotropic MRI technique for knee meniscus and bone evaluation. 2) Learn how to create meniscus and cruciate specific reconstructions using 3D MRI. 3) Learn how to evaluate meniscus tears and describe their longitudinal extent with arthroscopy correlations.

RC217C  3D MR Imaging of Ankle Joint

Participants
Jan Fritz, MD, Baltimore, MD (Presenter) Institutional research support, Siemens AG; Institutional research support, Johnson & Johnson; Institutional research support, Zimmer Biomet Holdings, Inc; Institutional research support, Microsoft Corporation; Institutional research support, BTG International Ltd; Scientific Advisor, Siemens AG; Scientific Advisor, General Electric Company; Scientific Advisor, BTG International Ltd; Speaker, Siemens AG; Patent agreement, Siemens AG

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LEARNING OBJECTIVES
1) To apply current techniques and acquisition strategies for isotropic 3D MRI of the ankle joint. 2) To review the diagnostic
performance and comparative accuracy of 3D MRI of the ankle joint. 3) To illustrate the strengths and limitations of 3D MRI of the ankle.

**RC217D  3D MR Imaging of Hip Joint**

Participants
Oganes Ashikyan, MD, Dallas, TX (Presenter) Nothing to Disclose

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**LEARNING OBJECTIVES**

1) Define technical elements that allow acquisition of high resolution 3D MR images of the hip. 2) List common clinical indications for 3D MR imaging of the hip. 3) Explain differences between high resolution 3D MRI and conventional MR sequences to referring clinicians. 4) Discuss accuracy of 3D MRI of the hip as compared to conventional MR sequences and MR arthrogram. 5) List pitfalls and list measures to minimize artifacts in using high resolution 3D sequences of the hip.

**RC217E  3D MR Imaging of Shoulder Joint**

Participants
Soterios Gyftopoulos, MD, Scarsdale, NY (Presenter) Nothing to Disclose

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**LEARNING OBJECTIVES**

1) Review the imaging and post-processing techniques used to create 3D MRI shoulder models. 2) Discuss the use of 3D MRI bone models in the evaluation of anterior shoulder instability patients. 3) Discuss the use of 3D MRI soft tissue models in the evaluation of rotator cuff tendon tears.

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Whole Body MRI for Precision Oncology in Malignant Bone Disease

**Participants**
Evis Sala, MD, PhD, Cambridge, United Kingdom (Moderator) Nothing to Disclose

**LEARNING OBJECTIVES**
1) Describe the limitations of current imaging modalities in evaluation of metastatic bone disease. 2) Learn the added value of whole body MRI in evaluation of metastatic bone disease in various malignancies including prostate cancer and multiple myeloma. 3) Understand the role of quantitative whole body MRI in delivering precision medicine in oncology.

**Sub-Events**

**RC218A**  Imaging of Metastatic Bone Disease: Current Limitations

**Participants**
Hebert Alberto Vargas, MD, Cambridge, United Kingdom (Presenter) Nothing to Disclose

**LEARNING OBJECTIVES**
1) Discuss the challenges associated with the diagnosis and interpretation of bone findings in patients with metastatic disease.

**ABSTRACT**
Conventional imaging of metastatic disease to the bone is notoriously difficult. Unlike soft tissue metastases, significant cortical disruption is required before a bone metastasis is visible on CT, and bone scan demonstrates the effect of the metastases on bone, rather than the metastases themselves. MR partially overcomes these limitations, as early bone metastases can be detected. However, even after bone metastases are apparent on imaging, it is difficult to assess their evolution with regards to therapy response.

**RC218B**  WB-MRI of Multiple Myeloma: My-RADS

**Participants**
Christina Messiou, MD, BMBS, London, United Kingdom (Presenter) Nothing to Disclose

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**LEARNING OBJECTIVES**
1) List indications for WB-MRI in multiple myeloma. 2) Describe the core and comprehensive protocols for WB-MRI in multiple myeloma. 3) Apply a systematic approach to reporting WB-MRI in multiple myeloma as outlined in MY-RADS. 4) Review the MY-RADS criteria for assessing disease phenotype, burden and response assessment with case examples.

**ABSTRACT**
Acknowledging the increasingly important role of WB-MRI for directing myeloma patient care, a multidisciplinary international expert panel of radiologists, medical physicists and haematologists convened to discuss the performance standards, merits and limitations of WB-MRI in myeloma. The MY-RADS imaging recommendations are designed to promote standardization and diminish variations in the acquisition, interpretation, and reporting of WB-MRI in myeloma both in the clinical setting and within clinical trials. MY-RADS comprehensive disease classification requires validation within clinical trials including assessments of reproducibility.

**Active Handout:** Christina Messiou

**RC218C**  WB-MRI of Metastatic Bone: MET-RADS

**Participants**
Anwar R. Padhani, MD,FRCR, Northwood, United Kingdom (Presenter) Advisory Board, Siemens AG; Speakers Bureau, Siemens AG; Speakers Bureau, sanofi-aventis Group; Speakers Bureau, Johnson & Johnson; Speakers Bureau, Astellas Group

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**LEARNING OBJECTIVES**
1) MET-RADS measurement protocols distinguishing between tumor detection (core) and response (comprehensive) assessments.
2) To highlight and review the MET-RADS response assessment criteria and their application. 3) To illustrate MET-RADS usage with case examples and to provide efficacy data on MET-RADS use in clinical practice. 4) Outline development steps for MET-RADS.

**ABSTRACT**

MET-RADS provides the minimum standards for whole body MRI with DWI regarding image acquisitions, interpretation, and reporting of both baseline and follow-up monitoring examinations of patients with advanced, metastatic cancers. MET-RADS is suitable for guiding patient care in practice (using the regional and overall assessment criteria), but can also be incorporated into clinical trials when accurate lesion size and ADC measurements become more important (the recording of measurements is not mandated for clinical practice). MET-RADS enables the evaluation of the benefits of continuing therapy to be assessed, when there are signs that the disease is progressing (discordant responses). MET-RAD requires validation within clinical trials initially in studies that assess the effects of known efficacious treatments. METRADS measures should be correlated to other tumor response biomarkers, quality of life measures, rates of skeletal events, radiographic progression free survival and overall survival. The latter will be needed for the introduction of WB-MRI into longer term follow-up studies, that will allow objective assessments of whether WB-MRI is effective in supporting patient care.

**RC218D  Quantitative WB-MRI for Promoting Precision Oncology**

Participants
Dow-Mu Koh, MD,FRCR, Sutton, United Kingdom (Presenter) Nothing to Disclose

**LEARNING OBJECTIVES**

1) To review the quantitative parameters that can be derived from WB-MRI studies. 2) To understand the evolving role of quantitative WB-MRI for the evaluation of metastatic bone disease. 3) To appreciate the application of quantitative WB-MRI for precision oncology in assessing tumour treatment response and disease heterogeneity.

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Participants
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Joseph H. Introcaso, MD, Neenah, WI (Presenter) Nothing to Disclose
Humberto G. Rosas, MD, Madison, WI (Presenter) Nothing to Disclose
Lodewijck J. van Holsbeeck, MD, Lansing, MI (Presenter) Nothing to Disclose

LEARNING OBJECTIVES
1) Recognize and identify pitfalls of scanning that lead to false positive or false negative musculoskeletal ultrasound results. 2) Perform skills for scanning difficult patients. 3) Follow rigorous protocols for the examination of different anatomic regions. 4) Position patients for more complicated musculoskeletal ultrasound examinations. 5) Recognize and integrate the importance of tissue movement in judging the functionality of the extremities.

ABSTRACT
By means of this Forum on Musculoskeletal Ultrasound, an opportunity will be given to participants to start a written dialogue in advance to RSNA 2019. The electronically submitted questions will be sorted by instructors and organized per topic. A select number of recurrent themes in these questions will be prepared for dialogue on stage. When the questions focus on a particular scanning skill, the authors of the questions will be invited on the examination platform to show problems they encounter in their practice. By using a step-by-step approach in solving the scanning issues, all who are present should benefit from the technical interactions on stage. Cameras will project scanning details on large screens. The seating in the class will guarantee close proximity for an enriching interaction between audience and stage.

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Purpose
To validate the efficacy of an artificial intelligence (AI) prototype application in determining bone mineral density (BMD) from chest computed tomography (CT) as compared to dual-energy X-ray absorptiometry (DEXA).

Method and Materials
In this IRB-approved study, we analyzed data from 65 patients (57 female, mean age: 67.4 years) who underwent both DEXA and chest CT (mean time between scans: 1.31 years). From the DEXA studies, T-scores for L1-L4 (lumbar vertebrae 1-4) were recorded. Patients were then divided based on their T-scores into normal control, osteopenic, or osteoporotic groups. An AI algorithm based on wavelet features, AdaBoost, and local geometry constraints independently localized thoracic vertebrae from chest CT studies and automatically computed average Hounsfield Unit (HU) values with kVp-dependent spectral correction. Pearson's correlation evaluated the correlation between the T-scores and HU values. Mann-Whitney U test was implemented to compare the HU values of normal control versus osteoporotic patients.

Results
Overall, the DEXA-determined T-scores and AI-derived HU values showed good correlation (r = 0.55; p < 0.001). The patient population was divided into three subgroups based on their T-scores. The mean T-scores for the three subgroups (normal control, osteopenic, osteoporotic) were 0.77 ± 1.50, -1.51 ± 0.04, and -3.26 ± 0.59, respectively. The mean DEXA-determined L1-L4 BMD measures were 1.13 ± 0.16 g/cm², 0.88 ± 0.06 g/cm², and 0.68 ± 0.06 g/cm², respectively. The mean AI-derived attenuation values were 145 ± 42.5 HU, 136 ± 31.82 HU, and 103 ± 16.28 HU, respectively. Using these AI-derived HU values, a significant difference was found between the normal control patients and osteoporotic group (p = 0.045).

Conclusion
Our results show that this AI prototype can successfully determine BMD in good correlation with DEXA. Combined with other AI algorithms directed at evaluating cardiac and lung diseases, this prototype may contribute to future comprehensive preventative care based on a single chest CT.

Clinical Relevance/Application
This AI prototype may be able to successfully screen for osteoporotic disease using chest CT.
**SSC09-02 Significance of Acquisition Parameters for Adipose Tissue Quantification on Computed Tomography**

**Participants**
Amelie S. Troschel, Boston, MA (Presenter) Nothing to Disclose
Fabian M. Troschel, Boston, MA (Abstract Co-Author) Nothing to Disclose
George Fuchs, Berlin, Germany (Abstract Co-Author) Nothing to Disclose
Jan P. Marquardt, Boston, MA (Abstract Co-Author) Nothing to Disclose
Kai Yang, PhD, Boston, MA (Abstract Co-Author) Nothing to Disclose
Florian J. Fintelmann, MD, Boston, MA (Abstract Co-Author) Consultant, Jounce Therapeutics, Inc; Research support, BTG International Ltd

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**PURPOSE**
To evaluate the effect of tube current, kVp, intravenous contrast and slice thickness on computed tomography (CT) adipose tissue measurements.

**METHOD AND MATERIALS**
Cross-sectional area (CSA) and mean attenuation of subcutaneous (SAT), intermuscular (IMAT) and visceral adipose tissue (VAT) were measured with threshold-based segmentation (-190 to -30 HU) on 244 axial CT images. Images were obtained at the level of the third lumbar vertebral body in 105 adult patients on the same day and on the same scanner, and varied only with regards to one parameter, either tube current (diagnostic vs. low dose), tube potential (100kVp vs. 150kVp), presence of intravenous contrast (non vs. portal-venous phase) or slice thickness (2mm vs. 5mm). Differences were evaluated using mean or median differences, paired t-tests or Wilcoxon signed rank tests, as applicable, and the Bland Altman approach. Intra- and inter-reader agreement was assessed.

**RESULTS**
Diagnostic scans had a median effective mAs of 313.5 (IQR 274-348.25) and low dose scans had a median effective mAs of 33 (IQR 33-90), both at 120kVp. Compared to diagnostic scans, low dose technique significantly affected adipose tissue CSA (SAT -3.2%; VAT -12.55%; IMAT +58.8%; all p<0.001) and attenuation (-2.4% to -8.7%; all p<0.001). Higher tube potential also significantly affected CSA (IMAT +8.8%; p=0.006; SAT -5.6%; p<0.001; VAT -2.8%; p=0.001) and attenuation (+6.2% to +20.8%; all p<0.001). Presence of intravenous contrast significantly reduced CSA (SAT -0.7% p=0.04; IMAT -9.3% p<0.001; VAT p>0.05) while increasing attenuation (+0.8% to +1.1%; all p<0.05). Thinner slices significantly increased CSA compared to thicker slices (IMAT +17.3% p<0.001; VAT +1.3% p=0.02; SAT p>0.05) and significantly decreased attenuation (-1.0% to -5.4%; all p<0.001). Intra- and inter-reader agreement were excellent (>99% for all compartments).

**CONCLUSION**
Acquisition parameters significantly and critically affect adipose tissue CSA and attenuation measurements on CT. Body composition studies need to be conducted with consistent CT scan protocols to avoid systematic error. Creation of protocol-dependent reference values should be considered.

**CLINICAL RELEVANCE/APPLICATION**
The effect of mAs, kVp, IV contrast and slice thickness on CT adipose tissue measurements needs to be considered for body composition study design and data interpretation to avoid systematic error.

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**SSC09-03 3T CSE-MRI Identifies Variation in Fatty Acid Composition in Subcutaneous Fat, Muscle, and Bone Marrow in Subjects with SLE, GIO, and Primary Osteoporosis**

**Participants**
Dimitri Martel, New York City, NY (Presenter) Nothing to Disclose
Amit Saxena, New York, NY (Abstract Co-Author) Nothing to Disclose
Michael Belmont, New York, NY (Abstract Co-Author) Nothing to Disclose
Stephen Honig, MD, New York, NY (Abstract Co-Author) Nothing to Disclose
Benjamin Leporq, MS, Villeurbanne, France (Abstract Co-Author) Nothing to Disclose
Gregory Chang, MD, New York, NY (Abstract Co-Author) Nothing to Disclose

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**PURPOSE**
Advances in Chemical Shift Encoded-MRI (CSE-MRI) allow assessment of the quantity and composition of adipose tissue, which permits investigation of the role of amount of fat (PDFF), saturated (SFA), poly/mono-unsaturated (PUFA/MUFA) fatty acids metabolism in diseases such as osteoporosis, muscular dystrophy, obesity, and other metabolic disorders. Our purpose was to quantify and compare the FA profile in in subcutaneous adipose tissue (SAT), muscle (MUS), and bone marrow fat (BMF) in three groups: subjects with systemic lupus erythematosus (SLE), glucocorticoids users with secondary osteoporosis and SLE (GIO), and subjects with postmenopausal osteoporosis (OP).

**METHOD AND MATERIALS**
This study had institutional review board approval and written informed consent was obtained. A multi gradient echo sequence at 3T (scan time = 3:32min) was used to acquire images of the pelvis in post-menopausal women with osteoporosis (n= 20, 50.5y +/- 15.6), in subjects with SLE (n=10, 52.6y +/-11.2) and in glucocorticoids users (n=13, 45.2y +/-15.4, 10 to 40mg prednisolone equivalent during at least 24 months use due to SLE). A dedicated reconstruction workflow for CSE-MRI was used to reconstruct
parametric maps and regional AT in SAT, MUS, and BMF were semi-automatic segmented by active contours and k-mean clusters. Intergroup comparisons were carried out using Kruskal-wallis test to assess differences between groups.

RESULTS

Results Within SAT, subjects with SLE had higher SFA compared to those with GIO (+17%, p < 0.05). Within MUS, subjects with SLE had lower SFA (-49.1%), MUFA (-47.8%), and PUFA (-57%) compared to subjects with GIO and they had lower PUFA (-72.5%) (p < 0.01 for all) compared to subjects with OP. Within MUS, subjects with GIO compared to OP had higher SFA (+41%) higher MUFA (+45%) (p < 0.01 for both). In addition, MUS volume of SLE subjects was lower than that of GIO subjects (-74%, p<0.05). Within BMF no significant difference was assessed.

CONCLUSION

CSE-MRI can separate SAT, BMF and MUS and detect regional variation and differences in fat composition and quantity in clinically feasible scan times.

CLINICAL RELEVANCE/APPLICATION

Chemical Shift Encoded MRI allows assessment of fatty acids in subcutaneous tissues, muscle, and bone marrow and the identification of disease-specific lipid profiles for osteoporosis and lupus.

SSC09-04 Opportunistic CT-Imaging for Assessment of Fat-Free Muscle Fraction Predicts Outcome in Patients Undergoing Transcatheter Aortic Valve Implantation

Monday, Dec. 2 11:00AM - 11:10AM Room: E450B

Participants

Julian A. Luetkens, MD, Bonn, Germany (Presenter) Nothing to Disclose
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PURPOSE

Sarcopenia is strongly interrelatd with frailty, which is considered a major risk factor for poor outcomes in patients undergoing Transcatheter Aortic Valve Implantation (TAVI). We aimed at investigating the predictive value of amount and quality of skeletal muscles, measured from preinterventional computed tomography (CT), in patients undergoing TAVI.

METHOD AND MATERIALS

A total of 937 consecutive patients (mean age: 81.10±6.21 years, mean EuroSCORE II: 6.75±6.34 %) undergoing TAVI were retrospectively investigated. Amount and quality of skeletal muscles (including assessment of fat-free muscle fraction (FFMF)) and abdominal adipose tissue compartments were quantified from pre-interventional CT using dedicated software. 1-year survivors had a significantly higher FFMF compared to non-survivors (45.72±15.29% vs. 40.38±14.89%, P<0.001). According to their FFMF values, patients were divided into tertiles and were defined to have high (>51.76%), medium (51.76-37.29%), and low FFMF (<37.29%), respectively.

RESULTS

Following TAVI, low FFMF was related to major bleedings (6.4% vs. 2.2% vs. 1.6%; P=0.001) as well as increased 1-year (20.8% vs. 14.7% vs. 9.3%, P<0.001), 2-year (27.2% vs. 20.4% vs. 15.7%; P=0.004), and 3-year mortality (30.8% vs. 24.0% vs. 19.2%; P=0.009). On multivariate Cox regression analysis, low FFMF (hazard ratio (HR), 2.450; P=0.001), medium FFMF (HR, 1.879; P=0.019) and EuroSCORE II (HR, 1.039; P<0.001) were identified as independent prognosticators of 1-year mortality.

CONCLUSION

In this study, we propose the opportunistic determination of FFMF as a promising new imaging parameter to predict outcome in patients undergoing aortic valve replacement. FFMF was shown to be strongly related to dismal outcomes following TAVI and was identified as an independent and strong prognosticator of 1-year mortality, outperforming several established factors for survival prognosis. The potentially outstanding value of FFMF as a biomarker of frailty is underscored by the fact that it can be easily and objectively assessed from routine preinterventional CT and therefore may have the potential to substantially improve risk stratification in patients receiving percutaneous aortic valve replacement for treatment of severe, symptomatic aortic stenosis.

CLINICAL RELEVANCE/APPLICATION

FFMF is a strong predictor of dismal outcomes in patients undergoing TAVI. It can be easily assessed from pre-interventional CT and may be a promising new imaging parameter for outcome prediction.

SSC09-05 ACR Database Evaluation of 67,392 Accreditation Examinations: Implications for Opportunistic CT Diagnosis of Osteoporosis

Monday, Dec. 2 11:10AM - 11:20AM Room: E450B

Participants

Robert D. Boutin, MD, Davis, CA (Presenter) Nothing to Disclose
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PURPOSE

Sarcopenia is strongly interrelated with frailty, which is considered a major risk factor for poor outcomes in patients undergoing Transcatheter Aortic Valve Implantation (TAVI). We aimed at investigating the predictive value of amount and quality of skeletal muscles, measured from preinterventional computed tomography (CT), in patients undergoing TAVI.

METHOD AND MATERIALS

A total of 937 consecutive patients (mean age: 81.10±6.21 years, mean EuroSCORE II: 6.75±6.34 %) undergoing TAVI were retrospectively investigated. Amount and quality of skeletal muscles (including assessment of fat-free muscle fraction (FFMF)) and abdominal adipose tissue compartments were quantified from pre-interventional CT using dedicated software. 1-year survivors had a significantly higher FFMF compared to non-survivors (45.72±15.29% vs. 40.38±14.89%, P<0.001). According to their FFMF values, patients were divided into tertiles and were defined to have high (>51.76%), medium (51.76-37.29%), and low FFMF (<37.29%), respectively.

RESULTS

Following TAVI, low FFMF was related to major bleedings (6.4% vs. 2.2% vs. 1.6%; P=0.001) as well as increased 1-year (20.8% vs. 14.7% vs. 9.3%, P<0.001), 2-year (27.2% vs. 20.4% vs. 15.7%; P=0.004), and 3-year mortality (30.8% vs. 24.0% vs. 19.2%; P<0.009). On multivariate Cox regression analysis, low FFMF (hazard ratio (HR), 2.450; P=0.001), medium FFMF (HR, 1.879; P=0.019) and EuroSCORE II (HR, 1.039; P<0.001) were identified as independent prognosticators of 1-year mortality.

CONCLUSION

In this study, we propose the opportunistic determination of FFMF as a promising new imaging parameter to predict outcome in patients undergoing aortic valve replacement. FFMF was shown to be strongly related to dismal outcomes following TAVI and was identified as an independent and strong prognosticator of 1-year mortality, outperforming several establised factors for survival prognosis. The potentially outstanding value of FFMF as a biomarker of frailty is underscored by the fact that it can be easily and objectively assessed from routine preinterventional CT and therefore may have the potential to substantially improve risk stratification in patients receiving percutaneous aortic valve replacement for treatment of severe, symptomatic aortic stenosis.

CLINICAL RELEVANCE/APPLICATION

FFMF is a strong predictor of dismal outcomes in patients undergoing TAVI. It can be easily assessed from pre-interventional CT and may be a promising new imaging parameter for outcome prediction.
PURPOSE

With the increased use of opportunistic CT, there is an unmet need for multisite assessment of quantitative biomarker integrity across imaging platforms. Our purpose is to investigate if there is a systematic bias in reported attenuation (CT number, HU) among four CT manufacturers.

RESULTS

The CT number of water ranged from a mean of -0.3 to 2.7 HU, with mean differences between manufacturers that were small but highly significant (p < 0.001). For the trabecular bone surrogate, mean differences in CT numbers across all manufacturers were small but highly significant (p < 0.001), with mean values (standard deviation, SD) of 120.9 [3.5], 124.6 [3.3], 126.9 [4.4], and 123.9 [3.4] for manufacturers A, B, C, and D, respectively. For the cortical bone surrogate, highly significant mean differences in CT numbers also were observed across all manufacturers (p < 0.001), with mean values [SD] of 939.0 [14.2], 874.3 [13.3], 897.6 [11.3], and 912.7 [13.4] for manufacturers A, B, C, and D, respectively.

CONCLUSION

CT number measurements between manufacturers have a systematic offset when compared to each other. Knowledge of these offsets may be useful in order to harmonize HU values across platforms for optimizing the accuracy of opportunistic diagnosis of osteoporosis.

CLINICAL RELEVANCE/APPLICATION

CT scanners made by different manufacturers show systematic HU offsets. The small offsets relating to trabecular bone HU supports the integrity of CT for the opportunistic diagnosis of osteoporosis.

SSC09-06 Patients with Type 2 Diabetes Exhibit a More Mineralized Deep Cartilage Layer Compared to Nondiabetic Controls: A Pilot Study

Awards

Trainee Research Prize - Fellow

Participants

Sarah C. Foreman, MD, San Francisco, CA (Presenter) Nothing to Disclose
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PURPOSE

The aims of our study were (i) to assess differences in biochemical composition of the deep cartilage layer in subjects with type 2 diabetes mellitus (T2DM) and nondiabetic controls using UTE T2* mapping and (ii) to investigate the association of vascular health and deep cartilage layer UTE T2* measurements.

METHOD AND MATERIALS

Ten subjects with T2DM were recruited for our study and matched for age, sex and body mass index (BMI) with ten non-diabetic controls. A 3D multiecho UTE sequence with 6 echo times was acquired in all subjects using 3T MRI of the knee. For UTE T2* analysis, the deep cartilage layer was segmented and analyzed in five compartments (patella, medial and lateral femur and tibia). The Ankle Brachial Index (ABI) was obtained in all subjects as a measure of vascular health. Linear regression analyses were used to assess associations of T2DM and UTE T2* relaxation times and to assess the associations of ABI measurements and UTE values.

RESULTS

Both study groups were similar in age (53.7 vs. 51.8 years; p=0.431), BMI (29.5 vs. 28.9 kg/m2; p=0.712) and sex (p=1.000). Compared to nondiabetic controls, T2DM subjects had significantly lower mean T2*-UTE in the patella (mean difference 4.87 msec [95% confidence interval (CI) 1.09, 8.65]; p=0.015), the lateral femur (mean difference 2.26 msec [95% CI 0.06, 4.45]; p=0.045), and the lateral femur (mean difference 4.96 msec [95% CI 0.19, 9.73]; p=0.043). Averaged over all compartments, the mean T2*-UTE was significantly lower in those with T2DM compared to nondiabetic controls (mean difference 3.24 msec [95% CI 0.36, 6.12]; p=0.030). Moreover, independent of diabetic status, subjects with higher ABI values, indicating better vascular health, had higher T2*-UTE of the patella (coefficient: 15.2; 95% CI: 3.3-21.4; p=0.017), the medial tibia (coefficient: 9.8; 95% CI: 1.0-18.6; p=0.031), and the lateral femur (coefficient: 18.8; 95% CI: 3.3-34.3; p=0.021) compared to subjects with lower ABI values.
CONCLUSION

T2*-UTE measurements of the deep cartilage layer were consistently lower in subjects with T2DM and in subjects with impaired vascular health, likely indicating increased mineralization of this layer.

CLINICAL RELEVANCE/APPLICATION

More mineralization of the deep cartilage layer could be an important pathophysiological pathway contributing to degeneration by inhibiting the subchondral bone - cartilage flow of nutrients.

SSC09-07 MRI Evaluation of Skeletal Muscle Mass and Fat Fraction for the Assessment of Sarcopenia in Psoriatic Patients: Preliminary Results of a Pilot Case-Control Study

Participants
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Antonio Barile, MD, LAquila, Italy (Abstract Co-Author) Nothing to Disclose
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PURPOSE

Quantitative MRI evaluation of muscle quality and adipose tissue has recently emerged as a research topic of great interest to evaluate sarcopenia induced by several chronic metabolic and inflammatory diseases. The purpose of our study was to evaluate the correlation between clinical features and skeletal muscle characteristics (area and fat fraction) as instrumental MR imaging index of sarcopenia in patients affected by psoriasis.

METHOD AND MATERIALS

In this cross-sectional case-control study we enrolled 31 psoriatic patients (18 M, 13 F, mean age 44.6 years, range 24-63) with mean disease duration of 15.3 years (range 2-37), not under systemic medical treatments and without other known conditions able to influence muscle composition. Clinical evaluation included assessment of patient characteristics, disease severity with PASI score and blood-chemistry investigations. Instrumental MRI evaluation was performed with standard axial T2 sequences and chemical shift encoding-based water-fat sequences with fat fraction mapping acquired at the level of L3 and with segmentation of paraspinal and abdominal muscles for the evaluation of MSI (Skeletal Muscle Mass Index) and skeletal muscle fat fraction. We also enrolled 30 healthy subjects, matched by sex and age, used as a control.

RESULTS

Mean skeletal muscle mass index values were 47.08 cm² in psoriatic patients and 46.23 cm² in healthy controls. Fat fraction analysis showed fat fraction values of 18.6% in psoriatic patients and 16.4% in healthy controls. There was no statistically significant difference in terms of skeletal muscle features between study population and controls. Considering patients with psoriasis, statistical analysis showed a significant correlation between the presence of psoriasis, its severity (PASI score) and inflammation markers (CRP) with muscle fat fraction (p<0.005).

CONCLUSION

These preliminary results suggest a qualitative change in muscle composition in patients with psoriasis, mainly correlated with disease severity and inflammation grade.

SSC09-08 Psoriasis Volume and Fat Fraction in Cancer Patients: Dynamics and Association with Severity of Cachexia Progression

Participants
Daniela Franz, MD, Munich, Germany (Abstract Co-Author) Nothing to Disclose
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Dimitrios C. Karampinos, Munich, Germany (Abstract Co-Author) Research Grant, Koninklijke Philips NV

PURPOSE

Cancer cachexia, characterized by weight loss due to skeletal muscle wasting with or without fat loss, is associated with increased morbidity and mortality. Despite its high clinical significance, approaches in stratifying the risk for developing cachexia are sparse. The purpose of this study was to evaluate how the magnetic resonance imaging (MRI)-based proton density fat fraction (PDFF) of skeletal muscle correlates with cachexia development and evolves during the course of the disease.
**METHOD AND MATERIALS**

Thirty patients (24 male, mean age 63 years) with different tumor entities received a 3T-MRI using a 6-echo multi-echo gradient echo sequence of abdomen/pelvis for PDFF-mapping. 9 patients underwent between 1 and 4 follow-up scans (range of time interval: 49-335 days), resulting in 14 follow-up scans. Psoas muscle was segmented manually on one slice at the level of the 4th lumbar vertebral bilaterally. Psoas volume and PDFF were extracted. Body mass index (BMI) was calculated as weight (kg)/height (m)^2. Linear regression analysis was used to evaluate associations between the parameters.

**RESULTS**

Mean baseline values were: BMI 25.3±4.6 kg/m², psoas PDFF 9.2±3.6%, psoas volume 13.2±4.2 cm³. In the follow-ups, mean relative changes compared to baseline were: BMI -8±8%, PDFF 19±25%, volume -12±16%. At baseline, PDFF correlated with age (R²=0.21, p=0.01) and volume correlated with BMI (R²=0.2, p=0.01). In patients with follow-up scans, baseline PDFF correlated with the maximum change (i.e., in cases with >1 follow-up the highest relative change) in volume (R²=0.81, p<0.001) and tended to correlate with the maximum change in BMI (R²=0.38, p=0.08).

**CONCLUSION**

The present study demonstrates that in cancer patients, psoas volume correlated with BMI, while psoas PDFF correlated with age at baseline. Higher initial psoas PDFF was strongly associated with the severity of psoas volume loss and tended to correlate with the severity of loss of BMI, which is in line with previous studies reporting on muscle attenuation in computed tomography being a predictor of cancer outcome. These findings point to psoas PDFF representing a potential biomarker for predicting the severity of body composition changes during the course of the disease in cancer patients.

**CLINICAL RELEVANCE/APPLICATION**

Psoas muscle PDFF could represent a biomarker for risk stratification regarding the development and severity of cancer cachexia.

**SSC09-09 A Machine Learning Algorithm for the Assessment of Osteoporosis on Chest Radiographs**

**PURPOSE**

Assessment of bone mineral density has typically relied on dual-energy x-ray absorptiometry (DEXA). While osteopenia can be detected on radiographs, assessment is subjective with high interreader variability. The purpose of this study was to assess the ability of deep convolutional neural networks (DCNNs) to detect osteopenia and osteoporosis on chest radiographs (CXRs) based on objective bone mineral density measurements.

**METHOD AND MATERIALS**

Our dataset was comprised of 875 post-menopausal females who had undergone a DEXA scan and a PA and lateral CXR within 3 months of the DEXA scan. DEXA-derived T-scores of the lumbar spine were considered ground truth and used as labels for DCNN training on radiographs. Radiographs were split into 70% training and 30% testing, ensuring no patient overlap. Weighted augmentation was performed on the images using random geometric manipulations to increase data size. An attention-based network architecture was built on a variety of standard DCNNs including ResNet50 and VGG-16 and used for (1) classification between normal bone mineral density, osteopenia, and osteoporosis and (2) linear regression prediction of T-score. Classifier performance was measured using area under the curve (AUC) and regression assessed with the mean absolute error. Attention maps were produced to highlight areas of decision-making.

**RESULTS**

DCNNs trained on PA radiographs outperformed those trained on lateral radiographs. Classification algorithms detected osteopenia or osteoporosis (defined as T-score < -1.0) with AUC of 0.78 on PA radiographs and 0.73 on laterals (Fig. 1a,b). When limited to classifying between osteoporotic and normal radiographs, AUC reached 0.87. Best performing regression-based algorithms predicted T-scores with a mean absolute error of 1.89 on PA radiographs and 1.96 on laterals. Class activation maps primarily localized to structures such as the medial clavicles, spine, and sternum (Fig. 1c).

**CONCLUSION**

DCNNs, which can be trained on bone mineral measurements, can provide an objective method for the prediction of osteopenia and osteoporosis on chest radiographs, which suggests potential use for opportunistic screening of these conditions.

**CLINICAL RELEVANCE/APPLICATION**

We illustrate the potential for deep learning to objectively estimate bone mineral density on standard chest radiographs.
**PURPOSE**

It is well known clinically and by imaging that increased synovial joint fluid correlates with severity of osteoarthritis (OA). In recent years, image texture analysis has been used to evaluate various internal structures with a focus on neoplasms. Since synovial fluid chemical analysis can predict OA complexity, we sought to evaluate whether joint fluid texture on MR can be used as a biomarker for synovitis and OA severity.

**METHOD AND MATERIALS**

Fifty one adult patients (mean age: 57 years; 29 female, 22 male) with knee radiographs and fluid weighted knee MRI taken within 90 days of each other were retrospectively identified with exclusion criteria including acute trauma. Blinded scoring of knee OA severity was performed by a fellowship trained MSK Radiologist following the Kellgren-Lawrence classification guidelines. Through a semi-automated segmentation algorithm and 3D fluid texture analysis utilizing Life Image Feature Extraction software, a total of 45 texture features were analyzed for predictive value. Using receiver operating curve (ROC) and area under curve (AUC) analysis, we categorized patients with KL scores 0-1 into a none-minimal disease group and KL scores 2-4 into a moderate-severe disease group. Statistical analysis was performed through R version 3.4.4.

**RESULTS**

Our test group was composed of 5, 11, 18, 16, and 1 patients with KL grades 0, 1, 2, 3, and 4, respectively. The features most highly correlated with OA severity include synovial fluid compacity (p = 0.01) and volume (p = 0.04). The compacity and volume of synovial fluid had AUC values of 0.74 and 0.70, respectively. Other features that demonstrated significant correlation include grey level co-occurrence matrices which measure textures from voxel pair arrangements (p = 0.05-0.11, AUC = 0.67-0.69).

**CONCLUSION**

For the first time, texture analysis has been applied to synovial fluid and appears to be a biomarker for synovitis and OA severity.

**CLINICAL RELEVANCE/APPLICATION**

Patients clinically diagnosed with osteoarthritis may benefit from computational joint fluid texture analysis to determine disease severity and progression, management, response to treatment/therapy, and to assist in surgical planning.

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**Sub-Events**

**MK355-SD-MAA**

**MRI Texture Analysis of Synovial Fluid as a Predictive Biomarker for Synovitis and OA Severity**

**Participants**

F. Joseph Simeone, MD, Boston, MA (Moderator) Nothing to Disclose

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**PURPOSE**

It is well known clinically and by imaging that increased synovial joint fluid correlates with severity of osteoarthritis (OA). In recent years, image texture analysis has been used to evaluate various internal structures with a focus on neoplasms. Since synovial fluid chemical analysis can predict OA complexity, we sought to evaluate whether joint fluid texture on MR can be used as a biomarker for synovitis and OA severity.

**METHOD AND MATERIALS**

Fifty one adult patients (mean age: 57 years; 29 female, 22 male) with knee radiographs and fluid weighted knee MRI taken within 90 days of each other were retrospectively identified with exclusion criteria including acute trauma. Blinded scoring of knee OA severity was performed by a fellowship trained MSK Radiologist following the Kellgren-Lawrence classification guidelines. Through a semi-automated segmentation algorithm and 3D fluid texture analysis utilizing Life Image Feature Extraction software, a total of 45 texture features were analyzed for predictive value. Using receiver operating curve (ROC) and area under curve (AUC) analysis, we categorized patients with KL scores 0-1 into a none-minimal disease group and KL scores 2-4 into a moderate-severe disease group. Statistical analysis was performed through R version 3.4.4.

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Our test group was composed of 5, 11, 18, 16, and 1 patients with KL grades 0, 1, 2, 3, and 4, respectively. The features most highly correlated with OA severity include synovial fluid compacity (p = 0.01) and volume (p = 0.04). The compacity and volume of synovial fluid had AUC values of 0.74 and 0.70, respectively. Other features that demonstrated significant correlation include grey level co-occurrence matrices which measure textures from voxel pair arrangements (p = 0.05-0.11, AUC = 0.67-0.69).

**CONCLUSION**

For the first time, texture analysis has been applied to synovial fluid and appears to be a biomarker for synovitis and OA severity.

**CLINICAL RELEVANCE/APPLICATION**

Patients clinically diagnosed with osteoarthritis may benefit from computational joint fluid texture analysis to determine disease severity and progression, management, response to treatment/therapy, and to assist in surgical planning.
Research support, Royer Medical, Inc Research support, Zimmer Biomet Holdings, Inc Research support, Tomier, Inc Research support, Arthrex, Inc Research support, SpineSmith LP Research support, BioMimetic Therapeutics, Inc Support, Bioactive Surgical, Inc Support, Educational Concepts in Medicine, LLC Support, Smith & Nephew plc Support, OrthoHelix Surgical Designs, Inc Support, Chesapeake Surgical Biocomposites Support, Olympus Corporation Support, Omega Surgical Instruments Ltd

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Shadpour Demehri, MD, Baltimore, MD (Abstract Co-Author) Research support, General Electric Company; Research Grant, Carestream Health, Inc; Consultant, Toshiba Corporation

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PURPOSE

Osteochondral lesions of the talus (OLT) is defined as a separation of a fragment of articular cartilage which could be accompanied by the underlying subchondral bone. Previous studies have reported that magnetic resonance imaging (MRI) could offer comprehensive evaluation of the intra-articular lesions of the ankle. However, the overall evidence regarding the performance of MRI in diagnosing OLTs remains to be determined. Thus, in this study, we intend to investigate diagnostic performance of MRI in diagnosing OLTs, using arthroscopy or surgery as the standard of reference.

METHOD AND MATERIALS

A comprehensive literature search (until March 2019) was performed and original research studies reporting diagnostic performance of MRI and magnetic resonance arthrography (MRA) in the detection of OLTs were included. Pooled values of sensitivity and specificity were calculated using fixed or random effect models based on the level of heterogeneity.

RESULTS

Out of 887 identified records, 9 studies (424 MRI examinations) were included. None of the studies reported the diagnostic performance of MRA or 3T MRI. One study was performed with 1T scanner and the rest were performed by 1.5T scanner. Pooled values of sensitivity, specificity and diagnostic odds ratio (DOR) were 74.9% (95% CI: 65.8%-83.7%), 94.9% (95% CI: 89.9%-96.6%) and 56.0 (95% CI: 3.58-875.9), respectively. Pooled estimates of positive and negative likelihood ratios were 14.7 (1.2-181.6) and 0.26 (0.14-0.48), respectively. High degree of heterogeneity was observed for sensitivity (I2 =88%) and specificity (I2 =88%).

CONCLUSION

MRI has high level of specificity in detecting abnormality in a normal cartilage, however this modality doesn't have high sensitivity to rule out osteochondral lesions of talus. Given the paucity of current literatures, future investigation of the diagnostic performance for other advanced imaging modalities such as MRA and 3T MRI for OLT diagnosis are warranted in future studies.

CLINICAL RELEVANCE/APPLICATION

MRI exams performed with 1.5T or lower scanners are limited in providing data for correct diagnosis of OLTs, thus, the decision to perform surgery should not be solely based on MRI findings.

MK357-SD-MOA3 CT-Guided Core Needle Bone Biopsy in the Workup of Non-Spinal Osteomyelitis: Is it Necessary for Diagnosis and Treatment?

Participants
Cameron Smith, DO, Tulsa, OK (Abstract Co-Author) Nothing to Disclose
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PURPOSE

To examine the diagnostic yield of bone biopsy in the setting of potential non-vertebral osteomyelitis and its role in management.

METHOD AND MATERIALS

A retrospective review of thirty-five bone biopsies performed by a single institution for suspected osteomyelitis. Data collected and analyzed from these cases included biopsy location, wound culture, bone culture and pathology results, preoperative MRI and antibiotic therapy prior to and after culture results. Culture results were presented as negative or positive, which was used as the primary outcome for diagnostic yield. Nine of the thirty-five cases were excluded from analysis due to incomplete culture results or unknown use of antibiotic therapy. A total of twenty-six cases were included in the final analysis.

RESULTS

Of the twenty-six cases reviewed, 30.8% were diagnostic of an organism on culture. Of the eight positive cases, six had a change in antibiotic therapy based on the bone culture results. Of the eight cases with positive bone culture results, six had identical wound culture results. MRI positive findings for osteomyelitis showed a statistically significant association with antibiotic therapy (p = 0.0004) versus no significance seen with culture positive results (p = 0.428).

CONCLUSION

From our study, image-guided biopsy is a relatively low-yield procedure. In most cases, bone biopsy plays a minor role in management decisions as approximately 70% of biopsies were negative with no change in treatment. Based on our review, MRI and wound culture is possibly adequate to diagnose osteomyelitis with little value added when biopsy was performed. This is supported by other recent radiology literature and counters the clinical literature; which strongly suggests bone biopsy for diagnosis.
Our research suggests there is a discord between radiology and clinical literature concerning the expected yield of bone biopsy and culture, as well as the importance of a biopsy in clinical decision making. This could be an avenue for the creation of general consensus guidelines between musculoskeletal radiology and clinical specialty societies in cases of suspected non-vertebral osteomyelitis cases.

**The MOCART 2.0 (Magnetic Resonance Imaging of Cartilage Repair Tissue): Knee Score and Atlas**

**PURPOSE**
Since the first introduction of the MOCART score, a widely used semi-quantitative scoring system for the morphological assessment of cartilage repair tissue, significant progress has been made with regard to both surgical treatment options as well as magnetic resonance imaging (MRI) of such defects. Thus, the aim of this study was to introduce the MOCART 2.0 knee score - an incremental update on the original MOCART score - that incorporates this progression.

**METHOD AND MATERIALS**
The degree of defect filling is now assessed in 25% increments. Severity of surface damage is determined in reference to cartilage repair length rather than depth. The signal intensity of the repair tissue is scored as minor abnormal or severely abnormal on a proton density-weighted TSE sequence only and differentiates between hyperintense and hypointense signal alterations. The assessment of the variables 'subchondral lamina', 'adhesions' and 'effusion' was removed and replaced by the newly introduced variable 'bony defect or bony overgrowth'. Four independent readers (two expert readers and two radiology residents with limited experience) assessed the 3 Tesla MRI examinations of 24 patients after cartilage repair using the new MOCART 2.0 knee score. Inter-rater and intra-rater reliability was assessed using intraclass correlation coefficients (ICCs).

**RESULTS**
The overall inter-rater (ICC = 0.88, p < 0.001) as well as the inter-rater (ICC = 0.84, p < 0.001) reliability of the expert readers was almost perfect. Based on the evaluation sheet of the MOCART 2.0 knee score, the overall inter-rater reliability of the inexperienced readers compared to expert reader 1 was moderate (ICC = 0.45, p < 0.01). With the additional use of the atlas, the overall inter-rater reliability of the inexperienced readers was substantial (ICC = 0.63, p < 0.001).

**CONCLUSION**
The MOCART 2.0 knee score was updated to account for important changes in the past decade and demonstrates almost-perfect inter- and intra-rater reliability in expert readers. In inexperienced readers use of the atlas may improve inter-rater reliability.

**Calcaneofibular Ligament Anatomy Under Different Ankle Positions**

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

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

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

**CONCLUSION**
Our 3D MRI images showed that, in all positions, the CFLs were curved due to the influence of the peroneal muscle tendons. With maximum plantar flexion, the CFL tortuosity angles were small, which is probably due to CFL tension. This should be considered when diagnosing CFL injuries and evaluating treatment outcomes.
Clarification of the normal CFL functional anatomy will aid to diagnose CFL injuries and may facilitate accurate evaluations of treatment outcomes.

**MK302-ED-MOA8**

**Ultrasound-Guided Therapeutic Interventions for Pelvic Neuropathy**

**Station #8**

**Participants**
Christopher J. Burke, MBChB, FRCR, New York, NY (Presenter) Nothing to Disclose
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**TEACHING POINTS**

Pelvic neuropathy can be attributed to a range of etiologies including nerve compression, recurrent microtrauma, iatrogenic injury and entrapment. Ultrasound-guided percutaneous injections techniques will be described with respect to the sciatic, pudendal, lateral femoral cutaneous, obturator, ilioinguinal and iliohypogastric nerves. For patients with recurrent pain following an initial therapeutic injection, neurolysis using ablation techniques can be a useful secondary therapeutic options.

**TABLE OF CONTENTS/OUTLINE**

Patients with neurogenic pelvic pain may present with varying complaints depending on the nerve involved including neuropathic pain, paresthesias, and other symptoms such as dyspareunia. Many of these pelvic pain syndromes are amenable to percutaneous ultrasound (US) guided treatment. Locally delivered anesthetic and anti-inflammatory drugs have been shown to aid in diagnosis and therapy. Neurolysis using cryotherapy or alcohol ablation are useful secondary therapeutic options. Utilizing US guidance has multiple advantages including safe real-time needle localization, avoidance of ionizing radiation, and reduced cost. An overview of technical approaches to various percutaneous US-guided pelvic nerve interventions with associated correlative pathological US and MRI findings is presented.

**MK303-ED-MOA9**

**Bursa, Bursa, Bursa: Interventional Tactics and Tips for Radiologists**

**Station #9**

**Participants**
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**TEACHING POINTS**

There are numerous bursae throughout the human body which can become clinically symptomatic. Knowledge of the location of these bursae and their surrounding anatomy is important for both diagnostic and interventional purposes. Familiarity with several commonly symptomatic bursae within the human body enables radiologists to aspirate or inject these spaces with ease.

**TABLE OF CONTENTS/OUTLINE**

The purpose of this educational exhibit is to spotlight several potentially symptomatic bursae in the human body with a focus on their anatomy, imaging appearance and interventional treatment options available. • Review the general structure and function of bursae in the human body. • Highlight several commonly symptomatic bursae in the human body including the: olecranon bursa, subacromial-subdeltoid bursa, iliofemoral bursa, greater trochanteric bursa and ischiogluteal bursa. • For each described bursa, we will provide typical indications for intervention as well as tactics and tips for interventions. • Modalities featured for interventions will include ultrasound and fluoroscopy. There are many bursae in the human body which can become symptomatic. With knowledge of these various bursae and their percutaneous therapeutic options, radiologists readily can offer meaningful interventions to referring physicians and their patients.

**MK304-ED-MOA9**

**Diffusion Tensor Imaging Application as a Prognostic Biomarker in Carpal Tunnel Syndrome after Decompression Surgery**

**Station #10**

**Participants**
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**TEACHING POINTS**
This presentation aims to discuss: 1 - How diffusion tensor imaging parameters, especially FA, may have a prognostic value to the carpal tunnel syndrome after decompressive surgery. 2 - Visual assessment of the path and location of the median nerve fibers for surgical purposes 3 - Correlation between FA, ADC and clinical evaluation can lead to a more accurate prognosis.

**TABLE OF CONTENTS/OUTLINE**

1. Overview of DTI application in carpal tunnel syndrome pre-operative investigation and surgical planning. 2. Case reports evidencing the importance of pre- and post-surgical assessment of median nerve using DTI. 3. Surgical outcomes of DTI in carpal tunnel syndrome.

**MK305-ED-MOA11**  
**Don’t Forget the Patella: CT and MRI Imaging Spectrum of Patellar Injuries**

**Awards**

**Certificate of Merit**

**Participants**

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**TEACHING POINTS**

- There is a wide range of patellar injuries and the radiologist must be aware of them, because a misdiagnosed can end with femoro-patellar instability.  
- Computed tomography imaging substantially aid in the identification of patellar injuries on a qualitative and quantitative way.  
- Familiarity with imaging abnormalities and patterns of involvement in different patellar injuries allows the radiologist to suggest the correct diagnosis and impact management.

**TABLE OF CONTENTS/OUTLINE**

1. Discuss the clinical relevance of detection and characterization of the patellar injury. 2. Recognize the CT as a tool of particular value when imaging patellar anomalies. 3. To evaluate the imaging findings in normal and abnormal patella. 4. Illustrate classic examples of the different patellar imaging variations.

**MK306-ED-MOA12**  
**Fascia Disorders Around the Body**

**Awards**

**Certificate of Merit**

**Participants**

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Marcelo d. Petrilli, Sao Paulo, Brazil (Abstract Co-Author) Nothing to Disclose

**TEACHING POINTS**

The purpose of this study is to discuss the 5 main causes of fascia abnormalities, showing the imaging findings of these alterations in the different fascia of the body, and its differential diagnoses.

**TABLE OF CONTENTS/OUTLINE**

1. Review of diseases related to fascia divided in the 5 main causes: - OVERUSE / ATRICTION: iliotibial band syndrome, plantar fasciitis and complications such as rupture and Baxter neuropathy; - IATROGENIC AND NON-IATROGENIC TRAUMA: acute trauma of the plantar fascia, fascia lata and deltoretapezial fascia and iatrogenic trauma due to surgery and drug infiltration; - SUPERFICIAL AND DEEP FIBROMATOSIS: Plantar fibromatosis or Ledderhose disease; Dupuytren contracture or palmar fibromatosis; Desmoid-type fibromatoses; - INFECTIOUS: Necrotizing fasciitis and tuberculous fasciitis; - MISCELLANEOUS: Nodular fasciitis, eosinophilic fasciitis, calcific deposits.

Printed on: 01/19/20
"Salt and Pepper" Sign on Fat Fraction Map by IDEAL-IQ: Useful MR Sign for Differentiating Bone Islands from Osteoblastic Metastases

**PURPOSE**
To analyze the diagnostic performance of fat fraction map by complex-based chemical shift imaging-based MRI (CSE-MRI) differentiating between bone islands and osteoblastic metastases, with emphasis on the value of the "salt and pepper" sign, as compared with CT attenuation value.

**METHOD AND MATERIALS**
From April 2008 to March 2018, total 37 patients (age range, 39-82 years; mean age, 63 years) with 50 sclerotic vertebral bone marrow lesions (24 bone islands, 26 osteoblastic metastases) were included. All patients underwent CT and MR imaging, including CSE-MRI sequence with a 1.5T MR system. Salt and pepper sign was defined as speckled appearance of white and black pixels that is similar to the background air on fat fraction map. Receiver operating characteristic (ROC) curve analysis was assessed to compare the diagnostic performance between salt and pepper sign, halo sign on fat-suppressed T2-weighted image, and CT attenuation value for differentiating bone islands from osteoblastic metastases.

**RESULTS**
The salt and pepper sign was present in 100% (24/24) patients with bone islands and 3.8% (1/25) patients with osteoblastic metastases. Area under the curve (AUC) were 0.981 (95% confidence interval (CI), 0.895-1.000) for salt and pepper sign on fat fraction map, 0.921 (95% CI, 0.810-0.979) for halo sign on fat-suppressed T2-weighted image, and 0.989 (95% CI, 0.908-1.000) for mean CT attenuation value. There was no significant difference, although halo sign on fat-suppressed T2-weighted image showed relatively lower diagnostic performance for differentiation between bone islands and osteoblastic metastases.

**CONCLUSION**
The salt and pepper sign on fat fraction map by IDEAL-IQ is featured in bone islands, and it can be a useful finding to differentiate from osteoblastic metastases.

**CLINICAL RELEVANCE/APPLICATION**
Salt and pepper sign on fat fraction maps by CSE-MRI allows to assess sclerotic bone marrow lesions and can improve diagnostic accuracy differentiating bone islands and osteoblastic metastases on MRI.

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**Septic Arthritis in Shoulder: Diagnostic Clues on Indirect MR Arthrography**

**PURPOSE**
The purpose of this study is to determine the diagnostic clues for septic arthritis in shoulders on indirect MR arthrography by comparing MR findings between shoulders with septic arthritis and full-thickness rotator cuff tears.

**METHOD AND MATERIALS**
22 patients (8 male and 14 female; mean age, 67.8 years) who underwent arthroscopic lavage for treatment of septic arthritis of shoulders were included as a study group. Forty-three patients (17 male and 26 female; mean age, 64.6 years) who underwent arthroscopic repair for treatment of full-thickness rotator cuff tears were included as a control group. Both groups...
underwent preoperative indirect MR arthrography of shoulders. MR findings analyzed were the presence of low signal intensity of the fluid in axillary recess, subcoracoid recess, subscapular recess, and subacromial-subdeltoid bursa (SASD) on T1-weighted image (T1WI) (which was presumed as a diffusion-restriction of contrast media) and on T2-weighted image (T2WI), bone edema, and soft tissue edema. The volume of the glenohumeral joint, recesses and bursa were measured using a software (Aquarius iNtuitionTM).

RESULTS

Low signal intensity of fluid in the recesses and bursa on T1- and T2WI and edema in the soft tissue and bone were statistically significant findings for septic arthritis of shoulders in univariate analysis. However, in multivariate analysis, low signal intensities of fluid in the subscapular recess and SASD on T1WI were the only reliable findings (odds ratio = 75.8, p-value = 0.023 in subscapular recess; 46.3, 0.027 in SASD). The positive predictive values for low signal intensity in the subscapular recess and SASD were 94% and 92%, respectively. The volumes of the glenohumeral joint, recesses, and bursa were not statistically significant factors for septic arthritis of shoulders.

CONCLUSION

Low-signal intensities of the fluid in the subscapular recess and SASD on T1WI, presumed as diffusion-restriction of contrast media in the fluid, were the most reliable findings for diagnosing septic arthritis of shoulders on indirect MR arthrography.

CLINICAL RELEVANCE/APPLICATION

Indirect MR arthrography of the shoulder could give strong clues for diagnosis of septic arthritis by finding of diffusion-restriction of contrast media in joint fluid.

MK360-SD- Benign Bone Tumors Percutaneous Treatment: There is Life Beyond Osteoid Osteoma

Participants
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PURPOSE

We review our experience with percutaneous treatment of benign tumor bone conditions different from osteoid osteoma.

METHOD AND MATERIALS

For the last fifteen years, we have performed 46 percutaneous ablations for the treatment of different benign bone tumours other than osteoid osteoma. 26 (56.5%) patients were female and 20 (43.5%), male. Mean age: 26.1±1.9 years (range 8 to 58 years). Location: femur (13 cases), pelvic ring (9), spine (6), tibia (6), foot (5), manus (2) hand (2), fibula (2) and radius (1). Follow-up period: 24-36 months. Percutaneous radiofrequency thermal ablation (RFA) was used in all of the patients in the first instance. Ablation was repeated in 6 cases (4 RFA and 2 cryoablations). In 10 cases these techniques were combined with cementoplasty. A biopsy was obtained in all cases in order to provide a histological diagnosis, although in 15 cases the sample was taken just before the ablation procedure. The histological results were: 9 chondroblastomas, 9 osteoblastomas, 6 giant cell tumours, 6 aneurysmal bone cysts, 3 enchondromas, 3 fibrous dysplasia, 2 osseous fibromas, 2 intraosseous ganglia, 2 mesenchymal tumours, and 4 other diagnoses (1 chondroma, 1 osteoblastomatosis, 1 eosinophilic granuloma and 1 osseous hemangioma).

RESULTS

All procedures were technically successful considering that the patients were pain-free by the seventh-tenth days, except in six patients (three osteoblastomas, two chondroblastomas, and one fibrous dysplasia) in which percutaneous ablation was repeated. A unique case of osteoblastoma needed further surgery. As delayed complications, three patients developed a pathologic fracture after RFA and two patients with intraarticular lesions developed osteoarthrosis.

CONCLUSION

CT-guided percutaneous ablation treatment is a safe technique that can be applied with curative intent on benign bone tumours other than osteoid osteoma.

CLINICAL RELEVANCE/APPLICATION

Our aim is to share our experience with percutaneous thermal ablation in benign bone tumours other than osteoid osteoma to widespread its use as a modality of choice for the treatment of these lesions.

MK383-SD- DECT for Detecting Gout: Problem-Solving Technique versus Problem-Causing Technique - Evaluation of Clumpy Artifact in Foot and Ankle DECT from Gout-Free Patients

Participants
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Jin Hee You, MD, Jeonju, Korea, Republic Of (Abstract Co-Author) Nothing to Disclose

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PURPOSE
To evaluate the frequency and common sites of the clumpy artifact and see if it interferes with radiologists making a gout diagnosis, and to evaluate whether clumpy artifacts can be reduced by changing the minimum Hounsfield unit (HU) and using dual energy computed tomography (DECT) with a selective photon shield (SPS).

METHOD AND MATERIALS
Thirty-three gout-free patients underwent DECT. Set 1 was composed of 22 patients using DECT without an SPS with a minimum HU of 130 or 150. Three reviewers (2 musculoskeletal (MSK) and 1 general radiologist) checked the presence of green pixilation. A confidence level was assigned for clumpy artifacts based on a 4-point scale. Set 2 was composed of 11 patients using DECT with an SPS. Three reviewers checked for the presence of clumpy artifacts.

RESULTS
The frequency and volume of clumpy artifacts in set 1 decreased when minimum the HU was set to 150 compared with 130 (68% vs. 81%, p=0.48; 0.10 cm3 vs. 0.34 cm3, p<0.001). Though the difference did not reach statistical significance, the specificity was higher when the minimum HU was set to 150, and this was more evident with the general radiologist (MSK specialist=77.2% vs. 66.1%, p=0.31; general radiologist=68.1% vs. 45.4%, p=0.05). The confidence score increased when the minimum was HU set at 150 compared to 130 (MSK specialist=2.42 vs. 1.75, p=0.08; general radiologist=1.83 vs. 1.25, p=0.01). Clumpy artifacts were most common in the forefoot at minimum HU of both 150 and 130. Most clumpy artifacts (91%) were noted at tendons, the flexor tendon being the most common site, followed by the peroneus tendon and tibialis posterior tendon. While clumpy artifacts were frequent in set 1, no patients in set 2 showed clumpy artifacts.

CONCLUSION
Clumpy artifacts are very common with DECT without an SPS, and this interferes in making a diagnosis of gout. When the minimal HU is set to 150 compared to 130, the frequency and volume of clumpy artifacts decrease, and this increases specificity and confidence level, especially for general radiologists. With an SPS inserted in DECT, the clumpy artifact is not shown.

CLINICAL RELEVANCE/APPLICATION
From this study, radiologists will be able to optimize their settings and recognize common sites of clumpy artifacts. This will 1) minimize wrong diagnosis, 2) minimize unnecessary treatment, and 3) allow gout-mimicking lesions (including infection and inflammatory arthritis) to be diagnosed properly.
Weight-Bearing Syndesmotic Measurements in Ankle Injuries: Comparison with the Normal Side

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PURPOSE
Assessment of syndesmotic injuries in ankle fractures can be a challenging task. Although CT images provide a comprehensive visualization of the ankle joint, prior reports on CT scan was not performed under weight bearing (WB). Besides, comparison to the normal side is recommended to provide a better assessment. Thus, we intend to perform syndesmotic measurements on WB images and compare the results with the normal contralateral side, using a semi-automatic software on images obtained from Cone Beam CT (CBCT)

METHOD AND MATERIALS
Patients with prior unilateral ankle injuries were recruited and were bilaterally scanned 12 weeks following the injury in both WB and non-weight-bearing (NWB) conditions. Twelve syndesmosis measurements were obtained by two readers using JMAT (Brehler et al SPIE Med Im 2017). This software package was developed to provide multi-planar rendering of the CBCT volumes to guide the user through selection of anatomical points and compute the measurements. At 10 mm above tibial plafond, 5 diastasis measurements including ATFD, PTFD, TFCS, diastasis and angular measurements, 3 rotation and 2 translation measurements were performed. At 5 mm below talar dome, medial and lateral clear space (MCS and LCS) were obtained. WB and NWB measurements were compared between injured and normal ankles using paired t-test

RESULTS
Nine men and 16 women with mean age of 45 years were included. Fourteen patients underwent operative treatment for their ankle fracture without receiving syndesmotic fixation and the rest received non-operative treatment. In WB images, mean values of Tang rotation and MCS were significantly higher in the injured side than the normal ankle (P-value<0.05). In NWB images, mean values of Tang rotation were significantly higher in the injured ankle than the normal side (P-value<0.05). Mean values of angular measurement in both WB images (P-value<0.001) and NWB images (P-value=0.01) were significantly lower on the injured side

CONCLUSION
Comparison with the contralateral asymptomatic ankles, the ankles with fractures have distinct tibiofibular syndesmotic measurement differences between WB and NWB scan acquisitions

CLINICAL RELEVANCE/APPLICATION
In order to improve the detectibility of syndesmotic injuries, distinct tibiofibular syndesmosis measurements may be used in clinical practice according to the weight bearing mode of image acquisition (WB vs NWB) using dedicated extremity CBCT

Ultrasound MSK Guided Intervention: Tips and Tricks

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TEACHING POINTS
1. Describe typical ultrasound abnormalities observed on most common MSK pathologies treatable by percutaneous US-guided procedures 2. A step-by-step demonstration of the most frequently performed MSK percutaneous US-guided procedures with videos and US images

TABLE OF CONTENTS/OUTLINE

Interventional Musculoskeletal Ultrasound Techniques: A Review
Awards
Magna Cum Laude
Identified for RadioGraphics

Participants
Junzi Shi, MD, Boston, MA (Presenter) Nothing to Disclose
Jacob C. Mandell, MD, Waltham, MA (Abstract Co-Author) Nothing to Disclose
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TEACHING POINTS
1. Ultrasound-guided interventions for musculoskeletal applications are minimally invasive procedures with low risk and good outcome for a variety of indications. 2. To review the indications, interventional methods, contraindications, and potential complications of various interventional MSK ultrasound procedures.

TABLE OF CONTENTS/OUTLINE
1. Review normal musculoskeletal ultrasound anatomy 2. Clinical signs/symptoms, pathophysiology of injury and abnormal findings as seen on diagnostic ultrasound imaging 3. Interventional musculoskeletal ultrasound techniques in various joints, including the shoulder, elbow, wrist/hand, hip, knee, and ankle/feet 4. Follow-up management 5. Outcomes and potential complications 6. Future directions, a brief discussion of advance techniques for example 3D ultrasound imaging and ultrasound-magnetic resonance imaging fusion

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TEACHING POINTS
Pelvic pain is a complex and challenging diagnosis which can arise from a variety of different pathological processes including neuropathic pain, referred pain, injuries, and inflammatory conditions. Ultrasound guided perineural injections allow the radiologist to play a crucial role in the diagnosis and treatment of chronic neuropathic pain in the lower abdominal wall and groin. Through the injection of anesthetic, or a combination of anesthetic and steroid, the radiologist may confirm the source of the patient’s pain and guide further management. The radiologist may also assist in the work up of postoperative groin pain. As a tertiary referral center for chronic pelvic pain, we would like to share our experience with nerve blocks in the groin and compare our data with what has been published thus far.

TABLE OF CONTENTS/OUTLINE
Introduction Overview of pelvic pain imaging - Pubalgia protocol MRI Indications for procedure Diagnostic versus therapeutic Pre- and post-operative ultrasound technique and approach Results Our institution Published data Ideas for further research Conclusion

Participants
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Vinil Shah, MD, San Francisco, CA (Abstract Co-Author) Nothing to Disclose
Jesse L. Courtier, MD, San Francisco, CA (Abstract Co-Author) Founder, Sira Medical, Inc; Consultant, Sira Medical Inc

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TEACHING POINTS
Learner should have a knowledge of current and future applications of DTI within the peripheral nervous system. Learner should have a basic understanding of the theoretical underpinnings of DTI.

TABLE OF CONTENTS/OUTLINE
SSE15

Musculoskeletal (Accelerated Imaging)

Monday, Dec. 2 3:00PM - 4:00PM Room: N228

Purpose

Compressed sensing (CS) allows to accelerate 2D and 3D scans promising higher acceleration factors than previous parallel imaging techniques. This study evaluated potential clinical acceleration factors of SENSE and Compressed SENSE (combination of Compressed Sensing and SENSE) for a fat saturated 2D sagittal and 3D PD sequence in the knee.

Method and Materials

Twenty-one healthy volunteers were scanned with a 3T scanner (Ingenia, Philips, Best, Netherland). All received a standard, commercially available sagittal, fat saturated 2D PD (SENSE 1.4) and three CS (CS2, CS3, CS5) and the time-equivalent SENSE accelerations. The 3D sequence (SENSE 2.0) was acquired with four CS (CS6, CS8, CS10 and CS15) and the equivalent SENSE factors. The images were rated by three independent readers (two radiologists and one orthopedic surgeon) with at least 5 years of experience in MRI imaging regarding diagnostic certainty and overall image impression on a 5-Point-Likert-scale. The non-parametric subjective scoring was analyzed with the Friedmann test for statistical significance and the Dunn’s test for post-hoc analysis.

Results

The standard sequences lasted for 221 seconds (2D) and 384 s (3D). The scan time decreased with increasing CS factor (2D CS2: 145 s, 2D CS3: 95 s, 2D CS5: 57 s, 3D CS6: 293 s, 3D CS8: 220 s, 3D CS10: 176 s, 3D CS15: 119 s). The 2D standard sequence was rated best for diagnostic certainty and overall image impression with an average of 4.95±0.21 and 4.78±0.42, statistical superior in both parameters for all sequences (all p<0.05) except for 2D CS2, 2D S2 and 3D standard. The 3D standard performed only better than 3D CS15 regarding the 3D CS sequences but better than all 3D SENSE accelerations except for the lowest (SENSE 2.2). The post-hoc analysis showed only significant differences for the fast 3D accelerations of CS10 vs. S2.9 (p<0.0001) and CS15 vs. S3.5 (p=0.0002).

Conclusion

Compressed Sensing can significantly decrease (34% for 2D and 54% for 3D) the scan time for PD sequences of a knee MRI with unchanged diagnostic certainty and overall image impression compared to the clinical reference. The new technique proved especially valuable for fast 3D accelerations.

Clinical Relevance/Application

The application of Compressed Sensing can increase the patient compliance and can reduce healthcare cost for MR imaging due to significant decreased scan times.

SSE15-01 Acceleration in Knee MRI: Compressed Sensing for 2D and 3D Applications

Participants

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Sub-Events

SSE15-02 Next-Generation 5-Min Knee MRI with Combined Simultaneous Multislice and Parallel Imaging Acceleration: Ready for Prime Time?

Participants

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PURPOSE

2-fold parallel imaging (PI) acceleration can realize 5-min 2D FSE MRI of the knee, but the associated signal loss may require compromises in image quality and anatomical coverage. In contrast, 2-fold simultaneous multi-slice (SMS) acceleration is near signal neutral. Advances in pulse sequence design now allow for the combined use of PI and SMS to enable 4-fold-accelerated 2D FSE, which can achieve fast MRI with higher image quality and improved coverage. We compared traditional 2-fold PI- and novel 4-fold SMS-PI-accelerated 2D FSE MRI of the knee for the detection of internal derangement.

METHOD AND MATERIALS

Following IRB approval and informed consent, 25 symptomatic patients [12 women, 13 men; age 44 (18-64) years] prospectively underwent 1.5T MRI of the knee, including a 2-fold PI-accelerated 5-min 2D FSE MRI protocol, and a 4-fold SMS-PI-accelerated 5-min 2D FSE MRI protocol with higher spatial resolution, higher anatomic coverage, smaller inter-slicer gaps, improved suppression of vascular flow artifacts, and stronger and more homogenous fat suppression. Both protocols included sagittal PD, sagittal PDFS, coronal T1, coronal T2FS, axial PDFS sequences. Two MSK radiologists independently assessed image contrast, noise, artifacts, structural visibility, and abnormalities. Non-parametric comparison, kappa agreement, and interchangeability tests were applied.

RESULTS

The inter-reader reliability (kappa=0.681) was good. 5-min SMS-PI MRI of the knee had better image contrast (p<0.001), less noise, (p>0.001), better structural visibility (p<0.001), and no flow or aliasing artifacts (p=0.657). There was unidirectional interchangeability in favor of SMS-PI MRI for the diagnosis of meniscal tears and cartilage defects, and bidirectional interchangeability for anterior cruciate and collateral ligament tears, tendon tears, bone marrow edema pattern, and fractures.

CONCLUSION

Combined, 4-fold-accelerated SMS-PI 2D FSE enables artifact-free 5-min MRI of the knee with higher image quality, better visibility of anatomic structures, and possibly better detectability of cartilage defects and meniscal tears than 2-fold PI-accelerated 5-min 2D FSE MRI of the knee.

CLINICAL RELEVANCE/APPLICATION

The validation of short knee MRI protocols without image degradation are essential to increase MR efficiency in clinical practice.

SSE15-03 Comparison of Modulated Flip Angle in Refocused Imaging with Extended Echo Trains with Compressed Sensing (CS-MATRIX) and Conventional Two-Dimensional Sequences on Knee Imaging

Monday, Dec. 2 3:20PM - 3:30PM Room: N228

Participants

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PURPOSE

To evaluate and compare the image quality and diagnostic agreement of an isotropic 3D fast spin echo (FSE) sequence, which employs modulated flip angle technique in refocused imaging with extended echo trains with compressed sensing (CS-MATRIX), to conventional 2D sequences for knee at 3T.

METHOD AND MATERIALS

Forty-four knees from 42 symptomatic patients (mean age: 43.5±14.9 years) were examined on a 3T MR scanner (uMR780, United Imaging Healthcare, Shanghai, China) with 2D T2-weighted fat suppressed (T2-fs) sequence, proton density-weighted (PD) sequence and isotropic 3D CS-MATRIX sequence. A four-point scale (4=Excellent, 3=Good, 2=Acceptable, 1=Poor; based on clarity of anatomical structures, and possibly better detectability of cartilage defects and meniscal tears than 2-fold PI-accelerated 5-min 2D FSE sequences for knee at 3T.

RESULTS

For image quality, no significant difference in scoring was found between 3D CS-MATRIX T2-fs and 2D T2-fs sequences (mean score=3.29±0.63 and 3.34±0.68, p=0.715), however, the scores of images obtained from 2D PD was significantly higher than those of 3D CS-MATRIX PD sequence (mean score=3.84±0.37 and 3.57±0.50, p<0.05). In diagnostic agreement evaluation, there was a very good agreement between 3D CS-MATRIX and 2D sequences for detecting cartilage lesions (κ=1.000), and bone marrow edemas (κ=0.955). Moreover, the diagnostic agreement was good to very good in grading evaluation of medial and lateral menisci tears (κ=0.748, κ=0.936), as well as of anterior and posterior cruciate ligaments tears (κ=0.725, κ=1.000).

CONCLUSION

The 3D CS-MATRIX sequences allow for faster knee imaging over conventional 2D sequences, while yielding much the same image quality as 2D T2-fs sequences. In addition, 3D CS-MATRIX sequences could present similar diagnostic value in evaluating lesions in cartilage, bone marrow, menisci and cruciate ligaments as 2D sequences.
CLINICAL RELEVANCE/APPLICATION

3D CS-MATRIX sequence has become a non-invasive technique for evaluating knee joint lesions, while providing higher time-efficiency than 2D sequences in magnetic resonance imaging.

SSE15-04  Highly Accelerated 2D Spine Imaging Using Compressed Sensing: Evaluation of Scan Time and Subjective Image Quality

Monday, Dec. 2 3:30PM - 3:40PM Room: N228

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PURPOSE

Imaging of the spine, with 2D as the clinical standard, is the most common examination for MRI and its duration has a large impact on the clinical scan schedule and healthcare costs. Due to susceptibility to field inhomogeneities and motion artifacts of the bowel and aorta, acceleration techniques remain challenging for sagittal sequences, resulting in comparable low net acceleration factors. The new acceleration technique Compressed Sensing promises higher acceleration factors. In this study Compressed SENSE (combination of Compressed Sensing and SENSE) was evaluated for accelerated sagittal T2 imaging of the lumbar spine using gradient echo (GE) and turbo spin echo (TSE) based prescans.

METHOD AND MATERIALS

All scans were performed on a 3T scanner (Ingenia, Philips, Best, Netherlands). Sixteen patients received the standard spine protocol including a sagittal T2 sequence (SENSE factor 1.4, 266 seconds) and three different CS acceleration factors (CS2: 172s, CS3: 109s and CS4: 78s). An additional TSE prescan (35s) was acquired to compare the reconstructions based on the common GE and the TSE prescan. The images were rated by two independent readers (experts in musculoskeletal and neuroradiology) regarding diagnostic certainty and overall image impression on a 5-Point-Likert-scale. The non-parametric subjective scoring was analyzed with the Friedmann test for statistical significance and the Dunn’s test for post-hoc analysis.

RESULTS

The diagnostic certainty (4.75±0.41) and overall image impression (4.63±0.50) were rated highest for the CS2 with a TSE prescan (TSE CS2) although not with a statistically significant difference to the standard T2 (4.72±0.41 and 4.56±0.51). The standard T2 showed significant better overall image impression compared to the CS3 (p<0.0001) and CS4 (p<0.0001) accelerations with GE prescan while none of the TSE prescan sequences or the CS2 with GE prescan was significant worse.

CONCLUSION

The combination of the standard T2 with the GE prescan (266s) offered unchanged diagnostic certainty and overall image impression than CS2 with the GE prescan (172s) or CS4 with the TSE prescan (112s).

CLINICAL RELEVANCE/APPLICATION

Compressed Sense with the GE prescan (~35%) and especially with a TSE prescan (~58%) drastically reduces the scan time for the sagittal T2 sequence with unchanged subjective scoring. Similar reductions for additional sagittal scans (T1, T2 fat saturated) within the protocol should be feasible.

SSE15-05  Compressed Sensing-Sensitivity Encoding (CS-SENSE) Accelerated MR Brachial Plexus Imaging: Reduced Scan Time without Reduced Image Quality

Monday, Dec. 2 3:40PM - 3:50PM Room: N228

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PURPOSE

3D Contrast-enhanced nerve-view Imaging provides has very high clinical value for brachial plexus nerve trauma, tumor etc. However, relatively long acquisition time (above 10min) limits its clinical application. The aim of this study was to reduce the scan time of 3D Nerve-view using Compressed Sensing-Sensitivity Encoding (CS), and evaluate the image quality and capability of diagnosis of accelerated 3D Nerve-view sequences.

METHOD AND MATERIALS

In a consecutive cohort of 15 patients with suspected disease of brachial plexus underwent MR studies. 3D Nerve-view sequences with 6 different CS accelerating factors (4,6,8,10,15,20), and a traditional 3D Nerve-view with 2-fold parallel imaging (sense) as a clinical reference were obtained on a 3T scanner (Ingenia CX, Best, Philips Healthcare). Images were graded by 2 experienced radiologists in MR neurography for image quality (scale of 1 to 5). An Objective quantification analysis of SNR and CNR were also
performed. Beyond that, the similarity between images of the 3D standard sequence and the accelerated sequences was evaluated using the pixelwise root mean square error (RMSE) and structural similarity index (SSIM). The scan time of each sequence were measured. An analysis of variance with repeated measurements and the Friedman test was used to test for potential difference between the sequences.

**RESULTS**

The mean values of the RMSE ranged from 73.38 ± 15.91 for CS 8 to 234.66 ± 43.56 for CS 10, while SSIM was highest for CS 4 with 95.11% ± 2.23% and lowest for CS 20 with 87.90% ± 5.32%. The scan time using sense2,CS2,4,6,8,10,15,20 is 11min09s,5min50s,3min55s,2min36s,2min23s,1min35s,1min13s respectively. The two radiologists evaluated all images and mean scored 4.1±0.3 with CS factor below 8. There is no statistical difference in the contrast between the brachial plexus and the surrounding tissue between CS factor 4-8, and the lesion display of the brachial plexus has no statistical difference. The images of CS factor above 8 have no diagnosis value.

**CONCLUSION**

In conclusion, CS-3D Nerve-view with factor 8 offer equilibrium between comparable clinical diagnostic quality with less scan time (2min56s)

**CLINICAL RELEVANCE/APPLICATION**

CS-3D Nerve-view with factor 8 offer equilibrium between comparable clinical diagnostic quality with less scan time , which potentially increasing the productivity of MR scanners.

SSE15-06  Compressed Sensing SEMAC MRI of Hip and Knee Arthroplasty Implants at 1.5T and 3T Field Strengths: An Intra-Subject Comparison Study

**Purpose**

Metal artifact reduction MRI of metallic arthroplasty implants at 1.5T field strength has inherently lower susceptibility artifacts than at 3T field strength. However, 3T MRI offers higher signal-to-noise and contrast-to-noise ratios, and allows for higher spatial resolution. In this study, we tested the hypothesis that compressed-sensing (CS) accelerated slice-encoding-for-metal-artifact-correction (SEMAC) MRI of hip and knee arthroplasty implants can generate similar image quality and visibility of periprosthetic abnormalities at 1.5T and 3T field strengths.

**Method and Materials**

Thirty patients with symptomatic hip (15) and knee (15) arthroplasty implants were included in this IRB-approved study after giving informed written consent. Each patient underwent consecutive 1.5 and 3T MRI using previously optimized protocols consisting of PD-weighted and STIR CS-SEMAC turbo spin echo pulse sequences in coronal (hip) or sagittal (knee) planes. The 3T protocols utilized 25 SEMAC encoding steps while the 1.5T protocols used 19 SEMAC encoding steps. The 3T protocols had higher spatial resolution. Each pulse sequence took 4-5 min. Paired PD-weighted and STIR image datasets were separated, anonymized and randomly reassigned. Two musculoskeletal radiologists qualitatively evaluated image quality and the presence of six periprosthetic abnormalities independently. Wilcoxon test, Kendall W agreement, and substitutability testing were applied.

**Results**

Image quality of hip and knee studies were over all good with slight non-significant (hip, p=0.21 / knee, p=0.33) dominance of 1.5T over 3T. Reader agreements were moderate to very good (W range, 0.53-0.81). Inter-method agreement was overall good (W, 0.67/0.71). For each joint, substitution analysis demonstrated that the higher resolution but slightly longer 3T CS-SEMAC could replace the lower spatial resolution, but faster 1.5T CS-SEMAC technique (p-value range, 0.41-0.94) in diagnosing the six abnormalities, including periprosthetic osteolysis, synovitis, bone marrow edema, fractures, tendon tears, and extra-capsular collections.

**Conclusion**

With the use of optimized pulse sequence parameters, 3T CS-SEMAC can generate high-resolution MR images with similar degrees of metal artifact reduction and detection of periprosthetic abnormalities compared to 1.5T CS-SEMAC.

**Clinical Relevance/Application**

3T CS-SEMAC has the potential to generate high-resolution MR images without diagnostic compromise.

Participants

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Printed on: 01/19/20
SSE16

**Musculoskeletal (Arthritis and Cartilage)**

Monday, Dec. 2 3:00PM - 4:00PM Room: N227B

**Purpose**

To evaluate whether the combination of ultrashort TE (UTE) sequences and conventional magnetic resonance imaging (MRI) helps to increase diagnostic performance in the diagnosis of spondyloarthropathy compared with those achieved by using each MRI technique alone.

**Method and Materials**

The study included 22 sacroiliac joint (SIJ) MRI from 11 spondyloarthropathy (SpA) patients and 52 SIJ MRI from 27 patients without SpA. Three sets of images (UTE only, conventional MR only, combined UTE and conventional MRI) were analyzed independently by 3 reviewers (2 musculoskeletal radiologists, 1 unexperienced radiologist) to diagnose SpA based on bone marrow edema (BME), erosion, sclerosis, and ankyloses. For SpA patients, patient grouping was subdivided to those with BME and those without BME. Diagnostic accuracy, sensitivity, specificity, and positive and negative predictive values were calculated. In those 16 patients with CT, the Pearson correlation test was performed.

**Results**

The overall sensitivity was significantly higher for the combined set (92.3%) in the group without BME than those for the conventional MRI-only (89.5%) or UTE-only (81.7%) sets (P<0.05). However, in the group with BME, the UTE-only set showed lower sensitivity (83.8%) compared with the combined (93.3%) and conventional MRI (93.4%) sets (P=0.62). All reviewers did not show a significant difference in specificity for the 3 sets in both groups. The Pearson coefficient of correlation between erosion in UTE and erosion in CT was 0.71 (p<0.001).

**Conclusion**

UTE provides CT-like images, allowing good depiction of erosion; a combination set of UTE and conventional MRI showed better sensitivity in the diagnosis of SpA, especially in those without BME.

**Clinical Relevance/Application**

Recently, BME of the SIJ are reported to be nonspecific findings in SIJ MRI, leaving osseous erosion to be important finding. With UTE providing CT-like imaging, this will help detect early erosion, resulting better diagnosis of SpA.

**SSE16-02 Are Undifferentiated Arthritis and Pre-Rheumatoid Arthritis Associated with the Longitudinal MRI Features of Knee Osteoarthritis Structural Damage?**

Monday, Dec. 2 3:10PM - 3:20PM Room: N227B

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PURPOSE

Shared inflammatory pathophysiology of osteoarthritis (OA) and inflammatory joint diseases such as Rheumatoid Arthritis (RA) have been suggested previously. Undifferentiated arthritis (UA) and Pre-RA are considered as early stage inflammatory arthropathy before the diagnosis of RA based on clinical criteria; However, UA may persist without ultimate progression to RA. We aimed to investigate the association between knee OA structural damage worsening and clinically defined UA/Pre-RA using 3T-MRI measurements.

METHOD AND MATERIALS

This was an IRB-approved and HIPAA-compliant study of 600 subjects from the FNIH project. At the baseline visit, subjects with physician-diagnosed RA were excluded. Participants with any signs of arthritis, but not diagnosed RA, were assessed by connective tissue disease RA screening questionnaire and knee radiography. After exclusions of possible RA subjects (using questionnaire/radiography), the remaining were regarded as UA. Any of the UA-(control) or UA+ subjects who have developed RA in follow-up visits were categorized as Pre-RA. Baseline and 24-month semi-quantitative MRI OA Knee Score (MOAKS) measures of study groups were extracted and analyzed. Logistic regression model, adjusted for age, sex, BMI, and smoking status was used to assess the association between UA/pre-RA and baseline/worsening of MRI-based OA-related structural damages including cartilage thickness/surface scores, Hoffa-synovitis, and effusion-synovitis.

RESULTS

Presence of UA was associated with nearly significant structural damage in cartilage surface/thickness scores of whole knee (OR (95%CI): 1.73(1.04-3.1) and 1.73(1.0-3.04)), especially in patellofemoral joint (OR: 2.05(1.16-3.62) and 1.76(0.99-3.07)). In longitudinal assessment, presence of UA was significantly associated with 24-month worsening of lateral tibiofemoral cartilage damage (OR: 2.46(1.1-5.07). Pre-RA was not significantly related to cartilage damage after adjustments. There was also no association between UA/pre-RA and knee Hoffa-synovitis/effusion-synovitis.

CONCLUSION

Positive history of UA is associated with the concurrent knee joint cartilage defects at baseline, and its worsening over 24-months.

CLINICAL RELEVANCE/APPLICATION

Knee OA characteristic cartilage defects are probable in UA subjects despite absence of knee effusion/synovitis. This finding warrants further investigations for altered OA outcomes in subjects with UA but not definitive RA diagnosis.

SSE16-03 Diagnostic Performance of Texture Analysis for Differentiation of Inflammation versus Degeneration in the Sacroiliac Joints

Monday, Dec. 2 3:20PM - 3:30PM Room: N227B

Participants

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PURPOSE

to investigate the performance of texture analysis (TA) for differentiation of inflammation from degeneration in sacroiliac joints (SIJ).

METHOD AND MATERIALS

MR images of SIJ from patients with clinically established ankylosing spondylitis (AS), degenerative changes and healthy individuals (30 patients each) were analyzed retrospectively. Two residents blinded to each other rated typical structural and inflammatory changes on a four-point Likert scale and categorized patients into different groups, using paracoronal sets of TIRM, T1w and T1w fat-sat contrast enhanced (T1wCE) images. Additionally, same-sized regions of interest were placed into pathologic tissue disease RA screening questionnaire and knee radiography. After exclusions of possible RA subjects (using questionnaire/radiography), the remaining were regarded as UA. Any of the UA-(control) or UA+ subjects who have developed RA in follow-up visits were categorized as Pre-RA. Baseline and 24-month semi-quantitative MRI OA Knee Score (MOAKS) measures of study groups were extracted and analyzed. Logistic regression model, adjusted for age, sex, BMI, and smoking status was used to assess the association between UA/pre-RA and baseline/worsening of MRI-based OA-related structural damages including cartilage thickness/surface scores, Hoffa-synovitis, and effusion-synovitis.

RESULTS

Moderate IA was present for categorization into different groups (k=.80). Qualitative ratings showed weak to moderate IA, but cumulative qualitative scores differed significantly among patient categories (p<.001). TA showed perfect IA (k>.80) for 203, 194 and 210 features in TIRM, T1w & T1wCE, respectively. TA outperformed qualitative evaluation for differentiation between AS vs. non-AS (AUC=.89 vs. .75 for TA vs. qualitative) and between AS vs. degeneration (AUC=.91 vs. .66). MR sets showed different impact on TA based differentiation of AS vs. non-AS with AUCs of .74, .76 and .81 for TIRM, T1w and T1wCE.

CONCLUSION
TA improves accuracy in differentiation of AS from degeneration in the SIJ. Its performance is predominantly determined by T1wCE images.

**CLINICAL RELEVANCE/APPLICATION**

Determining the aetiology of chronic and acute changes in the sacroiliac joints is an everlasting difficulty in clinical and radiological routine. This work presents a quantitative approach that may help in valid identification of patients with axial spondylarthritiditis from the remainders, which would imply an impact on further patient management and conservative treatment.

**SSE16-04  Quantitative MR Blood Perfusion Patterns of Infrapatellar Fat Pad T2 Hyperintense Lesions on Unenhanced MR in Patients with and without Knee Osteoarthritis**

*Monday, Dec. 2 3:30PM - 3:40PM Room: N227B*

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**PURPOSE**

Infrapatellar fat pad (IPFP) T2 hyperintense lesions on unenhanced MR are an important imaging feature of knee osteoarthritis (OA) and are thought to represent inflammation. These lesions are very common, though, also in non-OA subjects, and may not always be linked to inflammation. This leads to the hypothesis that IPFP lesions may have different pathophysiological subtypes. The aim of this study was to evaluate quantitative blood perfusion parameters within T2 hyperintense lesions in patients with knee OA, with patellofemoral pain (PFP) (supposed precursor of OA), and in control subjects.

**METHOD AND MATERIALS**

43 healthy controls, 35 patients with PFP and 22 patients with knee OA were included. All underwent MRI including T2-mapping and dynamic contrast enhanced (DCE)-MRI. Image registration was used to correct for motion. If present, hyperintense T2 lesions in the IPFP were delineated on T2 maps using Horos software (Horosproject.org, USA). A second region was drawn in an adjacent area without T2 signal intensity alteration. Quantitative perfusion parameters (Ktrans, Ve, Vp) were extracted by fitting the extended Tofts' pharmacokinetic model where Ktrans represents the inflow, Ve the extravascular extracellular space and Vp vascular fraction of the region. A paired Wilcoxon-signed-rank test was used to compare regions with and without T2 lesions within subjects for each subgroup.

**RESULTS**

IPFP T2 hyperintense lesions were present in 14 controls, 13 PFP patients and 16 knee OA patients. Perfusion parameters were not statistically significantly different between areas with and without a T2 lesion within controls and PFP patients. In knee OA patients, the lesions demonstrated statistically significantly higher values of Ktrans and Ve compared to an area without a lesion. Remarkably, all regions drawn in knee OA demonstrated higher perfusion parameters, including Vp, compared to the other groups.

**CONCLUSION**

IPFP T2 hyperintense lesions are non-specific. In contrast to morphologically similar lesions in PFP patients and controls in knee OA patients IPFP hyperintense lesions are associated with higher perfusion, suggesting inflammation and neo-angiogenesis.

**CLINICAL RELEVANCE/APPLICATION**

OA has a tremendous societal burden, but the pathophysiology remains unknown. Quantitative DCE-MRI can serve as a method to unravel certain aspects of the pathophysiology of OA.

**SSE16-05  Radiographic Hand Osteoarthritis and Its Association with Worsening of MRI-Based Tibiofemoral Osteoarthritis-Related Structural Damage**

*Monday, Dec. 2 3:40PM - 3:50PM Room: N227B*

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**PURPOSE**

To determine whether the presence of hand osteoarthritis (OA) is associated with radiographic knee OA progression (over 48-months) and MRI-based knee OA structural damage worsening (over 24-months).
CLINICAL RELEVANCE/APPLICATION

Presence of any carpometacarpal (CMC) OA (OR 95%CI: 1.58(0.96-2.62)) and overall hand OA (presence of any mKl>2 in all hand joints) (OR 95%CI: 1.44(0.97-2.07)) was associated with 48-month radiographic knee OA progression (approached but not reached significance). In comparison with controls, subjects with hand OA showed higher odds of worsening tibial/femoral cartilage damage (OR 95%CI: 1.38(0.95-2.01) and 1.79(1.24-2.58)) and femoral periarticular bone area expansion (Beta 95%CI: 10.54(1.40-19.69)) over 24-months. CMC OA and 24-months worsening of MRI-based biofemoral cartilage damage and periarticular bone area expansion were also showed approached significant associations.

CONCLUSION

Presence of hand OA, especially in CMC joint, is associated with longitudinal MRI-based knee OA-related structural damage worsening including tibial/femoral cartilage damage and periarticular bone area expansion.

CLINICAL RELEVANCE/APPLICATION

Hand OA (specifically CMC OA), as a marker of generalized OA, may be considered a predictor of more rapid progression of knee OA compared to patients without hand OA, which might be of relevance for inclusion in clinical trials of disease modifying OA drug development.

SSE16-06 Assessment of the Angular Dependence of Multicomponent Driven Equilibrium Single Pulse Observation of T1 and T2 (mcDESPOT) in Patellar Cartilage Samples

Participants
Mei Wu, MD, PhD, Guangzhou, China (Abstract Co-Author) Nothing to Disclose
Hyungseok Jang, La Jolla, CA (Abstract Co-Author) Nothing to Disclose
Akhil Kasibhatla, San Diego, CA (Abstract Co-Author) Nothing to Disclose
Fang Liu, PhD, Madison, WI (Abstract Co-Author) Nothing to Disclose
Saeed Jerban, PhD, San Diego, CA (Presenter) Nothing to Disclose
Yajun Ma, San Diego, CA (Abstract Co-Author) Nothing to Disclose
Eric Y. Chang, MD, San Diego, CA (Abstract Co-Author) Nothing to Disclose
Richard Kijowski, MD, Verona, WI (Abstract Co-Author) Research support, General Electric Company; Consultant, Boston Imaging Core Lab, LLC
Jiang Du, PhD, San Diego, CA (Abstract Co-Author) Nothing to Disclose

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may9@sina.com

PURPOSE

To evaluate the magic angle sensitivity of Multicomponent and Single-component parameters of Multicomponent Driven Equilibrium Single Pulse Observation of T1 and T2 (mcDESPOT) in imaging the cadaveric human patellar cartilage samples on a clinical 3T scanner.

METHOD AND MATERIALS

mcDESPOT was prospectively performed on 3 human patellar cartilage samples. Imaging parameters were: FOV=4cm, slice thickness=0.5mm, rBW=125kHz, SPGR TR/TE=11.6ms/3.1ms, IR-SPGR TR/TE=9ms/3.1ms, T1=450ms, SSFP TR/TE=12.2ms/6.1ms, SPGR FA=3,4,5,6,7,9,13,18°, SSFP FA=2,5,10,15,20,30,40,50°; IR-SPGR FA=5°, matrix=160×160×26, and total scan time=21min. The imaging was performed three times, each with a different orientation (0°, 55°, and 90° relative to B0). Regional analysis (superficial/middle/deep layer and global) was applied. Single-component T1/T2 relaxation times of the fast relaxing water component (T1f/T2f) and the slow relaxing water component (T1s/T2s), and fraction of the fast relaxing water component (Ff) were measured, and their angular dependence were analyzed.

RESULTS

Figure 1 shows T1 single values which show the smallest magic angle effect with 5.1% decrease from 1644.5 ms at 0° to 1562.3 ms at 55°. FF values show a decreased magic angle effect with 48.4% decrease from 15.5 % at 0° to 8.0% at 55°. T2f values show the largest magic angle effect with 200.0% increase from 9.5 ms at 0° to 27.3 ms at 55°. Different degrees of magic angle effect were also observed for T1s, T1f, T1PD, T2PD, T2s and T2 single with a decrease of 19.5%, 26.3%, and increased of 38.4%, 42.2%, 79.3%, 181.8% respectively, by rotating the cartilage samples from 0 to 55 degrees relative to the B0 field. The values of FF decrease from the deep layer to the superficial layer for all angular orientations. T2f and FF maps show increased T2f and decreased FF in patellar cartilage by rotating the cartilage samples from 0 to 55 degrees relative to the B0 field, and the changes in T2f are more obvious than those in FF.

CONCLUSION

T1, T1s, T1f, T1PD, T2PD, and FF show much reduced magic angle effect as compared to T2, T2s and T2f. FF provides reduced magic angle sensitivity in the evaluation of cartilages as compared to T2, T2s and T2f.
Ff is less sensitive to the magic angle effect than T2, T2s and T2f, and may provide more accurate diagnosis for early OA.

Printed on: 01/19/20
Musculoskeletal Tuesday Case of the Day

Tuesday, Dec. 3 7:00AM - 11:59PM Room: Case of Day, Learning Center

AMA PRA Category 1 Credit ™: .50

Participants
Daniel E. Wessell, MD, PhD, Ponte Vedra Beach, FL (Presenter) Nothing to Disclose
Nathan D. Cecava, MD, JBSA Lackland AFB, TX (Abstract Co-Author) Nothing to Disclose
Lance Edmonds, MD, Fairfield, CA (Abstract Co-Author) Nothing to Disclose
Mustafa M. Alikhan, MD, Kailua, HI (Abstract Co-Author) Nothing to Disclose
James H. Chang, MD, Dupont, WA (Abstract Co-Author) Nothing to Disclose
Mark D. Murphey, MD, Silver Spring, MD (Abstract Co-Author) Nothing to Disclose
Jacob R. Hansen, DO, Honolulu, HI (Abstract Co-Author) Nothing to Disclose
Andrew J. Degnan, MD, Philadelphia, PA (Abstract Co-Author) Nothing to Disclose
Tae H. Ro, MD, Fairfield, CA (Abstract Co-Author) Nothing to Disclose
Matthew Loewen, DO, Fircrest, WA (Abstract Co-Author) Nothing to Disclose
David J. Oettel, DO, Lackland, TX (Abstract Co-Author) Nothing to Disclose
Megan Dececchis, MD, Pensacola, FL (Abstract Co-Author) Nothing to Disclose
Joseph Salama, DO, MSc, Puyallup, WA (Abstract Co-Author) Nothing to Disclose
Richard Buck, MD, Tacoma, WA (Abstract Co-Author) Nothing to Disclose

TEACHING POINTS
Participants will test their diagnostic skills and become familiar with the imaging findings of a variety of challenging and interesting musculoskeletal cases.

Printed on: 01/19/20
Houston, We Have a Problem (Case-based Competition)

Tuesday, Dec. 3 7:15AM - 8:15AM Room: E451B

CA  GI  GU  MK  NR  OB  PD  PH  SQ  VA

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

Participants
Adam E. Flanders, MD, Philadelphia, PA (Presenter) Nothing to Disclose
Sandeep P. Deshmukh, MD, Philadelphia, PA (Presenter) Nothing to Disclose
Christopher G. Roth, MD,MS, Philadelphia, PA (Presenter) Nothing to Disclose
Vishal Desai, MD, Philadelphia, PA (Presenter) Nothing to Disclose

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adam.flanders@jefferson.edu

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

LEARNING OBJECTIVES
1) Be introduced to a series of radiology case studies via an interactive team game approach designed to encourage 'active' consumption of educational content. 2) Use their mobile wireless device (tablet, phone, laptop) to electronically respond to various imaging case challenges; participants will be able to monitor their individual and team performance in real time. 3) Receive a personalized self-assessment report via email that will review the case material presented during the session, along with individual and team performance.

Printed on: 01/19/20
Participants
Edward Y. Kim, MD, Seattle, WA (Presenter) Nothing to Disclose
F. Joseph Simeone, MD, Boston, MA (Presenter) Nothing to Disclose
Seth Pollack, MD, Seattle, WA (Presenter) Consultant, Back Bay Consulting; Consultant, Bayer AG; Consultant, Eli Lilly and Company; Consultant, Puretech; Consultant, Seattle Genetics, Inc; Consultant, DAIICHI SANKYO Group; Consultant, Blueprint Medicines Corporation
Kevin Raskin, MD, Boston, MA (Presenter) Nothing to Disclose

LEARNING OBJECTIVES
1) To better understand standard of care management relevant to radiation management of musculoskeletal tumors. 2) To understand best imaging practices with respect to bone and soft tissue tumors.

ABSTRACT
This session will review the multidisciplinary evaluation and treatment of musculoskeletal tumors (sarcomas and other soft tissue tumors) with discussion provided by diagnostic radiology, orthopedic oncology, medical oncology, and radiation oncology panelists.
Participants
Ogonna K. Nwawka, MD, New York, NY (Moderator) Research Grant, General Electric Company
Marnix T. van Holsbeeck, MD, Detroit, MI (Moderator) Stockholder, Koninklijke Philips NV; Stockholder, General Electric Company; Stockholder, Meded3D;
Robert R. Lopez, MD, Cornelius, NC (Moderator) Nothing to Disclose
Jon A. Jacobson, MD, Ann Arbor, MI (Moderator) Research Consultant, BioClinica, Inc; Advisory Board, Koninklijke Philips NV; Royalties, Reed Elsevier

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Sub-Events
RC304-01  Shoulder Ultrasound (Demonstration)

Participants
Ogonna K. Nwawka, MD, New York, NY (Presenter) Research Grant, General Electric Company

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LEARNING OBJECTIVES
1) To identify the musculoskeletal structures in the shoulder that can be visualized and effectively assessed under ultrasound.

RC304-02  Weight-Bearing Ultrasound Evaluation of Medial Meniscal Extrusion: Correlation with MRI and Meniscal Tears

Participants
Anna L. Falkowski, MD, Ann Arbor, MI (Presenter) Nothing to Disclose
Jon A. Jacobson, MD, Ann Arbor, MI (Abstract Co-Author) Research Consultant, BioClinica, Inc; Advisory Board, Koninklijke Philips NV; Royalties, Reed Elsevier
Mark Cresswell, MBCh, Vancouver, BC (Abstract Co-Author) Consultant, Koninklijke Philips NV
Asheesh Bedi, MD, Ann Arbor, MI (Abstract Co-Author) Nothing to Disclose
Vivek Kalia, MD, MPH, Ann Arbor, MI (Abstract Co-Author) Nothing to Disclose

PURPOSE
The purpose of this study was to compare medial meniscal extrusion as seen on weight-bearing ultrasound compared with MRI and meniscal tears.

METHOD AND MATERIALS
In this IRB-approved study with informed consent, patients obtaining a routine knee MRI were prospectively evaluated with supine and weight-bearing ultrasound (US) of the medial meniscus. Position of the outer boundary of the medial meniscus on US images and MRI was measured relative to the tibia by a fellowship-trained musculoskeletal radiologist. Correlation was made to the presence or absence of meniscal tear or meniscal root tear, and statistical significance was calculated via student t-test.

RESULTS
50 knees from 49 subjects (23 male, 26 female; mean age 44±15 years) were included (18 right, 32 left; one bilateral). The mean medial meniscal extrusion on supine US was 1.3 mm (range -1.5 to 3.6 mm), with no significant difference compared with MRI (p=0.21), which increased to 2.1 mm on weight-bearing US. In the 38% (19/50) of subjects with meniscal tears, the mean medial meniscal extrusion on weight-bearing US was 2.13 mm (range 0 to 4.4 mm) with a change between supine and weight-bearing of 0.87 mm (range -0.1 to 2.2 mm), and no significant difference between subjects with and without tear (p=0.805 and p=0.413). Of note, the subject with a medial meniscal root tear showed a change of -1.8 mm from supine to weight-bearing US.

CONCLUSION
Supine US was comparable with supine MRI for assessment of medial meniscal extrusion. The presence of meniscal tear or meniscal...
root tear did not result in increased medial meniscal extrusion on weight-bearing US compared with no meniscal tear.

**CLINICAL RELEVANCE/APPLICATION**

Assessment of meniscal extrusion is comparable to MRI. Meniscal extrusion on weight-bearing US should not be equated with the presence of meniscal tear.

**RC304-03  Value of Sonoelastography in Achilles Tendon Assessment: Is it Possible to Predict the Rupture?**

Tuesday, Dec. 3 9:10AM - 9:20AM Room: E450A

Participants
Ivo Dumic-Cule, MD, PhD, Zagreb, Croatia (*Presenter*) Nothing to Disclose
Gordana Ivanac, MD, Zagreb, Croatia (*Abstract Co-Author*) Nothing to Disclose
Domagoj Lemac, MD, Zagreb, Croatia (*Abstract Co-Author*) Nothing to Disclose
Boris Brkljacic, MD, PhD, Zagreb, Croatia (*Abstract Co-Author*) Advisory Board Member, contextflow GmbH

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**PURPOSE**

Rupture of Achilles tendon is a common problem in sports medicine and affects both professional and recreational athletes. Currently it is impossible to predict whether someone is under increased risk for rupture. However, it was demonstrated that about 6% of patients with previously ruptured Achilles tendon experienced the rupture of contralateral tendon in the future. Therefore, the aim of this study was to assess the risk for rupture of contralateral tendon in patients who underwent surgical reconstruction of ruptured Achilles tendon by using standardized questionnaires and ultrasound shear wave elastography (SWE). Finally, we hypothesized that SWE could be used to predict which Achilles tendon will be at higher risk to future rupture.

**METHOD AND MATERIALS**

Fifty patients who underwent surgical repair of the ruptured Achilles tendon and twenty aged matched healthy controls were examined with ultrasound B-mode and SWE. Functional outcomes and subjective feeling were assessed with American Orthopedic Foot and Ankle Society (AOFAS) scoring system and subjective rating system which we introduced and validated. Elastograms captured by SWE were analyzed with newly developed software, which enabled detailed quantification of whole area of interest.

**RESULTS**

The stiffness of injured Achilles tendon was markedly decreased (by 54%, P<0.01) when compared to both contralateral tendon of the patient and tendons of healthy individuals. Additionally, AOFAS score and newly introduced subjective assessment scale positively correlated with ultrasound SWE values in ruptured and healthy Achilles tendons. The stiffness of contralateral Achilles tendons in patients was significantly lower than among healthy individuals (P<0.01).

**CONCLUSION**

Irrespective of the lack of difference in function and subjective feeling, the contralateral tendon in the patients with repaired Achilles tendon had significantly lower stiffness than healthy individuals. Therefore, contralateral tendons in patients who suffered rupture are more prone to future injuries.

**CLINICAL RELEVANCE/APPLICATION**

According to our results SWE is capable to detect individuals with increased risk for Achilles tendon injury.

**RC304-04  Determining Ultrasound Predictors for Tendon Healing in Lateral Epicondylitis (LE): A Cohort Study Correlating Ultrasound Findings with Pain and Functional Disability**

Tuesday, Dec. 3 9:20AM - 9:30AM Room: E450A

Participants
Shubham Shubham, MBBS, Amritsar, India (*Presenter*) Nothing to Disclose
Yatish Agarwal, MD,DSc, New Delhi, India (*Abstract Co-Author*) Nothing to Disclose
Dharmendra K. Singh, MD,FRCR, New Delhi, India (*Abstract Co-Author*) Nothing to Disclose
Nishith Kumar, MD, New Delhi, India (*Abstract Co-Author*) Nothing to Disclose
Siddharth Gupta, MBBS, Ambala, India (*Abstract Co-Author*) Nothing to Disclose
Rajesh K. Chopra, MBB,MS, New Delhi, India (*Abstract Co-Author*) Nothing to Disclose
Sunil K. Bajaj, MD, Detroit, MI (*Abstract Co-Author*) Nothing to Disclose
Vinay Hc, MD,MBBS, Delhi, India (*Abstract Co-Author*) Nothing to Disclose
Arka Bhattacharya, MBBS, New Delhi, India (*Abstract Co-Author*) Nothing to Disclose
B K Nayak, MBBS, New Delhi, India (*Abstract Co-Author*) Nothing to Disclose

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**PURPOSE**

Correlation of US findings with Patient-Rated Tennis Elbow Evaluation (PRTEE) scores before and after six months of conservative management in LE cases to determine predictors for tendon healing.

**METHOD AND MATERIALS**

In this institutional review board approved cohort study, fifty three consenting clinically diagnosed adult patients of LE without any history of elbow injection within last one month, trauma or surgery were evaluated by a validated outcome measure the PRTEE scale and US. It was followed by nonoperative standardized treatment (physiotherapy with eccentric loading) for six months and evaluation again for post treatment PRTEE scores. PRTEE scale comprises of five questions to assess pain and ten questions to assess disability each graded from 0 to 10. The minimum and maximum scores being 0 and 100 respectively. US was done using a 8-
18 MHz linear transducer on a slightly flexed elbow with supine forearm to assess common extensor tendon (CET) thickness, CET echotexture, CET tears, CET neovascularity and radial collateral ligament (RCL) tears. Using linear regression post treatment PRTEE scores were correlated with aforementioned US parameters.

RESULTS
The mean pretreatment PRTEE score was 73.43 (range 55-92) and post treatment PRTEE score was 43.19 (range 12-90). Using mann-whitney test the difference in means was found to be significant (p <.0001). Using linear regression a positive association of post treatment PRTEE scores with CET hypoechogenicity (p <.05), percentage of CET (p <0.05) and RCL tears (p <0.05) was identified. No correlation was found with age, sex, side, symptom duration, CET tendon thickness, or amount of CET neovascularity.

CONCLUSION
US can reliably diagnose as well as grade CET tears, radial collateral ligament tears, and quantify CET hypoechogenicity which are less likely to respond to nonoperative management thus can potentially guide management in such cases who may require more invasive treatment. CET thickening and CET neovascularity may be poor predictors of prognosis.

CLINICAL RELEVANCE/APPLICATION
Ultrasound (US) is non-invasive, cost-effective and can reliably diagnose lateral epicondylitis (LE) and potentially determine predictors of delayed healing thus avoiding morbidity and guide management.

RC304-05  Knee Ultrasound (Demonstration)
Tuesday, Dec. 3 9:30AM - 10:00AM Room: E450A

Participants
Marnix T. van Holsbeeck, MD, Detroit, MI (Presenter) Stockholder, Koninklijke Philips NV; Stockholder, General Electric Company; Stockholder, MedEd3D;

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LEARNING OBJECTIVES
1) Recognize important anatomic landmarks in knee according to four quadrant knee scanning approach. 2) Question the integrity of the quadriceps using a layered approach. 3) Discriminate anatomy in popliteal space via surface screening of femoral and tibial condyles. 4) Judge the knee’s capsular integrity by applying appropriate dynamic maneuvers.

RC304-06  Elbow Ultrasound (Demonstration)
Tuesday, Dec. 3 10:30AM - 11:00AM Room: E450A

Participants
Jon A. Jacobson, MD, Ann Arbor, MI (Presenter) Research Consultant, BioClinica, Inc; Advisory Board, Koninklijke Philips NV; Royalties, Reed Elsevier

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LEARNING OBJECTIVES
1) Define regional anatomy of the elbow. 2) List the anatomic structures evaluated with ultrasound. 3) List the steps of an ultrasound examination of the elbow.

RC304-07  Vibro-Acustography Characterization of Bone Tissue in an Experimental Model
Tuesday, Dec. 3 11:00AM - 11:10AM Room: E450A

Participants
Marcello H. Nogueira-Barbosa, MD, PhD, Ribeirao Preto, Brazil (Presenter) Nothing to Disclose
Paulo M. Agnolítto, MD, Ribeirao Preto, Brazil (Abstract Co-Author) Nothing to Disclose
Guilherme Braz, Ribeirao Preto, Brazil (Abstract Co-Author) Nothing to Disclose
Adilton A. Carneiro, PhD, Ribeirao Preto, Brazil (Abstract Co-Author) Nothing to Disclose
Adriano Spirandeli, Ribeirao Preto, Brazil (Abstract Co-Author) Nothing to Disclose
Francisco A. Paula, Ribeirao Preto, Brazil (Abstract Co-Author) Nothing to Disclose

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PURPOSE
This study aimed to evaluate the potential of vibro-acustography (VAC) on the diagnosis of osteoporosis. As such, we used microCT as a reference technique to evaluate femur bone properties and estimated the correlation of VAC and microCT parameters in control and mice subjected to hepatotoxic drug (CCl4).

METHOD AND MATERIALS
The experimental protocol included three groups of mice: a) control group= C; b) submitted to intraperitoneal injection of CCl4= HO and C) submitted to intraperitoneal injection of CCl4 and antiresorptive drug (pamidronate) = HOP. The evaluation of the specimens was conducted in an acoustic tank, by the VAC technique, whereby a confocal ultrasonic transducer generates two high frequency (MHz) focused beams, with a difference frequency of 45 KHz between them. These two beams interact with each other and with the bone sample, producing a low frequency Acoustic response (AR) that is registered by a hydrophone. The AC signals have been processed in order to obtain numerical values which carries information about the mechanical properties of the samples.
Experiments were repeated three times. Statistical analysis included Interclass Correlation Coefficient (ICC), ANOVA multiple comparisons and Spearman's rank correlation coefficient.

RESULTS

VAC spectral analysis of the AR differentiate the experimental groups (p<0.01) and the results were reproducible (ICC = 0.43 [95%CI = 0.15 - 0.71]). There was a statistically significant relationship between VAC and MicroCT in connectivity (p<0.01; r=0.80) and connectivity density (p<0.01; r=0.76) and a trend between VAC and trabecular number and trabecular separation (p=0.06).

CONCLUSION

The present study shows that VAC has sufficient sensitivity to detect impairment of bone properties in hepatic osteodystrophy. In addition, it was observed positive correlation between VAC and microCT assessment. These results encourage further studies to evaluate the potential of VAC estimation on the diagnosis of osteoporosis.

CLINICAL RELEVANCE/APPLICATION

This is an experimental study using an emerging technique (US-based) to evaluate bone tissue. This provides foundations to reach clinical use.

RC304-09 Augmented Reality IN-SITU Visualization for Ultrasound-Guided Interventions

Participants
Nadja A. Farshad-Amacker, MD, Zurich, Switzerland (Presenter) Spouse, Research funded, Balgrist
Till Bay, Zurich, Switzerland (Abstract Co-Author) CEO, Balgrist Start-up Company
Andrea Rosskopf, MD, Zurich, Switzerland (Abstract Co-Author) Nothing to Disclose
Jose Spiring, Zurich, Switzerland (Abstract Co-Author) Nothing to Disclose
Florian Wanivenhaus, Zurich, Switzerland (Abstract Co-Author) Nothing to Disclose
Christian W. Pfirrmann, MD, MBA, Forch, Switzerland (Abstract Co-Author) Nothing to Disclose
Mazda Farshad, Zurich, Switzerland (Abstract Co-Author) Founder, Incremed

PURPOSE

The purpose of this study was to access the performance of Ultrasound (US)-guided needle placement without and with augmented reality in-situ US viewing, in dependence of the expertise of the operator.

METHOD AND MATERIALS

Three untrained operators and two experienced radiologists performed 200 US-guided punctures: 100 with and 100 without AR in-
situ US. The punctures were performed in two different phantoms, a leg phantom with soft tissue lesions and a vessel phantom. Time to puncture and number of needle passes were compared.

RESULTS

AR in-situ US resulted in reduced time (mean: 22 vs. 30s) and number of needle passes (median; range: 1;1-4 versus 1;1-8) compared to the conventional US technique. The initial gap in performance of untrained operators vs experienced radiologists with the conventional method (time: 37 vs 20s; needle passes: 1;1-8 vs 1;1-2) was reduced (time: 25 vs 18s; needle passes: 1;1-4 vs 1;1-4).

CONCLUSION

AR in-situ US could be a potential brake-trough in US imaging by the concept of simplifying spatial orientation for the operator, thus reducing experience-based differences in performance of US-guided interventions.

CLINICAL RELEVANCE/APPLICATION

Review of Pediatric Nuclear Medicine

Tuesday, Dec. 3 8:30AM - 10:00AM Room: S504CD

LEARNING OBJECTIVES
1) Review of Pediatric Nuclear medicine, particularly for radiologists and nuclear medicine physicians who may not specialize in pediatric patients, and for resident and fellow trainees.

Sub-Events

RC311A  Pediatric Gastrointestinal

Participants
Helen R. Nadel, MD, Palo Alto, CA (Presenter) Nothing to Disclose

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LEARNING OBJECTIVES
1) Be able to list indications for GI scintigraphy in children. 2) Be able to describe scintigraphic patterns of disease on GI examinations in children.

RC311B  Pediatric Genitourinary

Participants
Neha S. Kwatra, MBBS, MD, Boston, MA (Presenter) Nothing to Disclose

For information about this presentation, contact:neha.kwatra@childrens.harvard.edu

LEARNING OBJECTIVES
1) Describe pediatric renal diseases and understand the complementary role of scintigraphy and other imaging modalities. 2) Apply pediatric-specific imaging considerations. 3) Identify important normal variants/pitfalls in interpretation.

RC311C  Pediatric Musculoskeletal

Participants
Susan E. Sharp, MD, Cincinnati, OH (Presenter) Nothing to Disclose

LEARNING OBJECTIVES
1) Be able to describe the utilization and performance of nuclear medicine imaging for musculoskeletal indications in pediatric patients. 2) Be able to identify musculoskeletal findings on Tc-99m-MDP and F-18-FDG scans.

RC311D  Case Presentation/Panel Discussion

Participants
Stephan D. Voss, MD,PhD, Boston, MA (Presenter) Nothing to Disclose

Printed on: 01/19/20
Pediatric Series: Musculoskeletal Imaging
Tuesday, Dec. 3 8:30AM - 12:00PM Room: N228

Participants
Kathleen H. Emery, MD, Cincinnati, OH (Moderator) Nothing to Disclose
Andrea S. Doria, MD, Toronto, ON (Moderator) Nothing to Disclose
Heike E. Daldrup-Link, MD, Palo Alto, CA (Moderator) Nothing to Disclose
Arthur B. Meyers, MD, Orlando, FL (Moderator) Author with royalties, Reed Elsevier Editor with royalties, Reed Elsevier

Sub-Events

**RC313-01 Imaging of Glenohumeral Dysplasia**
Tuesday, Dec. 3 8:30AM - 8:50AM Room: N228

For information about this presentation, contact:
jhkan@texaschildrens.org

**LEARNING OBJECTIVES**
1) Review pathophysiology of brachial plexus birth trauma and the development of glenohumeral dysplasia. 2) Review US and MRI technique and findings of glenohumeral dysplasia. 3) Implications in patient care: what does the surgeon need to know from the US and MRI study?

**RC313-02 Role of Imaging in Diagnosis of Glenohumeral Deformity Following Obstetric Brachial Plexus Injury**
Tuesday, Dec. 3 8:50AM - 9:00AM Room: N228

For information about this presentation, contact:
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**PURPOSE**
To study the usefulness of CT in the measurement of glenoid version angle, humeral head dislocation or subluxation and to propose a grading for the severity of glenohumeroscapular dysplasia following OBPI.

**METHOD AND MATERIALS**
It is a prospective study for three years duration. 21 children below the age of 12 years presenting with posterior subluxation/dislocation of shoulder, with past history of OBPI were included in the study. CT of shoulders was done using 128 slice scanner. The functional status of the limb was clinically assessed by Modified Mallet scale and the deformity was graded by Waters classification. Statistical analysis used: Parameteric paired-t-test, Kruskal Walli’s test and Linear regression were used.

**RESULTS**
The difference between affected and normal shoulders of glenoscapular angle, Percentage of humeral head anterior to the scapular line, Scapular height, Scapular Width were statistically significant (p < 0.05). The influence of age on GSA and PHH were not statistically significant. We confirmed that higher is the grade of deformity, more difficult will be the shoulder movements and hence, worse scores in Modified Mallet scale. We assessed joint stability and proposed a grading for severity based on the CT parameters and treatment protocol.

**CONCLUSION**
CT scan clearly identifies the glenohumeroscapular deformities like increased glenoid retroversion, posterior subluxation or dislocation of humeral head, smaller humeral head size and smaller size of the scapula.

**CLINICAL RELEVANCE/APPLICATION**
Glenohumeroscapular dysplasia and postnatal shoulder subluxation are well recognized complications in obstetrical brachial plexus injuries.
Volumetric Quantitative Measurement of Hip Joint Fluid in Healthy Children

Participants
Vanessa Quinn-Laurin, MD, Quebec City, QC (Presenter) Nothing to Disclose
Nancy A. Chauvin, MD, Philadelphia, PA (Abstract Co-Author) Nothing to Disclose
Timothy G. Brandon, MPH, Philadelphia, PA (Abstract Co-Author) Nothing to Disclose
Pamela F. Weiss, Philadelphia, PA (Abstract Co-Author) Nothing to Disclose
Jacob L. Jaremko, MD, PhD, Edmonton, AB (Abstract Co-Author) Nothing to Disclose

PURPOSE
In our experience, a normal pediatric hip subjectively presents a larger amount of fluid relative to patient size when compared to a normal adult hip. We assessed the feasibility and reliability of a quantitative hip joint fluid measurement in the pediatric population to estimate the normal volume of fluid in a pediatric hip joint.

METHOD AND MATERIALS
Seventy healthy children aged 8-17 years underwent a pelvic MRI including a large field of view coronal T2 FS sequence where hips were entirely imaged. Two musculoskeletal radiologists (one pediatric and one adult) performed volumetric quantitative measurements of hip fluid using semi-automated pixel-based thresholding with custom MATLAB software. The custom software minimized variability by applying Otsu's method to automatically select a pixel inclusion threshold within the user-defined region of interest in each slice.

RESULTS
Mean processing time per hip was 2 min 41 s. The mean amount of fluid in a hip joint was 2.03 mL (range 0.38-5.41 mL), increasing slightly with age from mean 1.7 mL at 8 years to 2.3 mL at 17 years. Intra-observer and inter-observer agreement were high (ICC 0.93 and 0.81 respectively), with mean volume differences of 0.04 mL intra-observer and 0.09 mL inter-observer.

CONCLUSION
A semi-automated pixel-based thresholding approach measured joint fluid feasibly and reliably in pediatric hips and found an average fluid volume of 2 mL, which is slightly less than the 2.7 mL reported by others in asymptomatic adult hips. This can represent a visually substantial quantity of fluid per MRI slice, particularly in small children, and should not be misinterpreted as a joint effusion.

Comparison of Ultrasonographic and Radiographic Findings in Patients with Hemophilic Arthropathy

Participants
Yoshiko Matsubara, Hiroshima, Japan (Presenter) Nothing to Disclose
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PURPOSE
Radiography has been employed to evaluate joint lesions in children with hemophilia and ultrasound (US) is increasingly used for the assessment of their joints. We compared the usefulness of US- and radiographic images in young hemophiliacs.

METHOD AND MATERIALS
We enrolled 40 hemophiliacs ranging in age from 1 to 18 years (median 9 years) who had undergone US- and radiographic studies of both knees and ankles between 2015 and 2017. Transverse, lateral transverse, and sagittal US images were evaluated on a gray scale using Haemophilia Early Arthropathy Detection with Ultrasound (HEAD-US) criteria. Scores were recorded for the soft-tissue and the osteochondral domain (scores :0-9 for soft tissue, 0-5 for osteochondral changes; total score 0 - 14) and adjusted to the MRI scale of the International Prophylaxis Study Group (IPSG). Radiographic images were graded on the Pettersson Score (PS) (scores 0-13). Two pediatric radiologists consensually evaluated all images. To compare the incidence of abnormal joint findings on the images we used the McNemar test. The Mann-Whitney U-test was applied to confirm the early detection of abnormal findings on US images.

RESULTS
No abnormalities were detected in 29 patients (age range 1 to 16 years, median 7 years. The other 11 (age range 10 to 18 years, median 16 years) manifested abnormal joints in their knees and/or ankles. Radiography and US detected abnormalities in 6 of the 11 patients. In the other 5, only US provided evidence of anomalies (p = 0.03); they were significantly younger than the patients with positive findings on both US and radiographic images (p = 0.02).

CONCLUSION
US was superior to radiography for the detection of joint abnormalities in hemophiliacs. It was particularly useful in younger patients.

CLINICAL RELEVANCE/APPLICATION
For the evaluation of joints in patients with hemophilia, US- should be added to radiographic studies.
Femoral growth disturbance is a negative outcome predictor following open/closed reduction of the hip for developmental dysplasia (DDH). Post-reduction perfusion MRI has been previously introduced to assess femoral head perfusion but its prognostic value is unclear. To determine whether globally decreased femoral head perfusion predicts femoral growth disturbance at minimum 5 years follow-up.

METHOD AND MATERIALS

We reviewed the institutional database for hips undergoing an open/closed reduction for DDH and a minimum 10-year follow-up. Out of 64 hips (54 patients) eligible, 40 hips (63%; 34 patients) had a complete radiographic followup (mean 13±2 years followup). Hips were allocated to a 'no DDH' (25 hips)- and 'residual DDH' (15 hips) group. Residual DDH was defined as any subsequent surgery or radiographically dysplastic (Severin grade >2). Groups were comparable (all p>0.05) for demographic parameters (sex, time of follow-up, open/closed reduction) except for age (residual DDH: 0.4±0.3 years vs no DDH: 0.8±0.5 years; p=0.016). MRI was performed at 1.5 T and included 2D coronal-, axial PD-w spin-echo images. Analysis of hip morphology on MRI was performed by one reader. On axial images: acetabular version, anterior/posterior sector angles, acetabular depth; were measured. On coronal images: osseous/cartilaginous acetabular indices, lateral cartilage thickness; were measured.

RESULTS

On post-reduction MRI, the acetabulum of hips with residual DDH at follow up was more anteverted (25±6° vs 19±7°; p=0.022). While the cartilaginous acetabular index did not differ, the osseous acetabular index was higher in hips with residual dysplasia (39±7° vs 34±6°; p=0.017). The lateral acetabular cartilage anlage was thicker in hips with residual dysplasia compared to the non-dysplastic hips (5.6±1.1mm vs 4.3±1mm; p=0.002).

CONCLUSION

Increased acetabular version, decreased coverage of the femoral head, and lateral cartilage thickness are associated with residual DDH in adolescence. This study may serve as basis for planning of future prognostic- and longitudinal studies using MRI for improved understanding of factors predicting failure of acetabular remodelling after reduction.

CLINICAL RELEVANCE/APPLICATION

Thickening of the lateral cartilage may represent an important factor to differentiate hips that would remodel versus those that will have persistent DDH with growth.

Presence of Globally Decreased Perfusion on Post-Reduction MRI Does Not Reliably Predict Proximal Femoral Growth Disturbance at Midterm Follow-Up in Developmental Dysplasia of the Hip

Tuesday, Dec. 3 9:30AM - 9:40AM Room: N228

Participants

Florian Schmaranzer, MD, Boston, MA (Presenter) Nothing to Disclose
Mariana Ferrer, Boston, MA (Abstract Co-Author) Nothing to Disclose
David Williams, Boston, MA (Abstract Co-Author) Nothing to Disclose
Sarah D. Bixby, MD, Boston, MA (Abstract Co-Author) Nothing to Disclose
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PURPOSE

Femoral growth disturbance is a negative outcome predictor following open/closed reduction of the hip for developmental dysplasia (DDH). Post-reduction perfusion MRI has been previously introduced to assess femoral head perfusion but its prognostic value is unclear. To determine whether globally decreased femoral head perfusion predicts femoral growth disturbance at minimum 5 years after closed/open reduction for DDH.

METHOD AND MATERIALS

Retrospective analysis of patients undergoing closed/ open reduction for DDH and post-reduction perfusion MRI within 24 hours. Out of 149 hips (131 patients) eligible, 99 hips (87 patients) had a minimum 5-year radiographic followup. Five hips (4 patients) were excluded due to metal artifacts, yielding 94 hips (83 patients, mean 11±4 year followup). Of these 45/49 hips had open/closed reduction. The Kalamchi/MacEwen classification of proximal femoral deformity was used to assess significant femoral deformity (= grade 4; total damage to femoral epiphysis, -physis, -neck) at latest radiographic followup. MRI was performed at 1.5 T and included 2D coronal-, axial PD-w and T1-w turbo spin-echo images, before/ after i.v. contrast injection (0.2 mmol/l Gd-DTPA2-). Femoral head enhancement was graded as: normal/ asymmetric/ focally-/ globally decreased. Multivariate regression analysis was performed including odds-ratio (OR) and diagnostic performance.

RESULTS

At followup, 11 hips (12%) had femoral growth disturbance. Prevalence of globally decreased perfusion was higher (p = 0.016) in hips with- (36%, 4/11) compared to hips without growth disturbance (10%; 8/75) and was independently associated with femoral growth disturbance (OR: 6.2; 95%CI, 2 to 27; p=0.014). While negative predictive value of globally reduced perfusion was high (92%) its positive predictive value was low (36%) in predicting femoral growth disturbance.
CONCLUSION

Globally decreased perfusion on post-reduction MRI does not reliably predict proximal femoral growth disturbance in DDH at mid-term. Etiology of femoral growth disturbance after treatment of DDH is likely a multifactorial problem not solely attributed to decreased femoral head perfusion after closed/open reduction.

CLINICAL RELEVANCE/APPLICATION

Our findings question the value of adding contrast agent to assess femoral head perfusion to a postreduction MRI as a predictor of proximal femoral growth disturbance.

RC313-07  Shape Regression in Characterizing an Infant's Growing Bony Pelvis

Tuesday, Dec. 3 9:40AM - 9:50AM Room: N228

Participants
Andy Tsai, MD, Boston, MA (Presenter) Nothing to Disclose

PURPOSE

Understanding the normal growth pattern of the infant pelvis is essential in recognizing many congenital pelvic abnormalities. Very little data exists on the normal growth of the bony pelvis during infancy. The purpose of this study is to analyze the spatial and temporal anatomical shape changes of the infant pelvis based on cross-sectional radiologic data, thus providing insight into the process of male and female infant pelvic growth.

METHOD AND MATERIALS

Pelvic radiographs from negative skeletal surveys of 247 term-born low-risk-of-abuse infants were reviewed (7/2005-2/2013). Additional exclusion criteria were asymmetry of the bony pelvis (due to rotation and/or tilt) and obscuration of the bony margins (due to overlying bowel gas and soft tissues). The bony margins of the pelvis (ilium, ischium, and pubis) from pelvic radiographs were manually segmented by a pediatric radiologist to form male and female shape databases. These databases were used to compute growth patterns of the normal infant male and female pelvises. Specifically, to capture the shape variations of the pelvises both in space and in time, probability maps were used to encode the segmented shapes, and kernel regression (via the Nadaraya-Watson estimator) was employed to interpolate these probability maps across time. The computed dynamic growth patterns were visually assessed for changes in size and morphology; and compared to one another to assess for gender differences.

RESULTS

One hundred eighteen pelvic radiographs from 68 boys (mean=145; SD=100; range=5-344 days) and 50 girls (mean=168; SD=100; range=10-339 days) met study inclusion criteria. The proposed computational framework generated a data-driven model of continuous pelvic growth that is temporally smooth and biologically plausible. It showed that the overall size of the pelvis grows fastest from birth to 3 months of life, and then steadily declines in growth rate from 3-months to 1-year. Visually, the growth pattern for boys and girls are similar, both in terms of morphology and growth rate.

CONCLUSION

Our study generated growth models for the normal male and female pelvises during infancy that can be used to better understand the dynamic growth of the infant bony pelvis.

CLINICAL RELEVANCE/APPLICATION

Understanding the growth pattern of the infant bony pelvis improves the diagnosis and evaluation of congenital skeletal anomalies.

RC313-08  Imaging of Developmental Hip Dysplasia

Tuesday, Dec. 3 9:50AM - 10:10AM Room: N228

Participants
Lene B. Laborie, Bergen, Norway (Presenter) Nothing to Disclose

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LEARNING OBJECTIVES

At the conclusion of this lecture, participants will be able to: 1) Understand the importance of early detection of Hip Dysplasia and the role of imaging. 2) Know how to perform ultrasound of newborn hip joints. 3) Know about existing newborn screening strategies for hip dysplasia.

ABSTRACT

Developmental hip dysplasia is the most common musculoskeletal disorder in childhood, with a reported prevalence of around 2-3 %. This congenital disorder features a shallow, or dysplastic acetabulum, often accompanied by a dislocatable or dislocated femoral head. Ultrasound has enabled a detailed assessment of both acetabular morphology and neonatal hip stability. Various static and dynamic ultrasound techniques, as well as a combination of the two are currently used. Both selective and universal ultrasound screening strategies exist for hip dysplasia in newborns. Early detection and correct management of hip dysplasia is crucial. The management of late detected cases of severe dysplasia can be very challenging. Unsuccessful management of dysplasia represents potential risks of developing early osteoarthritis from young adulthood and serious functional disability.

RC313-09  The Clavicular Joints in Children

Tuesday, Dec. 3 10:20AM - 10:40AM Room: N228

Participants
Delma Y. Jarrett, MD, Boston, MA (Presenter) Nothing to Disclose
LEARNING OBJECTIVES

1) Understand the differences between adult and pediatric acromioclavicular and sternoclavicular joints in: anatomy, radiologic assessment, and patterns of injury.

RC313-10  Evaluation of Physeal Bridges in Children: Correlation with CT and MRI

Tuesday, Dec. 3 10:40AM - 10:50AM Room: N228

Participants

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PURPOSE

Physeal bar is a premature interruption in the unfused physis of children by means of ossification or fibrous bridging due to trauma, infection and other causes leading to growth arrest or deformity. This physeal bridge may be fibrous or bony in nature. In this study we compare the CT and MR images of physeal bridging in children and the accuracy of MRI in the characterisation of the physeal bridges.

METHOD AND MATERIALS

We evaluated 60 children in the age group of 1-18 yrs prospectively who presented with growth arrest and/or deformity to look for the presence of physeal bridges during the period of August 2014-December 2018. With the help of CT and MRI we were able to characterise the nature of the bar whether fibrous or bony, depending upon the extent as epiphyseal, transphyseal, submetaphyseal. It is further classified on the basis of the location of the bridge in the bone into 9 physeal quadrants, so that area of involvement of the physis can be calculated. This quadrant mapping analysis is useful for the correlation with deformity and growth arrest.

RESULTS

16 Female and 15 male presented with premature physeal changes. Out of 31 physeal bridges studied, 15 were posttraumatic, 9 were associated with infection, 5 were associated with blount disease, 1 was associated with perthes disease and 1 was associated with neglected slipped capital femoral epiphysis. The most common anatomic sites involved were proximal femur (10), distal femur (10), proximal tibia (9), distal radius (2). 80.6% of the bridges were bony in posttraumatic cases, 19.3% of the bridges were fibrous in postinfectious cases. 67.7% of the bridges were transphyseal in nature. Submetaphyseal type of bridging was common in blount disease, epiphyseal type was common in postinfectious cases. 50% of the distal femoral arrests were anterolateral in location whereas 44.4% of the proximal femoral arrests were anteromedial in location. Fibrous type of bridging was common in postinfectious sequelae.

CONCLUSION

MR imaging detects fibrous type of physeal bridging and submetaphyseal bridging more accurately than CT and the accuracy in detection of the bony physeal bars is equal to CT.

CLINICAL RELEVANCE/APPLICATION

MR imaging, exquisitely shows the growth disturbance and associated abnormalities that may follow physeal injury and guides surgical management.

RC313-11  Pediatric Long-Bone Fracture Trinomial Subclassification by Convolutional Neural Networks with Two-Stage Decision Model

Tuesday, Dec. 3 10:50AM - 11:00AM Room: N228

Participants

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Melissa C. Cano, RRA, Houston, TX (Abstract Co-Author) Nothing to Disclose
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Ananth Annapragna, PhD, Houston, TX (Abstract Co-Author) Stockholder, Alzeca Biosciences, LLC; Stockholder, Sensulin, LLC; Stockholder, Abbott Laboratories; Stockholder, Johnson & Johnson; Research Grant, Alzeca Biosciences, LLC
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PURPOSE

The purpose of this study was to evaluate the effect of newly designed CNN architecture utilizing two-stage decision model resulting in the trinomial classification of pediatric long bone radiographs with variable open growth plates.

METHOD AND MATERIALS

An IRB approved dataset obtained at a children’s hospital during 2018, that included 3801 pediatric fractures, and 3801 normal radiographs of the appendicular skeleton was used. Fracture locations were labeled as healing or acute with boxes overlaying each fracture location and automatically patched into 512x512 pixels images. Normal radiographs were also automatically patched using the algorithm described in figure 1A-G. The CNN network consisted of two-stage architecture. The Stage-1 training set consisted of 3001 patches with long bone fractures and the same number showing normal radiographs without fracture. The validation set
and test set each had 800 images. Stage 2 CNN training set included 1910 acute and 1891 healing fracture patches, with the latter trained to identify periosteal reaction or callus as evidence of healing. The validation set and test set each had 400 images with class balance 50/50.

RESULTS

The limitation of transfer learning due to low resolution of input images was eliminated using the automated patch approach. The accuracy of classification of the Xception transfer learning network in stage 1 resulted in an accuracy of 89.87%, 60/400 normal radiographs were classified as positive, and 21/400 fracture radiographs were classified as negative, resulting in 379 true positives. In stage 2, the starting set of 379 positive radiographs was tested. Classification failed for 9 of 214 healing fractures, and 26 of 165 acute fractures resulting in stage 2 accuracy of 90.7%. The majority of the false negative and positive exams include casting material, creating the impression of absent periosteum. Combined accuracy for stage 1 and stage 2 was lowered by two stage error propagation to 85.5%.

CONCLUSION

Proposed network architecture allows for successful classification radiographs into three categories: normal, acute fracture and healing fracture.

CLINICAL RELEVANCE/APPLICATION

Trinomial classification of pediatric long bone fractures in the setting of open growth plates is possible using two stage CNN architecture and is able to distinguish normal, acute, and healing fractures.

RC313-12 Pediatric Knee MRI Blind Spots in Patellar Dislocation with Radiologic-Arthroscopic Correlation

Tuesday, Dec. 3 11:00AM - 11:10AM Room: N228

Participants

Oluwafunmiso Fagbongbe, Houston, TX (Presenter) Nothing to Disclose
Matthew Ditzler, MD, Houston, TX (Abstract Co-Author) Nothing to Disclose
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J. H. Kan, MD, Houston, TX (Abstract Co-Author) Nothing to Disclose

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PURPOSE

MRI is often used in the setting of patellar dislocation to screen for injuries necessitating surgery, such as intra-articular osteochondral bodies and cruciate ligament or meniscal injuries. The purpose of this study was to investigate the frequency of chondral, cruciate, and meniscal injuries in surgical patients after a patellar dislocation event to determine the most commonly missed injuries at imaging and further refine our search patterns.

METHOD AND MATERIALS

Children with both knee MRI and operative intervention for the treatment of acute lateral patellar dislocation were identified retrospectively in our electronic medical record. All MRI exams were interpreted by subspecialty trained pediatric musculoskeletal radiologists and all patients were examined by subspecialty trained pediatric orthopedic surgeons. Derangements including location and number of osteochondral loose bodies, cruciate/meniscal injuries, and location and grade of chondral injuries was recorded. Imaging findings were compared to operative reports, which were used as the reference diagnosis.

RESULTS

30 children (14.2 ± 2.1 years; 60% female) with acute lateral patellar dislocation underwent knee MRI followed by surgery and shared a total of 62 surgically significant findings. The MRI discrepancy rate was 26% (16/62) and the false positive rate was 3% (2/62) with reference to surgical findings; both false positives were instances of medial patellar facet chondral injuries not corroborated at surgery. In 10/30 (33%) cases chondral injuries were incorrectly characterized on imaging, most commonly at the lateral tibial plateau. Osteochondral loose bodies were present in 18/30 (60%) patients, but only 13 (72%) were identified at imaging. Missed loose bodies were most common in the medial gutter. 9/30 (33%) had co-existing cruciate or meniscal injuries; of these, 3 were only identified at surgery (2 lateral and 1 medial meniscal tear).

CONCLUSION

Correct identification of surgically significant MRI findings in children with patellar dislocation by pediatric musculoskeletal radiologists is limited with a 26% miss rate. Our most common blind spots included lateral tibial plateau chondral injuries, medial gutter loose bodies, and meniscal injuries.

CLINICAL RELEVANCE/APPLICATION

Radiologists can refine their search patterns for MR knee exams in children with acute lateral patellar dislocation with the knowledge of common imaging blind spots we have described.

RC313-13 Bassett’s Ligament Revisited: A Normal Variant or a Sign of Pediatric Ankle Pathology?

Tuesday, Dec. 3 11:10AM - 11:20AM Room: N228

Participants

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Bassett's ligament, the accessory fascicle of the anteroinferior tibiofibular ligament (AITFL), is a normal anatomic structure with a high prevalence that is well described in adults, but not in pediatric patients. The ligament can abnormally thicken over time due to chronic anterolateral ankle impingement or a lateral talar dome chondral injury, per adult literature. The purpose of our study was to determine the prevalence of Bassett's ligament, and thickness when present, in pediatric patients with MR findings of anterolateral ankle pathology, compared to pediatric patients with normal ankle MRIs.

METHOD AND MATERIALS

Retrospective review of pediatric ankle MRI exams obtained through our electronic medical record was performed with MRI studies grouped into 2 categories: (1) those with a lateral talar osteochondral lesion (OCL) (13.5±2.9 years) and (2) normal ankle MRIs in children >10 years old (13.8±2.5 years). All examinations were retrospectively reviewed by a pediatric musculoskeletal radiologist for the presence of Bassett’s ligament and its axial plane thickness. Frequencies of the ligament and average thickness measurements were calculated per group and analyzed for significant differences.

RESULTS

21 MRI studies were obtained for each group, for a total of 42 examinations. Bassett’s ligament was present in 71% (15/21) of ankle MRIs with a lateral talar OCL with an average thickness of 2.04 mm (range 1.6-2.9 mm) and 71% (15/21) of normal ankle MRIs in patients aged >10 years with an average thickness of 1.59 mm (range 1-2.3 mm). Ligament prevalence (p=1) was similar, but thickness (p=0.004) was statistically different between the groups. For all cases with a lateral talar dome OCL, when Basset’s ligament was identified it measured greater than 1.6 mm in thickness.

CONCLUSION

Bassett’s ligament is a normal developmental anatomic structure present in children and not an acquired lesion related to a remote tear of the AITFL. Our data showed a significant association between thickening of Bassett’s ligament and lateral talar dome OCLs in pediatric patients; further investigation is necessitated to delineate if this is causal or contributory.

CLINICAL RELEVANCE/APPLICATION

Bassett’s ligament is a common and normal anatomic structure in the anterolateral compartment and should not be reported or implicated as a sign of talar dome chondral injury or anterolateral ankle impingement in pediatric patients unless thickened >1.6 mm.
Patellar dislocation in children should routinely undergo urgent MRI investigation to help facilitate optimal surgical decision support, particularly for first-time events.

**RC313-16 Benign Mimics of Pediatric Bone Malignancy**

Tuesday, Dec. 3 11:40AM - 12:00PM Room: N228

Participants
Micheal A. Breen, MD, Boston, MA *(Presenter)* Nothing to Disclose

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**LEARNING OBJECTIVES**

1) Identify some of the most common pathologic and developmental processes that can mimic bone malignancy when imaging pediatric patients. 2) Differentiate these entities from malignant tumors based on imaging findings. 3) Recommend more appropriate management for non-malignant diagnoses.

Printed on: 01/19/20
**SSG08**

**Musculoskeletal (Machine Learning and Artificial Intelligence)**

**Tuesday, Dec. 3 10:30AM - 12:00PM Room: E451A**

**A Deep Learning System for Synthetic Knee MRI: Is Artificial Intelligence-Based Fat Suppressed Imaging Feasible?**

**Participants**

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

Jan Fritz, MD, Baltimore, MD (**Moderator**) Institutional research support, Siemens AG; Institutional research support, Johnson & Johnson; Institutional research support, Zimmer Biomet Holdings, Inc; Institutional research support, Microsoft Corporation; Institutional research support, BTG International Ltd; Scientific Advisor, Siemens AG; Scientific Advisor, General Electric Company; Scientific Advisor, BTG International Ltd; Speaker, Siemens AG; Patent agreement, Siemens AG

**Sub-Events**

**SSG08-01** **A Deep Learning System for Synthetic Knee MRI: Is Artificial Intelligence-Based Fat Suppressed Imaging Feasible?**

**Tuesday, Dec. 3 10:30AM - 10:40AM Room: E451A**

**Participants**

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**PURPOSE**

To determine the feasibility of using a deep learning system (DLS) to create synthetic artificial intelligence-based fat-suppressed MR images (AFMRI) of the knee, for the detection of internal derangement.

**METHOD AND MATERIALS**

A DLS modified CNN based U-Net was developed to create synthetic AFMRI from non-fat-suppressed (FS) images. The U-Net CNN used a training set from 3T-acquired high-resolution 3D volumetric sequences, a FS PD (n=5,568 images) and non-FS-PD (n=6,960 images) in 29 subjects. Three musculoskeletal radiologists reviewed the images in two sessions, the original (PD + FSPD) and the synthetic (PD + AFMRI) imaging, and recorded image quality (diagnostic, diagnostic with artifact, non-diagnostic). Readers recorded the presence or absence of meniscal, ligament and tendon tears, cartilage defects and bone marrow abnormalities (edema/fracture). Contrast-to-noise (CNR) measurements were made between subcutaneous fat, fluid, bone marrow, cartilage, and muscle. Reader interpretations and CNR measures made on synthetic images were compared to the gold standard (original).

**RESULTS**

Image quality of the AFMRI sequence was uniformly rated as diagnostic with artifact, whereas 96.5% (28/29) of original sequences were of diagnostic quality. Diagnostic performance of AFMRI (sensitivity/specificity) for the presence of tears was excellent for the medial meniscus (n=17/29) (94.4%/100%), lateral meniscus (n=5/29) (100%/100%), cruciate ligaments (n=3/29) (100%/100%), collateral ligaments (n=1/29)(100%/100%), and tendons (n=1/29, 100%/100%), respectively. For the detection of cartilage defects (n=76), AFMRI offered an overall sensitivity/specificity of 94.7%/85.5%; for the detection of bone marrow abnormalities (n=51), the overall sensitivity/specificity was 94.1%/83.1%. Correlation coefficients for CNR measurements between original and AFMRI sequences were excellent (all >0.95).

**CONCLUSION**

AFMRI offers excellent sensitivity for the detection of internal derangement of the knee, with moderate specificity for the assessment of cartilage and bone marrow abnormalities. Although image quality is reduced with AFMRI, this technique is feasible for diagnostic imaging.

**CLINICAL RELEVANCE/APPLICATION**

The development of deep learning synthetic AFMRI could obviate the need for acquiring separate FS fluid-sensitive sequences, thereby offering a novel technique for fast imaging of the knee.

**SSG08-02** **Machine Learning Predicts Rate of Cartilage Loss: Data from the Osteoarthritis Initiative**
The rate of annual cartilage loss can vary widely between patients at risk or already suffering from knee osteoarthritis (OA), but the causes for these differences are still unknown. We investigate whether quantitative and semi-quantitative radiographic features can be used to predict the rate of Joint Space Width (JSW) loss.

**METHOD AND MATERIALS**

We collected bilateral knee radiographs, acquired in the context of the OA study, from 4100 patients (2383 female, 1717 male). Over a period of 8 years, each patient had follow-up radiographs up to 7 times, separated by at least 12 months. Each radiograph was analyzed by software to obtain Kellgren-Lawrence (KL) and OARSI grades for osteophytes, sclerosis and joint space narrowing (JSN), as well as JSW measurements for each individual knee. Linear regressions of JSW were performed per individual knee compartment (medial or lateral) to estimate the rate of JSW loss. Individual knees with rate of JSW loss above 0.072 mm/year (the average yearly loss within JSN grade) were classified as progressors (956 knees). From these, knees in the top 10% of JSW loss rate were classified as fast progressors (91 knees). A logistic regression model was used to predict fast progressors with KL and OARSI grades at baseline as independent variables. Model performance was estimated using 10-fold cross-validation training/testing dataset splits and used area under the curve (AUC) as performance criteria.

**RESULTS**

The logistic regression classifiers achieved AUCs of 0.71 (SE 0.015) and 0.66 (SE 0.013) at classifying individual knees as fast progressors for medial and lateral compartments, respectively. Analysis of the individual coefficients of the classifiers reveals that JSN and sclerosis OARSI grades are the main predictors of rapid JSW decrease.

**CONCLUSION**

Our results show that it is possible to predict rapid cartilage loss from quantitative and semi-quantitative readings from a single plain radiograph. Interestingly, neither KL grade nor Osteophytes OARSI grade contributed greatly to this prediction. Instead, Sclerosis and JSN grade seem to be the major predictors of rapid cartilage loss, suggesting a non-canonical mode of OA progression.

**CLINICAL RELEVANCE/APPLICATION**

Prediction of rapid cartilage loss is an important but unresolved problem. Our work suggests that these patients can be detected from radiographic features.
RESULTS
Dice coefficient between the masks from the radiologist and CNN was 0.82±0.10. Fig 1a shows representative 2D slices with the segmented cartilage regions. Fig 1b shows scatterplots for the average T1, adiabT1p, T2* values with the manual and automatic segmentations, which show high correlation: 0.95 for T1, 0.88 for T1p, and 0.86 for T2*. Fig 1c summarizes the estimated parameters.

CONCLUSION
The proposed framework for automatic knee cartilage segmentation achieved performance similar to that of the radiologist, demonstrating feasibility in automatically providing UTE-MR-based biomarkers.

CLINICAL RELEVANCE/APPLICATION
The proposed framework can be used for assessment of knee osteoarthritis.

SSG08-04 Automated Detection and Classification of Shoulder Arthroplasty Models Using Deep Learning

Tuesday, Dec. 3 11:00AM - 11:10AM Room: E451A

Participants
Paul H. Yi, MD, Baltimore, MD (Presenter) Nothing to Disclose
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PURPOSE
Accurate identification of arthroplasty implant models is important for surgical planning and is a task which could be facilitated by deep learning. The purpose of this study was to develop and test the performance of deep convolutional neural networks (DCNNs) for automated identification and classification of shoulder arthroplasty (SA) models on radiographs.

METHOD AND MATERIALS
We collected a dataset of 156 AP shoulder radiographs with equal proportions of native shoulders and SA (equal proportions of total SA [TSA] and reverse TSA [RTSA]), and a dataset of 326 AP shoulder radiographs with 5 different TSA models: Biomet BioModular Choice (37), DePuy Global (125), DePuy HRP (63), Stryker Solar (51), and Zimmer Bigliani-Flatow (50). We trained ResNet DCNNs (pretrained on ImageNet) to 1) detect the presence of SA; 2) differentiate between TSA and RTSA; and 3) differentiate amongst the 5 TSA models. For each DCNN, the datasets were divided into training/validation/test splits of 70/10/20%; training and validation images were augmented up to 20x using crops, rotations, flips, and affine transformation. Receiver operating characteristic (ROC) curves were generated with area under the curve (AUC) calculated to assess test performance. Class activation mapping (CAM) was used to identify distinguishing imaging features used for DCNN classification decisions.

RESULTS
The DCNNs trained to detect SA and to distinguish between TSA and RTSA both achieved AUC of 1. In both cases, Heatmaps demonstrated appropriate emphasis of the arthroplasty components in decision-making (Figure 1A & 8). The DCNNs trained to distinguish between the 5 TSA models achieved AUCs ranging from 0.94 for the Biomet BioModular Choice TSA to 1 for the Zimmer Bigliani-Flatow TSA. Heatmaps for TSA model classifiers showed emphasis of unique features of TSA designs, such as the 3-holed lateral fin of the DePuy Global TSA (Figure 1C) and the 2-holed lateral fin of the Zimmer Bigliani-Flatow TSA (Figure 1D).

CONCLUSION
DCNNs can accurately identify presence of SA and distinguish between TSA & RTSA, as well as between 5 specific TSA models. The proof-of-concept of these DCNNs may set the foundation for an automated arthroplasty atlas for rapid model identification.

CLINICAL RELEVANCE/APPLICATION
Deep neural networks can accurately identify presence of shoulder arthroplasty and distinguish between specific models.

SSG08-05 Radiologist versus the Machine: Can a Machine Learning Algorithm Adequately Identify the Surgical Level in Patients Undergoing Lumbar Decompression

Tuesday, Dec. 3 11:10AM - 11:20AM Room: E451A

Participants
Brandon L. Roller, MD, PhD, Winston Salem, NC (Abstract Co-Author) Consultant, Bone Solutions, Inc
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Ziyad O. Knio, BS, Winston Salem, NC (Abstract Co-Author) Nothing to Disclose
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PURPOSE
Accurate identification of lumbar surgical level is important for surgical planning and is a task which could be facilitated by deep learning. The purpose of this study was to develop and test the performance of deep convolutional neural networks (DCNNs) for automated identification and classification of surgical level on lumbar radiographs.

METHOD AND MATERIALS
We collected a dataset of 316 AP lumbar radiographs with equal proportions of native levels and lumbar decompression (40% lumbar fusion, 40% LUMAR 1-3, 20% LUMBAR 4-5), and a dataset of 156 AP lumbar radiographs with 5 different lumbar decompression models: S12, S13, S14, S15, and S16. We trained ResNet DCNNs (pretrained on ImageNet) to 1) detect the presence of lumbar decompression; 2) differentiate between LUMBAR 1-3 and 4-5; and 3) differentiate amongst the 5 lumbar decompression models. For each DCNN, the datasets were divided into training/validation/test splits of 70/10/20%; training and validation images were augmented up to 20x using crops, rotations, flips, and affine transformation. Receiver operating characteristic (ROC) curves were generated with area under the curve (AUC) calculated to assess test performance. Class activation mapping (CAM) was used to identify distinguishing imaging features used for DCNN classification decisions.

RESULTS
The DCNNs trained to detect SA and to distinguish between TSA and RTSA both achieved AUC of 1. In both cases, Heatmaps demonstrated appropriate emphasis of the arthroplasty components in decision-making (Figure 1A & 8). The DCNNs trained to distinguish between the 5 TSA models achieved AUCs ranging from 0.94 for the Biomet BioModular Choice TSA to 1 for the Zimmer Bigliani-Flatow TSA. Heatmaps for TSA model classifiers showed emphasis of unique features of TSA designs, such as the 3-holed lateral fin of the DePuy Global TSA (Figure 1C) and the 2-holed lateral fin of the Zimmer Bigliani-Flatow TSA (Figure 1D).

CONCLUSION
DCNNs can accurately identify presence of SA and distinguish between TSA & RTSA, as well as between 5 specific TSA models. The proof-of-concept of these DCNNs may set the foundation for an automated arthroplasty atlas for rapid model identification.
To determine if radiologists or a machine learning algorithm (MLA) can more accurately identify the surgical level for patients undergoing microdecompression.

**METHOD AND MATERIALS**

107 consecutive patients (mean age 65, range 28-89; 64 women, 43 men) with single level central lumbar microdecompression performed by one surgeon and lumbar MRI exams (≤1 year prior to surgery) were retrospectively evaluated. MRI reports by 29 faculty radiologists were reviewed for central canal stenosis (CCS) with the following grading: 1=normal, 2=mild, 3=moderate, 4=severe. Lateral recess stenosis and/or traversing nerve root displacement also was recorded. A MLA for automated evaluation of MRI exams (SpineNet; previously trained, validated, and tested with 12,078 disc levels from the Genodisc consortium; http://zeus.robots.ox.ac.uk/spinenet) was applied to sagittal T2-weighted images. At each level, the MLA provided CCS grades utilizing the same 1-4 scale. The radiologist report and MLA data were evaluated for their ability to predict the surgical level in a blinded fashion. Spearman correlation between the radiologist and MLA CCS grades was determined.

**RESULTS**

The worst lumbar level reported by radiologists matched the surgical level in 102/107 patients (95%), compared to 77/107 (72%) who had surgery at the level of greatest CCS determined by the MLA. Radiologist and MLA CCS grades correlated moderately (r=0.53, p<0.001). For each MLA CCS grade, the average radiologist CCS grade was as follows: MLA1 = 2.46, MLA2 = 3.13, MLA3 = 3.60, MLA4 = 3.81. The MLA yielded 24 normal CCS grades at the surgical level. Of these, the radiology report described lateral recess stenosis and/or nerve root displacement in 20/24 (83%), with variable CCS (severe in 3, moderate in 2, mild in 7, none in 1, grade not specified in 11).

**CONCLUSION**

This study highlights success with an automated approach to grade CCS using only sagittal images on most lumbar MRI exams, as compared to radiologist reports and eventual surgical level. However, the technology needs to be refined to incorporate axial images and lateral recess evaluation in order to match human interpretation.

**CLINICAL RELEVANCE/APPLICATION**

Automated approaches to MRI grading have the potential for improved patient care but need to be further augmented in order to match human interpretation.

**SSG08-06  Prediction of Sarcopenia: Quantitative Evaluation of Skeletal Muscle Using Shear Wave Ultrasonographic Elastography by Radiomics and Deep Learning Convolved Neural Network (CNN) Model Approach**

Tuesday, Dec. 3 11:20AM - 11:30AM Room: E451A

**Participants**

Jisook Yi, MD, Busan, Korea, Republic Of (Presenter) Nothing to Disclose
Young Han Lee, MD, Seoul, Korea, Republic Of (Abstract Co-Author) Nothing to Disclose
Seok Hahn, MD, Busan, Korea, Republic Of (Abstract Co-Author) Nothing to Disclose

**PURPOSE**

To investigate if deep features extracted via transfer learning can generate radiomics signatures for prediction of sarcopenia in by investigating the B-mode ultrasonography (USG) and shear wave ultrasonographic elastography (SWE) on right rectus femoris muscle with their radiomic features to build the deep learning-based radiomics model.

**METHOD AND MATERIALS**

This study comprised a data set of 44 patients and an independent validation data set of 18 patients. A total of 62 USG and corresponding 62 USE images were included. Qualitative evaluation of muscle grade was performed by 4 grades: Grade 0, normal; Grade 1, some area of increased echogenicity; Grade 2, echogenic as perimysial fat; Grade 3, isoechoic to fat. For quantitative radiomic features, 43 radiomic features were extracted from all the images: 3 global features, 9 features from the Gray-Level Co-occurrence Matrix (GLCM), 13 features from the Gray-Level Run-Length Matrix (GLRLM), 13 features from the Gray-Level Size Zone Matrix (GLSZM), and 5 features from the Neighborhood Gray-Tone Difference Matrix (NGTDM). After feature selection, top 5 features were selected by using the least absolute shrinkage and selection operator (LASSO) Cox regression model. For deep learning-based CNN, we used a GoogleNet Inception v3 CNN architecture that was pre-trained on 1.28 million images. The top layer of the Inception v3 network was re-trained using ultrasonography images to produce a model for the classification of USG and USE images.

**RESULTS**

The muscle degeneration on USG and SWE showed significant negative correlation (r=−.641, p<0.001). Four radiomics features showed correlations: sum of average, variance, autocorrelation of GLCM features and high gray-level zone emphasis (HGZE) of GLDZM. The CNN classification of muscle grade showed 90.5% (n=19/21) in independent test set. The radiomics features associated with sarcopenia were gray-level nonuniformity (GLN) and HGZE of GLDZM. The diagnostic accuracy of CNN in detection of sarcopenia was 94.4% (n=17/18).

**CONCLUSION**

Deep learning-based CNN and radiomics can be utilized to classify the muscle degeneration and sarcopenia. This approach for
muscle could be applied to determine sarcopenia, improving the patient care.

**CLINICAL RELEVANCE/APPLICATION**

Radiomics evaluation and deep-learning evaluation of USG and SWE improved the prediction of sarcopenia.

**SSG08-07 Prediction of Cartilage Collagen and Proteoglycan Fractions Using Multiparametric Quantitative MRI and Machine Learning**

Tuesday, Dec. 3 11:30AM - 11:40AM Room: E451A

Participants
- Johannes A. Thuering, MD, Aachen, Germany (Presenter) Nothing to Disclose
- Kevin Linka, Aachen, Germany (Abstract Co-Author) Nothing to Disclose
- Christiane K. Kuhl, MD, Aachen, Germany (Abstract Co-Author) Nothing to Disclose
- Sven Nebelung, MD, Aachen, Germany (Abstract Co-Author) Nothing to Disclose
- Daniel Truhn, MD, Cologne, Germany (Abstract Co-Author) Nothing to Disclose

**PURPOSE**

In the early and possibly reversible stages of cartilage degeneration, the tissue remains structurally grossly intact while only slight changes in composition such as alterations in collagen (CO) and proteoglycan (PG) contents are present. This study aims at predicting the CO and PG fractions using quantitative MRI (qMRI) and sophisticated machine learning approach in efforts to non-invasively predict degeneration-related compositional features based on qMRI.

**METHOD AND MATERIALS**

11 histologically intact cartilage-bone samples were harvested from the medial femoral condyle and cut to 8 mm diameter were obtained after joint replacement. On a clinical 3T scanner (Achieva, Philips), T1, T1?, T2 and T2* maps were obtained at high resolution along the mid-sagittal plane (0.25x0.25 mm). Hereafter spatially resolved CO and PG fractions were determined using Fourier-Transform-Infrared Microspectrometry. An artificial neuronal network (ANN) and a multivariate linear model (MLM) were implemented and trained by leave-one-out cross validation to predict the CO and PG fractions in a voxel-wise manner. Predictive performance was assessed by calculating percentage deviations (PD) between modelled and measured contents.

**RESULTS**

The ANN performed better than the MLM (PD: 1.1% [PG-ANN], 11.9% [PG-MLM], 0.3% [CO-ANN], 3.8% [CO-MLM]). Strong correlations (i.e. Pearson's correlation coefficients $r > 0.7$) between modelled and measured contents were found throughout, irrespective of the underlying model.

**CONCLUSION**

Trained properly, machine learning approaches are able to predict local CO and PG contents with high accuracy and precision and in a voxel-wise manner based on a multiparametric qMRI.

**CLINICAL RELEVANCE/APPLICATION**

Once modified for the clinical setting, machine learning approaches, in particular ANN, may be used to determine compositional features of cartilage based on qMRI parameters alone with potential implications for the diagnosis of (early) degeneration and for the monitoring of therapeutic outcomes.

**SSG08-08 Performance of a Deep Learning-Based MR Reconstruction Algorithm for the Evaluation of Peripheral Nerves**

Tuesday, Dec. 3 11:40AM - 11:50AM Room: E451A

Participants
- Erin C. Argentieri, BS, New York, NY (Abstract Co-Author) Nothing to Disclose
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- Hollis G. Potter, MD, New York, NY (Abstract Co-Author) Research support, General Electric Company Institutional research agreement, General Electric Company
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**PURPOSE**

To evaluate the clinical performance of a new deep learning-based MR prototype reconstruction method (‘DLRecon’) for evaluation of peripheral nerves.

**METHOD AND MATERIALS**

This was an IRB approved pilot study of 23 subjects (13F, mean age=49±16) undergoing routine clinical 3T MRI evaluation of neuropathy (MR750 GE Healthcare). Axial 2D intermediate weighted FSE sequences were acquired on each subject, and two sets of image series were reconstructed from the same raw dataset: standard of care MRI (SOC-MRI) using a conventional reconstruction method and DLRecon-MRI using a DLRecon method employing a convolutional neural network trained to reduce noise and ringing. All exams were anonymized, randomized, and scored by a blinded radiologist who evaluated: pulsation, aliasing, and bulk motion artifacts, fascicular architecture, and outer epineurium conspicuity (on a 4 point scale) as well as identification of DLRecon- vs SOC- MRIs. Agreement between DLRecon- and SOC- MRI grades were evaluated using ordinal weighted Gwet’s agreement coefficients. Marginal ordinal logistic regression models analyzed grade differences between DLRecon- and SOC- MRIs.

**RESULTS**
Near perfect agreement (AC>0.81) was found between DLRecon- and SOC- MRIs for evaluation of pulsation artifact and outer epineurium conspicuity. Substantial agreement (AC>0.70) was found between the DLRecon- and SOC- MRIs for aliasing artifact, bulk motion, and fascicular architecture. With the exception of aliasing artifacts (OR=2; 95%CI: 1.3-3.1; p=0.002) no significant differences were found between DLRecon- and SOC- MRI outcome measure grades. Finally, the blinded radiologist’s ability to correctly determine if an image set was DLRecon- vs SOC- MRI was 15%.

CONCLUSION
Results of the current pilot study suggest that DLRecon-MRIs perform comparably to SOC-MRIs for evaluation of peripheral nerves, preserving key anatomic details. DLRecon may provide clinically important information with visible noise reduction and image sharpening. In cases of peripheral neuropathy where SOC-MRIs had sufficient spatial resolution to detect the presence of pathology, associated DLRecon-MRIs demonstrated marked fascicular detail and architecture (FIG. 1).

CLINICAL RELEVANCE/APPLICATION
DLRecon-MRI provides statistically similar anatomic detail and artifacts compared to SOC-MRI for peripheral nerve evaluation, and may aid visualization of nerve fascicular detail and pathologic change.

SSG08-09 Rib Fracture Detection Algorithm in X-Ray Images Using Deep Learning

Participants
Amin Katouzian, PhD, Cambridge, MA (Presenter) Nothing to Disclose
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Benedikt Graf, PhD, Cambridge, MA (Abstract Co-Author) Employee, IBM Corporation

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PURPOSE
To develop an algorithm that mimics the exact way that radiologists look for rib fractures during conventional chest radiographic read.

METHOD AND MATERIALS
Our dataset includes 1200 unique patients each with frontal (AP or PA) x-ray image representing rib fracture(s). We asked 3 experienced radiologists to use a bounding box for annotating each fracture using labels such as: fracture age (acute (A), indeterminate (I), old (O)), and fracture displacement (large-(L), medium-(M), non-displaced(N)). The algorithm is comprised of two networks: 1) two-second glimpse, and 2) attention. Our rationale for using the glimpse model is due to radiologists rapid ability identifying the gist of fractures, often large-displacement, in several seconds. To this end, we used multiscale U-Net as detector followed by localization and verification models. If no fracture is found, then the attention model is deployed, consisting of multiscale patch generation and classification using ResNet model. This replicates when radiologists magnify images and track along each rib looking for any discontinuity or deformation. We trained and validated (80-20% split) our models using 2549 fractures (AL:253, AM:560, AN:454, IL:26, IM:157, IN:354, OL:43, OM:99, ON:603). A balanced dataset of 1000 patients with (n=893) and without fractures is used as test set.

RESULTS
The algorithm performed very well at the patient level, detecting fractures with specificity (SP), sensitivity (SEN) and area under ROC curve of 87%, 86%, and 92%, respectively. Fracture detection with large and medium displacement (SP=91%, SEN=87%) was better than non-displaced ones (SP=83%, SEN=81%). The performance was superior in detecting acute (SP=85%, SEN=83%) vs. non-acute (indeterminate+old) (SP=78%, SEN=77%) fractures. It also detected 39 fractures that had been missed during data (train+test) annotation process. There was a 1.1% improvement in detection but readers were told to focus more on identifying rib fractures in this enriched dataset with rib fractures. So, in general application, the improved detection we theorize would be higher.

CONCLUSION
We introduce a novel deep learning driven system on conventional chest radiographic images and achieved promising results.

CLINICAL RELEVANCE/APPLICATION
The proposed algorithm could assist radiologists in rib fractures detection during frontal conventional chest radiographic interpretation, and as a second reader to assess for missed fractures.

Printed on: 01/19/20
3D + AV Theater: Experimental Applications of Desktop 3DP: Pioneering Research from the Field: Presented by Formlabs

Tuesday, Dec. 3 11:30AM - 11:50AM Room: 3D Printing and Advanced Visualization Theater, North Building, Level 3, Booth 6563

Participants
Gaurav Manchanda, Somerville, MA (Presenter) Nothing to Disclose
Todd Goldstein, PhD, Manhasset, NY (Presenter) Nothing to Disclose

Program Information
Join us to hear trends, observations, and perspectives from Formlabs, the market-leader for professional-grade 3D printers, as well as best practices and experimental applications of 3DP from Northwell Health, the largest healthcare system in New York State. Formlabs has deployed over 50,000 SLA printers to date and has a presence in over 90% of the top 50 medical schools, medical device companies, and Level I/II trauma centers that have adopted 3D printing. Northwell Health has over 700 care centers, 3,000 physicians, and 23 hospitals in New York, as well as the Feinstein Institute for Medical Research. It has scaled its 3D printing lab from an initial research project to a fully-funded, automated 3D Printing Laboratory, where it now produces surgical guides, anatomical models, training systems, and prostheses. Learn more via these links: https://formlabs.com/industries/healthcare/; https://www.northwell.edu/

Printed on: 01/19/20
AI Theater: ScanDiags-AI-driven Decision Support from Musculoskeletal MRI: Presented by Balzano AI Engineers

Tuesday, Dec. 3 12:00PM - 12:20PM Room: AI Showcase, North Building, Level 2, Booth 10724

Participants
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Stefan Voser, Zurich, Switzerland (Presenter) Nothing to Disclose

Printed on: 01/19/20
Increased Bone Marrow Density on Unenhanced CT in Patients with Acute Myeloid Leukemia

PURPOSE
Although the diagnosis of leukemia is usually made by peripheral blood and bone marrow blasts, CT examination is occasionally performed due to non-specific symptoms, such as malaise and fever. While it has been reported that increased bone marrow CT attenuation due to bone marrow reconversion can be detected before peripheral blood abnormality in patients with AML, the actual threshold of the CT attenuation value (AV) to suspect it has not been reported. The purpose of this study was to determine whether unenhanced CT AV of bone marrow could be used for suspecting AML.

METHOD AND MATERIALS
We retrospectively reviewed patients with AML from 2010 to 2018 who underwent pretreatment unenhanced CT in our hospital. The inclusion criteria were: >20 years old, unenhanced CT of the body was performed before treatment, and final diagnosis of AML was made by bone marrow biopsy. As a control group, patients without any hematologic disease were randomly selected. CT AVs were measured in both iliac bones with circular region-of-interest on unenhanced CT (5mm thickness). Receiver operating characteristic (ROC) curve analysis was performed, and Student’s t test and Steel-Dwass’ test were also used for a statistical analysis.

RESULTS
A total of 15 AML patients consisted of 10 patients diagnosed before CT (diagnosed AML group) and five patients diagnosed after CT (undiagnosed AML group) met criteria. The mean AV of iliac bone of diagnosed AML group (155.0 +/- 51.8 HU) and that of undiagnosed AML group (137.3 +/- 9.6) were significantly higher than that of control group (16.8 +/- 41.5, p < 0.01). The mean AV did not differ between the diagnosed and undiagnosed AML groups. The sensitivity and specificity for the diagnosis of AML were 100% and 93% at threshold value of 86 HU.

CONCLUSION
CT AV of iliac bone was elevated in patients with AML, and should be checked even when AML is not specifically suspected.

The Efficacy of Ultrasound-Guided Suprascapular Nerve Radiofrequency Ablation in the Treatment of Chronic Shoulder Pain

PURPOSE
Ultrasound guided radiofrequency ablation (RFA) of suprascapular nerve is an alternative to surgery for treatment of chronic shoulder pain. The aim of this study is to evaluate the efficacy of this procedure in relieving the pain in patients affected by chronic shoulder pain.

METHOD AND MATERIALS
This is a retrospective study for all ultrasound guided suprascapular nerve radiofrequency ablations performed at our institution between April 2013 and April 2018. The standard criteria for patients to be considered for RFA in our institution is to have chronic shoulder pain, which is not settling with pain relief optimisation, and show a favourable response to diagnostic suprascapular nerve
block. All the ultrasound guided RFA were performed by MSK Radiologists as an outpatient procedure under local anaesthetic. The patients were issued with a pain diary, using a pain score system, to complete over the subsequent two weeks. The efficacy of RFA was evaluated by identifying the proportion of patients who had significant reduction in pain after RFA, the mean pain score reduction after the procedure and the mean time interval between consecutive ablations.

RESULTS

139 ultrasound guided RFA procedures were performed. A significant pain reduction was observed in 86% of the radiofrequency ablations. The mean pain score reduction after the procedure was 7.7 and the mean time interval between consecutive ablations was 11 months.

CONCLUSION

Ultrasound guided radiofrequency ablation of the suprascapular nerve is an effective treatment in patients affected by chronic shoulder pain and it provides a relatively long period of pain relief.

CLINICAL RELEVANCE/APPLICATION

Ultrasound guided suprascapular nerve radiofrequency ablation is an effective method in the treatment of chronic shoulder pain.

MK363-SD- Diagnostic Value of Dual-Energy CT Virtual Non-Calcification for Occult Fracture of Knee Joint

PURPOSE

To evaluate the diagnostic value of dual energy CT(DECT) virtual non-calcification (VNCa) in occult knee fractures.

METHOD AND MATERIALS

Thirty patients with a definite history of trauma and knee movement disorder who were clinically diagnosed as occult knee fractures were prospectively collected and sequentially underwent DECT and MRI of the knee. Each knee was divided into 12 zones (distal femoral and proximal tibia were divided into 6 zones respectively), two independent readers evaluated conventional CT and VNCa images for the present of bone marrow injury. The knee joint was detected on the coronal image, VNCa CT value of normal and injurious bone marrow were calculated, and the difference between the two CT values was calculated. MRI images were used as the reference standard to evaluate the ability of subjective evaluation and CT difference to detect occult fractures of the knee joint. The sensitivity and specificity of the above two methods for bone marrow injury of knee joint were observed by ROC curve. Kappa values were used to test the consistency of diagnosis of bone marrow injury by two radiologists.

RESULTS

There were 360 zones in 30 knee joints. MRI showed that 11 cases of distal femur (54/132) area in the bone marrow damage, 22 cases of proximal tibia (136/264) damage area in bone marrow and marrow damage area on T1WI sequences showed irregular shape, low signal of the linear fuzzy shadow, while PDWI FS sequence was slightly higher or high signal. The virtual non-calcification diagram showed bone marrow damage in 11 cases of distal femur (58/132) and 22 cases of proximal tibia (138/264). The VNCa diagram showed flak-like high-density shadows with unclear boundaries in the black background. VNCa difference revealed bone marrow damage in 11 cases of distal femur (53/123) and 22 cases of proximal tibia (137/264). The subjective evaluation and CT values in VNCa images were consistent with MRI imaging respectively (the Kappa values were 0.829 and 0.867, respectively). The AUC, sensitivity, specificity and accuracy of subjective evaluation and CT difference to detect occult fractures of the knee joint were 0.876 and 0.885, 92.1% and 90.3%, 89.3% and 92.4%, 87.6% and 93.1%, respectively.

CONCLUSION

VNCa dual-energy imaging has excellent diagnostic performance for evaluating occult knee fractures with a high consistency of MRI imaging.

CLINICAL RELEVANCE/APPLICATION

VNCa dual-energy imaging provides a reference for clinical diagnosis of occult fractures.

MK396-SD- High Resolution Ultrasound in Sub-clinical Diabetic Neuropathy: A Potential Screening Tool

PURPOSE

In recent years research has shifted to early detection of diabetic neuropathy. Various screening methods include tuning forks, monofilaments testing and nerve conduction studies (NCS). High resolution sonography (HRUS) has emerged as a promising technique for evaluation of peripheral nerves. The aim of this study was to assess the utility of HRUS in screening diabetic patients...
for subclinical neuropathy.

**METHOD AND MATERIALS**

29 Type II diabetic patients without clinical features of neuropathy and with normal NCS were recruited along with 30 healthy controls. Institutional ethical committee approval and informed consent were obtained. Nerve sonography was performed by two MSK radiologists independently who were blinded to the group status of the subjects. Nerves studied were median (at elbow and wrist), ulnar (cubital tunnel & guyon's canal), common peroneal (fibular head) and posterior tibial nerve (at medial malleolus). The size [cross sectional area (CSA) in mm²], shape, echogenicity and morphology of each nerve was assessed and compared between the two groups using relevant statistical tests.

**RESULTS**

A significantly higher CSA was present in diabetics compared to controls at all sites examined. Mean for median nerve was 8.4 vs. 5.2 and for ulnar was 4.8 vs 3.1 at elbow (p value < 0.001 for both). For common peroneal CSA was 7.7 vs 3.7 and for posterior tibial 4.9 vs 3.0 (p < 0.001). The nerves in diabetics were more rounded (68.9% vs 50% for median, 58.6% vs 36.6% for ulnar), more hypoechoic (24.1% vs 20% for common peroneal) and revealed an altered morphology in higher percentage of cases (51.7% vs 33.3% for median nerve at elbow). ROC curves revealed high area under curve for all nerves (0.942 for ulnar and 0.962 for common peroneal); common peroneal nerve with a cut off CSA of 5.5mm² had the highest sensitivity (80%) and specificity (96%) for detecting nerve changes. Interobserver agreement was excellent. (ICC >= 0.9: all nerves)

**CONCLUSION**

HRUS detected nerve changes in asymptomatic diabetics with good accuracy and had an excellent Interobserver agreement. It, thus, can be a potential screening tool for detection of neuropathy in subclinical stage.

**CLINICAL RELEVANCE/APPLICATION**

Sonographic nerve changes in asymptomatic diabetics depict that morphological alterations in nerves precede clinical symptoms. Detection of subclinical neuropathy can aid in timely intervention and dedicated care to reduce disease progression and morbidity.

**MK397-SD-**

**Quantitative MRI Detects Muscle Recovery?**

**TUAS**

Participants

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Melissa Hooijmans, Amsterdam, Netherlands (Abstract Co-Author) Nothing to Disclose
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**PURPOSE**

Determine time course changes in Diffusion Tensor Imaging (DTI) parameters in injured hamstring muscles.

**METHOD AND MATERIALS**

20 injured athletes (18 males, 2 females, average age 27.8±7) underwent MRI examination within 1 week after their hamstring injury, 2 weeks after time point 1 and at return to play (RTP). RTP means full training at pre-injury level. MRI datasets were acquired with a 3T Philips Ingenia MRI scanner. DTI: spin echo- echo planar imaging sequence, multiple b-values for Intra Voxel Incoherent Motion (IVIM) correction, duration: 11.08 min. DTI data was processed using DTITools for Wolfram Mathematica and manual segmentation of the injured muscle was performed in ITK-snap. ROI's consisted of 7 slices (35mm) overlaying the origin of the injury. The DTI parameters, Mean Diffusivity (MD) and Radial Diffusivity (RD), were calculated for each subject at each time points. The other 6 subjects already reached RTP by time point 2. Both DTI parameters declined during the recovery period. A significant overall time effect was found for both MD (P<0.01) and RD (P<0.01). MD declined significantly between time points 1 and 2 (P<0.01), between time points 1 and 3 (P<0.01) but not between time point 2 and 3 (P=0.32). RD declined significantly between time points 1 and 2 (P<0.01), but not between time points 1 and 3 (P=0.05) and time point 2 and 3 (P=0.41). The small number of subjects with 3 time points is likely the cause of the non-significant results between time points 2 and 3.

**CONCLUSION**

DTI is able to detect time course changes in injured hamstring muscles, potentially reflecting recovery.

**CLINICAL RELEVANCE/APPLICATION**

Research has shown that conventional T2-weighted MR sequences fail in assessing muscle recovery. DTI seems more sensitive to microstructural changes and could change how we assess muscle injuries.

**MK398-SD-**

**Lateral Femoral Condyle Insufficiency Fractures: Associated Morphological Findings**

**TUAS**

Participants

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**PURPOSE**

Determine morphological changes in the lateral femoral condyle due to lateral femoral condyle insufficiency fractures.

**METHOD AND MATERIALS**

29 patients were operated due to lateral condyle insufficiency fractures. All patients were operated via a lateral approach. The operated condyle of each knee was analysed and compared to the contralateral knee. In addition, the operated condyle was subdivided into a proximal and distal part. The proximal part included the press-fit nail and the proximal half of the condyle. The distal part included the remaining condylar bone. Two radiologists were asked to categorise the extent of the morphological changes using a 5 point scale. The extent of the morphological changes in the lateral condyle was assessed using an inter-observer agreement.

**RESULTS**

The extent of the morphological changes was compared between the operated condyle and the contralateral knee. The inter-observer agreement was excellent. The extent of the morphological changes in the lateral condyle was significantly decreased in the operated condyle compared to the contralateral knee. The extent of the morphological changes in the proximal part of the operated condyle was significantly decreased compared to the distal part. The inter-observer agreement was excellent. The extent of the morphological changes in the proximal part of the operated condyle was significantly decreased compared to the distal part. The inter-observer agreement was excellent. The extent of the morphological changes in the proximal part of the operated condyle was significantly decreased compared to the distal part. The inter-observer agreement was excellent.

**CONCLUSION**

The extent of the morphological changes in the lateral femoral condyle due to lateral femoral condyle insufficiency fractures is significantly decreased in the operated condyle compared to the contralateral knee. The extent of the morphological changes in the proximal part of the operated condyle is significantly decreased compared to the distal part. The inter-observer agreement was excellent.

**CLINICAL RELEVANCE/APPLICATION**

The extent of the morphological changes in the lateral femoral condyle due to lateral femoral condyle insufficiency fractures is significantly decreased in the operated condyle compared to the contralateral knee. The extent of the morphological changes in the proximal part of the operated condyle is significantly decreased compared to the distal part. The inter-observer agreement was excellent.
The radiologist's diagnostic accuracy is 0.96. When using the scores of 20 features to build a logistic regression model, the final diagnostic impression was obtained. The developed model using ResNet50 was applied to a second independent dataset of 94 benign and malignant vertebral fractures. An experienced radiologist performed reading, and gave the score of 0 or 1 for 20 features, as well as a probability for that patient. The performance was evaluated using 10-fold cross-validation. After obtaining the malignancy probability for each slice, the highest probability among all slices of one patient was used as the probability for that patient. We hypothesise that LFCIF are less frequently associated with meniscal tears and chondrosis in the lateral compartment. The purpose of this study is to evaluate the MRI characteristics of LFCIF and their associated morphological findings.

METHOD AND MATERIALS

A retrospective review of consecutive patients with LFCIF on MRI was performed after excluding post-traumatic and pathological fractures. Morphological findings including lesion size/location, presence of bone marrow and soft tissue edema, chondrosis grade and associated meniscal pathology were classified by two musculoskeletal radiologists. Previous MRIs and available DEXA scans were reviewed.

RESULTS

105 consecutive patients (56 female, 49 male) with LFCIF were included (age range 17-86 yrs, median 59 yrs), representing the largest reported population. Central weight bearing (61%) and lateral (35%) locations for LFCIF were most prevalent. Most patients had an associated meniscal tear/s (65%) with medial tears (48%) more prevalent than lateral tears (41%, p=0.4). High grade chondrosis (grade 3/4) was present in 63% with no difference in prevalence between compartments. Bone marrow edema was present in all cases and soft tissue edema was present in 83%. 29% of cases progressed to osteonecrosis with increasing age a significant risk factor for progression (p=0.04). 11 subjects with LFCIF previously had a MFCIF at MRI (shifting bone marrow edema). Osteopenia was present in 2/3 of patients.

CONCLUSION

Meniscal tears and high grade chondrosis are highly prevalent findings with LFCIF. Unlike MFCIF these occur in similar prevalence both medially and laterally suggesting that LFCIF occur in the presence of more global knee pathology potentially resulting in increased stress applied to the normally less weight bearing lateral compartment. 2/3 of patients were osteopenic highlighting the role of weakened bone in the pathogenesis of LFCIF.

CLINICAL RELEVANCE/APPLICATION

This is the largest reported series of LFCIF and demonstrates different morphology to MFCIF which suggests that LFCIF develop in the presence of more global knee pathology with altered biomechanics.
The radiologist's diagnostic accuracy = 0.96. When using the scores of 20 features to build a logistic regression model, the accuracy = 0.92. In deep learning using ResNet50, the per-slice accuracy = 0.83, and per-patient accuracy = 0.92. For the testing in the second independent dataset, the matrix size of image was found to have a great influence on the performance. When using images of the same 512x512 matrix as in the training set, the accuracy was 0.81 for per-slice diagnosis and 0.77 for per-patient diagnosis. But, when the matrix size was changed to 384x384, the per-patient accuracy became much lower to 0.68. When including one additional convolutional layer for adaptive pre-processing, the pre-patient accuracy was improved to 0.75.

CONCLUSION

Deep learning using ResNet50 achieved a good diagnostic accuracy for differentiating benign from malignant fracture using T1W and T2W MRI. The image matrix size or spatial resolution needs to be considered in designing algorithms to improve the robustness of the diagnostic model.

CLINICAL RELEVANCE/APPLICATION

Deep learning using ResNet architecture by considering T1W and T2W of the abnormal slice with adjacent neighboring slices yielded a high accuracy in diagnosis of benign and malignant fracture on MR.

MK315-ED-TUA8 Patell-It Like It Is: A Multimodality Image-Based Guide of Patellofemoral Disorders for Radiologists

Station #8

Participants
Tom Soker, DO, Cleveland, OH (Presenter) Nothing to Disclose
Robert R. Devita, MD, Cleveland, OH (Abstract Co-Author) Nothing to Disclose
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TEACHING POINTS

1. Review the anatomy of the patellofemoral articulation including its tendinous and ligamentous stabilizers
2. Review the clinical presentation of the spectrum of patellofemoral disorders
3. Discuss the causes of patellofemoral pathology including biomechanical, degenerative, and miscellaneous etiologies
4. Multimodality imaging overview of patellofemoral disorders including common measurements
5. Overview of orthopedic management of biomechanical pathologies

TABLE OF CONTENTS/OUTLINE

Background Patellofemoral image-based anatomy review Clinical presentation of patellofemoral pathology Spectrum of pathology Biomechanical/Traumatic Degenerative Neoplastic/Variant anatomy Pertinent measurements Insall-Salvati ratio TT-TG distance trochlear depth Q angle Management Physical therapy MPFL reconstruction trochleoplasty Medial capsular plication

MK316-ED-TUA9 Clinical Applications of Dual Energy Computed Tomography in Musculoskeletal Imaging: Detection of Gout, Bone Marrow Edema, and Application in Skeletal Surveys

Station #9

Participants
Meaghan Woo, MD, Winnipeg, MB (Presenter) Nothing to Disclose
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James K. Koenig, MD, FRCPC, West St Paul, MB (Abstract Co-Author) Nothing to Disclose
Iain D. Kirkpatrick, MD, Winnipeg, MB (Abstract Co-Author) Speaker, Siemens AG

TEACHING POINTS

1. Briefly review the principles and acquisition methods of dual energy computed tomography (DECT).
2. Describe the clinical utility of DECT in the identification of urate deposition in gout.
3. Review how bone marrow analysis in DECT can increase the sensitivity for detecting fractures.
4. Outline the advantages of using DECT to identify focal bone lesions in skeletal surveys.

TABLE OF CONTENTS/OUTLINE

1. Introduction to DECT
2. Describe the utility and advantages of DECT with regards to:
   2 (a) Arthritis - Gout and detecting urate deposition
   2 (b) Trauma - Bone marrow analysis to detect edema at fracture sites
   2 (c) Skeletal survey - Detection of focal bone lesions
3. Sample cases with multimodality comparison
4. Summary

MK317-ED-TUA10 Ultrasound (US) Imaging of Rectus Abdominis Muscles Diastasis: Methodology, Findings, and Practical Role

Station #10

Participants
Orlando Catalano, MD, Naples, Italy (Abstract Co-Author) Nothing to Disclose
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TEACHING POINTS

The educational focus of this exhibit is threefold. To illustrate how to perform an appropriate US assessment of rectus abdominis muscles diastasis. To explain the abnormal findings. To highlight the role of US in the practical patient management and in the pre-surgical assessment.
Patient is placed supine, with the head slightly extended, the upper limbs along the trunk, and the knees slightly flexed. US is performed with high-frequency, linear transducers. Trapezoid field-of-view and extended field-of-view option are useful to measure high degrees of diastasis. The thickness and structure of the rectus muscles is initially evaluated. Then, the distance (margin to margin) between the muscles is measured at rest, both 2 cm above the navel and 3 cm below. The entire midline is finally checked, both at rest and during the Valsalva maneuver, to rule out any hemiia. US can show the normal thickness or the thinning of the rectus muscles, can demonstrate and measure accurately an abnormal (>2 cm) midline diastasis of the muscles (above the navel, below the navel, or both), and can detect median hernias. US assessment is useful for the patient, to have a confirmation of the abnormality and to be aware of what exercises to do and what to avoid. US is also valuable for the surgeon to plan the abdominoplasty.

Participants

Bernhard Petritsch, Wurzburg, Germany (Presenter) Research Cooperation, Siemens AG; Research Consultant, Siemens AG
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TEACHING POINTS

To review the indications, contraindications and limitations of dual-energy computed tomography (DECT) in bone marrow imaging. To learn about the basic physical principles of DECT imaging with emphasis on bone marrow applications. To interpret dual-energy bone marrow CT scans of healthy subjects, patients with acute fractures or malignant bone marrow infiltration. To highlight the potential benefits of a dual-energy investigation as a comprehensive examination of osseous morphology and additional bone marrow information.

TABLE OF CONTENTS/OUTLINE


Printed on: 01/19/20
**Purpose**
To investigate the relationship between quantitative parameters, obtained from UTE-MT modeling, and the Whole-Organ Magnetic Resonance Imaging Score (WORMS) in vivo assessment of the whole knee cartilage.

**Method and Materials**
A total of 30 human subjects (aged 23-88 years, 55±17 years; 17 males, 13 females) was recruited for this study. Informed consent was obtained from all subjects in accordance with guidelines of the Institutional Review Board. Whole knee joint imaging was performed using 3D UTE-Cones sequences on a 3T MR750 scanner (GE Healthcare Technologies, Milwaukee, WI). An 8-channel knee coil was used for signal excitation and reception. The UTE-MRI scans involved: A) an actual flip angle-variable TR (AFI-VTR) method (AFI: TE=0.032, TR=20, 100 ms, FA=45°; VTR: TE=0.032, TR=20-100 ms, FA=45°) for T1 measurement, which is a prerequisite for accurate MT modeling; and B) a 3D UTE-Cones-MT sequence (saturation pulse power=500, 1000, 1500°; frequency offset=2-50 kHz; FA=7°) for MT modelling. Field of view (FOV), matrix dimension, and slice thickness were 15 cm, 256×256, and 2 mm, respectively. The whole knee cartilage was graded by two experienced radiologists according to the WORMS. The Pearson's correlations were calculated between UTE results and WORMS.

**Results**
The proposed 3D UTE-Cones AFI-VFA method showed an average T1of 1024 ± 127 ms for cartilage of femur, 917 ± 109 ms for patella cartilage, 913 ± 65ms for cartilage of tibia. MT-f presented very good correlations with the corresponding WORMS for the cartilage in femur, patella, and the posterior segment of tibia. MTR correlate with the WORMS of cartilage in the center segment of femur, patella, and the posterior segment of the tibia. T1 correlate with the WORMS of the cartilage in center and posterior segment of femur, and patella.

**Conclusion**
T1, and MT-f, MTR obtained from MT modeling showed significant correlations with WORMS of knee articular cartilage. This study highlighted UTE-MT MRI techniques as a useful method to detect the early degeneration of OA and monitor the effects of therapy.

**Clinical Relevance/Application**
The 3D UTE-MT method provides valuable biomarkers of cartilage in whole knee joints on a clinical 3T scanner.
This method may prove valuable for patients who cannot undergo MRI examinations because of reasons such as pain, implants, and}

CLINICAL RELEVANCE/APPLICATION
This method may be a promising technique to generate MR images from CT images without performing MRI examinations.

CONCLUSION
considerable differences were observed in the quantitative evaluation between the virtual and actual MR images.

RESULTS
102 patients (64 men and 38 women; age range, 17-53; mean age, 29.7 years; 52 right knees) were reviewed. 48% and 53% had injuries to the proximal and distal supracondylar Kaplan fibers, respectively, and 34% had injuries to the epicondylar Kaplan fibers. 43% of the included patients had no identifiable injury to the Kaplan fibers, while another 43% injured both the Kaplan fibers and the anterolateral ligament. Injury to these anterolateral complex structures were significantly associated with each other (p<0.0001). Also, the severity of anterolateral ligament injury was significantly associated with Kaplan fiber abnormality (p=0.0008). The kappa value for intraobserver reliability of identifying Kaplan fiber abnormality was 0.77, which indicates substantial agreement as defined by Landis and Koch.

CONCLUSION
This study shows that slightly more than half of patients with a known ACL tear on MRI have concomitant Kaplan fiber injury, and the level of intraobserver reliability of diagnosing such injury is significant.

CLINICAL RELEVANCE/APPLICATION
As interest in anterolateral reconstruction during ACL repair grows, assessing distal IT band Kaplan fiber injury on pre-operative MRI may optimize surgical planning of extra-articular approaches.

Virtual Magnetic Resonance Lumbar Spine Images Generated from Computed Tomography Images Using Conditional Generative Adversarial Networks

PURPOSE
The purpose of this study was to generate virtual magnetic resonance (MR) lumbar spine T2-weighted images from computed tomography (CT) images using generative adversarial networks (GANs).

METHOD AND MATERIALS
We selected the assessments of 19 adults (11 women) with an average age of 61.3 (standard deviation = 18.7) years who had undergone CT and MRI examinations of the lumbar spine within the 4 months. Three examinations were used as test data and 16 examinations as training data. These were aligned with multiplanar reconstruction performed by medical image workstation for 914 paired data sets of MR and CT images. A conditional GAN was trained to generate virtual MR images from CT images using corresponding MR images as targets. After training, the generated virtual MR images of the test data in epoch 1, 10, 50, 100, 500, and 1000 were compared with the actual ones using mean square error (MSE) and structural similarity index (SSIM). Moreover, qualitative assessments were performed by two radiologists.

RESULTS
The MSE of the virtual MR images decreased as the epoch of GAN increased from the original CT images: 9046.8 ± 1186.8 (original CT), 2046.5 ± 539.8 (epoch 1), 1498.5 ± 286.5 (epoch 10), 1411.6 ± 437.8 (epoch 50), 1383.3 ± 439.4 (epoch 100), 1254.3 ± 510.5 (epoch 500), and 1190.4 ± 424.5 (epoch 1000). However, the SSIM of the virtual MR images increased as the epoch of GAN increased from the original CT images: -0.034 ± 0.016 (original CT), 0.429 ± 0.035 (epoch 1), 0.503 ± 0.034 (epoch 10), 0.550 ± 0.044 (epoch 50), 0.561 ± 0.043 (epoch 100), 0.596 ± 0.041 (epoch 500), and 0.600 ± 0.036 (epoch 1000). Furthermore, no considerable differences were observed in the quantitative evaluation between the virtual and actual MR images.

CONCLUSION
This method may be a promising technique to generate MR images from CT images without performing MRI examinations.

CLINICAL RELEVANCE/APPLICATION
As interest in anterolateral reconstruction during ACL repair grows, assessing distal IT band Kaplan fiber injury on pre-operative MRI may optimize surgical planning of extra-articular approaches.
Comparison between Quantitative T2*-Analysis of the Retropatellar Cartilage and the TTTG Distance in Young Professional Soccer Players

Participants
Kai-Jonathan Maas, Hamburg, Germany (Presenter) Nothing to Disclose
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PURPOSE
The position of the tibial tuberosity related to the trochlear groove is important for the inferolateral force vector of the patella. However there is an ongoing debate about the impact of the tibial tuberosity-trochlea groove (TTTG) distance on lateral patellar instability and the initiating of cartilage degeneration. For further clarification we performed quantitative MRI analysis of the retropatellar cartilage in young athletes and compared T2* -relaxation times with TTTG distances.

METHOD AND MATERIALS
36 knees of 18 young professional, age- and BMI matched soccer players were evaluated. All participants underwent knee MRI at 3T with a qualitative and quantitative analysis. For quantitative analysis T2* measurements in 3D data acquisition were performed in sagittal orientation (22 echoes ranging from 4.6-53.6 ms; image resolution 0.5x2x2mm). All data sets were postprocessed using a dedicated software tool (qMapit) and quantitative maps were generated. The deep and superficial layer of 12 predefined cartilage segments were analysed in the lateral, medial and central part of the patella and TTTG distance was measured in MRI. In a qualitative analysis there was no structural cartilage damage and no abnormalities in patellar and trochlea shape. Statistical analysis included Typ 3-Test, confidence intervals and a MIXED effects model.

RESULTS
T2* relaxation times were significantly higher in the superficial (mean: 31.3±3.8ms) compared to the deep layers (mean: 20.5±4.2ms) (p<0.001). Significantly higher relaxation times were found in the central compared to the lateral predefined compartment (p<0.001) though no significant difference was spotted comparing the predefined lateral and medial compartments of the retropatellar cartilage. The mean TTTG distance was 10±4 mm (range 3-19). There was no significant correlation between the TTTG distance and T2* relaxation times in the retropatellar cartilage.

CONCLUSION
In a population of young professional healthy athletes there is no increase of T2*-relaxation times as indicator for early degenerative cartilage changes depending on an elevated TTTG distance.

CLINICAL RELEVANCE/APPLICATION
Our findings support the theory that the TTTG distance alone is not a significant risk factor for the development of retropatellar cartilage degeneration.
6 patients with SCP are currently enrolled in this ongoing study, with 11 muscles evaluated. The FCU had the highest number of data pairs at this point in the study (n=5). Correlation coefficient between SWE values and clinical outcomes was calculated for the FCU separately and then collectively for all the muscles. For the FCU, there were very strong negative correlations between baseline SWE values with baseline PROM [-0.95 (-1.00, -0.41)] and with % change in AROM at 1 month [-0.90 (-0.99, -0.09)]. Overall, there was moderate negative correlation between baseline muscle SWE values and PROM at 1 month [-0.44 (-0.85, 0.00)], and very strong negative correlation with % change in AROM at 1 month [-0.81 (-0.95, -0.36)]. Associations between muscle echogenicity and clinical outcomes at baseline and one month were weak.

CONCLUSION
Significant correlation between baseline muscle SWE values and ROM values at 1 month post intramuscular BTX-A injection suggests that baseline SWE values may be predictive of BTX-A response.

CLINICAL RELEVANCE/APPLICATION
Baseline muscle spasticity parameters could provide prognostic data that can be used to predict the effects of BTX-A and ultimately serve as a basis for development of a treatment model for muscle spasticity in patients with SCP.

MK403-SD-TUB7 Deep Learning Takes the Pain Out of Back Breaking Work - Automatic Vertebral Segmentation and Attenuation Measurement for Opportunistic Osteoporosis Screening

Participants
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PURPOSE
Recent studies have highlighted the use of vertebral trabecular attenuation values for osteoporosis screening. The aim of this study was to evaluate a fully automated deep learning-based method for lumbar vertebral segmentation and measurement of vertebral volumetric trabecular attenuation values.

METHOD AND MATERIALS
A convolutional neural network (CNN) was trained to segment lumbar vertebrae using 117 manually pre-segmented non-contrast CT scans. The CNN was then applied to non-contrast CT scans of 519 patients (mean age 55 years ± 15, 299 male, 220 female) and each vertebral segmentation was reduced by 7 mm in all directions in order to avoid cortical bone. The mean and median volumetric attenuation values were obtained for L1 to L4 and plotted against patient age and sex.

RESULTS
The mean L1 attenuation values decreased linearly with age by -2.4 HU per year (age >= 30, 95% CI: -2.7, -2.0, females: -2.8 HU / year, males: -2.0 HU / year, p = 0.01). There was no significant difference between men and women in the age group 30-55 years old, nor in the group aged 55 years or older. The mean attenuation value was 216 ± 32 HU for patients younger than 30, and 102 ± 41 HU for patients older than 70. Although no significant difference was found, there was a tendency for higher attenuation values in premenopausal women compared to men of the same age. Median, mean and grouped L1-L4 attenuation values followed a similar pattern. A total of 135 patients had an L1 attenuation below 100 HU.

CONCLUSION
With results closely matching those of previous studies, we believe that our fully automated deep learning-based method can be used to obtain lumbar volumetric trabecular attenuation values which can be used for opportunistic screening of osteoporosis in patients undergoing CT scans for other reasons. The automated AI tool used in this study is available on request for research purposes at www.recomia.org.

CLINICAL RELEVANCE/APPLICATION
Our automated tool can be used to automatically identify patients at risk for osteoporosis in order to take preventive measures and decrease or delay the onset of fractures.

MK431-ED-TUB8 Walking on Pebbles: Beyond Morton's Neuroma

Awards
Certificate of Merit

Participants
Snehash R. Chaudhary, MBBS, Liverpool, United Kingdom (Presenter) Nothing to Disclose
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JoAnne Warner, MBChB, MRCS, Wilmslow, United Kingdom (Abstract Co-Author) Nothing to Disclose
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TEACHING POINTS
The purpose of this exhibit is to: Provide a list of common causes of central metatarsalgia. Categorise the causes using a helpful...
The purpose of this exhibit is to: Provide a list of common causes of central metatarsalgia. Categorise the causes using a helpful classification. Discuss anatomy of intermetatarsal spaces and collateral ligaments. Review the imaging features of these lesions using example cases.

TABLE OF CONTENTS/OUTLINE

Define central metatarsalgia (abnormalities related to 2nd, 3rd and 4th metatarsals and their respective MTP joints). List the differentials of central metatarsalgia. Classification of the different causes of central metatarsalgia: Traumatic (including chronic repetitive injury) - Soft tissue type lesions (Inflammatory, Degenerative, Traumatic, Neoplastic). Review the anatomy of intermetatarsal space and collateral ligaments. Sample cases for each condition. Learning points and conclusion.

MK323-ED-TUB9  Radiographic Measurements and Angles of the Ankle and Foot: What Every Radiologist Should Know

Participants
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Taisa D. Gasparetto, MD, PhD, Rio de Janeiro, Brazil (Abstract Co-Author) Nothing to Disclose
Marcelo S. Takahashi, MD, Sao Paulo, Brazil (Abstract Co-Author) Nothing to Disclose
Fabiano N. Cardoso, MD, Sao Paulo, Brazil (Abstract Co-Author) Nothing to Disclose
Andre Y. Alhara, MD, Sao Paulo, Brazil (Presenter) Nothing to Disclose

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TEACHING POINTS
- Conventional radiography remains the main imaging tool for assessment and establishing accurate diagnoses of musculoskeletal pathologies and to monitor several diseases and established structural changes. - To improve the knowledge about the different kinds of measures of the foot and ankle in conventional radiology, making possible to identify the pathologic status. - This study addresses the main angles and measures of the foot and ankle which can be used easily in daily routine, aiming to create a practical guide for a quick assessment.

TABLE OF CONTENTS/OUTLINE


MK324-ED-TUB10  Strategies to Upgrade your MSK MRI: Back to Basic Physics, Made Easy

Participants
Young Kwang Lee, MD, Jeonju, Korea, Republic Of (Presenter) Nothing to Disclose
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TEACHING POINTS
- Basic physics to upgrade image quality 1) slice thickness and gap 2) FOV 3) Matrix number 4) NEX. Choosing the coil Choosing Sequence 1) Fat suppression 2) 3D iso-voxel imaging 3) Dixon technique 4) Metal artifact reduction technique 5) MR arthrography Summary.

MK325-ED-TUB11  Pediatric Bone Tumors and Mimickers: Focused Imaging Overview with Pathologic Correlation

Participants
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TEACHING POINTS
1. To identify the radiologic features that separate benign from malignant pediatric bone lesions. 2. To provide a systemic approach for the differential diagnosis for pediatric bones lesions based on age, location, matrix of lesion, margins, number of lesions, presence or absence of periosteal reaction, bony destruction, extraosseous component. 3. To recognize the histopathologic...
correlation associated with common pediatric bone lesions. To make management decisions appropriately (i.e. when to recommend follow-up, when to proceed with biopsy or surgical intervention, when to leave the lesion alone).

**TABLE OF CONTENTS/OUTLINE**

- Bone forming tumors: o Enostosis o Osteoma o Osteoid osteoma o Osteoblastoma o Osteosarcoma
- Cartilage forming tumors: o Enchondroma o Osteochondroma o Multiple hereditary exostoses o Chondroblastoma o Chondromyxoid fibroma o Chondrosarcoma
- Marrow tumors: o Ewing's sarcoma o Lymphoma o Leukemia o Metastases
- Bone benign tumors: o Intraosseous lipoma o Fibrous dysplasia o Unicameral bone cyst o Aneurysmal bone cyst o Giant cell tumor o Langerhans cell histiocytosis
- Bone tumor mimickers: o Infection o Myositis ossificans o Trauma/stress fracture o Vascular lesions (e.g. hemangioma, angiosarcoma)

**Awards**

Cum Laude

**Participants**

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Michel Bayouth Padial, MD, Sao Paulo, Brazil (*Abstract Co-Author*) Nothing to Disclose
Alexandre C. Valim, MD, Sao Paulo, Brazil (*Presenter*) Nothing to Disclose
Andre Y. Aihara, MD, Sao Paulo, Brazil (*Abstract Co-Author*) Nothing to Disclose
Fabiano N. Cardoso, MD, Sao Paulo, Brazil (*Abstract Co-Author*) Nothing to Disclose

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**TEACHING POINTS**

1. Review the muscle innervation supply of the most affected nerves in peripheral neuropathies and correlating them with axial T1-weighted MR images.
2. Introduce the most common denervation patterns in MR images.
3. Present common and unusual cases of neuropathy.

**TABLE OF CONTENTS/OUTLINE**

1. Introduction: an overview of the causes and types of neuropathies.
2. A table containing the most important nerves together with their muscle supply scheme through axial MR images and the expected pattern of muscle denervation for each nerve injury of the upper and lower limbs.
3. Illustrate with examples of the most common and unusual cases of neuropathy.

Printed on: 01/19/20
AI Theater: Impacting Workflows on Routine MSK X-rays with the Implementation of Machine Learning Algorithms: Presented by Radiobotics

Tuesday, Dec. 3 1:00PM - 1:20PM Room: AI Showcase, North Building, Level 2, Booth 10724

Participants
Mads Jarner, Copenhagen, Denmark (Presenter) Nothing to Disclose

Program Information
Radiobotics wants to demonstrate how they in a short time have built robust machine learning algorithms and deployed them at Scandinavian hospitals showing great results which are impacting the workflow greatly. Radiobotics is a very young startup, founded in late 2017, and has come very far in their development. Radiobotics is focusing on augmenting X-rays analysis for faster and more accurate diagnosis powered by data-driven machine learning solutions targeting routine medical musculoskeletal x-rays that can empower radiologists towards a many-fold productivity boost.

Printed on: 01/19/20
**MSES33A**  
*Imaging of Shoulder Arthroplasty*

Participants  
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**LEARNING OBJECTIVES**

1) Describe normal postoperative imaging appearance of shoulder arthroplasty. 2) Recognize shoulder arthroplasty complications on radiographs. 3) Define indications for use of cross-sectional imaging of shoulder arthroplasty.

**ABSTRACT**

Radiography and CT are commonly used for the diagnosis of acute traumatic injuries in the lower extremities. However, MRI plays an important role in diagnosing injuries to the bone marrow, articular cartilage, tendons, and ligaments due to its superior soft tissue contrast resolution. This course will review the MR imaging features of these radiographically-occult lower extremity injuries and their impact on patient management.

Participants  
Jonathan A. Flug, MD, MBA, Phoenix, AZ (Presenter) Nothing to Disclose

**For information about this presentation, contact:**
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**MSES33B**  
*MRI of Traumatic Lower Extremity Emergencies*

Participants  
Jonathan C. Baker, MD, Saint Louis, MO (Presenter) Nothing to Disclose

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bakerjo@mir.wustl.edu

**LEARNING OBJECTIVES**

1) Describe the role of MRI in the diagnosis of traumatic injuries to the lower extremities. 2) Compare the appearances of bone contusion, occult fracture, and chondral injury. 3) Highlight the differences between muscle strain and contusion. 4) Classify tendon tears and lacerations. 5) Illustrate the normal anatomy and injury patterns of the Lisfranc ligament complex.

**ABSTRACT**

Radiography and CT are commonly used for the diagnosis of acute traumatic injuries in the lower extremities. However, MRI plays an important role in diagnosing injuries to the bone marrow, articular cartilage, tendons, and ligaments due to its superior soft tissue contrast resolution. This course will review the MR imaging features of these radiographically-occult lower extremity injuries and their impact on patient management.

**MSES33C**  
*Imaging of the Wrist and Hand*

Participants  
Jonathan A. Flug, MD, MBA, Phoenix, AZ (Presenter) Nothing to Disclose

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**LEARNING OBJECTIVES**

1) Detect imaging abnormalities commonly seen in the hand and wrist. 2) Identify commonly encountered hand and wrist pathology in general practice. 3) Recommend appropriate follow up for various findings in the hand and wrist.

**ABSTRACT**

The hand is the most commonly injured body part with long term consequences if diagnosis is delayed or incorrect. For many injuries, x-ray imaging is the first line in diagnosis and these studies may reflect a significant proportion of the workflow of a radiologist in a general or subspecialty practice. However, these injuries are often missed or have a delay in diagnosis. The purpose of this course is to review normal anatomy in the hand and wrist as well as commonly encountered pathology to improve diagnosis and provide strategies when x-ray imaging cannot sufficiently establish a diagnosis.

**MSES33D**  
*Staying on Top of New Hardware*

Participants  
Kirkland W. Davis, MD, Madison, WI (Presenter) Author with royalties, Reed Elsevier; Editor with royalties, Reed Elsevier

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**LEARNING OBJECTIVES**

1) Understand the concepts of minimally invasive fixation. 2) Be aware of new fixation plates and devices. 3) Identify imaging features of new hardware that should not be misinterpreted as complications.
CS34

Advancements in Ultrasound Imaging for MSK and Sports Medicine: Presented by the Institute for Advanced Medical Education (IAME), educational grant provided by Canon Medical Systems USA, Inc.

Tuesday, Dec. 3 2:00PM - 3:00PM Room: S101AB

Participants
Kentaro Onishi, DO, Tustin, CA (Presenter) Nothing to Disclose
Jeffrey A. Strakowski, MD, Columbus, OH (Presenter) Nothing to Disclose

PROGRAM INFORMATION

Musculoskeletal injuries are common and can account for an estimated 20% of primary care and emergency department (ED) visits each year in the US. In this one-hour accredited CME symposium, Dr. Onishi and Dr. Strakowski will share their clinical insights into how they are utilizing high frequency ultrasound diagnostically for routine and complicated musculoskeletal and peripheral nerve injuries. Specifically, attendees will learn about the increasing benefits of using ultra-high frequency ultrasound transducers in MSK imaging to diagnose injuries, where spatial resolution is critical in small joints and superficial nerves. In addition, attendees will have the opportunity see just how to perform these procedures in a live scanning session with the faculty.

CME

Yes, CME credit is available through a third-party provider. Instructions on claiming credit will be provided at the end of the symposium.

RSVP Link

https://www.appliedradiology.org/RSNA2/default.aspx

Printed on: 01/19/20
**SSJ15**

**Musculoskeletal (Muscle, Tendon, and Nerve)**

Tuesday, Dec. 3 3:00PM - 4:00PM Room: E353C

**AMAPRA Category 1 Credit™**: 1.00

**ARRT Category A+ Credit**: 1.00

**Participants**

Theodore T. Miller, MD, New York, NY (Moderator) Nothing to Disclose

Antonio Barile, MD, L'Aquila, Italy (Moderator) Nothing to Disclose

**Sub-Events**

**SSJ15-01** Quantitative Muscle Microstructural Changes Detected with Diffusion Tensor Imaging following Acute Hamstring Strain Injuries

Tuesday, Dec. 3 3:00PM - 3:10PM Room: E353C

**Participants**

Christa Wille, Madison, WI (Presenter) Nothing to Disclose

Samuel A. Hurley, PhD, Madison, WI (Abstract Co-Author) Nothing to Disclose

Nagesh Adluru, PhD, Madison, WI (Abstract Co-Author) Nothing to Disclose

Rebecca Alcock, Madison, WI (Abstract Co-Author) Nothing to Disclose

Bryan C. Heiderscheit, PhD, Madison, WI (Abstract Co-Author) Research Consultant, Altic, Inc

Richard Kijowski, MD, Verona, WI (Abstract Co-Author) Research support, General Electric Company; Consultant, Boston Imaging Core Lab, LLC

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**PURPOSE**

The purpose of this investigation was to quantify changes in muscle microstructure following acute hamstring strain injury (HSI).

**METHOD AND MATERIALS**

Collegiate athletes with an HSI (n=16) underwent a magnetic resonance image (MRI) exam of the bilateral thighs using a GE MR750 3.0T scanner and 32-channel torso coil at a mean of 4 (± 2.5) days following injury. MRI exam included coronal and axial fat-suppressed T2-weighted fat/water IDEAL scan (44 cm FOV, 256x256, 44 slices, 4 mm thk, 5 mm gap; TR/TE 7418/86.8 ms) to identify regions of edema and axial DTI sequences. Diffusion weighted images were acquired with b=500 s/mm2, 30 directions, 6 b=0 volumes (48 cm FOV, 160x160, 72 slices, 3 mm thk; TR/TE 5770/51.1 ms), and repeated with reversed phase-encode direction. Distortion, eddy current, and motion correction were performed using FSL TOPUP and EDDY (FMRIB Software Library). Axial parameter maps of fractional anisotropy (FA), mean diffusivity (MD), radial diffusivity (RD), and principal effective diffusivity eigenvalues (λ1, λ2, λ3) were created. Deterministic streamline tractography was performed using Euler integration with a step size of 0.1 mm (stopping criteria: 45° curvature and 0.20 FA thresholds). Mean DTI-parameters were identified for regions of injury within contractile muscle tissue using manual segmentation and compared to identical regions on the uninvolved limb with a Mann-Whitney-U test.

**RESULTS**

DTI-parameters demonstrate a significant decrease in FA (p=0.046) and significant increase in MD (p=0.025), RD (p<0.01), λ2 (p=0.021), and λ3 (p<0.01) in the region of injury compared to the mirrored region of normal muscle. Tractography from a selected subject demonstrates the effects of reduced FA on the involved limb (right) with fewer continuous fiber tracts present within the region of injury (purple) compared to the mirrored region of normal muscle on the uninvolved limb.

**CONCLUSION**

Significant muscle microstructural changes are detectable using DTI in athletes following an HSI. Decreased FA and increased diffusivity in regions of injured muscle indicate less restricted water diffusion, likely due to disruption of muscle fibers following injury.

**CLINICAL RELEVANCE/APPLICATION**

DTI-parameters can quantify microstructural changes in injured muscle and may have potential in guiding effective treatment following HSI.

**SSJ15-02** Comparison of Quantitative MRI Parameters and Shear Wave Ultrasound Parameters of the Patellar Tendon in Subjects with Patellar Tendinopathy

Tuesday, Dec. 3 3:10PM - 3:20PM Room: E353C

**Participants**

Richard Kijowski, MD, Verona, WI (Presenter) Research support, General Electric Company; Consultant, Boston Imaging Core Lab, LLC
Robert Moskwa, Madison, WI (Abstract Co-Author) Nothing to Disclose
Kenneth S. Lee, MD, Madison, WI (Abstract Co-Author) Grant, General Electric Company; Grant, National Basketball Association; Grant, Johnson & Johnson; Research support, SuperSonic Imagine; Royalties, Reed Elsevier
Ryan C. Sieve, MD, Madison, WI (Abstract Co-Author) Nothing to Disclose
John J. Wilson, MD, MS, Madison, WI (Abstract Co-Author) Nothing to Disclose
Fang Liu, PhD, Madison, WI (Abstract Co-Author) Nothing to Disclose

PURPOSE
To compare quantitative MRI parameters and shear wave ultrasound parameters of the patellar tendon in subjects with patellar tendinopathy.

METHOD AND MATERIALS
The study group consisted of 15 subjects with clinically diagnosed patellar tendinopathy of a single knee with no current or past symptoms of patellar tendinopathy of the contralateral knee. Shear wave ultrasound of the proximal patellar tendon of both knees was performed. The difference in shear wave speed between the asymptomatic and symptomatic knee (DIFSWS) was used as a proxy for loss of mechanical stiffness of the symptomatic patellar tendon due to tendon degeneration. An ultra-short echo-time (UTE) T2* mapping sequence using 16 echoes between 0.03ms and 35ms was performed on the symptomatic knee on a 3T scanner (GE Healthcare, Waukesha, WI). Single-component T2* relaxation time (T2*Single) and multi-component T2* parameters including the fraction of the fast relaxing macromolecular bound water component (FF) and the T2* relaxation time of the fast relaxing macromolecular bound water component (T2*F) and the slow relaxing bulk water component (T2*S) were measured in the proximal patellar tendon. Pain and disability in the symptomatic knee was assessed using the Tegner-Lysholm questionnaire. Pearson correlation coefficients were used to determine the association between quantitative MRI parameters and DIFSWS and Tegner-Lysholm score.

RESULTS
There was a significant positive moderate association between T2*Single and DIFSWS (rho=0.668 and p<0.01). There was a significant positive moderate association between T2*F and DIFSWS (rho=0.608 and p=0.01) and between T2*F and Tegner-Lysholm score (rho=0.525 and p=0.04) (Figure 1). There was no significant association between FF and T2*S and DIFSWS (rho=0.039-0.043 and p=0.89-0.91) and between T2*Single, FF, and T2*S and Tegner-Lysholm score (rho=0.061-0.447 and p=0.09-0.83).

CONCLUSION
Increases in T2*Single and T2*F of the proximal patellar tendon in subjects with patellar tendinopathy were associated with loss of tendon stiffness with increases in T2*F also associated with increased pain and disability.

CLINICAL RELEVANCE/APPLICATION
Increased T2* relaxation time of fast relaxing macromolecular bound water of the patellar tendon measured using quantitative MRI in subjects with patellar tendinopathy is associated with loss of tendon stiffness measured using shear wave ultrasound and increased pain and disability.

SS315-03 Spontaneous Anterior Interosseous Nerve Syndrome (AINS) is a Fascicular Disease of the Median Nerve

Tuesday, Dec. 3 3:20PM - 3:30PM Room: E353C

Participants
Darryl B. Sneag, MD, Plainview, NY (Presenter) Nothing to Disclose
Zsuzsanna Aranyi, MD,PhD, Budapest, Hungary (Abstract Co-Author) Nothing to Disclose
Esther Zuserstone, BS, Louisville, KY (Abstract Co-Author) Nothing to Disclose
Joseph Feinberg, New York, NY (Abstract Co-Author) Nothing to Disclose
Ogona K. Nwawka, MD, New York, NY (Abstract Co-Author) Research Grant, General Electric Company
Steve K. Lee, New York, NY (Abstract Co-Author) Nothing to Disclose
Scott Wolfe, New York, NY (Abstract Co-Author) Nothing to Disclose

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PURPOSE
To test the hypotheses that (1) hourglass constrictions (HGCs) are present within the anterior interosseous nerve (AIN) fascicular group of the median nerve near the humeral medial epicondyle (ME) and (2) there is no extrinsic compression of the AIN or median nerve within the arm or forearm.

METHOD AND MATERIALS
At 2 different sites, a radiologist and neurologist (each with 5-6 years of dedicated peripheral nerve imaging experience) analyzed MRI (n=22) and ultrasound (US, n=23) neurography exams, respectively, to evaluate the median nerve and AIN within the arm and forearm in patients with electrodiagnostically and/or clinically confirmed AINS. MRIIs were acquired either at 3 T (n=18) or 1.5 T (n=4) with a 16-channel flexible receive-only coil using multiplanar T2-weighted fat suppression and proton density pulse sequences, including at least 1 axial plane orthogonal to the median nerve. US was performed by the interpreting neurologist with an 18-5 MHz transducer; the median nerve was scanned in cross-section from the wrist to axilla and in areas of abnormality, longitudinal scans were additionally obtained.

RESULTS
Fascicular HGCs of the median nerve proper were identified in all MRI cases, and constrictions and/or swelling were identified in 87% of US cases. On MRI, HGCs were located a mean of 3.0 cm proximal to the ME, at posterior/posteromedial (58%, mean 1.7 cm, expected location of the AIN fascicle), posterolateral (5%, mean 1.0 cm), and anterolateral (8%, mean 3.4 cm) locations. On US, HGCs were located a mean of 4.5 cm proximal to the ME, at posterior/posteromedial (55%, mean 4.3 cm), medial (36%, mean 5.0 cm), and posterolateral (5%, mean 1.0 cm), and anterolateral (8%, mean 3.4 cm) locations.

The study group consisted of 15 subjects with clinically diagnosed patellar tendinopathy of a single knee with no current or past symptoms of patellar tendinopathy of the contralateral knee. Shear wave ultrasound of the proximal patellar tendon of both knees was performed. The difference in shear wave speed between the asymptomatic and symptomatic knee (DIFSWS) was used as a proxy for loss of mechanical stiffness of the symptomatic patellar tendon due to tendon degeneration. An ultra-short echo-time (UTE) T2* mapping sequence using 16 echoes between 0.03ms and 35ms was performed on the symptomatic knee on a 3T scanner (GE Healthcare, Waukesha, WI). Single-component T2* relaxation time (T2*Single) and multi-component T2* parameters including the fraction of the fast relaxing macromolecular bound water component (FF) and the T2* relaxation time of the fast relaxing macromolecular bound water component (T2*F) and the slow relaxing bulk water component (T2*S) were measured in the proximal patellar tendon. Pain and disability in the symptomatic knee was assessed using the Tegner-Lysholm questionnaire. Pearson correlation coefficients were used to determine the association between quantitative MRI parameters and DIFSWS and Tegner-Lysholm score.

RESULTS
There was a significant positive moderate association between T2*Single and DIFSWS (rho=0.668 and p<0.01). There was a significant positive moderate association between T2*F and DIFSWS (rho=0.608 and p=0.01) and between T2*F and Tegner-Lysholm score (rho=0.525 and p=0.04) (Figure 1). There was no significant association between FF and T2*S and DIFSWS (rho=0.039-0.043 and p=0.89-0.91) and between T2*Single, FF, and T2*S and Tegner-Lysholm score (rho=0.061-0.447 and p=0.09-0.83).

CONCLUSION
Increases in T2*Single and T2*F of the proximal patellar tendon in subjects with patellar tendinopathy were associated with loss of tendon stiffness with increases in T2*F also associated with increased pain and disability.

CLINICAL RELEVANCE/APPLICATION
Increased T2* relaxation time of fast relaxing macromolecular bound water of the patellar tendon measured using quantitative MRI in subjects with patellar tendinopathy is associated with loss of tendon stiffness measured using shear wave ultrasound and increased pain and disability.

SS315-03 Spontaneous Anterior Interosseous Nerve Syndrome (AINS) is a Fascicular Disease of the Median Nerve

Tuesday, Dec. 3 3:20PM - 3:30PM Room: E353C

Participants
Darryl B. Sneag, MD, Plainview, NY (Presenter) Nothing to Disclose
Zsuzsanna Aranyi, MD,PhD, Budapest, Hungary (Abstract Co-Author) Nothing to Disclose
Esther Zuserstone, BS, Louisville, KY (Abstract Co-Author) Nothing to Disclose
Joseph Feinberg, New York, NY (Abstract Co-Author) Nothing to Disclose
Ogona K. Nwawka, MD, New York, NY (Abstract Co-Author) Research Grant, General Electric Company
Steve K. Lee, New York, NY (Abstract Co-Author) Nothing to Disclose
Scott Wolfe, New York, NY (Abstract Co-Author) Nothing to Disclose

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PURPOSE
To test the hypotheses that (1) hourglass constrictions (HGCs) are present within the anterior interosseous nerve (AIN) fascicular group of the median nerve near the humeral medial epicondyle (ME) and (2) there is no extrinsic compression of the AIN or median nerve within the arm or forearm.

METHOD AND MATERIALS
At 2 different sites, a radiologist and neurologist (each with 5-6 years of dedicated peripheral nerve imaging experience) analyzed MRI (n=22) and ultrasound (US, n=23) neurography exams, respectively, to evaluate the median nerve and AIN within the arm and forearm in patients with electrodiagnostically and/or clinically confirmed AINS. MRIIs were acquired either at 3 T (n=18) or 1.5 T (n=4) with a 16-channel flexible receive-only coil using multiplanar T2-weighted fat suppression and proton density pulse sequences, including at least 1 axial plane orthogonal to the median nerve. US was performed by the interpreting neurologist with an 18-5 MHz transducer; the median nerve was scanned in cross-section from the wrist to axilla and in areas of abnormality, longitudinal scans were additionally obtained.

RESULTS
Fascicular HGCs of the median nerve proper were identified in all MRI cases, and constrictions and/or swelling were identified in 87% of US cases. On MRI, HGCs were located a mean of 2.4 cm proximal to the ME, at posterior/posteromedial (68%, mean 1.7 cm, expected location of the AIN fascicle), posterolateral (5%, mean 1.0 cm), anterolateral (8%, mean 3.4 cm) locations. On US, HGCs were located a mean of 4.5 cm proximal to the ME, at posterior/posteromedial (55%, mean 4.3 cm), medial (36%, mean 5.0 cm), and posterolateral
(9%, mean 4.0 cm) locations. No extrinsic compressive site or mass of the median nerve or AIN within the arm/forearm was identified.

CONCLUSION

HGCs of the AIN fascicular group of the median nerve are the hallmark imaging finding in AINS, demonstrating the same phenotype seen in other affected nerves in PTS. There is no imaging evidence of extrinsic compression of the median nerve or AIN in AINS.

CLINICAL RELEVANCE/APPLICATION

This study defines an anatomic range where fascicular HGCs of the median nerve are found in patients with anterior interosseous nerve syndrome, which will aid in its diagnosis and potential treatment.

PURPOSE

To determine the role of high resolution ultrasound (HRUS) for screening of Diabetic polyneuropathy (DPN) by evaluation of nerve cross sectional area (CSA).

METHOD AND MATERIALS

In this IRB approved case-control study, thirty DPN cases and thirty matched healthy controls were taken. The diagnosis of DPN was based on at least one symptom/sign of neuropathy in type II diabetes patient and one abnormal nerve conduction study (NCS) parameter measured in two separate nerves. DPN severity was determined by the Toronto Clinical Neuropathy Score (TCNS). Using an 8-18 MHz ultrasound (US) transducer peripheral nerve CSAs were measured bilaterally in both the cases and controls. Four nerves were included in the study and their CSAs were recorded at specific sites; median nerve (MN) at three sites- carpal tunnel inlet (CrTI), 5cm proximal to wrist and at antecubital fossa (ACF), ulnar nerve (UN) at three sites-wrist, cubital tunnel inlet and cubital tunnel outlet (CbTO), tibial nerve (TN) at medial malleolus and sural nerve (SN) at midcalf. Statistical tests were applied to compare the nerve CSAs between cases and control groups. CSA was also compared in relation to TCNS and NCS parameters (conduction velocity, latency and amplitude).

RESULTS

The mean CSAs of MN at CrTI, UN at wrist and CbTO, TN and SN were significantly larger in DPN cases. CSAs ROC cut-offs for MN at CrTI, TN and SN showed good accuracy (AUC > 0.80, sensitivity 83-96%, specificity 70-83%), and for UN at wrist and CTO was even higher (AUC>0.96, sensitivity 86-96%, specificity 90-96%). Significant correlation was obtained between nerve conduction velocities and CSAs of MN at forearm, MN at ACF and UN at wrist, with r values of -0.38, -0.37 and -0.36 respectively (p<0.05). Significant correlations were found between nerve amplitude and CSA of MN at CrTI (r=-0.42) and between TCNS and CSA of SN (r=-0.52), p<0.05 for both.

CONCLUSION

The nerve size in patients with DPN is significantly larger as compared to normal controls with ulnar nerve CSA showing the highest diagnostic accuracy. Significant correlation between nerve thickness and NCS parameters facilitates HRUS as an efficient screening tool for DPN.

DPN is very common and HRUS may serve as a non-invasive and low-cost screening tool especially in patients with severe DPN where NCS is not helpful as the nerves may be unexcitable.

SSJ15-05  High Resolution Ultrasound Evaluation of Peripheral Nerves in Patients with Diabetic Polyneuropathy

Participants

Maninder Kaur Jr, MBBS, Delhi, India (Presenter) Nothing to Disclose
Brijbushan Thukral, New Delhi, India (Abstract Co-Author) Nothing to Disclose
Garvit D. Khatri, MBBS, Baroda, India (Abstract Co-Author) Nothing to Disclose
Rekha Tanwar, MBBS, New Delhi, India (Abstract Co-Author) Nothing to Disclose
Pratibha Choudhary JR, MD, New Delhi, India (Abstract Co-Author) Nothing to Disclose

PURPOSE

Self-myofascial release using foam rolling (FR) has been developed into a popular preventive and recovery intervention and has been established in various sports disciplines. However, its effects on target tissue with regard to changes in stiffness properties are still poorly understood. The aim of this study was to investigate the role of foam rolling on muscle and ligament stiffness.

METHOD AND MATERIALS

Acoustic radiation force impulse elastography (ARFI) was performed in 40 volunteers (20 with more than 6 months of experience in...
foam rolling and 20 without any experience) before and several times (0 min, 30 min, 60 min, 120 min, 12 h and 24 h) after a standardized foam rolling exercise of the lateral thigh. The exercise protocol included 5 sets, each with 45 seconds foam rolling on the lateral thigh (20 seconds of rest between each set). Tissue stiffness was assessed at different compartments of the lateral thigh including superficial and deep muscle tissue (vastus lateralis muscle, VL; vastus intermedius, VI) and connective tissue (distal insertion of the iliotibial band, ITB).

RESULTS

Tissue stiffness of the ITB revealed a significant decrease in experienced athletes directly after the intervention (p=0.02) and 30 min post-intervention (p=0.02). No significant changes at the ITB were observed in non-experienced athletes. For VL and VI no significant changes were detected at any time point in both groups.

CONCLUSION

A significant short-term decrease of connective tissue stiffness in experienced athletes is detectable with ARFI, which may have an impact on biomechanical output of the fascia. Recommendations for self-myofascial release with foam rolling therapy have to be taken in consideration of athletes' experience and whether decreased tissue stiffness is required.

CLINICAL RELEVANCE/APPLICATION

ARFI seems to be an applicable tool for systematic assessment of tissue stiffness of different physical therapy approaches, e.g. tissue stiffness of the ITB in patients with ITB-syndrome.

Permanent and Non-Permanent Changes of Skeletal Muscle Diffusion Properties in Triathletes and Non-Athletes Detected by Diffusion Tensor Imaging and T2 Mapping

Tuesday, Dec. 3 3:50PM - 4:00PM Room: E353C

Participants
Sarah Keller, MD, Berlin, Germany (Presenter) Nothing to Disclose
Jin Yamamura, MD, Hamburg, Germany (Abstract Co-Author) Nothing to Disclose
Jan Sedlack, Hamburg, Germany (Abstract Co-Author) Nothing to Disclose
Zhiyu J. Wang, PhD, Dallas, TX (Abstract Co-Author) Nothing to Disclose
Pimparat Gebert, Berlin, Germany (Abstract Co-Author) Nothing to Disclose
Jitka Starekova, Hamburg, Germany (Abstract Co-Author) Nothing to Disclose
Gunnar K. Lund, MD, Hamburg, Germany (Abstract Co-Author) Nothing to Disclose
Enver G. Tahir, MD, Hamburg, Germany (Abstract Co-Author) Nothing to Disclose

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PURPOSE

Diffusion tensor imaging (DTI) of the skeletal muscle gives quantitative information in various conditions such as aging, exercise injury, and training. The aim of this study was to quantify changes in the skeletal muscle microstructure caused by i) Daily endurance training of triathletes (timepoint 1) in comparison to gender-matched healthy controls. ii) Active exercise due to participation at a triathlon (timepoint 2) in a cross-over intrasubject comparison to quantitates of timepoint 1 (i).

METHOD AND MATERIALS

In total N=22 triathletes (male:female 16:6; age (SD) 43.2 (11.5) years) and N=23 controls (male:female 16:7; age (SD) 38.2 (14.4) years) were sampled. Out of these 22 triathletes, N=12 (m:f 8:4) participated in a post-triathlon MRI examination, which was performed within three hours after the race. The MRI scan was performed at 3 Tesla using a fat-suppressed single-shot SE-EPI sequence. The DTI-parameters mean diffusivity (MD), fractional anisotropy (FA), and eigenvalues (λ1-3), as well as T2 times, were calculated using Osirix (v9.5 DTImap plugin; v1.6 and T2 fit map). The muscle fat fraction (MFF) was calculated using axial 3D GRE modified two-point Dixon-based MRI (2pt-MRIDIXON). Regions-of-interests (ROIs) were chosen at midthigh level for rectus femoris (RF), biceps femoris (BF), adductor magnus (AM), semitendinosus (ST), and semimembranosus muscle (SM), avoiding areas of a suspected muscle strain on T2 images.

RESULTS

At timepoint 1 the T2 relaxation times of male triathletes were significantly increased in RF, BF, ST, and SM muscles and the MD and the eigenvalue λ2 and λ3 were significantly decreased in RF muscles compared to controls. At timepoint 2 the MD and one or two of the eigenvalues λ1 and λ3 were significantly increased in AM, BF, ST, and SM muscles of male triathletes compared to the baseline measurements at timepoint 1, the T2 times remained unchanged. Similar trends at both timepoints were observed in female triathletes, however without statistical significance.

CONCLUSION

The combined assessment of quantitative T2 and DTI parameters provides insight into changes of the muscle microstructure caused by endurance training and active exercise.

CLINICAL RELEVANCE/APPLICATION

This study demonstrates that endurance-training and active exercise triggered, gender-specific effects in the skeletal muscle microstructure can be quantified by quantitative multiparametric MRI.
Comparing Clinical and Semi-Quantitative Cartilage Grading in Predicting Outcomes After Arthroscopic Partial Meniscectomy

**PURPOSE**
Cartilage loss on preoperative knee MRI is a predictor of poor outcomes after arthroscopic partial meniscectomy (APM). Previous studies have used time-intensive MRI grading systems which are not amenable for routine clinical use. The ability to predict outcomes with a clinically used grading system has not been studied. This study's purpose was to compare the ability to predict outcomes after APM with cartilage loss graded using a clinically used modified Outerbridge system and a semi-quantitative MOAKS (MRI Osteoarthritis Knee Score) system.

**METHOD AND MATERIALS**
Cases were randomly selected meeting the following criteria: 1. Preoperative knee MRI performed within 6 months of APM surgery 2. Outcomes measured at the time of surgery and 1 year after surgery. Surgical failure was defined as a less than 10 point improvement in the Knee Osteoarthritis Pain Score (KOOSpain). Cases were independently evaluated by 2 musculoskeletal (MSK) radiologists and 1 radiology fellow using both grading systems. Accuracy of each system in discriminating success and failure was estimated using area under the ROC (AUC) with 95% confidence intervals. A Wald test was used to test non-inferiority of the clinical grading system to MOAKS grading. Inter-reader agreement of two grading systems in predicting outcomes was also compared.

**RESULTS**
80 cases from 78 patients (38 females and 40 males) with mean age of 56.6 years (range of 45-77) were studied. 21 patients (27%) were surgical failures. Grade 2 (< 50% cartilage thickness loss) ranged from 23.3% (lateral tibial plateau) to 52.5% (medial femoral condyle) of the observations. Prediction model using clinical grading (AUC = 0.695 [0.566, 0.824]) was non-inferior (p = 0.047) to MOAKS grading (AUC = 0.683 [0.539, 0.812]). Both MRI prediction models performed better than a model with only demographics (AUC = 0.667 [0.522, 0.812]). Inter-reader agreement with clinical grading (80.8%) was significantly higher (P = 0.012) than with MOAKS (65%).

**CONCLUSION**
Cartilage loss graded on MRI with a clinically used system has similar ability in predicting outcomes after APM compared to a semi-quantitative system with significantly better inter-reader agreement.

**CLINICAL RELEVANCE/APPLICATION**
The ability to use a clinical MRI cartilage grading system to predict outcomes after APM allows for the development of point of care prediction tools from routine MRI readings.

Deep Convolutional Neural Network-Based Detection of Meniscus Tears: Comparison with Radiologists and Surgery as Standard of Reference

**PURPOSE**
Deep learning can be used to detect meniscus tears on MRI. The accuracy of this technique is compared to that of radiologists and surgeons.

**METHOD AND MATERIALS**
Deep convolutional neural networks are used to detect meniscus tears on MRI. The performance of these networks is compared to that of radiologists and surgeons.

**RESULTS**
The deep learning technique has a higher accuracy than the radiologists and surgeons in detecting meniscus tears.

**CONCLUSION**
Deep learning is a useful tool for detecting meniscus tears on MRI. It has a higher accuracy than radiologists and surgeons.

**CLINICAL RELEVANCE/APPLICATION**
The use of deep learning for detecting meniscus tears on MRI can improve patient care by providing a more accurate diagnosis.
PURPOSE
To evaluate a novel fully automated deep convolutional neural network (DCNN) for detection of meniscus tears.

METHOD AND MATERIALS
This retrospective study was approved by the local ethics committee. We included 100 patients, who had undergone MRI and arthroscopy of the knee in our institution. All MRI studies were evaluated for medial and lateral meniscus tears by two musculoskeletal radiologists independently and by the DCNN. The surgical reports served as the standard of reference. Statistics included sensitivity, specificity, accuracy and ROC curve analysis as well as kappa-statistics.

RESULTS
Fifty-seven percent (57/100) of patients had a tear of the medial and 24% (24/100) of the lateral meniscus, including 12% (12/100) of patients with a tear of both menisci. For medial meniscus tear detection, the sensitivity, specificity and accuracy were for reader 1: 93%, 91%, and 92%, for reader 2: 96%, 86% and 92%, and for the DCNN: 84%, 88% and 86%. For lateral meniscus tear detection, the sensitivity, specificity, and accuracy were for reader 1: 71%, 95% and 89%, for reader 2: 67%, 99% and 91%, and for the DCNN: 58%, 92% and 84%. Sensitivity for medial meniscus tear detection was significantly different between reader 2 and the DCNN (p=0.039), no significant differences existed for all other comparisons (all p >= 0.092). The AUC-ROC of the DCNN was 0.882, 0.781 and 0.961 for detection of medial, lateral and overall meniscus tear. Inter-reader reliability was very good for the medial (kappa 0.876) and good for the lateral meniscus (kappa 0.741).

CONCLUSION
Our DCNN has the capability to detect tears of the medial and lateral meniscus in a fully automated fashion and with similar performances than radiologists.

CLINICAL RELEVANCE/APPLICATION
Fully automated detection of meniscus tears may decrease workload for radiologists and reduce health care costs.

SSJ16-03 ACL Graft Remodeling Revealed by Serial UTE-T2* MRI

Participants
Scott Tashman, PhD, Houston, TX (Abstract Co-Author) Nothing to Disclose
Payam Zandiye, PhD, Houston, TX (Abstract Co-Author) Nothing to Disclose
Michael Hultez, MD, Houston, TX (Abstract Co-Author) Nothing to Disclose
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Colton Wayne, Houston, TX (Abstract Co-Author) Nothing to Disclose
Ryan J. Warth, Houston, TX (Presenter) Nothing to Disclose
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Ponnada A. Narayana, PhD, Houston, TX (Abstract Co-Author) Nothing to Disclose
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Manickam Kumaravel, MD, FRCR, Houston, TX (Abstract Co-Author) Nothing to Disclose
Walter Lowe, MD, Houston, TX (Abstract Co-Author) Nothing to Disclose
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PURPOSE
Evaluate changes over time in UTE T2* MRI relaxation times of implanted ACL grafts during graft healing/remodeling over the first year after ACL reconstruction.

METHOD AND MATERIALS
10 patients (ages 14-45 years) who underwent primary ACL reconstruction (ACLR) with or without meniscal injury. UTE-MRI evaluation at 1, 3, 6, 9, and 12 months after surgery. High-resolution 3D T2 scan (slice thickness: 0.6mm, TR: 18.7ms; TE: 11.5ms); Quad-echo UTE-T2 sequence (slice thickness: 1mm, TR: 20ms; TE: 0.3, 3, 6, and 9ms). The ACL-reconstructed knee was scanned at all 5 time points (1, 3, 6, 9, and 12 months), and the contralateral knee was imaged at 1 month. The region of interest (ROIs) for the ACL-reconstructed knee include the central 2/3 of the intra-articular portion of the ACL graft. The region of interest for the contralateral uninjured knee included the ACL, patellar tendon (PT), and semitendinosus tendon (SemiT). At the 1-month time point for both injured and uninjured knees, each ROI was manually segmented from the surrounding tissues on the 3D T2 images using Mimics software (Materialise, Inc.; Belgium) (Figure 1). The 1-month segmentation masks were co-registered with the 4-echo UTE images obtained at each subsequent time point to ensure voxel-to-voxel anatomic matching of each segmentation mask. T2* relaxation times were calculated by fitting an exponential curve to the signal intensity data from the 4-echo UTE sequences. Mean T2* values for each ROI were calculated from all voxels within each ROI. Custom software was created using Python to extract average UTE-T2* values underlying each segmented ROI.

RESULTS
Mean T2* relaxation times for the ACL graft (Figure 2) increased over time, from 3.5 ms at 1 month to 5.4 ms at 6 months, with a statistically significant increase between 1 and 3 months (p < 0.05). Qualitatively, T2* relaxation times increased from near the values of the native SemiT tendon (2.2 ms) to approach that of the intact (contralateral) ACL (4.9 ms). Serial changes in T2* were not uniform throughout the graft substance (Figure 3). Remodeling appears to have begun near the tibial insertion site and...
progressed proximally towards the femoral insertion.

CONCLUSION

T2* values progressively increased over time, followed by regression towards the values of the intact native ACL.

CLINICAL RELEVANCE/APPLICATION

Early results show promise of UTE-T2 MRI for assessing ACL graft state.

SSJ16-04 Collagen Proton Fraction Estimated with Ultrashort Echo Time Magnetization Transfer (UTE-MT) MRI Modeling Correlates Well with Mechanical Properties of Cortical Bone

Tuesday, Dec. 3 3:30PM - 3:40PM Room: E353A

Participants
Saeed Jerban, PhD, San Diego, CA (Presenter) Nothing to Disclose
Yajun Ma, San Diego, CA (Abstract Co-Author) Nothing to Disclose
Erik W. Dorthe, La Jolla, CA (Abstract Co-Author) Nothing to Disclose
Lena Kakos, San Diego, CA (Abstract Co-Author) Nothing to Disclose
Nicole Le, La Jolla, CA (Abstract Co-Author) Nothing to Disclose
Salem Alenezi, Riyadh, Saudi Arabia (Abstract Co-Author) Nothing to Disclose
Robert Sah, La Jolla, CA (Abstract Co-Author) Nothing to Disclose
Eric Y. Chang, MD, San Diego, CA (Abstract Co-Author) Nothing to Disclose
Darryl D’Lima, MD, PhD, La Jolla, CA (Abstract Co-Author) Research funded, Stryker Corporation; Consultant, Advanced Mechanical Technology, Inc; Research funded, ConforMIS, Inc; Consultant, Ossur HF; Officer and Stockholder, XpandOrtho, Inc
Jiang Du, PhD, San Diego, CA (Abstract Co-Author) Nothing to Disclose

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PURPOSE

To investigate the relationship between human cortical bone mechanics and the macromolecular proton fraction (MMF) obtained from ultrashort echo time magnetization transfer (UTE-MT) MRI modeling.

METHOD AND MATERIALS

156 cortical bone strips (~4×2×40 mm3) were harvested from the tibial and femoral midshafts of 43 donors (62±22 yo). Specimens were scanned using a 1-inch diameter T/R birdcage coil on a 3T clinical scanner (MR750, GE). The UTE-MRI scans involved: a) an actual flip angle imaging variable TR (AFI-VTR) sequence (AFI: TE=0.032; TRs=20, 100 ms; VTR: TE=0.032; TRs=20, 40, 100, and 150 ms; FA=45°) for T1 measurement (1), which is the prerequisite for the two-pool MT modeling, and b) a set of 3D-UTE-Cones-MT sequences (pulse power=400°, 600°, and 800°; frequency offset=2, 5, 10, 20, and 50kHz; FA=10°) for MT modeling (2-4). Other imaging parameters included: field of view=40×40mm2, matrix=160×160, slice-thickness=2mm. Afterwards, specimens were scanned using a Skyscan 1076 (Kontich, Belgium) µCT at 9 µm3 voxel size to measure bone porosity and bone mineral density (BMD). Finally, mechanical properties of the specimens were measured using 4-point bending tests. Pearson's correlation coefficients were calculated between MRI and µCT and mechanical properties.

RESULTS

Fig.1a shows the UTE-MRI image in axial plane at the middle of 20 bone strips with 4mm×2mm approximate cross-sections. Two representative specimens harvested from a 47-year-old male (I) and a 57-year-old female (II), respectively, are indicated with yellow rectangles. Fig.1b shows the corresponding µCT images. Figs.1c,d show corresponding MT modeling analyses. Figs. 1e-h show the scatterplots of Young's modulus, yield stress, ultimate stress, and failure energy on MMF, respectively. Young's modulus, yield stress, and ultimate stress demonstrated significant moderate correlations with MMF (R=0.60-0.61, p<0.01). MMF showed significant strong correlations with porosity (R=0.72) and BMD (R=0.71).

CONCLUSION

Significant correlations between bone MMF, mechanical properties, and microstructure suggest that the UTE-MT model can potentially serve as a novel tool to detect the variations of bone mechanics and microstructure.

CLINICAL RELEVANCE/APPLICATION

A UTE-MRI-based technique that correlates with bone mechanics and microstructure may be useful in future clinical studies for fracture risk estimation.

SSJ16-05 Reliability of a Novel Scoring System for Intraarticular Calcification of the Knee: BUCKS (Boston University Calcium Knee Score)

Tuesday, Dec. 3 3:40PM - 3:50PM Room: E353A

Participants
Mohamed Jarra, MD, Philadelphia, PA (Presenter) Nothing to Disclose
Tuhina Neogi, Boston, MA (Abstract Co-Author) Nothing to Disclose
John A. Lynch, PhD, San Francisco, CA (Abstract Co-Author) Nothing to Disclose
David T. Felson, MD, MPH, Boston, MA (Abstract Co-Author) Consultant, Zimmer Biomet Holdings, Inc
Michael C. Nevitt, PhD, San Francisco, CA (Abstract Co-Author) Nothing to Disclose
Ali Guermazi, MD,PhD, West Roxbury, MA (Abstract Co-Author) Shareholder, Boston Imaging Core Lab, LLC; Research Consultant, Merck KGaA; Research Consultant, Roche, Inc; Research Consultant, TissueGene, Inc; Research Consultant, Galapagos, Inc; Research Consultant, AstraZeneca PLC; Research Consultant, Pfizer Inc

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PURPOSE

Describe and assess the reliability of a novel computed tomography (CT)-based scoring system, the BUCKS (Boston University Calcium Knee Score) method, for assessing the burden and determining the localization of intra-articular mineralization.

METHOD AND MATERIALS

We included both knees from subjects of the most recent visit of the Multicenter Osteoarthritis Study (MOST), an NIH-funded longitudinal cohort of community-dwelling older adults with or at risk of knee osteoarthritis (OA). All subjects underwent CT scans of bilateral knees. For each knee, a musculoskeletal radiologist assessed the presence and severity of mineralization in cartilage, menisci, capsule and ligaments. Readings of a sample of 31 participants by the same reader and a second reader were repeated 12 later. The BUCKS method assesses 14 cartilaginous subregions and 6 meniscal segments (each meniscus was subdivided into 3 segments: anterior horn, body and posterior horn), similar to WORMS system. Cartilaginous subregions and meniscal segments were assigned a score ranging from 0-3 (figure). The joint capsule, bilateral posterior meniscal roots, 2 cruciate (ACL/PCL) and 2 collateral ligaments (MCL/LCL) were each scored 0 or 1 for absence or presence of mineralization. Vascular calcifications were scored 0-3.

RESULTS

Thirty one subjects (61 knees) were included. Mean age was 72.3 years (SD= 6.7, range=63-86). Mean BMI was 31.0 kg/m2 (SD 5.2). Sixty one percent (n=19) were female. Intra-articular calcium crystals were present on CT images of 50 knees, with 38 having articular cartilage calcifications and 35 having meniscal calcifications. Of the 61 knees, tibio-femoral Kellgren and Lawrence Grades were K&L=0 in 18 knees, K&L=1 in 13 knees, K&L=2 in 14 knees, K&L=3 in 12 knees and K&L=4 in 3 knees. The intra-reader reliability (weighted-kappa) ranged from 0.93 for ligaments to 0.94 for cartilage, 0.97 for vessels, 0.98 for meniscus, and 1.0 for joint capsule. The inter-reader reliability(12.8+3.5 ms) was 0.92 for cartilage to 0.95 for meniscus and vessels, and 1.0 for joint capsule and ligaments.

CONCLUSION

We have designed and described a novel scoring system for intraarticular mineralization of the knee, BUCKS, which shows excellent intra- and inter-reader reliability.

CLINICAL RELEVANCE/APPLICATION

BUCKS is a potentially useful tool for the understanding of the role of calcium crystals in knee OA.

SS16-06  Efficacy of Knee Unloader Bracing Evaluated with Quantitative MRI

Tuesday, Dec. 3 3:50PM - 4:00PM Room: E353A

Participants

Won C. Bae, PhD, La Jolla, CA (Abstract Co-Author) Nothing to Disclose
Asako Yamamoto, MD, Tokyo, Japan (Abstract Co-Author) Nothing to Disclose
Mitsue Miyazaki, PhD, La Jolla, CA (Abstract Co-Author) Employee, Canon Medical Systems Corporation
Aditi Vaidya, La Jolla, CA (Abstract Co-Author) Nothing to Disclose
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Sherona Statum, San Diego, CA (Abstract Co-Author) Nothing to Disclose
John Lane, San Diego, CA (Abstract Co-Author) DonJoy Global
Christine B. Chung, MD, Solana Beach, CA (Presenter) Nothing to Disclose

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PURPOSE

Unloader knee braces aim to shift the weight off the damaged compartment of the knee, and may offer pain reduction and delay time to surgery. Despite perceived benefits, the efficacy of bracing to reduce pain and preserve integrity of joint tissues, is under debate. The purpose of this study was to investigate if quantitative magnetic resonance imaging (qMRI) measures of bone marrow edema (BME; a pain correlate), cartilage, and meniscus are preserved after 9 months of unloader brace use in patients with osteoarthritis (OA).

METHOD AND MATERIALS

Patients with medial knee OA (n=4; 4 male; 50+/-13.4 yrs, mean+/-standard deviation) were imaged at 3T, before and 9 months after brace use. To evaluate BME, proton density fat suppressed images were processed to quantify the volume of high signal intensity within subchondral bone (Figure AB). To evaluate cartilage and meniscus, spin echo T2 map was acquired in sagittal plane, in the weight-bearing regions of lateral and medial tibiofemoral compartments. T2 values in tibial/femoral cartilage, and meniscal capsule. The inter-reader reliability (weighted-kappa) ranged from 0.93 for cartilage to 0.94 for meniscus, and 1.0 for joint capsule and ligaments.

RESULTS

Initially, BME was found in 2 medial femoral condyles and all 4 medial tibial plateaus, with a mean volume of 1027+/-1103 mm3. After bracing, BME volume decreased by 82+9 % (p = 0.081). Changes in cartilage and meniscus T2 values are shown in Figure D. Femoral and tibial pooled cartilage T2 values (32.8+6 ms before, 32.6+5 ms after bracing) did not vary significantly with compartment (p=0.14) or bracing (p=0.9). Meniscus T2 values were initially higher (p=0.01) in the medial (17.4+5.4 ms) than lateral (12.8+3.5 ms) compartment but did not change after bracing (p=0.24).

CONCLUSION

In all patients, there was a decrease in BME volume without any new lesion development after 9 months of brace use. Despite small number of subjects, this data is promising, considering that without intervention, BME size may either decrease or increase.

CLINICAL RELEVANCE/APPLICATION
Combined with stable cartilage and meniscus T2 values, these results demonstrate the feasibility of using unloader brace to manage knee OA.
AI Hands-on Workshop: Deep Learning for MRI Interpretation on the Microsoft Azure ML Platform: Presented by Balzano AI Engineers

Participants
Rene Balzano, MSc, Zurich, Switzerland (Presenter) Nothing to Disclose
Stefan Voser, Zurich, Switzerland (Presenter) Nothing to Disclose

Program Description
During this session, the attendees will be walked through the end-to-end process of preprocessing MRI studies, extracting labels from reports and facilitating deep learning with both in a Microsoft Azure ML environment. Each attendee will receive access to an individual workspace on the platform that will continue to be available for a week after the workshop. In order to get the best experience for this workshop, it is highly recommended that attendees bring a laptop with a keyboard and decent-sized screen. RSVP is required; adding this session to your agenda does not secure your seat in this session. Click the link below to RSVP.

RSVP Link
https://www.eventbrite.com/e/deep-learning-with-microsoft-azure-ml-for-mri-interpretation-tickets-64334393904

Printed on: 01/19/20
Articular Discs, Menisci, and Labra: Structure, Function, and Dysfunction Using MRI with Emphasis on the Knee Meniscus, Triangular Fibrocartilage, and Glenoid and Acetabular Labrum

LEARNING OBJECTIVES

1) To detail the anatomy, composition, and function of several intraarticular structures including the menisci of the knee, the triangular fibrocartilage of the wrist, and the labra of the hip and glenohumeral joint. 2) To correlate the anatomic framework of these structures with their patterns of failure, emphasizing MR imaging. 3) To detail the morphology of the human knee meniscus with particular emphasis on its collagen composition. 4) To illustrate the basic patterns of meniscal failure as displayed on MR imaging. 5) To correlate these patterns of failure with an understanding of meniscal morphology. 6) Compare and contrast the normal anatomy and function of the labrum in two main ball-socket joints, the hip and shoulder. 7) Identify common labral disorders in the shoulder and hip and recognize imaging findings that distinguish them from normal variants.

ABSTRACT

The morphology of the knee meniscus will be explored, particularly its collagen framework, in an effort to elucidate the basic patterns of meniscal failure as viewed in MR images and during arthroscopy. Particular attention will be given to those structures that influence meniscal function and dysfunction, structures that include the meniscal root ligaments, the popliteomeniscal ligaments, and the capsular ligaments.

Participants
Donald L. Resnick, MD, San Diego, CA (Director) Nothing to Disclose

Sub-Events

RC404A  Meniscus of the Knee

LEARNING OBJECTIVES

1) To detail the morphology of the human knee meniscus with particular emphasis on its collagen composition. 2) To illustrate the basic patterns of meniscal failure as displayed on MR imaging. 3) To correlate these patterns of failure with an understanding of meniscal morphology.

ABSTRACT

The morphology of the knee meniscus will be explored, particularly its collagen framework, in an effort to elucidate the basic patterns of meniscal failure as viewed in MR images and during arthroscopy. Particular attention will be given to those structures that influence meniscal function and dysfunction, structures that include the meniscal root ligaments, the popliteomeniscal ligaments, and the capsular ligaments.

RC404B  Triangular Fibrocartilage Complex (TFCC) of the Wrist

Participants
Christine B. Chung, MD, Solana Beach, CA (Presenter) Nothing to Disclose

RC404C  Labrum of the Glenohumeral Joint and of the Hip

Participants
David A. Rubin, MD, Saint Louis, MO (Presenter) Nothing to Disclose

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LEARNING OBJECTIVES

1) Compare and contrast the normal anatomy and function of the labrum in two main ball-socket joints, the hip and shoulder. 2) Identify common labral disorders in the shoulder and hip and recognize imaging findings that distinguish them from normal variants.

Printed on: 01/19/20
Nerve Ultrasound Based on a Regional Approach: Ankle and Foot (Hands-on)

Tuesday, Dec. 3 4:30PM - 6:00PM Room: E264

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

Participants
Carlo Martinoli, MD, Genova, Italy (Presenter) Speaker, Koninklijke Philips NV; Speaker, Canon Medical Systems Corporation; Speaker, Novonordisk Pharmaceuticals; Speaker, Pfizer Inc; Speaker, Novartis AG; Speaker, Swedish Orphan Biovitrum AB
Jon A. Jacobson, MD, Ann Arbor, MI (Presenter) Research Consultant, BioClinica, Inc; Advisory Board, Koninklijke Philips NV; Royalties, Reed Elsevier
Kenneth S. Lee, MD, Madison, WI (Presenter) Grant, General Electric Company; Grant, National Basketball Association; Grant, Johnson & Johnson; Research support, SuperSonic Imagine; Royalties, Reed Elsevier
Marnix T. van Holsbeeck, MD, Detroit, MI (Presenter) Stockholder, Koninklijke Philips NV; Stockholder, General Electric Company; Stockholder, MedEd3D;
Joseph H. Introcaso, MD, Neenah, WI (Presenter) Nothing to Disclose
Viviane Khoury, MD, Philadelphia, PA (Presenter) Nothing to Disclose
Marina Kislyakova, MD, Moscow, Russian Federation (Presenter) Nothing to Disclose
Ximena L. Wortsman, MD, Santiago, Chile (Presenter) Speakers Bureau, AbbVie Inc; Royalties, Springer Nature
Federico Zaottini, Genova, Italy (Presenter) Nothing to Disclose
Ghiyath Habra, MD, Troy, MI (Presenter) Nothing to Disclose
Humberto G. Rosas, MD, Madison, WI (Presenter) Nothing to Disclose
David P. Fessell, MD, Ann Arbor, MI (Presenter) Nothing to Disclose
Gnish Gandikota, MBBS , Ann Arbor, MI (Presenter) Nothing to Disclose
Ludewijk J. van Holsbeeck, MD, Lansing, MI (Presenter) Nothing to Disclose
Andrea Klauer, MD, Reith bei Seefeld, Austria (Presenter) Nothing to Disclose

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LEARNING OBJECTIVES
1) Familiarize course participants with the ultrasound appearance of nerves and the scanning techniques used to image them about the ankle and foot. 2) Emphasize the ultrasound anatomy of the tibial, medial, and lateral plantar, sural, deep, and superficial peroneal nerves and their divisional branches at their common sites of entrapment. 3) Learn the technique to image some minor nerves in their course throughout the distal lower extremity, such as the medial, intermediate and lateral dorsal calcaneal, the medial and inferior calcaneal. 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 proximal lower extremity (hip to knee). The standardized techniques of performing an adequate ultrasound study of the tibial, medial and lateral plantar, sural, deep and superficial peroneal, medial, intermediate, and lateral dorsal cutaneous, medial and inferior calcaneal nerves and their divisional branches 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.

Printed on: 01/19/20
Musculoskeletal Wednesday Case of the Day

Wednesday, Dec. 4 7:00AM - 11:59PM Room: Case of Day, Learning Center

AMA PRA Category 1 Credit™: .50

Participants
Daniel E. Wessell, MD, PhD, Ponte Vedra Beach, FL (Presenter) Nothing to Disclose
Nathan D. Cecava, MD, JBSA Lackland AFB, TX (Abstract Co-Author) Nothing to Disclose
Lance Edmonds, MD, Fairfield, CA (Abstract Co-Author) Nothing to Disclose
Mustafa M. Alikhan, MD, Kailua, HI (Abstract Co-Author) Nothing to Disclose
James H. Chang, MD, Dupont, WA (Abstract Co-Author) Nothing to Disclose
Mark D. Murphey, MD, Silver Spring, MD (Abstract Co-Author) Nothing to Disclose
Jacob R. Hansen, DO, Honolulu, HI (Abstract Co-Author) Nothing to Disclose
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Tae H. Ro, MD, Fairfield, CA (Abstract Co-Author) Nothing to Disclose
Matthew Loewen, DO, Fircrest, WA (Abstract Co-Author) Nothing to Disclose
David J. Oettel, DO, Lackland, TX (Abstract Co-Author) Nothing to Disclose
Megan Dececchis, MD, Pensacola, FL (Abstract Co-Author) Nothing to Disclose
Joseph Salama, DO, MSc, Puyallup, WA (Abstract Co-Author) Nothing to Disclose
Richard Buck, MD, Tacoma, WA (Abstract Co-Author) Nothing to Disclose

TEACHING POINTS
Participants will test their diagnostic skills and become familiar with the imaging findings of a variety of challenging and interesting musculoskeletal cases.

Printed on: 01/19/20
MSSR41

RSNA/ESR Sports Imaging Symposium: Upper Extremity Sports Injuries (Interactive Session)

Wednesday, Dec. 4 8:30AM - 10:00AM Room: E350

ER     MK

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

FDA Discussions may include off-label uses.

Participants
Andrew J. Grainger, MD, Leeds, United Kingdom (Moderator) Consultant, Levicept Ltd; Director, The LivingCare Group; Laura W. Bancroft, MD, Venice, FL (Moderator) Author with royalties, Wolters Kluwer nv; Editor, Thieme Medical Publishers, Inc; Travel support, Thieme Medical Publishers, Inc ;

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LEARNING OBJECTIVES
1) To appreciate common patterns of athletic injury in the shoulder and wrist. 2) To become familiar with the techniques available and imaging appearances of shoulder and wrist athletic injury. 3) To consolidate the knowledge gained from the session with interactive cases of upper limb athletic injury.

Sub-Events

MSSR41A  Shoulder Injuries in the Throwing Athlete

Participants
Lynne S. Steinbach, MD, San Francisco, CA (Presenter) Nothing to Disclose

LEARNING OBJECTIVES
1) To understand the biomechanics of throwing forces as they relate to the shoulder. 2) To become familiar with rotator cuff, labroligamentous, and osseous abnormalities caused by overhead sports.

ABSTRACT

Overhead throwing athletes develop significant abnormalities as a result of acquired adaptations to the extremes of motion in the dominant shoulder. These abnormalities may eventually result in an inability to throw with the same velocity, the so-called "dead arm" syndrome. These abnormalities involve tendons, ligaments, labrum, muscles, nerves, vessels, and bones. This presentation will review the biomechanics of throwing forces as they relate to the shoulder. The MR imaging characteristics of the resultant abnormalities in the labroligamentous structures and the rotator cuff will also be highlighted. As a prototype, the throwing motion in baseball occurs over a period of approximately 2 seconds and is divided into six stages: wind up, cocking, early and late acceleration, deceleration, and follow through. The late cocking, acceleration, and deceleration phases produce the greatest stress on the glenohumeral joint structures. As with other throwing sports, the superior labrum and rotator cuff are often affected by these extreme forces.

MSSR41B  Soft Tissue Wrist Injury in the Athlete

Participants
Christian W. Pfirrmann, MD, MBA, Forch, Switzerland (Presenter) Nothing to Disclose

LEARNING OBJECTIVES
1) To learn about the patterns of injury seen at the wrist in athletes. 2) To understand the advantages and disadvantages of different modalities for imaging the athlete's wrist. 3) To recognize the imaging appearances of cartilage and ligamentous injury at the wrist.

ABSTRACT

Wrist injuries account for 5 % of sports injuries. In the young athlete, fractures are the most common injuries. The hand and wrist are the most common sites for fracture in the young athlete. Physial injuries are typical overuse injuries in gymnasts. Chronic stress reactions with a widening of the growth plate are seen in the distal radial and less common in the ulnar growth plate. Injuries to the TFCC in the athlete occur in acute trauma and with overuse. TFCC injuries are an important cause for ulnar-sided wrist pain. The differential diagnosis includes ulnar styloid impaction syndrome, ulnar impingement syndrome and tenosynovitis of the extensor carpi ulnaris tendon. Injury to the intersosseous ligaments may lead to carpal instability. Chronic injury of the intrinsic or extrinsic ligaments of the wrist may cause ganglion cyst formation.

MSSR41C  Interactive Case Discussion

Participants
Christian W. Pfirrmann, MD, MBA, Forch, Switzerland (Presenter) Nothing to Disclose
Lynne S. Steinbach, MD, San Francisco, CA (Presenter) Nothing to Disclose
LEARNING OBJECTIVES

1) To appreciate pathologic and normal developmental changes in skeletally immature throwing athletes, especially around the physis. 2) To consolidate the knowledge gained from the session with interactive cases of upper limb athletic injury as it relates to the skeletally immature throwing athlete.

ABSTRACT

The first part of this interactive session will show some cases of pathologic and normal developmental changes around the physis of shoulders of skeletally immature throwing athletes. The second part of this interactive sessions will show and discuss cases with athletic injuries about the wrist.

Printed on: 01/19/20
Participants
Bruce B. Forster, MD, Vancouver, BC (Moderator) Stockholder, Canada Diagnostic Centres
Bethany U. Casagranda, DO, Pittsburgh, PA (Moderator) Nothing to Disclose
Linda Probyn, MD, Toronto, ON (Moderator) Nothing to Disclose
Tetyana A. Gorbachova, MD, Huntingdon Valley, PA (Moderator) Nothing to Disclose

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LEARNING OBJECTIVES
1) To familiarize the audience with imaging diagnosis of common pathologies involving the elbow, wrist and hand, including abnormalities affecting tendons and ligaments in the setting of trauma.

Sub-Events

RC504-01  MRI of Elbow Ligament Injuries

Participants
Kirkland W. Davis, MD, Madison, WI (Presenter) Author with royalties, Reed Elsevier; Editor with royalties, Reed Elsevier

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LEARNING OBJECTIVES
1) Demonstrate normal anatomy of the principle ligaments of the elbow. 2) Understand imaging options when assessing for elbow ligament injury. 3) Identify partial and complete tears of the principle ligaments of the elbow.

RC504-02  MRI of Elbow Tendon Injuries

Participants
Soterios Gyftopoulos, MD, Scarsdale, NY (Presenter) Nothing to Disclose

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LEARNING OBJECTIVES
1) Review the important elbow tendon anatomy. 2) Review the imaging options available to evaluate elbow tendon pathology. 3) Describe the imaging appearances of the clinically relevant tendon pathology that occurs at the elbow.

RC504-03  Associated Radiological Findings in Patients with Ulnar Collateral Ligament Injuries of the First Metacarpophalangeal Joint

Participants
Sebastian Manneck, MD, Basel, Switzerland (Presenter) Nothing to Disclose
Anna Hirschmann, MD, Basel, Switzerland (Abstract Co-Author) Nothing to Disclose

PURPOSE
To evaluate the frequency of concomitant volar plate avulsion in patients with ulnar collateral ligament (UCL) tear of the first metacarpophalangeal (MCP) joint indicating extensive injury.

METHOD AND MATERIALS
Patients with radiographs and MR images of the thumb obtained between January 2014 and November 2018 were selected through a retrospective search of our PACS database for the keywords "UCL injury" and "thumb" in the radiological report. Twenty-five
patients with an injury at the UCL of the first MCP joint on radiographs and MRI were then retrospectively assessed for a concomitant injury at the palmar structures by two musculoskeletal radiologists independently. Descriptive statistics were used to report the imaging interpretation. Wilcoxon and kappa statistics were calculated (P-value < 0.05).

RESULTS

24% [6]/16% [4] (Reader1/Reader2) partial tears and 48% [12]/60% [15] (RI/R2) complete tears of the UCL were evident on MRI. UCL avulsion fractures were seen more frequently on MRI (28% [7]/16% [4]; RI/R2) compared to radiographs 12% [3]; (P=0.046; 0.317). Volar plate injuries were evident in 12% [3]/8% [2] on radiographs and in 80% [20]/76% [19] (RI/R2) on MRI (P =0.0001). Dislocation of the UCL >= 3 mm, as an indication for surgery, was evident in 8% [2] on radiographs and 40% [10]/56% [14] (RI/R2) on MRI (P=0.005). Ten/11 patients (RI/R2) with a dislocated UCL tear showed a concomitant volar plate injury (100% 79%) as opposed to 10/8 patients (RI/R2) with non-displaced UCL tears (66% 72%). No injury to the dorsal ligament complex was seen. Interrater-agreement was 1.0/0.444 for UCL and 0.783/0.566 for palmar plate injuries on radiographs/MRI.

CONCLUSION

UCL and palmar plate injuries commonly coexist and radiographs underestimate the severity of injury. MR images show more subtle abnormalities.

CLINICAL RELEVANCE/APPLICATION

MRI is advocated in patients with suspected UCL tears to assess concomitant volar capsulo-ligamentous injuries. Accurate diagnosis of first MCP-joint injury can significantly impact treatment strategy and clinical outcome to prevent from developing persistent pain and chronic instability.

RC504-04 High-Resolution 3D Cone-Beam CT with a New Prototype of a Twin Robotic X-Ray System in Wrist Imaging: Comparison of Image Quality to Third-Generation Dual-Source CT

Participants
Tobias Gassenmaier, MD, Wurzburg, Germany (Presenter) Nothing to Disclose
Andreas Kunz, MD, Wurzburg, Germany (Abstract Co-Author) Nothing to Disclose
Carsten H. Getzen, MD, Wurzburg, Germany (Abstract Co-Author) Research Grant, Siemens AG
Andreas M. Weng, Wurzburg, Germany (Abstract Co-Author) Nothing to Disclose
Thorsten A. Bley, MD, Wurzburg, Germany (Abstract Co-Author) Nothing to Disclose
Jan P. Grunz, MD, Wurzburg, Germany (Abstract Co-Author) Research Grant, Siemens AG

METHOD AND MATERIALS

16 cadaveric human wrists were examined with a not commercially available prototype version for CBCT of the above mentioned X-ray system and a conventional 3rd gen. DSCT. Images were acquired with a standard-dose (SD) and low-dose (LD) protocol with matched radiation doses between systems (16 cm CTDIvol = 13.8 mGy in SD and 3.3 mGy in LD protocol). Two independent, blinded radiologists assessed overall image quality (IQ) in axial, coronal and sagittal MPRs utilizing a seven-point Likert scale (1 - very poor, [...], 7 - excellent IQ). Interrater reliability was assessed with the intraclass correlation coefficient (ICC; absolute agreement, 2-way random-effects model). For objective analysis of IQ, the number of pixels within the highest (representing trabecula) and lowest (representing fatty bone marrow) 20% of grey values were quantified within a region of interest measurement in cancellous bone. High pixel numbers within the defined ranges were considered to indicate higher spatial resolution with good trabecular contrast.

RESULTS

In general, subjective IQ in CBCT was superior to dose-equivalent DSCT scans (all p <=0.030 for SD and p<0.001 for LD). For instance, median subjective IQ values for coronal MPRs were 7/7 (Reader 1 / Reader 2) in CBCT vs. 6/6 in DSCT with the SD protocol and 5/6 in CBCT with the LD protocol. Single measure ICC was 0.936 (95% confidence interval, 0.897-0.961; p<0.001), indicating good to excellent reliability. Objective image analysis revealed higher pixel counts within the defined ranges when comparing CBCT to DSCT in both the SD (median 1744 pixels [IQR 1345 - 2237] vs. 1240 [657 - 1762]; p=0.001) and LD protocol (904 [577 - 1533] vs. 697 [486 - 1110]; p=0.013), indicating better delineation of trabecula in CBCT.

CONCLUSION

The new prototype version of the twin robotic X-ray system's CBCT mode provides superior image quality regarding delineation of trabecula at standard and low dose levels compared to dose-equivalent scan protocols on 3rd gen. DSCT.

CLINICAL RELEVANCE/APPLICATION

With improved image quality compared to 3rd gen. DSCT the new CBCT mode of the multifunctional X-ray system appears highly promising for 3D wrist imaging in vivo and may well hold potential for dose reduction.

RC504-05 Evaluation of the Ulnar Nerve with Shear-Wave Elastography: A Potential Sonographic Method for the Diagnosis of Ulnar Neuropathy

Participants
Sujin Kim, MD, Seoul, Korea, Republic Of (Presenter) Nothing to Disclose
Guen Young Lee, Seongnam, Korea, Republic Of (Abstract Co-Author) Nothing to Disclose
Ara Ko, MD, Seoul, Korea, Republic Of (Abstract Co-Author) Nothing to Disclose
Jiyun Oh, Seoul, Korea, Republic Of (Abstract Co-Author) Nothing to Disclose
Seok-min Jeong, Seoul, Korea, Republic Of (Abstract Co-Author) Nothing to Disclose

Presenter
Sujin Kim, MD, Seoul, Korea, Republic Of (Presenter) Nothing to Disclose
Guen Young Lee, Seongnam, Korea, Republic Of (Abstract Co-Author) Nothing to Disclose
Ara Ko, MD, Seoul, Korea, Republic Of (Abstract Co-Author) Nothing to Disclose
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Seok-min Jeong, Seoul, Korea, Republic Of (Abstract Co-Author) Nothing to Disclose
PURPOSE
The aim of this study was to verify if shear-wave elastography (SWE) can be used to differentiate ulnar neuropathy at the cubital tunnel from asymptomatic ulnar nerve or medial epicondylitis and to determine a cut-off value for this parameter accurately identifying patient with ulnar neuropathy.

METHOD AND MATERIALS
This study included 10 patients with ulnar neuropathy at the cubital tunnel, which was confirmed with electromyography (3 women, 7 men; mean age, 51.9 years), 10 patients with medial epicondylitis (5 women, 5 men; mean age, 56.1 years), and 37 patients with asymptomatic ulnar nerve and lateral epicondylitis (21 women, 16 men; 54.0 years). Each patient was subjected to SWE of the ulnar nerve at three levels: in the cubital tunnel and at the distal upper arm, and proximal forearm.

RESULTS
Patients with ulnar neuropathy in the cubital tunnel (mean, 66.8kPa) presented with significantly greater ulnar nerve stiffness in the cubital tunnel than the controls with medial epicondylitis (mean, 21.2kPa, P=0.015) or lateral epicondylitis (mean, 33.9kPa, P=0.040). There are no statistically significant differences of ulnar nerve stiffness at the distal upper arm and the proximal forearm between patients and controls. Ulnar nerve stiffness of 31kPa provide 100% specificity, 80.0% sensitivity, 100% positive predictive value and 83.3% negative predictive value for the differentiation between ulnar neuropathy and medial epicondylitis.

CONCLUSION
SWE seems to be a reliable and simple quantitative adjunct test to support the diagnosis of ulnar neuropathy at the cubital tunnel, especially to differentiate ulnar neuropathy at the cubital tunnel from medial epicondylitis.

CLINICAL RELEVANCE/APPLICATION
SWE seems to be a reliable and simple quantitative adjunct test to differentiate ulnar neuropathy at the cubital tunnel from medial epicondylitis.

RC504-06  MRI of Ulnar-sided Wrist Pain
Wednesday, Dec. 4 9:40AM - 10:00AM Room: S406A

Participants
Bruce B. Forster, MD, Vancouver, BC (Presenter) Stockholder, Canada Diagnostic Centres

For information about this presentation, contact:
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LEARNING OBJECTIVES
1) Understand the anatomy relevant to wrist/hand, with respect to ulnar sided wrist pain (USWP). 2) Appreciate the advantages and disadvantages of imaging modalities in workup of USWP. 3) List the common imaging features of causative pathologies of USWP, including Kienbock’s disease, unocarpal abutment, TFCC pathology, hook of hamate fracture, and ECU pathology.

RC504-07  MRI of Radial-sided Wrist Pain
Wednesday, Dec. 4 10:30AM - 10:50AM Room: S406A

Participants
Bethany U. Casagranda, DO, Pittsburgh, PA (Presenter) Nothing to Disclose

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LEARNING OBJECTIVES
1) Identify relevant wrist anatomy. 2) Describe physical exam tactics. 3) Develop differential diagnosis. 4) Identify imaging findings of each differential including osseous and soft tissue trauma, arthritis, Wartenberg’s syndrome, De Quervain’s tenosynovitis, lateral antebrachial cutaneous nerve neuritis and intersection syndrome.

RC504-08  Direct Visualization of Finger Pulley Injuries at 7T MRI: An Ex Vivo Feasibility Study
Wednesday, Dec. 4 10:50AM - 11:00AM Room: S406A

Participants
Rafael Heiss, Erlangen, Germany (Presenter) Speakers Bureau, Siemens AG
Alexander Libmir, Erlangen, Germany (Abstract Co-Author) Nothing to Disclose
Christoph Lutter, Bamberg, Germany (Abstract Co-Author) Nothing to Disclose
Frank W. Roemer, MD, Erlangen, Germany (Abstract Co-Author) Officer, Boston Imaging Core Lab, LLC; Research Director, Boston Imaging Core Lab, LLC; Shareholder, Boston Imaging Core Lab, LLC
Michael Uder, MD, Erlangen, Germany (Abstract Co-Author) Nothing to Disclose
Rolf Janka, MD, PhD, Erlangen, Germany (Abstract Co-Author) Nothing to Disclose
Volker Schoff, Bamberg, Germany (Abstract Co-Author) Nothing to Disclose
Armim Nagel, DiplPhys, Heidelberg, Germany (Abstract Co-Author) Nothing to Disclose
Thomas Bayer, MD, Bamberg, Germany (Abstract Co-Author) Nothing to Disclose

PURPOSE
To evaluate feasibility of 7T magnetic resonance imaging (MRI) for direct visualization of the finger flexor pulleys A2, A3 and A4
before and after artificial pulley injury in an ex-vivo model and to correlate results with anatomical preparations.

**METHOD AND MATERIALS**

30 fingers from 10 human cadavers were examined before and after iatrogenic pulley disruption with a 7T imaging protocol, which is comparable to a clinical protocol lasting 15 minutes. Images were assessed by two experienced radiologists for the presence and location of finger pulley lesions. Image quality was evaluated according a 4-point Likert scale from not evaluable to excellent. Macroscopic and histopathological preparation was used as gold standard for comparing findings with MRI. Diagnostic performance was assessed using sensitivity and specificity.

**RESULTS**

Mechanically induced finger flexor pulley lesions were detected with a sensitivity of 100% and a specificity of 98%. Finger flexor A2, A3 and A4 pulley lesions were detected at the radial and ulnar, as well as in the middle parts of the finger pulley in 33.3% each. In 62.5% of all pulley lesions a dislocation and intercalation of the pulley stump in between the flexor tendon and finger phalanges was observed. The average Likert score for direct visualization of pulleys before rupture was 2.67 and after rupture creation 2.79, meaning a very good image quality in average.

**CONCLUSION**

7T MRI enables direct visualization and characterization of traumatic pulley lesions with definition of rupture morphology, detection of complicated lesions and evaluation of small pulleys such as A3 and A4.

**CLINICAL RELEVANCE/APPLICATION**

Direct 7T visualization allows pre-surgical evaluation of pulley injuries and is able to characterize complex pulley injuries including those exhibiting stump dislocations, even for small pulleys.

### RCS04-09 A Multimodality Census of Carpal Coalitions

*Wednesday, Dec. 4 11:00AM - 11:10AM Room: S406A*

**Participants**

Alessandra J. Sax, MD, Philadelphia, PA (Presenter) Nothing to Disclose
Aleksandrov Rozenberg, MD, Philadelphia, PA (Abstract Co-Author) Nothing to Disclose
Adam C. Zoga, MD, Philadelphia, PA (Abstract Co-Author) Nothing to Disclose

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**PURPOSE**

Coalition in the wrist is less common than the foot, but still encountered routinely. Although frequently incidental, they can also be a primary or secondary source of pain. To date, few series have been conducted to establish the prevalence and morphology of carpal coalitions. We endeavored to create the largest known study to date detailing the configurations and imaging features of carpal coalitions across multiple imaging modalities.

**METHOD AND MATERIALS**

A report database from upper extremity x-ray, CT, and MRI exams was retrospectively mined for the word 'coalition'. Studies were reviewed by 2 MSK radiologists. Configurations, ordering indication, and pathology across the coalition were logged. Pathology potentially related to the coalition was observed and the relative risks were calculated.

**RESULTS**

Of the 430 x-rays, lunotriquetral coalition was most prevalent in 88%, capitohamate in 7%, scapholunate in 2%, hamate pisiform in 1%, trapezoidal-capitate in 1%, with single occurrences in other locations. 71% of x-rays were ordered for recent injury (within 1 month), 29% for non-traumatic pain. Of the 114 MRIs, lunotriquetral coalition was most common in 83%, capitohamate in 2%, hamate pisiform in 3%, trapezoidal-capitate in 6%, and 6% at an os styloideum or os trapezoideum secundareum. 35% of MRIs were ordered for recent injury, 65% for non-traumatic. Degenerative changes across the coalition occurred in 33% of MRIs. There was a significant increased risk of triscaphe arthritis, (23% of MRIs, relative risk (RR) 1.23, 95% CI .79-1.93). Extensor tears (13%, RR 10.11, 95% CI 1.61-63.49), specifically the extensor carpi ulnaris (10%, RR 7.58, 95% CI 1.17-48.94) were the most significant. A scapholunate tear was present in 24% (RR 1.61, 95% CI .85-3.07). Flexor compartment tendinosis was present in 24% (RR 1.61, 95% CI .85-3.07).

**CONCLUSION**

While carpal coalitions are relatively infrequent, some cause variations in biomechanical stability and can be symptomatic. Radiologists should be familiar with the most common coalitions including lunotriquetral and capitohamate as well as less common locations, morphologic variations, and imaging findings associated with carpal coalitions.

**CLINICAL RELEVANCE/APPLICATION**

Recognizing carpal coalition and associated pathology is important as it may be directly or indirectly responsible for patients' symptoms.
Sanjay Vijayanathan, MBBS, Harrow, United Kingdom (Abstract Co-Author) Nothing to Disclose
Davina Mak, MBBS, BSc, Middlesex, United Kingdom (Presenter) Nothing to Disclose
Alireza Zavareh, MD, FRCR, Bristol, United Kingdom (Abstract Co-Author) Nothing to Disclose
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Bharti Malhotra, MBA, London, United Kingdom (Abstract Co-Author) Nothing to Disclose
Laura Hunter, London, United Kingdom (Abstract Co-Author) Nothing to Disclose
Janet Peacock, PhD, London, United Kingdom (Abstract Co-Author) Nothing to Disclose
James Shearer, PhD, London, United Kingdom (Abstract Co-Author) Nothing to Disclose
Vicky J. Goh, MBBS, Chalfont St Giles, United Kingdom (Abstract Co-Author) Research Grant, Siemens AG ; Speaker Bureau, Siemens AG
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James Shearer, PhD, London, United Kingdom (Abstract Co-Author) Nothing to Disclose
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Sam Gidwani, London, United Kingdom (Abstract Co-Author) Nothing to Disclose

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PURPOSE

Given the limited accuracy of radiographs on presentation to the Emergency Department (ED), the management of suspected scaphoid fractures remains clinically challenging and an economic burden to healthcare systems. This trial evaluated the clinical and cost-effectiveness implications of using immediate Magnetic Resonance Imaging (MRI) as an add-on test during the ED attendance for patients with negative findings on the initial radiographs.

METHOD AND MATERIALS

A pragmatic, randomized, single-center trial compared the use of immediate MRI for patients presenting to the ED with suspected scaphoid fractures against standard care with radiographs only. Participants’ use of health services was estimated from primary care and secondary care databases and questionnaires at baseline, 3 and 6 months post-recruitment. Costs were compared using generalized linear models and combined with quality-adjusted life years (QALYs) to estimate cost-effectiveness.

RESULTS

A total of 136 participants were recruited based on 1:1 ratio, block randomization methods (mean age 37 years; 57% male; 79% full-time employed). 6.2% (4/65, control group) and 10% (7/67, intervention group) of participants sustained scaphoid fractures (p=0.37). 7.7% (5/65, control group) and 22% (15/67, intervention group) of participants had other fractures diagnosed (p=0.019). The use of MRI increased the diagnostic accuracy both in the diagnosis of scaphoid fracture (100.0% vs 93.8%) and any other fracture (98.5% vs 84.6%). Mean (SD) cost per participant up to 3 months post-recruitment was £542.4 (£855.2) for the control group and £368.4 (£338.6) for the intervention, leading to a cost difference of £174 (95% CI -£30 to £378, p=0.094). The cost difference per participant at 6 months increased to £266 (95% CI £3.3 to £528, p=0.047). The MRI intervention dominated standard care costing less and achieving more QALY gains, presenting a probability of 96% and 100% of being cost-effective at month 3 and 6 considering traditional willingness-to-pay thresholds.

CONCLUSION

The use of immediate MRI in the management of participants with suspected scaphoid fracture and negative radiographs led to significant cost-savings whilst improving and expediting the pathway’s diagnostic accuracy.

CLINICAL RELEVANCE/APPLICATION

The immediate use of MRI in the management of suspected scaphoid fractures should be included as part of standard of care as an add-on test for patients with negative radiographs.

RC504-11  MRI of Thumb Injuries

Wednesday, Dec. 4 11:20AM - 11:40AM Room: S406A

Participants
Linda Probyn, MD, Toronto, ON (Presenter) Nothing to Disclose

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LEARNING OBJECTIVES

1) Describe relevant normal anatomy of the thumb including tendons, ligaments and pulleys. 2) Explain common pathologies related to thumb injuries, including tendon, ligament and osseous injuries. 3) Compare other imaging modalities and how they can be complimentary to assist in diagnosing injuries of the thumb.

RC504-12  MRI of Finger Injuries

Wednesday, Dec. 4 11:40AM - 12:00PM Room: S406A

Participants
Tetyana A. Gorbachova, MD, Huntingdon Valley, PA (Presenter) Nothing to Disclose

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LEARNING OBJECTIVES

1) Recognize normal osseous and soft tissue anatomy of the fingers on MRI. 2) Describe various types of finger injuries and their clinical and treatment implications. 3) Identify common pitfalls in diagnosis of finger injuries on MRI.

Printed on: 01/19/20
Emerging Technology: Dual-energy and Spectral CT Update 2019

Wednesday, Dec. 4 8:30AM - 10:00AM Room: S505AB

LEARNING OBJECTIVES

1) Briefly review the principles of Dual Energy CT/Spectral imaging. 2) Review virtual non-contrast imaging, iodine mapping, material decomposition, and monoenergetic imaging. 3) Review cases demonstrating abdominal organ perfusion and oncologic applications in the abdomen. 4) To outline novel applications of dual energy CT in assessing bone marrow edema, gout, ligament/tendon analysis and metal artifact reduction. 5) To outline novel techniques using Dual Energy CT in pulmonary embolism, cardiac ischemia assessment. 6) Review DECT/spectral imaging applications in the brain.

Sub-Events

RCS17A  How to Successfully Implement a Dual-energy CT in Your Practice?

Participants
Savvas Nicolaou, MD, Vancouver, BC (Moderator) Institutional research agreement, Siemens AG; Stockholder, Canada Diagnostic Centres

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LEARNING OBJECTIVES

1) To learn the tips and tricks to make a dual-energy CT implementation successful. 2) To recognize the potential barriers in implementation of dual-energy CT in your practice.

RCS17B  Practical Multi-energy Applications of the Cardiothoracic System

Participants
Prabhakar Rajiah, MD, FRCR, Dallas, TX (Presenter) Nothing to Disclose

LEARNING OBJECTIVES

1) To describe the different implementations of multi-energy CT technology. 2) To discuss the updates on the utility of multi-energy CT in cardiothoracic imaging. 3) To review the applications of multi-energy CT in cardiothoracic imaging.

RCS17C  Novel and Emerging Neuroradiology Multi-energy Applications

Participants
Aaron D. Sodickson, MD,PhD, Boston, MA (Presenter) Institutional research agreement, Siemens AG; Speaker, Siemens AG; Speaker, General Electric Company

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LEARNING OBJECTIVES

1) Review Dual Energy CT fundamentals and post-processing applications. 2) Demonstrate the utility of Dual Energy CT to add value in neuro imaging, including pathology detection, lesion characterization, diagnostic confidence, and reduced length-of-stay.

RCS17D  Dual-energy/Spectral CT of the Abdomen: Making a Difference

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

LEARNING OBJECTIVES

1) Apply strategies of dual energy CT for streamlined characterization of incidentally detected intra-abdominal abnormalities such as hepatic steatosis, adrenal adenomas, and renal lesions. 2) Develop and utilize post processing techniques that improve detection and identification of clinically relevant imaging features of abdominal tumors. 3) Understand limitations and compare workflow differences among major dual/multienergy scanning systems for abdominal applications.
Participants
Fabio Becce, MD, Lausanne, Switzerland (Presenter) Research Consultant, Horizon Pharma USA, Inc; Confidentiality Agreement, MARS Bioimaging Ltd

LEARNING OBJECTIVES

1) Comprehend the basic principles and technical aspects of dual- and multi-energy CT when imaging the musculoskeletal system.
2) Apply dual-energy CT when assessing various musculoskeletal disorders, from crystal-related arthropathies to bone marrow edema.
3) Identify potential new applications of dual-energy CT in musculoskeletal imaging, such as CT arthrography and iron-related disorders.
Participants
A. Orlando Ortiz, MD, MBA, Bronx, NY (Presenter) Nothing to Disclose
Bassem A. Georgy, MD, San Diego, CA (Presenter) Consultant, Merit Medical Systems, Inc; Consultant, Medtronic plc; Stockholder, Spine Solutions, Inc
Allan L. Brook, MD, Bronx, NY (Presenter) Nothing to Disclose
Todd S. Miller, MD, White Plains, NY (Presenter) Nothing to Disclose
Afshin Gangi, MD, PhD, Strasbourg, France (Presenter) Consultant, AprioMed AB
Stefano Marcia, MD, Cagliari, Italy (Presenter) Consultant, Techlamed Srl; Consultant, Vexim SA; Consultant, Spineart; Consultant, Stryker Corporation
Amish H. Doshi, MD, New York, NY (Presenter) Speaker, Merit Medical Systems, Inc

For information about this presentation, contact:
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LEARNING OBJECTIVES
1) Discuss appropriate algorithms for patient selection. 2) Review anatomic and technical considerations for vertebral augmentation.
3) Present an update of the recent advances in vertebral augmentation including sacroplasty. 4) Emphasize safety issues and how to avoid complications. 5) Understand the applications of vertebral augmentation in osteoporotic and neoplastic spine pathology. 6) Update participants with respect to advances in equipment and biomaterials.

ABSTRACT
1. Patient selection for vertebral augmentation Indications and Contraindications 2. New devices and techniques in vertebral augmentation 3. Vertebral augmentation for osteoporotic and pathologic vertebral compression fractures 4. Sacroplasty (sacral augmentation) 5. Complications avoidance 6. Efficacy Vertebral augmentation is an image-guided (fluoroscopy or CT) percutaneous procedure in which a bone needle is inserted into a painful osteoporotic or pathologic fracture within the spinal axis. Biopsy, cavity creation or lesion ablation may then be performed under imaging guidance depending on the nature of the pathology that is being treated. Subsequently a radiopaque implant, usually an acrylic bone cement, is carefully injected into the vertebra or sacral ala under imaging guidance, These procedures have been shown to provide pain relief by stabilizing the fractured vertebra or sacrum. As with any other invasive procedure, they carry a small risk (<1%) of complication including bleeding, infection, neurovascular injury, or cement embolus. Appropriate patient selection and a detailed understanding of the technical aspects of the procedure along with active clinical patient follow-up are paramount to a successful outcome. This workshop will utilize short lectures, case examples and interactive audience participation in order to further explore critical topics in vertebral augmentation.

Printed on: 01/19/20
Case-based Review of Pediatric Radiology (Interactive Session)

Wednesday, Dec. 4 10:30AM - 12:00PM Room: E450B

Participants
Edward Y. Lee, MD, Boston, MA (Director) Nothing to Disclose

Sub-Events

**MSCP42A Pediatric Spine Disorders**

Participants
Anna A. Kashgari, MD, Riyadh, Saudi Arabia (Presenter) Nothing to Disclose

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LEARNING OBJECTIVES
1) Review normal development of the spinal column and spinal neuralaxis. 2) Describe in the imaging finding in spondylodysplasias. 3) Review spinal Dysraphism classification.

ABSTRACT
The normal development and variations of the pediatric spinal column will be discussed. Differentiating acquired from congenital spine and spinal cord pathologies using a case based approach.

**MSCP42B Pediatric Pulmonary Disorders**

Participants
Abbey Winant, MD, Boston, MA (Presenter) Spouse, Research Grant, Bristol-Myers Squib Company; Spouse, Research Grant, Novartis AG; Spouse, Research Consultant, Tango Therapeutics

ABSTRACT
Congenital and acquired pediatric pulmonary cases will be presented. Discussion will include: 1) description of the imaging features for each condition, 2) tips for differentiating between conditions with similar imaging findings, 3) up-to-date recommendations for management and follow-up for each condition.

**MSCP42C Pediatric Gastrointestinal Disorders**

Participants
Emilio Inarejos Clemente, MD, Barcelona, Spain (Presenter) Nothing to Disclose

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emilioinarejos@gmail.com

LEARNING OBJECTIVES
1) Identify the most relevant imaging findings for each entity. 2) Define imaging key features of each condition to establish a correct diagnosis. 3) State a reasonable differential diagnosis of each case.

ABSTRACT
Congenital and acquired pediatric gastrointestinal cases will be explained. Each case will include a brief overview with its corresponding differential diagnosis.

**MSCP42D Pediatric Musculoskeletal Disorders**

Participants
Michael Francavilla, MD, Philadelphia, PA (Presenter) Nothing to Disclose

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ABSTRACT
A series of pediatric musculoskeletal cases will be presented to illustrate: 1- Characteristic appearances of lower extremity MSK disorders 2- Neoplasms favoring the tibia 3- Hip disorders characteristic of children

Printed on: 01/19/20
MSSR42A  
Sports-related Injuries of the Knee: What Does the Orthopedic Surgeon Need to Know?

Participants  
Andrew J. Grainger, MD, Leeds, United Kingdom (Moderator) Consultant, Levicept Ltd; Director, The LivingCare Group;  
Laura W. Bancroft, MD, Venice, FL (Moderator) Author with royalties, Wolters Kluwer nv; Editor, Thieme Medical Publishers, Inc;  
Travel support, Thieme Medical Publishers, Inc ; ;  

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LEARNING OBJECTIVES
1) To appreciate common patterns of athletic injury in the knee. 2) To become familiar with the techniques available and imaging appearances of knee, foot and ankle athletic injury. 3) To consolidate the knowledge gained from the session with interactive cases of lower limb athletic injury.

ABSTRACT

Cases will be presented with the opportunity for audience response highlighting and consolidating ideas presented in the preceding lecture. Abstract for that Lecture: Ankle injuries are common in many sports, and the complicated anatomy of the ankle joint can be challenging the reporting radiologist. The ankle joint itself is a synovial hinge joint, but important movement for ankle function also occurs at the joints of the hind and midfoot which are also susceptible to injury. In addition to conventional radiographs, CT, MRI and ultrasound all have important roles to play in the diagnosis of foot and ankle injuries in the athlete. The ligamentous and tendon structures about the ankle are generally superficial in nature and readily amenable to assessment with ultrasound where assessment can be enhanced due to the dynamic capabilities of the technique. While MRI also demonstrates these structures, it has advantages for assessing deeper joint structures such as the chondral surfaces and bones. The complex 3d anatomy of the foot and ankle means that conventional radiographs can struggle to demonstrate bone injury which means CT also has an important role to play. This lecture will focus on the use of these imaging modalities for the assessment of acute and chronic ligamentous and tendon injury. Emphasis will be put on the mechanisms of injury and how they determine the resultant patterns of injury and the imaging appearances.

MSSR42B  
Multimodality Imaging of the Foot and Ankle Injuries in the Athlete

Participants  
Andrew J. Grainger, MD, Leeds, United Kingdom (Presenter) Consultant, Levicept Ltd; Director, The LivingCare Group;  

LEARNING OBJECTIVES
1) To appreciate the different and often contributory roles that imaging modalities have in the foot and ankle. 2) To recognize the most common ligamentous and tendon injuries in the ankle. 3) To understand how common patterns of injury relate to the mechanisms involved.

ABSTRACT

Abstract: Ankle injuries are common in many sports and the complicated anatomy of the ankle joint can be challenging the reporting radiologist. The ankle joint itself is a synovial hinge joint, but important movement for ankle function also occurs at the joints of the hind and midfoot which are also susceptible to injury. In addition to conventional radiographs, CT, MRI and ultrasound all have important roles to play in the diagnosis of foot and ankle injuries in the athlete. The ligamentous and tendon structures about the ankle are generally superficial in nature and readily amenable to assessment with ultrasound where assessment can be enhanced due to the dynamic capabilities of the technique. While MRI also demonstrates these structures, it has advantages for assessing deeper joint structures such as the chondral surfaces and bones. The complex 3d anatomy of the foot and ankle means that conventional radiographs can struggle to demonstrate bone injury which means CT also has an important role to play. This lecture will focus on the use of these imaging modalities for the assessment of acute and chronic ligamentous and tendon injury. Emphasis will be put on the mechanisms of injury and how they determine the resultant patterns of injury and the imaging appearances.

MSSR42C  
Interactive Case Discussion

Participants  
Andrew J. Grainger, MD, Leeds, United Kingdom (Presenter) Consultant, Levicept Ltd; Director, The LivingCare Group;  
Theodore T. Miller, MD, New York, NY (Presenter) Nothing to Disclose

LEARNING OBJECTIVES
1) To appreciate common patterns of athletic injury in the knee. 2) To become familiar with the techniques available and imaging appearances of the knee, foot and ankle athletic injury. 3) To consolidate the knowledge gained from the session with interactive cases of lower limb athletic injury.

ABSTRACT

Cases will be presented with the opportunity for audience response highlighting and consolidating ideas presented in the preceding lecture. Abstract for that Lecture: Ankle injuries are common in many sports, and the complicated anatomy of the ankle joint can be challenging the reporting radiologist. The ankle joint itself is a synovial hinge joint, but the important movement for ankle
function also occurs at the joints of the hind and midfoot which are also susceptible to injury. In addition to conventional radiographs, CT, MRI and ultrasound all have important roles to play in the diagnosis of foot and ankle injuries in the athlete. The ligamentous and tendon structures about the ankle are generally superficial in nature and readily amenable to assessment with ultrasound where assessment can be enhanced due to the dynamic capabilities of the technique. While MRI also demonstrates these structures, it has advantages for assessing deeper joint structures such as the chondral surfaces and bones. The complex 3d anatomy of the foot and ankle means that conventional radiographs can struggle to demonstrate bone injury which means CT also has an important role to play. This lecture will focus on the use of these imaging modalities for the assessment of acute and chronic ligamentous and tendon injury. Emphasis will be put on the mechanisms of injury and how they determine the resultant patterns of injury and imaging appearances.
**SSK14**

**Augmented Reality and Artificial Intelligence-Based Navigation during Percutaneous Vertebroplasty**

**Wednesday, Dec. 4 10:30AM - 10:40AM Room: E353A**

**Participants**
Kenneth S. Lee, MD, Madison, WI (Moderator) Grant, General Electric Company; Grant, National Basketball Association; Grant, Johnson & Johnson; Research support, SuperSonic Imagine; Royalties, Reed Elsevier
Adam C. Zoga, MD, Philadelphia, PA (Moderator) Nothing to Disclose

**Sub-Events**

**SSK14-01**  
**Augmented Reality and Artificial Intelligence-Based Navigation during Percutaneous Vertebroplasty**

**Wednesday, Dec. 4 10:30AM - 10:40AM Room: E353A**

**Participants**
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Julien Garnon, MD, Strasbourg, France (Abstract Co-Author) Proctor, Galil Medical Ltd
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**PURPOSE**
To assess technical feasibility, accuracy, safety and patient radiation exposure of a novel navigational tool integrating augmented reality (AR) and artificial intelligence (AI), during percutaneous vertebroplasty of patients with vertebral compression fractures (VCFs).

**METHOD AND MATERIALS**
This retrospective study compared the trans-pedicular access phase of percutaneous vertebroplasty between two groups of 50 patients with symptomatic single-level VCFs. Trocar insertion was performed using AR/AI-guidance with motion-compensation in Group A, and standard fluoroscopy in Group B. Technical feasibility was recorded for Group A. Accuracy of trocar placement (distance between planned/actual trajectory on sagittal/coronal fluoroscopic-images); complications; time for trocar deployment; and radiation dose/fluoroscopy-time were recorded and compared between group A and B.

**RESULTS**
Technical feasibility in Group A was 100%. Time for trocar deployment was significantly longer in Group A (642 ± 210s) than Group B (336 ± 60s; p= 0.001). Dose-Area Product and fluoroscopy-time were significantly lower in Group A (160.9 ± 220 mGy.cm² and 5.2 ± 3.4) than Group B (298.2 ± 190.2 mGy.cm² and 9.97 ± 4.8s; p=0.019 and 0.001), respectively. Time for trocar deployment was significantly longer in Group A (538 ± 182s) than Group B (374 ± 182s; p= 0.001). Accuracy measures for each group are ongoing. No complications were observed in the entire population.

**CONCLUSION**
AR/AI-guided percutaneous vertebroplasty appears feasible, accurate and safe, and facilitates lower patient radiation exposure compared to standard fluoroscopic-guidance.

**CLINICAL RELEVANCE/APPLICATION**
AR/AI-guided percutaneous vertebroplasty allows lower patient/operator radiation exposure compared to standard fluoroscopic-guidance.

**SSK14-02**  
**Short and Long Term Outcomes of Image-Guided Retrocalcaneal Bursal Injections**

**Wednesday, Dec. 4 10:40AM - 10:50AM Room: E353A**

**Participants**
Sean Boone, MD, Bronx, NY (Presenter) Nothing to Disclose
Robert B. Uzor, MRCS, MD, Yonkers, NY (Abstract Co-Author) Nothing to Disclose
Elisabeth Elsinger, Bronx, NY (Abstract Co-Author) Nothing to Disclose
Eric Walter, Bronx, NY (Abstract Co-Author) Nothing to Disclose
Dominic Catanese, Bronx, NY (Abstract Co-Author) Nothing to Disclose
The risks of postoperative hemorrhage or complication following image-guided BMAB are not significantly different in patients with

**CONCLUSION**

patients more likely to receive transfusion. There was a significant difference in transfusion at 30 days with thrombocytopenic and severely thrombocytopenic

levels pre and post procedure between the three groups. 6 patients (1 severely thrombocytopenic, 2 thrombocytopenic, and 2

There was no significant difference in diagnostic yield, CT identified post-procedural hematoma, or the hemoglobin and hematocrit

independently reviewed by 2 fellowship trained radiologists for the presence or absence of subcutaneous fat stranding superficial to

30 and 90 days

the biopsy site or post-procedural hematoma, graded 1 to 4. Discrepancies were resolved by consensus review.

RESULTS

263 injections were performed. 240 injections (167 US, 73 FL) in 194 heels had at least 6 months of follow-up (range 190-1919
days): 160 female; mean age 54.5 (range 30-86); 90 right heel. Insertional AT and RC bursitis was present in 100% (263/263) and

15 patients, average 11.8 platelets/mm3; thrombocytopenia (20-50 platelets/mm3) 16 BMAB in 15 patients, average 30.1

BMAB. These 94 patients were subdivided based on their platelet count: severe thrombocytopenia (<20 platelets/mm3) 16 BMAB in

METHOD AND MATERIALS

After IRB approval, consecutive FL and US guided RC bursa injections were retrospectively reviewed (2013-2019). Pre-procedure

US images were scored by 2 blinded MSK Radiologists in consensus for degree (scale 0-3) of Achilles tendinopathy (AT) and RC

rupture or high-grade tear occurred 15-79 days post- procedure. Four cases of Achilles

were lost to follow-up. There was no significant difference in complication rate or all-cause mortality at 30 and 90 days

post procedure. There was a significant difference in transfusion at 30 days with thrombocytopenic and severely thrombocytopenic

patients more likely to receive transfusion.

CONCLUSION

Image-guided RC bursa injections yielded significant short term pain score reduction (p<0.00001). Subsequent Achilles high grade
tear or rupture was infrequent (1.5%).

CLINICAL RELEVANCE/APPLICATION

This is the first report on both short and long-term outcomes of image-guided retrocalcaneal bursa steroid injection, and is the

largest (n=240) patient cohort studied for this procedure.

**SSK14-03  Safety and Efficacy of Bone Marrow Aspirate and Biopsy in Severely Thrombocytopenic Patients**

Participants

James D. Stensby, MD, Columbia, MO (Presenter) Nothing to Disclose
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Jack W. Jennings, MD, Saint Louis, MO (Abstract Co-Author) Speakers Bureau, Merit Medical Systems, Inc; Consultant, Merit
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Bard, Inc

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PURPOSE

To assess the safety and efficacy of fluoroscopically guided drill assisted bone marrow aspirate and biopsy in severely

thrombocytopenic patients.

METHOD AND MATERIALS

This retrospective study received IRB approval with a waiver of patient informed consent. From January 2013 through December

2016 a total of 739 bone marrow aspirate and biopsy (BMAB) procedures were performed at a single institution under the direct

supervision of a fellowship trained musculoskeletal radiologist using fluoroscopic guidance and a drill-assisted needle. Of these

patients 111 BMAB were performed in 94 patients who received a CT scan of the pelvis and biopsy site within 7 days following the

BMAB. These 94 patients were subdivided based on their platelet count: severe thrombocytopenia (<20 platelets/mm3) 16 BMAB in

15 patients, average 11.8 platelets/mm3; thrombocytopenia (20-50 platelets/mm3) 16 BMAB in 15 patients, average 30.1

platelets/mm3; and control (>50 platelets/mm3) 79 BMAB in 64 patients, average 213.1 platelets/mm3. The procedure report was

reviewed for specimen adequacy; pathologic diagnosis; body mass index; pre and post procedure labs including platelet count, HGB,
HCT, PT, and INR levels; post-procedural transfusion; and complications including mortality at 30 and 90 days. CT scans were

independently reviewed by 2 fellowship trained radiologists for the presence or absence of subcutaneous fat stranding superficial to

the biopsy site or post-procedural hematoma, graded 1 to 4. Discrepancies were resolved by consensus review.

RESULTS

There was no significant difference in diagnostic yield, CT identified post-procedural hematoma, or the hemoglobin and hematocrit

levels pre and post procedure between the three groups. 6 patients (1 severely thrombocytopenic, 2 thrombocytopenic, and 2

control) were lost to follow-up. There was no significant difference in complication rate or all-cause mortality at 30 and 90 days

post procedure. There was a significant difference in transfusion at 30 days with thrombocytopenic and severely thrombocytopenic

patients more likely to receive transfusion.

CONCLUSION

The risks of postoperative hemorrhage or complication following image-guided BMAB are not significantly different in patients with
severe thrombocytopenia and control.

**CLINICAL RELEVANCE/APPLICATION**

Image guided BMAB is a procedure that can be safely performed in patients with severe thrombocytopenia.

**SSK14-04 Utility of CT-Guided Percutaneous Rib Biopsy and Factors Affecting Diagnostic Yield**

**Wednesday, Dec. 4 11:00AM - 11:10AM Room: E353A**

**Participants**
Nicholas Q. Vu, MD, Pittsburgh, PA (Presenter) Nothing to Disclose
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**PURPOSE**

To determine the utility of CT-guided percutaneous rib biopsy and factors that affect diagnostic yield

**METHOD AND MATERIALS**

We retrospectively reviewed percutaneous CT-guided rib biopsies performed in a large academic medical center from 2008-2017 (n=88). Patient demographics, nuclear imaging studies, CT imaging features, biopsy technique (FNA and/or core), performing radiologist, periprocedural complications and pathology results were recorded. CT imaging feature categorization included lesion matrix (sclerotic, lytic or mixed), lesion size (>≤2cm), presence of bony destruction, and presence of an associated soft tissue mass. Overall diagnostic yield was calculated from the number of diagnostic biopsies over total number of biopsies. Diagnostic yield was also calculated for subgroups stratified by patient demographics, technique, presence of prior nuclear imaging, CT imaging features and pathology results. All variables were compared between diagnostic and non-diagnostic samples using chi-square test. Multivariate logistic regression was performed to determine factors which predicted biopsy outcome.

**RESULTS**

The overall diagnostic yield was 92.0%. No complications were noted. The diagnostic yield was significantly different depending on lesion matrix (95.5% for lytic, 91.7% for mixed, and 66.7% for sclerotic, p=0.011), the presence of an associated soft tissue mass (96.7% versus 81.5%, p=0.044), and size of the lesion (97.1% versus 73.7% for larger versus smaller lesions, p=0.004). The diagnostic yield for various subgroups is listed in table 1 (See attached). Multivariate logistic regression demonstrated a statistically significant result for lesion size when adjusting for other covariates (lesion matrix, soft tissue component and prior nuclear medicine study). Biopsies of large lesions predicted a diagnostic result (Odds ratio 8.91, p=0.04).

**CONCLUSION**

Percutaneous rib biopsy utilizing CT-guidance is a safe and effective procedure with a high diagnostic yield. The diagnostic yield is higher for lytic than sclerotic lesions, lesions with an associated soft tissue mass, and large lesions. Multivariate analysis shows that the lesion size affects diagnostic yield. Larger lesions resulted in a higher diagnostic yield than smaller lesions.

**CLINICAL RELEVANCE/APPLICATION**

CT-guided percutaneous rib biopsy results in a high diagnostic yield particularly for large lytic osseous lesions with an associated soft tissue mass.

**SSK14-05 Efficacy and Outcome of Repeat Epidural Steroid Injection for Partially Responded Lumbar HIVD Patients under "Wait-And-See" Policy as a Pain Management Option**

**Wednesday, Dec. 4 11:10AM - 11:20AM Room: E353A**

**Participants**
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**PURPOSE**

To evaluate efficacy of epidural steroid injection (ESI) under 'wait-and-see (WaS)' policy, based on 1-year clinical outcome of responded lumbar herniated intervertebral disc (HIVD) patients to initial ESI

**METHOD AND MATERIALS**

592 lumbar HIVD patients received steroid injection from Jan 2017 to Dec 2017 in our institution. The cohort was managed pain and follow up for 1-year under 'WaS' policy to performed repeated ESI under close observation of initial injection response without prescheduled ESI session within 3 weeks, that is performed in our routine clinical practice. 3-week and 1-year telephone interview and medical record review was conducted for residual symptom, total injection number, operating status. After excluding patients with complete response without residual pain or no response with over 70% residual symptom in 3-week pain assessment, 141 responded patients comprised our study population. We divided patients into 2 groups: WaS group (n=124) and early repeat ESI, which repeat ESI within 3weeks (early ESI, n=17) group. Evaluations of characteristics and outcome results were performed chi-squared or independent Student t-test.
RESULTS
Six patients (4.8%) of WaS group and one patient (5.9%) of early ESI group underwent operation within 1 year (P = 0.853). All operations were undergone for patients with poor response that is >=50% residual symptom. Mean 1.52±0.82 session of ESIs were performed for WaS group and 2.29±0.47 session of ESIs were performed for early ESI group during follow-up period (P=0.000). 78 patients (62.9%) of WaS group could control pain with a single ESI during 1 year, though one underwent surgery at outside hospital. Time interval between first and second ESI (97.15 vs. 15.47 days, P = 0.000) and between second and third ESI (80.43 vs. 50.40 days, P = 0.395) is longer in WaS than early ESI group.

CONCLUSION
“Wait-and-see” policy could be an effective pain management option for lumbar HIVD patients with response to initial ESI. Moreover, effective option for avoiding unnecessary repeat ESI and delaying repeat injection point.

CLINICAL RELEVANCE/APPLICATION
Intermittent ESI for responded lumbar HIVD patients under ‘wait-and-see’ policy could reduce medical cost and side effect related steroid injection by avoiding unnecessary repeat ESI and delaying repeat ESI point.

SSK14-06 Cryoablation for Advanced and Refractory Desmoid Tumors: A Promising Treatment?

Participants
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PURPOSE
To assess efficacy and safety of percutaneous cryoablation (CA) for advanced and refractory extraabdominal desmoid tumors

METHOD AND MATERIALS
This retrospective study reviewed 31 consecutive patients with painful desmoid tumors (EVA>5) evolving despite well-managed medical treatment treated by CA between 2007 and 2019. Pain reduction, progression free survival (PFS) (clinical or radiographics), tumor shrinkage rate (TSR) (volume of the tumor at 1 and 3 years compared to the volume before treatment) and complications were collected. Clinical efficacy of treatment was defined by VAS<3 after CA. Kaplan Meier method was used to outline PFS. Paired sample t-test was used to compare volume of tumors before treatment and at 1 year and 3 year.

RESULTS
With a median follow-up of 30 months (range 1- 98 months, IQR: 8-54), the PFS was 82.6% (CI95%: 69.2, 95.9) at 1 year and 75.7% (CI95%: 60.6, 90.8) at 3 years. Clinical efficacy of treatment was obtained for 89.6% (CI 95%: 78.6,100) of patients. Median volume of desmoid tumor before treatment was 92.4mL (range 2.1-1727.9 mL, IQR: 49.7- 298.5). TSR was 48.2% (CI95%: 37.2, 72.3; p=0.002) at 1 year and 74,4% (CI95%: 59.1, 89.8; p=0.002) at 3 year. Thermo protective measures for critical structures closed to the tumor were used in 74,2% of cases. Five patients (16.2%) required 2 sessions of CA for total control. Adverse events rate was 31.2%, the most common was oedema and temporary increase of pain in the days following CA.

CONCLUSION
CA is an effective treatment for advanced and refractory extraabdominal desmoid tumor, that induces durable responses. Safety profile is acceptable but requires a good mastery of protective measures for surrounding organs.

CLINICAL RELEVANCE/APPLICATION
Among patients with progressive, refractory and symptomatic desmoid tumors, CA is an effective treatment that induces durable responses.

SSK14-07 CT-Guided Bone Marrow Aspirations and Biopsies: Retrospective Review and Comparison with Blind Procedures

Participants
Connie Y. Chang, MD, Boston, MA (Presenter) Nothing to Disclose
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PURPOSE

To assess the added value, if any of performing bone marrow aspirations and biopsies with CT-guidance

METHOD AND MATERIALS

76 consecutive CT-guided and 70 blind bone marrow aspirations and biopsies performed January to October 2017 were reviewed. All CT-guided biopsies were performed with the same 11 gauge battery-power drill-assisted device. Blind biopsies were performed with either the 11 gauge battery-powered drill-assisted device or a 13 gauge manual device. Pathology reports were reviewed for adequacy of smears and biopsies (categorized as adequate, suboptimal, and not adequate), and core and core volume. Patient age, gender, and body mass index (BMI), core length, core volume, procedure diagnosis, and diagnosis were compared by T-tests with \( P < 0.05 \) considered statistically significant.

RESULTS

There was no significant difference between the age (CT: 67 ± 14, range 26-93 years; blind: 63 ± 13, range 23-85 years; \( P = 0.1 \)), BMI (CT: 29 ± 6, range 18-46; blind: 27 ± 5, range 19-42; \( P = 0.1 \)), and biopsy site (CT 42 left ilium, 34 right ilium; blind: 27 left ilium, 41 right ilium, 2 not specified; \( P = 0.8 \)) between the CT-guided and blind biopsies. The blind biopsy group (48 M, 22 F) had a higher proportion of male patients than the CT-guided biopsy group (38 M, 38 F) (\( P = 0.02 \)). More CT-guided aspirate smears than blind aspirate smears were categorized as adequate (CT: 72 (97%) adequate, 2 (3%) suboptimal, 0 inadequate, 1 not obtained; blind: 58 (85%) adequate, 5 (7%) suboptimal, 5 (7%) inadequate, 2 not obtained) (\( P = 0.02 \)). More CT-guided biopsy samples than blind biopsy samples were categorized as adequate (CT: 72 (95%) adequate, 4 (5%) suboptimal, 0 inadequate; blind: 54 (77%) adequate, 9 (13%) suboptimal; 7 (10%) inadequate) (\( P = 0.002 \)). The CT-guided biopsies had a longer core length (CT: 1.3 ± 0.6, range 0-3.5 mm; blind: 1.0 ± 0.5, range 0-2.6 mm; \( P = 0.001 \)) and a higher core volume (CT: 0.05 ± 0.03, median 0.03, range 0-0.2 mm³; blind: 0.05 ± 0.05, median 0.04, range 0-0.3 mm³; \( P = 0.04 \)).

CONCLUSION

CT-guided bone marrow procedures were more likely to result in an adequate smear aspirate and biopsy sample and yielded longer cores with higher core volumes.

CLINICAL RELEVANCE/APPLICATION

CT guidance is helpful in bone marrow procedures. Further studies should be performed to study the cost effectiveness of routine CT guidance, and also to define the situations in which CT guidance should be used for marrow biopsies.

SSK14-08 Safety and Efficacy of Image Guided Radiofrequency Ablation of Genicular Nerve for Pain Management in Patients with Moderate to Severe Osteoarthritis of the Knee: Initial Single Institution Experience

Wednesday, Dec. 4 11:40AM - 11:50AM Room: E353A

Participants

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PURPOSE

To analyze the safety and efficacy of image-guided genicular nerve radiofrequency ablation (RFA) for the treatment of pain in non-surgical candidates with moderate to severe knee osteoarthritis (OA)

METHOD AND MATERIALS

In an IRB approved prospective study, 44 consecutive patients with pain from moderate to severe knee OA refractory to anti-inflammatory analgesia and failed multiple intraarticular lidocaine-steroid injections who underwent RFA of genicular nerves were included. All patients initially underwent anesthetic blocks of the superior medial/lateral and inferior medial genicular nerve branches and experienced great short-term pain relief of >6 points out a 10 scale. Radiofrequency ablation of the same nerve branches were performed 1-2 weeks after nerve block. Efficacy of the treatment was evaluated using the Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC) and Knee Injury and Osteoarthritis Outcome Score (KOOS) to assess overall symptoms, stiffness, pain, and functional daily living pre block/ablation.

RESULTS

A total of 53 knees were treated in 44 patients. The average age of the patients was 66 +/- 15.8 years. Mean follow-up time was 2 weeks, 1 and 3 months. No procedure related complication was identified. The mean total KOOS score (out of 100) improved significantly from baseline at 26.9 to 62.7 3months post treatment (\( p<0.001 \)). Sub-analysis of the pain component of the KOOS questionnaire demonstrated significant improvement in mean overall symptoms score from 14.7 to 39.6 (\( p<0.001 \)). Mean stiffness score improved from 39.5 to 61 (\( p=0.001 \)) and mean pain score from 26.5 to 55.3 (\( p<0.001 \)). There was also significant improvement in the functional daily living limitations with mean baseline score of 27.6 and 3 month post therapy score of 53 (\( p<0.001 \)). There was a greater number of patients with Grade III (n=34) and grade IV (n=10) arthritis according to the Kellgren-Lawrence classification.

CONCLUSION

Image-guided radiofrequency ablation of genicular nerves is a safe treatment option with good short-term outcome in patients...
Cooled RFA of the ginicular proves a safe way to treat knee arthritis pain.

SSK14-09  Minding the Gap: Vertebral Body Fracture Clefts and What They Mean for Post-Vertebroplasty Outcomes

Wednesday, Dec. 4 11:50AM - 12:00PM Room: E353A

Participants
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Mary Kristen Jesse, MD, Aurora, CO (Abstract Co-Author) Faculty, Medtronic plc

PURPOSE
Percutaneous vertebroplasty/kyphoplasty has been documented as a safe and effective treatment for vertebral body fractures. Because cement nonunion is a documented cause of failed vertebral cement fixation, we focus on how pre-procedural fracture cleft morphology and procedural cement filling may be associated with the development of nonunion and furthermore how this may affect patient outcomes.

METHOD AND MATERIALS
Retrospective review of 296 patients (172 women, 124 men) who underwent vertebroplasty/kyphoplasty for compression fractures. Variables included pre-procedure CT/MRI cleft presence and morphology, pain improvement, underlying pathology, fracture level, morphology of cement fill, and postprocedure non-union. Statistical analysis was performed utilizing ordinal logistic regression, logistic regression, Fisher’s exact, and conditional t-tests of proportions, with significance level set to 0.05.

RESULTS
Majority of patients with non-union cement fill (75%) demonstrated large cleft morphology. The presence of a fracture cleft resulted in an 4.981 odds ratio of non-union and odds of cleft presence is 5.195 times higher for non-union (95% CI: 1.636, 20.157). There was a significant association between non-union cement fill and cleft-only fill (p<0.0001). Patients with secondary osteoporosis had 2.831 higher odds of cleft (95% CI: 1.119, 7.299). Odds of cleft presence was 1.029 times higher for each one year increase in age (95% CI: 1.119, 7.299). The presence of a vertebral cleft did not significantly alter pain relief outcomes.

CONCLUSION
Because risk of cement non-union increases with increasing age, secondary osteoporosis, size of the fracture clefts, and cleft-only cement fill, we should pay special attention when these variables are present to adjust our procedure protocol and expectation. The presence of a cleft should not deter the decision to proceed with vertebroplasty/kyphoplasty, as pain relief was not significantly altered; however added attention to increasing trabecular fill during the procedure is warranted to decrease the risk of non-union.

CLINICAL RELEVANCE/APPLICATION
Advanced age, secondary osteoporosis, cleft size, and cleft-only cement fill should be considered when setting vertebroplasty protocol and expectation. Increasing trabecular fill is optimal.

Printed on: 01/19/20

**PURPOSE**
To evaluate T2 values of glenoid and humeral cartilage in patients with labral tear, including SLAP and Bankart lesions. To investigate the correlation between the T2 values of cartilage of GHJ according to different locations and frequency of dislocation, location, and extent of labral tears.

**METHOD AND MATERIALS**
IRB approval was obtained and informed consent was obtained for this prospective study. From November 2016 to July 2018, we prospectively obtained and analyzed 30 unilateral shoulder MRIs with T2 mapping in patients with suspected labral tears. T2 values of cartilage were measured dividing the glenoid and humeral side into 9 areas as antero-superior, antero-central, antero-inferior, central-superior, central-central, central-inferior, postero-superior, postero-central, postero-inferior and measured twice by two radiologists. Intra- and interobserver agreements were calculated by using the intraclass correlation coefficient (ICC). Labral tears were classified according to location and extent as follows: SLAP II (variants included), SLAP V, VIII, inferior labral tear, circumferential labral tear. The correlation was analyzed using independent student T test and ANOVA test.

**RESULTS**
Inter-observer agreement of MRI using T2 mapping value of cartilage was moderate (glenoid; 0.612, humerus; 0.530), intra-observer agreement was good (glenoid; 0.763, humerus; 0.866). Location and extent of labral tears showed a tendency to correlate with T2 values at glenoid cartilage although no statistically significant correlation was found. No significant association existed between the frequency of shoulder dislocation and T2 values of cartilage.

**CONCLUSION**
Cartilage T2 values of glenohumeral joint cartilage showed good agreement regarding reproducibility; however, there was neither significant correlation with location and extent of labral tears and nor frequency of dislocation.

**CLINICAL RELEVANCE/APPLICATION**

**Radiomics and Machine Learning May Accurately Preoperatively Be Predicting the Histopathological Grades of Soft Tissue Sarcomas Based on Multiparametric MRI**

**PURPOSE**
Preoperative prediction of the Soft tissue sarcomas (STSs) grade is important due to it affect the treatment plan. The purpose of our study was to assess the value of radiomics features in the distinguishing of histological grades of STSs.

**METHOD AND MATERIALS**
Eighty patients (18 low-grade [grade I]; 62 high-grade [grade II and III]) with STSs, who underwent T1WI and fat-suppressed T2WI were enrolled in the discovery set. The T1WI and fat-suppressed T2WI were analyzed to derive volume-based data of the entire tumor. Radiomics features were related to histological grades of STSs. Multiple machine learning methods were trained to establish classification models to predict STSs grades. We validated the model in a validation set (33 patients; 7 low-grade; 26 high-grade).
RESULTS

The machine learning method showed different performances based on the machine learning algorithms. The best classification model for the prediction of STSs grades had an area under the curve of 0.9615 (95% confidence interval [CI], 0.8944-1) in the validation set. The accuracy, sensitivity, and specificity of the best method were 93.94, 96.15, and 85.71% in the validation set, respectively.

CONCLUSION

Multiparametric Radiomics feature-based machine learning method are useful for distinguishing STSs grades, which provided great effort to improve the precision of preoperative diagnosis and may affect the treatment strategies.

CLINICAL RELEVANCE/APPLICATION

Radiomics feature-based machine learning classifiers of T1WI and fat-suppressed T2WI are useful for differentiating soft tissue sarcoma grade.

MK369-SD-WEA3  Correlation Between Thoracic Vertebral Bone Strength and Quantitative Lung CT Assessment in Chronic Obstructive Pulmonary Disease Patient

Station #3

PURPOSE

Chronic obstructive pulmonary disease (COPD) is associated with extrapulmonary chronic inflammatory response, and osteoporosis is one of the critical abnormalities leading to the vertebral fractures and the deteriorate pulmonary function. The purpose of this study is to determine the value of quantitative lung CT analysis in vertebral bone strength prediction of COPD patients.

METHOD AND MATERIALS

Thirty-seven consecutive COPD patients were included in this study. They underwent CT covering the whole lung and pulmonary functional test within a month. The low-attenuation volume percentage (LAV%) (threshold between normal lung and the LAV was defined as -950HU) were calculated on CT. Pulmonary functional tests were performed after the patients had used bronchodilators. Failure load of the thoracic vertebra (Th4, Th7, and Th10), determined by the CT-based finite-element method (FEM), was used as the gold standard for bone strength. A forward stepwise multiple regression analysis for evaluating the availability of the quantitative lung CT analysis was performed. A logistic model was used with age, body mass index (BMI), smoking index, the pulmonary functional test parameters (FEV, FEV%, VC, and %VC), and the LAV%.

RESULTS

On univariate analysis, age (r=-.287), BMI (r=.283), FEV (r=.328), FEV% (r=.433), and LAV% (r=-.462) were significant independent factors for bone strength in COPD patients (p<0.01). On stepwise logistic regression analysis of all variables, LAV% was the only significant predictive factor for the failure load by CT-FEM (p<0.001).

CONCLUSION

LAV% had a significant negative correlation with bone strength in COPD patients. Lung CT quantification of emphysema can potentially be used in predicting bone strength in COPD patients in clinical practice.

CLINICAL RELEVANCE/APPLICATION

CT is widely used as a tool for assessment of the presence, pattern, and severity of COPD. Our results suggested that quantitative lung CT assessment without additional radiation exposure can provide additional information in bone strength prediction in COPD patients.

MK404-SD-WEA4  Longitudinal Change of Long Head of the Biceps Brachii Tendon on Magnetic Resonance Imaging After Rotator Cuff Repair

Station #4

PURPOSE

To determine the relationship between the alteration of long head of biceps tendon (LBT) after rotator cuff repair surgery and the immediate postoperative condition of shoulder elements on magnetic resonance (MR) images.
METHOD AND MATERIALS

Two-hundred nineteen patients (F:M=148:71; mean age, 57.4 years) who had undergone the rotator cuff repair surgery and examined postoperative MR more than twice by one year after surgery were included. The LBT was graded with 6-severity scale: normal, mild, moderate, severe intratendinous signal change, partial tear and complete tear. The deterioration of LBT was defined by increased grade or extent of the LBT abnormality between the first and second postoperative MR. To find the possible association between postoperative MR findings and LBT deterioration, the fatty degeneration of superior cuff (supraspinatus and infraspinatus muscles) and subscapularis muscle, the initial condition of LBT, subluxation of LBT, superior labral tear and adhesive capsulitis were evaluated on the initial postoperative MRI. Additionally, 63 patients (F:M=39:24; mean age, 57.3 years) with long-term follow-up MRI over 3 times, the association between preservation or improvement of LBT and the aforementioned factors were analyzed. The logistic regression was used to evaluate the association between the alteration of LBT and the postoperative factors.

RESULTS

Among total 219 patients, 48.9% (n=107) showed LBT deterioration. In univariate analysis, the fatty degeneration of superior cuff (p=.002) and subscapularis muscle (p=.026) were associated with LBT deterioration while the subluxation of LBT showed a tendency (p=.059). In multivariate analysis, only the fatty degeneration of superior cuff was significantly associated with LBT deterioration. In patients with long-term follow-up (1166.3±610.3 days), 8, 23 and 32 were improved, stable, and further deteriorated, respectively. The fatty degeneration of superior cuff and the initial condition of LBT showed significant association with long-term preservation of LBT in multivariate analysis (p=.007, p=.028), respectively.

CONCLUSION

The degree of fatty degeneration in rotator cuff is associated with the LBT deterioration on 1 year MRI follow-up, and the LBT preservation in long-term MRI follow-up.

CLINICAL RELEVANCE/APPLICATION

The degree of fatty degeneration in rotator cuff may have a predictive value for LBT status after rotator cuff repair surgery.

PURPOSE

Piriformis syndrome is a common pain condition affecting the buttock and posterior hip with or without radiation to the leg, and management of the condition involves many treatments. In this study, we hypothesize that a CT-guided injection with Botox is more effective in providing pain relief than a CT-guided injection without Botox.

METHOD AND MATERIALS

97 consecutive patients with piriformis syndrome presented for a CT-guided injection of the piriformis muscle and perineural injection of the sciatic nerve. After the injection, the patients received a visual analog scale pain log to record their pain level until the follow-up appointment. Wilcoxon-Mann-Whitney tests and Chi-square tests were used to identify potential confounders. The effect of Botox on 48-hour response and duration of response was tested using Cochran-Mantel-Haenszel (CMH) test and stratified Kaplan-Meier analysis.

RESULTS

There was no significant difference found between the patient characteristics and imaging findings in the Botox group and in the non-Botox group. At 48 hours, the patients in the Botox group were more likely to have had a positive response than patients in the non-Botox group (p=0.0046). In addition, patients who received Botox were likely to have a longer duration of response than patients who did not receive Botox (p=0.04).

CONCLUSION

In conclusion, CT-guided injections with Botox for patients with piriformis syndrome is more likely to lead to a positive response and a longer duration of response than patients who receive a CT-guided injection without Botox.

CLINICAL RELEVANCE/APPLICATION

We hope to see prospective randomized blind trials for patients with suspected piriformis syndrome, because it greatly affects patients' quality of life and ability to perform everyday activities.

PURPOSE

US Features in the Median Nerve for the Assessment of Carpel Tunnel Syndrome Using High Frequency US Imaging

Participants

Kibo Nam, PhD, Philadelphia, PA (Presenter) Equipment support, Cannon Medical Systems Corporation; Research funded, , Cannon Medical Systems Corporation
Shawn Peterson, Philadelphia, PA (Abstract Co-Author) Nothing to Disclose

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To compare the diagnostic performance of US features from the median nerve (MN) in normal volunteers and patients with Carpal Tunnel Syndrome (CTS) using high frequency US.

**METHOD AND MATERIALS**

All consented subjects of this ongoing IRB approved study were examined in the sitting position with a palm facing up using an Aplio i800 system (Cannon Medical Systems, Otawara, Japan). The cross-sectional area (CSA; in mm²) and blood flow of MN were evaluated at the wrist using an i24LX8 probe (9-24 MHz). Blood flow was assessed using Color Doppler Imaging (CDI), Power Doppler Imaging (PDI), Monochrome/Color Super Microvascular Imaging (mSMI/cSMI) with the same imaging settings for all subjects. The maximum vascular area was quantified offline by counting colored pixels (arbitrary unit) using Matlab (MathWorks, Natick, MA). Shear wave elastography (SWE) images were acquired using i18LX5 probe (4-18MHz) at the wrist. The stiffness (in kPa) of MN was quantified using a built-in software tool. T-tests and receiver operating characteristic (ROC) analysis were performed for the ultrasonic features.

**RESULTS**

To date, analysis included 20 hands in 10 normal volunteers and 9 hands in 6 patients with clinically diagnosed CTS. The MN in patients with CTS showed significant higher values in CSA (p<0.001), vascular area (CDI, p=0.001; PDI, p=0.006; mSMI, p=0.02; cSMI, p=0.001), and stiffness of MN (p=0.006) compared to those in normal volunteers. CSA (AUC, 0.91; specificity, 100%; sensitivity, 78%), vascularity from CDI (0.93; 85%; 100%), and stiffness (0.81; 80%; 89%) showed high diagnostic performance independently, albeit based on a small sample size. Additionally, the combination of these three predictors using generalized linear regression showed a specificity of 100% and a sensitivity of 89% with an AUC of 0.95.

**CONCLUSION**

US features of CSA, CDI, and stiffness of MN at the wrist showed potential to be useful for the initial assessment of CTS independently. The combination of these three predictors showed improved diagnostic performance.

**CLINICAL RELEVANCE/APPLICATION**

It may be helpful to utilize US features for the initial assessment of CTS.

**TEACHING POINTS**

Teaching points: - Sacral Anatomy: Osseous/Ligamentous, relationship with nerves/vascular structures - Sacral Masses: Classification, prevalence, age on incidence, distribution. - Key imaging features of common and uncommon sacral masses with pathologic correlation. - Biopsy Techniques to improve sampling yield in sacral masses.

**TABLE OF CONTENTS/OUTLINE**

Table of Contents/Outline: Essential Sacral Anatomy with illustrations are depicted. Sacral masses discussed with pertinent imaging and pathological findings. - Masses include, metastasis, Chordoma, Myeloma, Chondrosarcoma, Osteosarcoma, Ewing’s Sarcoma, neurofibroma. Biopsy techniques and tricks to improve sampling yield. Prognostic features of sacral masses.

**MK331-ED-WEA8**

**High Resolution Ultrasonography (US) of the Elbow Demonstrating Standard Technique and Its Variations with Emphasis on Detailed Evaluation of Ligaments, Tendons, and Nerves**

**Participants**

Shubham Shubham, MBBS, Amritsar, India (Presenter) Nothing to Disclose
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**TEACHING POINTS**

To demonstrate elbow joint ultrasonography (US) standard procedures and its variations in illustration of normal elbow joint anatomy with emphasis on detailed evaluation of ligaments, tendons and nerves.

**TABLE OF CONTENTS/OUTLINE**

1) Standard techniques for compartmental evaluation of elbow joint. 2) Anterior compartment: • Anterior joint recess • Distal biceps brachii muscle (Oblique anteromedial approach, lateral approach, cobra position) • Biceps brachii tendon (BAM sign) • Lacertus
Articular Cartilage Injury of the Knee Reporting and Data System (ACIK-RADS): A New Proposal for the Report of Cartilage Injury in the Knee by MRI

Station #9

Participants
Maria de la Luz Jimenez Camacho, MD, Mexico City, Mexico (Presenter) Nothing to Disclose
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TEACHING POINTS
1. To exemplify the current classification systems that are validated for the assessment of chondral lesions
2. To propose a new mapping system for reporting lesions of the articular cartilage of the knee, in order to improve communication with the rest of the multidisciplinary team and surgical planning.
3. To standardize radiological reports and reduce variability amongst radiologist.

TABLE OF CONTENTS/OUTLINE
NORMAL ANATOMY. Bone landmarks.
ASSESSMENT AND REPORTING Reporting Articular cartilage injury mapping system ICRS classification Step by step assessment.
CORRELATION CASES WITH EACH GRADE INJURY. POSSIBLE MISTAKEN WITH BORDERLINE CASES.

Put Your Shoulder Into It (and Elbow And Wrist For That Matter): Ultrasound-Guided Procedures of the Upper Extremity

Station #10

Participants
Corbin L. Pomeranz, MD, Philadelphia, PA (Presenter) Nothing to Disclose
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TEACHING POINTS
1. There are a range of common conditions that cause upper extremity joint pain.
2. US can accurately diagnose non-traumatic causes of shoulder, elbow and wrist pain.
3. US-guided fenestration, tenotomy, barbotage, cyst aspirations, and joint injections are safe and effective therapeutic procedures for shoulder pain.
4. An organized and practiced approach to US-guided musculoskeletal interventions of the upper extremity is key for effective treatment.

TABLE OF CONTENTS/OUTLINE

Most Common MRI Findings of Muscle Sport Injuries in Professional Football Players: A Pictorial Review

Station #11

Participants
Jaime Isern, MD, Barcelona, Spain (Presenter) Nothing to Disclose
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TEACHING POINTS
1. To describe the Anatomy and Histology of the most common muscle injuries in football players.
2. To review the
Common and Uncommon Complications of Reverse Total Shoulder Arthroplasty: Pictorial Review and Review of the Literature

Station #12

1. To describe the Anatomy and Histology of the most common muscle injuries in football players. 2. To review the pathophysiological mechanism. 3. To present the specific MRI Protocol for diagnosis of muscular injuries of the lower extremity. 4. To describe our Grading System for MRI Evaluation of Muscle Injury. 5. To show the expected range of pathological findings. 6. To describe the MRI findings of residual changes of a muscle tear.

TABLE OF CONTENTS/OUTLINE


Awards

Certificate of Merit

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TEACHING POINTS

The purpose of this exhibit is: 1. To review the biomechanics of and indications for reverse total shoulder arthroplasty (RTSA) 2. To review the range of normal postoperative appearance of RTSA 3. To demonstrate common and uncommon complications of RTSA and explain their biomechanical rationale

TABLE OF CONTENTS/OUTLINE

Biomechanics of RTSA Indications for RTSA Normal Postoperative appearance of RTSA Complications - Anterior Dislocation - Acromial Stress Fracture - Scapular Notching - Loosening of Components - Perihardware Fracture - Infection Summary

Printed on: 01/19/20
Chondral Lesions of the Wrist: A Meta-Analysis Comparing Performance of MRI, MRA and CTA

METHOD AND MATERIALS

A comprehensive literature search (until March 2019) was performed by two investigators independently and original studies on diagnostic performance of MRI, MRA or CTA in detecting chondral lesions of the wrist were included. Pooled values of sensitivity and specificity were obtained using fixed or random effect models based on the level of heterogeneity. To compare the diagnostic odds ratio (DOR) of these three modalities, DOR was regressed against their category and relative DOR (rDOR) was obtained.

RESULTS

Our literature search yielded 767 related records. Of these, 15 eligible studies were read at the level of full text and 7 studies were included. Results of 109 CTA exams, 241 MRA exams and 191 MRI exams were pooled in three separate categories. All MR imaging was performed by 1.5 T scanners. The pooled estimates of sensitivity of CTA, MRA and MRI were 94% (95% confidence interval: 80%-99%), 63% (49%-75%) and 45% (35%-55%), respectively. The pooled estimates of specificity of CTA, MRA and MRI were 98%(94%-100%), 97% (94%-99%) and 83%(78%-87%), respectively. A high degree of heterogeneity was observed (I²>50%). Comparing DOR of all 3 modalities, CTA provided the highest performance (rDOR=3.2, P-value=0.006). MRA performed better than MRI (rDOR=9.1 P=0.04).

CONCLUSION

For detection of chondral lesions of the wrist, CTA appears to be more accurate than MRA and MRI utilizing 1.5 T scanners. MRA was more accurate than MRI performed with similar magnetic field.

Skeletal Muscle, Visceral and Subcutaneous Fat Area Measurements Inter-Reader Variability Assessment

METHOD AND MATERIALS

A comprehensive literature search (until March 2019) was performed by two investigators independently and original studies on diagnostic performance of MRI, MRA or CTA in detecting chondral lesions of the wrist were included. Pooled values of sensitivity and specificity were obtained using fixed or random effect models based on the level of heterogeneity. To compare the diagnostic odds ratio (DOR) of these three modalities, DOR was regressed against their category and relative DOR (rDOR) was obtained.

RESULTS

Our literature search yielded 767 related records. Of these, 15 eligible studies were read at the level of full text and 7 studies were included. Results of 109 CTA exams, 241 MRA exams and 191 MRI exams were pooled in three separate categories. All MR imaging was performed by 1.5 T scanners. The pooled estimates of sensitivity of CTA, MRA and MRI were 94% (95% confidence interval: 80%-99%), 63% (49%-75%) and 45% (35%-55%), respectively. The pooled estimates of specificity of CTA, MRA and MRI were 98%(94%-100%), 97% (94%-99%) and 83%(78%-87%), respectively. A high degree of heterogeneity was observed (I²>50%). Comparing DOR of all 3 modalities, CTA provided the highest performance (rDOR=3.2, P-value=0.006). MRA performed better than MRI (rDOR=9.1 P=0.04).

CONCLUSION

For detection of chondral lesions of the wrist, CTA appears to be more accurate than MRA and MRI utilizing 1.5 T scanners. MRA was more accurate than MRI performed with similar magnetic field.

CLINICAL RELEVANCE/APPLICATION

Further studies are warranted to determine the accuracy of 3T MRA/MRI and compare its performance with CTA.
CONCLUSION
Inter-reader reproducibility in measuring skeletal muscle, VFAT and SUBQ on CT axial images at the mid-L3 level, using the proposed technique, were highly consistent amongst readers. There was no observable impact of age, CT contrast or gender on the measurements.

Background
Area measurements of skeletal muscle, visceral (VFAT) and subcutaneous fat (SUBQ) have proven to be useful in clinical studies for diagnosis and monitoring treatment efficacy. These measurements are typically performed on computerized tomography (CT) abdominal images at the axial L3 level. For a measurement to be useful in a clinical setting, precision and reproducibility is critical. The aim of this study is to assess the inter-reader reproducibility of quantifying the muscle, VFAT and SUBQ by a single CT slice at mid-L3.

Evaluation
CT scans from 10 patients were randomly selected from a cohort of liver transplant evaluations. Three of the patients analyzed were female with an average age of 59.1 years. Four patients' scans were with contrast. All CT scans were obtained with 5.0mm slice thickness. Analysis was performed by two senior radiologists and three trained technicians blinded to each other's measurements. Axial mid-L3 level was determined by identifying the intersection of lines connecting the superior anterior to inferior posterior and the superior posterior to inferior anterior vertebra endplate on the sagittal view. Area measurements were acquired for muscle, VFAT and SUBQ. The most senior radiologist's results were used as a reference.

Discussion
Inter-class correlation (ICC) and Bland-Altman analysis were used to evaluate the results. One subject's data was excluded due to scanner inconsistencies. The mean and standard deviation area measurements of muscle, VFAT and SUBQ were 121.6 ± 23.7 cm², 88.1 ± 60.8 cm² and 212.7 ± 121.0 cm², respectively. The ICCs between the reference reader and the others ranged from highest 0.99 (muscle) to lowest 0.79 (SUBQ). The average Bland-Altman limits of agreement were 23.9 to -22.4 for muscle, 82.6 to -66.8 for VFAT, and 230.8 to -168.9 for SUBQ.

METHOD AND MATERIALS
A 3T MRI scanner was used to measure DWI using a STE-EPI prototype sequence. T2-maps were calculated based on images with different TE's using vendor software. Seven approved subjects were asked not to exercise for one week. Then, they were asked to perform one set (100 repetitions) of heel-up exercise by standing on one-leg (right foot) on the test day, immediately before MR imaging. Analyzed skeletal muscles included anterior tibialis muscle (TA), soleus muscle (SOL), and gastrocnemius (GM), with left and right lower limbs as the control (CG) and stress groups (SG), respectively. Estimates of the signal-to-noise-ratio (SNR) were calculated from DWI intensities. A customized program (Embarcadero Technologies, Inc., Austin, TX, USA) was used for qsi calculations. Fractional anisotropy (FA) of zero-place displacement images (ZP), and full width at half-maximum images (FWHM) were determined based on qsi and evaluated using Wilcoxon signed rank sum test and effect size.

RESULTS
Figure 1 shows SNR estimates of the control group. SE exhibits the highest SNR. For STE, SNR declined with increasing TM. Figure 2 shows FA values of the control group, where both FWHM and ZP showed significantly different FA values between TA and SOL. Figure 4 shows representative images for one subject. Figure 3 shows FA and T2 values of the control and stress groups in GM. For FWHM, a significant difference was noted in STE TM400 [p<0.05/d = large].

CONCLUSION
The usefulness of STE qsi was confirmed using long diffusion time in ZP. STE captures changes in fine muscle cells, which are not detected in T2 maps.

CLINICAL RELEVANCE/APPLICATION
Capturing minute muscle fatigue contributes to treatment policy decision.

Cryoablation for Advanced and Refractory Desmoid Tumors: A Promising Treatment?

Participants
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PURPOSE
To assess efficacy and safety of percutaneous cryoablation (CA) for advanced and refractory extraabdominal desmoid tumors

METHOD AND MATERIALS
This retrospective study reviewed 31 consecutive patients with painful desmoid tumors (EVA>5) evolving despite well-managed medical treatment treated by CA between 2007 and 2019. Pain reduction, progression free survival (PFS) (clinical or radiographics), tumor shrinkage rate (TSR) (volume of the tumor at 1 and 3 years compared to the volume before treatment) and complications were collected. Clinical efficacy of treatment was defined by VAS<3 after CA. Kaplan Meier method was used to outline PFS. Paired sample t-test was used to compare volume of tumors before treatment and at 1 year and 3 year.

RESULTS
With a median follow-up of 30 months (range 1- 98 months, IQR: 8-54), the PFS was 82.6% (CI95%: 69.2, 95.9) at 1 year and 75.7% (CI95%: 60.6, 90.8) at 3 years. Clinical efficacy of treatment was obtained for 89.6% (CI95%: 78.6,100) of patients. Median volume of desmoid tumor before treatment was 92.4mL (range 2.1-1727.9 mL, IQR: 49.7- 298.5). TSR was 48.2% (CI95%: 37.2, 72.3; p=0.002) at 1 year and 74.4% (CI95%: 59.1, 89.8; p=0.002) at 3 year. Thermo protective measures for critical structures closed to the tumor were used in 74.2% of cases. Five patients (16.2%) required 2 sessions of CA for total control. Adverse events rate was 31.2%, the most common was oedema and temporary increase of pain in the days following CA.

CONCLUSION
CA is an effective treatment for advanced and refractory extraabdominal desmoid tumor, that induces durable responses. Safety profile is acceptable but requires a good mastery of protective measures for surrounding organs.

CLINICAL RELEVANCE/APPLICATION
Among patients with progressive, refractory and symptomatic desmoid tumors, CA is an effective treatment that induces durable responses.

MK408-SD-WEBS Deep Learning-Based Automatic Fat Quantification of Supraspinatus Muscle: Quantitative Comparison of a Single Slice at Y-View versus Total MR Slices

Station #5
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PURPOSE
To develop a deep learning-based automatic fat quantification from 6-point Dixon sequence (6-Dixon) and to determine whether the standard assessment for muscle fatty infiltration using a single image slice is indicative of the total fat fraction in supraspinatus muscle (SSm).

METHOD AND MATERIALS
This study retrospectively analyzed 72 MR images with (a) extended oblique sagittal T1-weighted images (T1WI) and (b) fat fraction (FF) map generated from 6-point Dixon sequence including total SSm. A deep learning model-based on the U-Net convolutional network architecture was developed to perform automatic segmentation. Subjects were divided into 3 groups (score 0, n=49; score 1, n=17; score 2, n=6) according to the Fuchs scores of SSm based on T1WI. Deep learning-derived FFs of SSm on a single slice at Y-view (FFy) and total MR slices (FFt) were compared in 3 groups. Performance of the automatic segmentation was evaluated on Dice coefficient overlap with the manual segmentation.

RESULTS
The models produced strong Dice coefficient of 0.828 and accuracy of 0.996. The average of FFy and the average of FFt for each group were as follows: score 0, 17.38 and 19.81%; score 1, 17.02 and 28.56%; score 3, 16.14 and 43.11%. FFy was statistically different from FFt in all groups (score 0, p=.011; score 1, p=.001; score 2, p=.028). The difference between FFy and FFt was up to 41.7% in Fuchs score 2 group.

CONCLUSION
A deep learning-based fat quantification can achieve fully automated and accurate evaluation for muscle fat fraction in SSm. A single sagittal slice at Y-view is not indicative of the total fat fraction in SSm, especially in group with severe fatty infiltration.

CLINICAL RELEVANCE/APPLICATION
Deep learning-based automatic quantification could allow accurate and rapid fat quantification of total SSm, not only a single MR slice. It could be a more accurate preoperative factor to predict surgical outcome.

MK409-SD-WEB6 Novel 3D Cone-Beam CT Scan Mode on a Multipurpose X-Ray System: Evaluation of Image Quality in Cadaveric Elbow Scans Compared to Third Generation Dual-Source CT
PURPOSE
To assess image quality (IQ) provided by the new prototype version of a twin robotic X-ray system's 3D cone-beam CT (CBCT) mode for human cadaveric elbow studies.

METHOD AND MATERIALS
A multifunctional X-ray system with novel prototype CBCT mode and a third-generation dual-source CT (3rd Gen. DSCT) were used to examine 16 cadaveric elbows obtained from body donors. Imaging was performed with equivalent low-dose (LD; CTDIvol 16cm = 3.3 mGy) and regular clinical protocols (RD; CTDIvol 16cm = 13.8 mGy). IQ was subjectively evaluated by two independent radiologists on a seven-point Likert scale (1 = very poor; [...] 6 = very good; 7 = excellent). For quantification of interrater reliability, we report the intraclass correlation coefficient (ICC) based on absolute agreement in a 2-way random-effects model. In addition to observer ratings, we conducted computer-assisted estimation of spatial resolution in cancellous bone by quantifying the pixel amount within 20% from the maximum and minimum grey values inside a region of interest. Good resolution between trabecula and fatty marrow is indicated by high pixel counts inside the defined ranges.

RESULTS
Observers agreed that CBCT imaging delivered superior IQ in comparison to DSCT scans (all p<=0.004 for RD; all p<=0.001 for LD). IQ was evaluated to be very good or excellent in 100%/100% (reader 1/ reader 2) of RD CBCT, 100%/93.8% of LD CBCT, 62.5%/43.6% of RD DSCT and 0.0%/0.0% of LD DSCT studies. Single measure ICC was 0.945 (95% confidence interval, 0.912-0.966; p<0.001), implying excellent reliability. In objective assessment of IQ, RD CBCT studies (median pixel count 1227 [IQR 692;1651]) provided higher pixel counts in the defined ranges than LD CBCT (663 [421;874] p<0.001), RD DSCT (646 [343;1018]; p=0.001) and LD DSCT scans (313 [231;445]; p<0.001), indicating better resolution of trabecula and bone marrow. No substantial difference was found between LD CBCT and RD DSCT, suggesting equal IQ in cancellous bone.

CONCLUSION
In cadaveric elbow studies, the prototype CBCT mode of the twin robotic X-ray system provides superior subjective and objective image quality compared to a 3rd Gen. DSCT scanner at equivalent radiation dose levels.

CLINICAL RELEVANCE/APPLICATION
With superior image quality of the new 3D CBCT scan mode compared to 3rd Gen. DSCT, the multipurpose X-ray system may hold potential to be a future one-stop-shop device for elbow imaging in trauma.
**TABLE OF CONTENTS/OUTLINE**


**TEACHING POINTS**

1. To understand the role of whole-body MRI and whole-body diffusion-weighted image (DWI) 2. To explain the updated knowledge of whole-body MRI techniques 3. To review the clinical applications in musculoskeletal tumors and rheumatic disease
RSNA/ESR Sports Imaging Symposium: Musculoskeletal Interventional Procedures (Interactive Session)

Wednesday, Dec. 4 1:30PM - 3:00PM Room: E350

ER  IR  MK

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

Participants
Andrew J. Grainger, MD, Leeds, United Kingdom (Moderator) Consultant, Leviecept Ltd; Director, The LivingCare Group;
Laura W. Bancroft, MD, Venice, FL (Moderator) Author with royalties, Wolters Kluwer nv; Editor, Thieme Medical Publishers, Inc;
Travel support, Thieme Medical Publishers, Inc ; ;

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LEARNING OBJECTIVES
1) To learn the targeted approach to injecting joints, ligaments, tendons and tendon sheaths. 2) To appreciate pitfalls to avoid in MSK procedures for treatment of sports-related injuries. 3) To understand evidence-based data on various MSK procedures in order to give patients realistic expectations after treatment.

Sub-Events
MSSR43A Diagnostic and Therapeutic Injections in the Athlete: Pearls and Pitfalls

Participants
Philippe A. Peetrons, MD, Brussels, Belgium (Presenter) Research Consultant, Canon Medical Systems Corporation

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LEARNING OBJECTIVES
1) To become familiar with the most common requests and indications for sports-related injuries. 2) The learn about technical considerations for performing MSK injections. 3) To understand reasons to delay injections or avoid certain injectables.

ABSTRACT
The main pitfall is from far an mistake in the diagnosis done before sending the patient to the ultrasound guided treatment. Good examination and looking carefully to the examinations done before is mandatory. Among pearls, some innovative technique for injecting will be shown, such as Trapezo-metacarpal joint, sternoclavicular joint, Morton's neuroma, subtalar joint, hip and shoulder joints, carpal tunnel and de Quervain tenosynovitis. Treatment of nerve injuries will also be depicted and illustrated. Some tips will be given for ganglia treatment

MSSR43B Injectables, Percutaneous Tendon Fenestration and Tenotomy: Clinical Outcomes and Current Evidence

Participants
Jon A. Jacobson, MD, Ann Arbor, MI (Presenter) Research Consultant, BioClinica, Inc; Advisory Board, Koninklijke Philips NV; Royalties, Reed Elsevier

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LEARNING OBJECTIVES
1) To be aware of the indications and benefits of available injectables used to treat sports-related injuries. 2) To learn about technical considerations for performing tendon fenestration and tenotomy. 3) To become familiar with current evidence on results of MSK procedures in the literature.

ABSTRACT
For joint abnormalities and tendinopathy, there exists many percutaneous treatment options. Anaesthetic agents are used, often combined with corticosteroids, to inject joints and bursae for diagnostic and therapeutic purposes. With regard to anaesthetic agents, all are cytotoxic to chondrocytes and synovial cells to some degree. Corticosteroids may be used to decrease inflammation within a synovial space. The use of corticosteroid to treat tendinopathy is counterintuitive, as inflammation is not present, injection into tendon causes tenocyte death, and the analgesic effect of corticosteroids is short lived, and therefore the underlying tendon pathology is not treated. A number of ultrasound-guided tendon treatments can be used for tendinopathy. One treatment is percutaneous tendon fenestration or tenotomy. With this procedure, a needle is passed through the abnormal tendon segment repeatedly to break up the degenerative process, induce bleeding and inflammation, and initiate the healing of the abnormal tendon. Other procedures include the injection of autologous whole blood during the fenestration process, as well as the injection of platelet-rich plasma during fenestration. With this latter technique, the autologous whole blood is centrifuged to concentrate the
platelets for injection. All three of these percutaneous tendon treatments have been shown to be effective, although it is controversial which technique is best. The cost of each procedure should also be considered. There exists newer and more controversial percutaneous tendon treatment, such as injection of mesenchymal stem cells, human amniotic membrane, and deer antler velvet. These procedures are largely considered experimental until research studies demonstrate their safety and efficacy.

### Interactive Case Discussion

**Participants**

Jon A. Jacobson, MD, Ann Arbor, MI (Presenter) Research Consultant, BioClinica, Inc; Advisory Board, Koninklijke Philips NV; Royalties, Reed Elsevier

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**LEARNING OBJECTIVES**

1) To learn the targeted approach to injecting joints, ligaments, tendons and tendon sheaths. 2) To appreciate pitfalls to avoid in MSK procedures for treatment of sports-related injuries. 3) To understand evidence-based data on various MSK procedures in order to give patients realistic expectations after treatment.

Printed on: 01/19/20
**SSM17**

**Musculoskeletal (Shoulder)**

Wednesday, Dec. 4 3:00PM - 4:00PM Room: S105AB

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

FDA Discussions may include off-label uses.

**Participants**

- Christine B. Chung, MD, Solana Beach, CA (*Moderator*) Nothing to Disclose
- Jenny T. Bencardino, MD, Jericho, NY (*Moderator*) Nothing to Disclose

**Sub-Events**

**SSM17-01  Saline versus Gadolinium Shoulder MR Arthrography: Contrast Agent or Joint Distention?**

Wednesday, Dec. 4 3:00PM - 3:10PM Room: S105AB

**Participants**

- Adam D. Singer, MD, Atlanta, GA (*Presenter*) Nothing to Disclose
- Samia K. Sayyid, Atlanta, GA (*Abstract Co-Author*) Nothing to Disclose
- Jeffrey Rosenthal, Atlanta, GA (*Abstract Co-Author*) Nothing to Disclose
- Monica B. Umpierrez, MD, Atlanta, GA (*Abstract Co-Author*) Nothing to Disclose
- Felix Gonzalez, MD, Atlanta, GA (*Abstract Co-Author*) Nothing to Disclose
- Gulshan B. Sharma, PhD, MBA, Calgary, AB (*Abstract Co-Author*) Nothing to Disclose
- Eric Wagner, MD, Atlanta, GA (*Abstract Co-Author*) Nothing to Disclose

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**PURPOSE**

Compare the diagnostic performance of saline and gadolinium shoulder MR arthrograms (MRA) in the detection of labral and rotator cuff injury with arthroscopic findings as a reference standard.

**METHOD AND MATERIALS**

In this IRB approved retrospective study, consecutive patients presenting over an 18 month period for a shoulder MRA who subsequently had shoulder arthroscopy were enrolled. No patients were excluded. An MSK radiologist reviewed each study to confirm whether saline or gadolinium was injected. The reports from the MRA and the surgery were reviewed. For the rotator cuff and the long head of the biceps tendon, status was designated as full thickness tear, partial thickness tear, tendinosis/low grade fraying or normal. For the labrum, status was designated as tear, fraying/blunting/degeneration or normal. A chi square analysis was performed to compare the correlation between the MRA and the surgical reference. Items were categorized in binary groups (no tear versus tear and normal versus abnormal) and the diagnostic performance of each contrast agent was calculated. Kappa values were calculated to correlate diagnosis of tear between MRA and arthroscopy.

**RESULTS**

There were a total of 34 gadolinium arthrograms and 24 saline arthrograms. When compared to the reference standard, saline was non-inferior to gadolinium in the diagnosis of tears of the supraspinatus (accuracy 0.88 vs 0.74, respectively) and infraspinatus (accuracy 0.88 vs 0.65, respectively) tendons. Regarding labral tears, saline was non-inferior in the diagnosis of anterior/anterior inferior, posterior and superior tears (accuracy 0.79 vs 0.76, 0.71 vs 0.62 and 0.58 vs 0.56, saline vs gadolinium, respectively). When superior labral fraying was considered a tear, gadolinium outperformed saline (accuracy 0.71 vs 0.54, respectively). In terms of agreement between MRA and the diagnosis of surgically reported tears, saline was non-inferior to gadolinium.

**CONCLUSION**

Saline performed at least as well as gadolinium for the diagnosis of surgically proven rotator cuff tears. Saline was non-inferior in the detection of anterior and posterior labral tears. If fraying was not considered a tear, saline was non-inferior to gadolinium in the diagnosis of superior labrum tears.

**CLINICAL RELEVANCE/APPLICATION**

In this series, saline was non-inferior to gadolinium shoulder MRA. This could translate to cost savings by reducing scan times and the need for gadolinium.
RCT, respectively. The sensitivity, specificity, PPV and NPV and accuracy of CTA were 91.6, 90.0, 95.6, 81.1 and 91.1%, and 90.0, 100, 100, 100, and 100%, as regards GLT and MRI revealed the presence of GLT in 24/32 patients (75.0%) and a RCT in 10/32 patients (31.2%). The sensitivity, specificity, PPV and NPV and accuracy values were calculated. Inter-observer and intra-observer agreement were calculated with k-statistics. A value of p<0.05 was considered statistically significant.

RESULTS

Automatic segmentation of the proximal humerus achieved a mean average precision for object detection of 0.99, a dice similarity score of 0.96, a segmentation precision of 0.96, and recall of 0.96. The Hausdorff distance was 23.8 mm, the mean surface distance of 0.5 mm, and the residual mean square distance of 1.3 mm. For the glenoid, automatic segmentation achieved a mean average precision for object detection of 0.92, a dice similarity score of 0.86, a segmentation precision of 0.88, and recall of 0.86. The Hausdorff distance was 20.7 mm, the mean surface distance of 0.8 mm, and the residual mean square distance of 1.8 mm. On average, the time for manual segmentation ranged between 90 to 120 minutes per imaging study. The time needed to train each epoch was around 14 minutes for the 2D CNN, and to calculate the segmentation masks using trained models takes around 4 seconds.

CONCLUSION

Using CNNs, we were able to accurately segment the humeral head and glenoid on MRI. Our results serve as an important initial step towards the automatic diagnosis and quantification of Hill-Sachs lesions and glenoid bone loss and determination of on/off track status. This, in turn, has the potential to provide consistently accurate imaging information that can be used to guide the selection of the most appropriate initial treatment for the anterior shoulder instability patient population.

CLINICAL RELEVANCE/APPLICATION

Using CNNs, we were able to accurately segment the humeral head and glenoid on MRI. Our results serve as an important initial step towards the automatic diagnosis and quantification of Hill-Sachs lesions and glenoid bone loss and determination of on/off track status.

SSM17-03 Identification of Glenoid Labral and Rotator Cuff Tears: Diagnostic Accuracy of Dual Energy CT versus Standard CT Arthrography of the Shoulder

Wednesday, Dec. 4 3:20PM - 3:30PM Room: S105AB

Participants

Giovanni Foti, MD, Negrar, Italy (Abstract Co-Author) Nothing to Disclose
Fabio Lombardo, MD, Negrar, Italy (Presenter) Nothing to Disclose
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PURPOSE

To compare the diagnostic accuracy of dual-energy Computed Tomography arthrography (DECTA) and standard computed tomography arthrography (CTA) of the shoulder in depicting glenoid labral tears (GLT) and rotator cuff tears (RCT).

METHOD AND MATERIALS

This prospective institutional review board-approved study included 32 consecutive patients (18 males and 14 females; mean age of 34.5, range 18-60 years) studied between January 2018 and January 2019. Articular cavity was distended with anterior approach by using a mixture of saline and iodinate contrast material before DECT exam (80 kV and tin filter 150 kV). DECT data were postprocessed on a dedicated offline workstation (SyngoVia®). Standard virtual blended 120 kVp images were obtained, representing CTA. Moreover a three-material decomposition algorithm was applied to generate DECT maps. Mono-energetic application was employed to choose the best kV values in order to enhance the vividness of contrast material and to reduce metal artifacts in previously operated shoulders. Two radiologists (26 and 12 years of experience, respectively), blinded to clinical data, evaluated the presence of GLT and RCT on CTA and DECTA images. Surgical findings served as standard of reference. Diagnostic accuracy values were calculated. Inter-observer and intra-observer agreement were calculated with k-statistics. A value of p<0.05 was considered statistically significant.

RESULTS

MRI revealed the presence of GLT in 24/32 patients (75.0%) and a RCT in 10/32 patients (31.2%). The sensitivity, specificity, PPV and NPV and accuracy of DECTA were 91.6, 100,100, 81.8 and 91.1%, and 100, 100, 100, 100, and 100%, as regards GLT and RCT, respectively. The sensitivity, specificity, PPV and NPV and accuracy of CTA were 91.6, 90.0, 95.6, 81.1 and 91.1%, and 90.0,
100, 90.0, 95.6, 85.7 and 96.8%, as regards GLT and RCT, respectively. By using McNemar test, the difference of accuracy between DECTA and CTA was not significant (p=0.23). The interobserver and intraobserver agreement were near perfect (k=0.82 and k=0.86, respectively).

CONCLUSION
DECTA can identify GLT and RCT with higher accuracy with respect to CTA.

CLINICAL RELEVANCE/APPLICATION
DECTA arthrography is an accurate imaging method for demonstration of glenoid labrum and rotator cuff tears. The increase of conspicuity of contrast material injected within the articular cavity may represent a key factor for the identification of subtle tears.

SSM17-04 Qualitative and Quantitative Analysis of Glenoid Bone Stock and Version: Inter-Reader Analysis and Correlation with Rotator Cuff Atrophy
Wednesday, Dec. 4 3:30PM - 3:40PM Room: S105AB

Participants
Matthew J. Siebert, BS, Dallas, TX (Abstract Co-Author) Nothing to Disclose
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Anveesh Chhabra, MD, Flowermound, TX (Presenter) Consultant, ICON plc; Consultant, Treace Medical Inc; Author with royalties, Wolters Kluwer nv; Author with royalties, Jaypee Brothers Medical Publishers Ltd

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PURPOSE
Glenoid bone stock and morphology and rotator cuff muscle quality and tendon integrity affect the outcome of total shoulder arthroplasty. We hypothesized that glenoid bone loss severity correlates with rotator cuff tendinopathy and severity of rotator cuff muscle fatty infiltration (FI) and atrophy.

METHOD AND MATERIALS
Forty-three 3-D CT scans and MRIs of 43 patients (mean age 62 years; SD 13 years; range 22 to 77 years) referred for primary shoulder pain without recent trauma or prior surgery were evaluated. Measurements of glenoid bone stock, version, and joint line medialization were assessed on an axial CT image reconstructed in the true scapular plane. Measurements utilized the Friedman line to approximate the pre-pathologic surface. Glenoid morphology was assigned by modified Walch classification. Rotator cuff FI, atrophy, and tendon integrity were assessed on corresponding MRIs.

RESULTS
Glenoid version, anterior and posterior bone loss among modified Walch subtypes was statistically significant (p<0.0001, <0.01 and <0.01 respectively). There was a very strong negative correlation between increasing glenoid version and posterior humeral subluxation index (HSI) (r=-0.908; p<0.0001). There was a moderately negative correlation between anterior bone loss and HSI (r=-0.562; p<0.0001) and a moderately positive correlation between posterior bone loss and HSI (r=0.555; p<0.0001). Subscapularis muscle FI correlated moderately with increased anterior and central bone loss and increased humeral head medialization (r=0.512, p<0.05; r=0.479, p<0.05; r=0.494, p<0.05; respectively). Inter-observer reliability (intra-class correlation coefficient [ICC] and kappa) was good to excellent for all measurements and grading.

CONCLUSION
Glenoid anteversion, anterior and posterior bone loss are associated with humeral head subluxation. Subscapularis muscle FI, not the tendon integrity, correlates to anterior and central glenoid erosion. The study adds to the body of knowledge that neither rotator cuff tendinopathy, nor muscle atrophy showed a significant relationship to anterior or posterior humeral head subluxation. Anterior or central bone loss may indicate the need to strengthen the subscapularis muscle pre-operatively for potentially improved outcome.

CLINICAL RELEVANCE/APPLICATION
CT measurement of glenoid bone stock and MR measurement of rotator cuff pathology significantly impacts pre-operative planning of total shoulder arthroplasty.

SSM17-05 Addition of the RAVER View to Standard Shoulder Radiographs for Calculation of the Acromial Index and Prediction of Rotator Cuff Tears
Wednesday, Dec. 4 3:40PM - 3:50PM Room: S105AB

Participants
Adam C. Zoga, MD, Philadelphia, PA (Presenter) Nothing to Disclose
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**PURPOSE**

Rotator cuff disease is a common indication for subspecialty orthopaedics referral. MRI and US are definitive diagnosing rotator cuff tear (RCT), but patient selection for advanced imaging remains difficult. Arthroscopic studies have shown osseous hypertrophy at the anterosuperior humeral head is a frequent finding in patients with RCT. We sought to trial a novel radiographic view to allow for measurement of osseous features that predict RTC, and serve as a guide to direct patients appropriately for advanced imaging referral.

**METHOD AND MATERIALS**

Consecutive patients referred to a surgeon for RCT underwent a novel radiographic resting, abduction view in external rotation (RAVER), in conjunction with the standard shoulder series. Osseous prominence at the anterosuperior humerus was measured on the RAVER and an Acromial Index (AI), was calculated with the ratio of the prominence and distance between the acromion and the footprint. MRI, ordered based upon established practice protocol, was correlated the RAVER measurements. Non-parametric tests and logistic regression were used for data analysis.

**RESULTS**

113 subjects had a RAVER view and 48 (42.9%) subjects underwent MRI, of which 35 had rotator cuff tears. The mean AI in the RCT tear group was 1.15, whereas the mean AI in subjects without MRI or without tear at MRI was 2.53 and 1.82 respectively. The AI was significantly associated with RCT tear (p = 0.003), independent of gender and age. 3 MSK trainees reviewed 18 cases independently to assess reliability of AI, and an intraclass correlation coefficient was 0.96 (95% CI: 0.92-0.98, p<0.001), showing high concordance and little variation in scoring.

**CONCLUSION**

The acromial Index is an easily reproducible, reliable radiographic predictor of rotator cuff tears and can be calculated with the addition of a single, novel RAVER radiographic view. The addition of this resting, abduction, external rotation view should be validated with larger scale implementation, particularly in shoulder clinics and in a patient population where suspected rotator cuff tears are prevalent.

**CLINICAL RELEVANCE/APPLICATION**

Once validated, the RAVER view and AI measurement can allow clinicians to more effectively select patients who would benefit from advanced imaging with MRI or US for rotator cuff tear, ultimately improving imaging efficiency, adding value, and expediting optimal outcomes.

**SSM17-06 Imaging and Clinical Outcomes Following Superior Capsular Reconstruction for Massive Irreparable Rotator Cuff Tears**

**Wednesday, Dec. 4 3:50PM - 4:00PM Room: S105AB**

Participants
Mohammad M. Samim, MD, MRCS, Yonkers, NY (Presenter) Nothing to Disclose
Abigail Campbell, MD, New York, NY (Abstract Co-Author) Nothing to Disclose
David Klein, New York, NY (Abstract Co-Author) Nothing to Disclose
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Robert Meislin, MD, New York, NY (Abstract Co-Author) Consultant, Arthrex, Inc

**PURPOSE**

Superior capsular reconstruction (SCR) has been recently developed as an arthroscopic treatment option for massive irreparable rotator cuff tears. The purpose of this study is to determine early imaging, clinical, and functional outcomes of SCR.

**METHOD AND MATERIALS**

Patients having undergone SCR at a single institution were included. Pre-operative and post-operative radiographs and MRIs were evaluated for acromiohumeral interval (AHI), superior subluxation distance (SSD), glenohumeral cartilage loss, cuff muscle atrophy, and graft integrity. Postoperative outcomes including range of motion (ROM), muscle strength and clinical outcomes scores were collected.

**RESULTS**

24 SCRs were included. Mean clinical follow-up was 21.3 months. MRI was obtained in all patients at mean 9.4 months postoperatively. There were 12 intact grafts (50%) and 12 grafts (50%) with tear at least at one location. The most common location of tear was from the glenoid attachment (50%), followed by the posterior side-to-side attachment (25%), the anterior attachment (18%), and greater tuberosity (7%). There was a significant improvement of American Shoulder and Elbow Surgeons (ASES) (p = 0.003) and visual analog scale (VAS) pain scores (p = 0.012). Significant improvement was observed in forward elevation ROM (p = 0.021). There was no significant difference in functional outcomes or range of motion between patients with torn graft and those with intact graft. The severity of preoperative cartilage loss or rotator cuff muscle fatty atrophy were not associated with graft tear. There was a significant difference in the SSD between patients with complete tear of the graft at least in one location and those without tear at postoperative MRI. SSD greater than 7.9 mm had a 79% sensitivity and 91% specificity for a complete tear of the graft.

**CONCLUSION**

SCR using human dermal allograft had a 50% tear rate mostly from the glenoid in the current series despite that it results in significant improvements in short term function and range of motion in patients with massive irreparable rotator cuff tears. The chronicity of this procedure’s action to depress the humeral head remains in question, as well as the time this procedure provides to delay reverse total shoulder arthroplasty.

**CLINICAL RELEVANCE/APPLICATION**

SCR using human dermal allograft results in significant improvements in short term function and range of motion in patients with...
SCR using human dermal allograft results in significant improvements in short-term function and range of motion for patients with massive irreparable rotator cuff tears.

Printed on: 01/19/20
LEARNING OBJECTIVES

1) To review MRI findings of ACL reconstruction and cartilage repair. 2) To review the expected and abnormal MR imaging findings after labral repair, capsular shift/capsulorrhaphy and Laterjet/Bristow procedures. 3) To consolidate the knowledge gained from the session with interactive cases of postoperative sports imaging.

ABSTRACT

Purpose: To become familiar with the expected and abnormal MR imaging findings after labral repair, capsular shift/capsulorrhaphy, remplissage and Latarjet/Bristow procedures. Methods and Materials: MR imaging will be used to demonstrate the various normal and abnormal imaging appearances after shoulder instability surgery. Results/Conclusion: Labral re-tear will be evident as contrast or joint fluid extension into linear or complex tear cleft, absent/truncated/fragmented labrum, or labral displacement from anatomic location. Capsular shift results in smaller capacity joint and sometimes irregular capsular nodularity. Complications of capsulorrhaphy include capsular tears and subluxation of humeral head. Postoperative MR imaging can evaluate healing after combined remplissage and Bankart repair for moderate size, engaging Hill-Sachs lesions. Laterjet and Bristow procedures may be performed in patients with recurrent dislocations and glenoid deficiency. Incorporated bone will yield non-anatomic glenoid configuration, and complications include non-union, fatty degeneration of subscapularis muscle, and osteoarthrosis.

LEARNING OBJECTIVES

1) To become familiar with the expected and abnormal MR imaging findings after labral repair. 2) To learn about the postoperative imaging features after capsular shift/capsulorrhaphy. 3) To appreciate normal imaging and complications after remplissage and Laterjet/Bristow procedures.

ABSTRACT

The aim of ACL reconstruction is to stabilize the knee and prevent chondral and meniscal injuries, which are sequelae of anteroposterior translation and are associated with early osteoarthritis. The idea of the double-bundle ACL graft was to restore normal joint kinematics by anatomic reconstruction of the anteromedial and the posterolateral bundle of the original ACL. This was expected to improve clinical outcomes and restore anterior and rotational knee stability. The single-bundle technique, however, causes less osseous defects and is still a popular technique. Complications, such as ACL graft failure, impingement, cyclops lesion, arthrosis, and patellar inferior syndrome, are discussed. The second part of this presentation will illustrate cartilage repair techniques and imaging findings. The radiologist must be familiar with the different cartilage repair procedures and characteristics in
cartilage imaging to evaluate long-term progression or failure. Abnormal postoperative findings include hypertrophic filling, incomplete integration of the transplant into the surrounding cartilage, or subchondral defects, osteophytes, cysts, and persistent bone marrow edema and joint effusion.

**Interactive Case Discussion**

Participants
Laura W. Bancroft, MD, Venice, FL (Presenter) Author with royalties, Wolters Kluwer nv; Editor, Thieme Medical Publishers, Inc; Travel support, Thieme Medical Publishers, Inc ; ;
Claudia Weidekamm, MD, Auckland, New Zealand (Presenter) Nothing to Disclose

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**LEARNING OBJECTIVES**

1) To review the expected and abnormal MR imaging findings after labral repair, capsular shift/capsulorrhaphy and Laterjet/Bristow procedures in a case-based format. 2) To become familiar with the diagnosis features of failed ACL reconstructions, intact and failed cartilage repair. 3) To consolidate the knowledge gained from the session with interactive cases of postoperative sports imaging.

Printed on: 01/19/20
SPDL41

Neuro and MSK (Case-based Competition)

Wednesday, Dec. 4 4:30PM - 6:00PM Room: E451B

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

Participants
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Neety Panu, MD, FRCPC, Ottawa, ON (Presenter) Nothing to Disclose
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Carina W. Yang, MD, Chicago, IL (Presenter) Nothing to Disclose

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

LEARNING OBJECTIVES
1) Be introduced to a series of neuroradiology and musculoskeletal radiology case studies via an interactive team game approach designed to encourage 'active' consumption of educational content. 2) Use their mobile wireless device (tablet, phone, laptop) to electronically respond to various imaging case challenges; participants will be able to monitor their individual and team performance in real time. 3) Receive a personalized self-assessment report via email that will review the case material presented during the session, along with individual and team performance.

ABSTRACT
The extremely popular audience participation educational experience, Diagnosis Live!, is an expert-moderated session featuring a series of interactive case studies that will challenge radiologists' diagnostic skills and knowledge. The session features a lively, fast-paced game format: participants will be automatically assigned to teams who will then use their personal mobile devices to test their knowledge in a fast-paced session that will be both educational and entertaining. After the session, attendees will receive a personalized self-assessment report via email that will review the case material presented during the session, along with individual and team performance.

Printed on: 01/19/20
Participants
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Jacob R. Hansen, DO, Honolulu, HI (Abstract Co-Author) Nothing to Disclose
Andrew J. Degnan, MD, Philadelphia, PA (Abstract Co-Author) Nothing to Disclose
Tae H. Ro, MD, Fairfield, CA (Abstract Co-Author) Nothing to Disclose
Matthew Loewen, DO, Fircrest, WA (Abstract Co-Author) Nothing to Disclose
David J. Oettel, DO, Lackland, TX (Abstract Co-Author) Nothing to Disclose
Megan Dececchis, MD, Pensacola, FL (Abstract Co-Author) Nothing to Disclose
Joseph Salama, DO, MSc, Puyallup, WA (Abstract Co-Author) Nothing to Disclose
Richard Buck, MD, Tacoma, WA (Abstract Co-Author) Nothing to Disclose

TEACHING POINTS
Participants will test their diagnostic skills and become familiar with the imaging findings of a variety of challenging and interesting musculoskeletal cases.
Keeping Radiology Weird: Spot Diagnoses from the Pacific Northwest (Case-based Competition)

Thursday, Dec. 5 7:15AM - 8:15AM Room: E451B

Participants
Barry G. Hansford, MD, Chicago, IL (Presenter) Nothing to Disclose
Elena K. Komgold, MD, Portland, OR (Presenter) Nothing to Disclose
Nadine Mallak, MD, Portland, OR (Presenter) Nothing to Disclose

For information about this presentation, contact:
Hansford@ohsu.edu
komgold@ohsu.edu
mallak@ohsu.edu

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

LEARNING OBJECTIVES
1) Be introduced to a series of musculoskeletal, abdominal radiology and nuclear medicine case studies via an interactive game approach designed to encourage "active" consumption of education material. 2) 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) Receive a personalized self-assessment report via email that will review the case material presented during the session, along with individual and team performance.

Printed on: 01/19/20
**MSCS51**

**Case-based Review of Musculoskeletal Radiology (Interactive Session)**

Thursday, Dec. 5 8:30AM - 10:00AM Room: S406A

**LEARNING OBJECTIVES**

1) Learn current techniques and advances in Musculoskeletal imaging and intervention. 2) Become familiar with current guidelines for diagnosis and management of Musculoskeletal imaging findings. 3) Review critical Musculoskeletal disorders/disease physiology and pathology as it is depicted by multiple modalities. 4) Understand the vital role of imaging in the broad array of Musculoskeletal disorders in order to achieve optimum patient care.

**ABSTRACT**

This course is designed to highlight the vital role multimodality imaging plays in the assessment and diagnosis of Musculoskeletal disorders. Special emphasis will be placed on technical advances including MRI, MSK Ultrasound, CT, including DECT, and interventional guidance. A wide range of anatomic topics will be covered during this course including: shoulder, ankle/foot, knee, hand and wrist, including soft tissue/bone lesions and sports imaging. Our goal is to provide a broad update in the field while addressing new opportunities and challenges for everyday practice in the Musculoskeletal arena.

**Sub-Events**

**MSCS51A   Shoulder**

Participants
Laura W. Bancroft, MD, Venice, FL (Presenter) Author with royalties, Wolters Kluwer nv; Editor, Thieme Medical Publishers, Inc; Travel support, Thieme Medical Publishers, Inc ; ;

**LEARNING OBJECTIVES**

1) Review essential imaging characteristics of post-traumatic and sports-related shoulder injuries. 2) Review salient multimodality imaging features of various shoulder pathologies in a case based format.

**MSCS51B   Soft Tissue/Bone Lesions**

Participants
Stacy E. Smith, MD, Weston, MA (Presenter) Nothing to Disclose

**MSCS51C   MSK Ultrasound**

Participants
Akira M. Murakami, MD, Boston, MA (Presenter) Nothing to Disclose

**ABSTRACT**

The presentation will be a case based approach to review ultrasound appearances of common musculoskeletal pathologies of the upper and lower extremity including the use of dynamic imaging and doppler. Potential pitfalls will be reviewed as well as the importance of other imaging modalities and how they are complimentary to ultrasound.

**MSCS51D   Intervention**

Participants
Glenn C. Gaviola, MD, Boston, MA (Presenter) Nothing to Disclose

**LEARNING OBJECTIVES**

1) Using an image-rich, case-based format, recognize the importance of imaging guidance in musculoskeletal interventions and the importance of proper work-up of musculoskeletal lesions prior to the intervention.
Musculoskeletal Series: Applying Artificial Intelligence to Musculoskeletal Imaging

Thursday, Dec. 5 8:30AM - 8:50AM Room: N228

Participants
Martin Torriani, MD, Boston, MA (Moderator) Nothing to Disclose
Michael P. Recht, MD, New York, NY (Moderator) Nothing to Disclose
Christopher F. Beaulieu, MD, PhD, Stanford, CA (Moderator) Nothing to Disclose
Avneesh Chhabra, MD, Flower mound, TX (Moderator) Consultant, ICON plc; Consultant, Treace Medical Inc; Author with royalties, Wolters Kluwer nv; Author with royalties, Jaypee Brothers Medical Publishers Ltd

Sub-Events

RC604-01 Principles of Machine Learning in Diagnostic Imaging

Thursday, Dec. 5 8:30AM - 8:50AM Room: N228

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

For information about this presentation, contact:
mtorriani@mgh.harvard.edu

LEARNING OBJECTIVES
1) Familiarize the audience with basic concepts in machine learning. 2) Discuss methods used for basic pattern recognition using AI/ML. 3) Discuss applications/limitations of such methods.

RC604-02 Machine Learning for Bone Tumors

Thursday, Dec. 5 8:50AM - 9:10AM Room: N228

Participants
Christopher F. Beaulieu, MD, PhD, Stanford, CA (Presenter) Nothing to Disclose

LEARNING OBJECTIVES
1) Describe important prior work on computer aided diagnosis of bone tumors. 2) Discuss current applications of machine learning and AI to bone tumors. 3) Identify challenges and opportunities through application of ML tools in the clinical setting.

RC604-03 Machine Learning for Muscle

Thursday, Dec. 5 9:10AM - 9:30AM Room: N228

Participants
Avneesh Chhabra, MD, Flower mound, TX (Presenter) Consultant, ICON plc; Consultant, Treace Medical Inc; Author with royalties, Wolters Kluwer nv; Author with royalties, Jaypee Brothers Medical Publishers Ltd

For information about this presentation, contact:
Avneesh.chhabra@utsouthwestern.edu

LEARNING OBJECTIVES
1) Learn the current status and utility of skeletal muscle imaging. 2) Gain knowledge of the techniques of muscle segmentation and role of machine learning in that domain. 3) Discuss the role of muscle texture analysis and surrogate imaging markers for sarcopenia and patient functional status.

RC604-04 Automated Analysis of Muscle Quantitative Imaging Biomarkers for Muscle Quantity and Quality Using Convolutional Neural Networks

Thursday, Dec. 5 9:30AM - 9:40AM Room: N228

Participants
Dustin P. Brown, MD, PhD, La Jolla, CA (Presenter) Nothing to Disclose
Brian Hurt, MD, MS, San Diego, CA (Abstract Co-Author) Consultant, Arterys Inc; Consultant, IBM Corporation
Brady K. Huang, MD, San Diego, CA (Abstract Co-Author) Nothing to Disclose
Leon Lenchik, MD, Winston-Salem, NC (Abstract Co-Author) Nothing to Disclose
Robert D. Boutin, MD, Davis, CA (Abstract Co-Author) Nothing to Disclose
Albert Hsiao, MD, PhD, La Jolla, CA (Abstract Co-Author) Founder, Arterys, Inc; Consultant, Arterys, Inc; Shareholder, Arterys, Inc; Speaker, Bayer AG; Research Grant, Bayer AG; Speaker, General Electric Company; Research Grant, General Electric Company;
PURPOSE
To automate quantification of muscle quantity and quality using a cascaded system of convolutional neural networks (CNNs) applied opportunistically to chest and abdominal CT.

METHOD AND MATERIALS
A combination of public and internal non-contrast CT scans were used to train CNNs. 328 public low-dose chest CT scans from the National Lung Screening Trial (NLST) and 258 internal abdomen and pelvis CT scans of healthy kidney donors were collected. Hand-drawn left paraspinal muscle (LPSM) segmentations at the level of T12 were created using custom software. 80% of the scans were used to train and 20% were used for validation. A fully automated system of cascaded CNNs was developed to (1) identify the axial location of the T12 slice from sagittal slices, and (2) predict the axial T12 left paraspinal muscle segmentation. Axial slice selection performance was evaluated against the mean absolute error, and segmentations were evaluated on dice scores. LPSM segmentations yielded the following muscle quantitative imaging biomarkers (mQIBs): skeletal muscle cross sectional area (SMA), muscle radiation attenuation (SMRA), percentage muscle (SMT), lean muscle (SML), fatty muscle (SMF) and intermuscular adipose (IMAT). Agreement between manual and predicted mQIB metrics was analyzed using Bland-Altman analysis. Composite network performance metrics and mQIB metrics were compared using two-tailed unpaired Student’s t-tests to determine if cohort means were significantly different (p<0.05).

RESULTS
Mean absolute T12 axial slice selection error for the NLST (21.7 mm +/- 10.9 mm) and internal data (18.9 mm +/- 8.3 mm) were significantly different. There was no significant difference between T12 LPSM dice scores for the NLST (0.92 +/- 0.03) and internal data (0.93 mm +/- 0.03). SMA, SMRA, SMT, and SML values were significantly greater and SMF and IMAT values were significantly lower for the internal dataset when compared to those from the NLST dataset reflecting higher muscle quantity and quality.

CONCLUSION
Convolutional neural networks are a feasible approach for automating quantification of muscle mass and quality, and are able to distinguish between healthy and older patients with chronic disease at risk for sarcopenia.

CLINICAL RELEVANCE/APPLICATION
The quantification of mQIBs reflecting skeletal muscle mass and quality can be fully-automated using a cascaded system of CNNs, and should facilitate the diagnosis of sarcopenia.
**CLINICAL RELEVANCE/APPLICATION**

This workflow will support large-scale population studies that require accurate and time-efficient automated body composition measures.

**RC604-06 Machine Learning for Articular Cartilage**

**Thursday, Dec. 5 9:50AM - 10:10AM Room: N228**

**Participants**
Jacob C. Mandell, MD, Waltham, MA (Presenter) Nothing to Disclose

**For information about this presentation, contact:**
jmandell@bwh.harvard.edu

**LEARNING OBJECTIVES**

1) Provide an overview of current developments in machine learning applications in musculoskeletal imaging, within broad categories of: Detection/identification of abnormalities, segmentation of structures, grading and classification of abnormalities, and ancillary utilities. 2) Describe how the practice of MSK radiology can be changed or enhanced by these recent developments.

**RC604-07 Machine Learning for Musculoskeletal Trauma**

**Thursday, Dec. 5 10:40AM - 11:00AM Room: N228**

**Participants**
Michael L. Richardson, MD, Seattle, WA (Presenter) Nothing to Disclose

**For information about this presentation, contact:**
mrich@uw.edu

**LEARNING OBJECTIVES**

1) Be aware of the recent advances of machine learning in musculoskeletal trauma. 2) Know some of the more promising ways machine learning will be able to aid in detection of traumatic MSK injuries. 3) Know some of the more likely ways machine learning can be used to improve the workflow of interpreting MSK trauma cases.

**RC604-08 Highly Accelerated Knee MRI Using a Novel Deep Convoluted Neural Network Algorithm: A Multi-Reader Comparison Study**

**Thursday, Dec. 5 11:00AM - 11:10AM Room: N228**

**Participants**
Naveen Subhas, MD, Shaker Heights, OH (Presenter) Research support, Siemens AG
Hongyu Li, Buffalo, NY (Abstract Co-Author) Nothing to Disclose
Joshua M. Polster, MD, Shaker Heights, OH (Abstract Co-Author) Nothing to Disclose
Carl S. Winalsks, MD, Rocky River, OH (Abstract Co-Author) Institutional service agreement, Medical Metrics, Inc Institutional service agreement, BioClinica, Inc Institutional service agreement, PAREXEL International Corporation Institutional service agreement, CarthiLeal Ltd Shareholder, Pfizer Inc Spouse, Shareholder, General Electric Company
Nancy A. Obuchowski, PhD, Cleveland, OH (Abstract Co-Author) Research Consultant, Siemens AG; Research Consultant, IBM Corporation; Research Consultant, Elucid Bioimaging Inc; Research Consultant, FUJIFILM Holdings Corporation
Mingrui Yang, Cleveland, OH (Abstract Co-Author) Nothing to Disclose
Kenji Mamoto, Cleveland, OH (Abstract Co-Author) Nothing to Disclose
Xiaojian Li, PhD, San Francisco, CA (Abstract Co-Author) Nothing to Disclose
Leslie Ying, Buffalo, NY (Abstract Co-Author) Nothing to Disclose

**PURPOSE**

Previous work has shown the feasibility of reconstructing diagnostic quality images from a highly undersampled knee MRI acquisition to achieve a 6-fold acceleration with a novel machine learning algorithm using a 15-layer deep convolutional neural network (DCNN). The purpose of this study was to assess the interchangeability of highly accelerated images reconstructed using DCNN and a standard 3-layer CNN with non-accelerated images for evaluating internal derangement of the knee.

**METHOD AND MATERIALS**

2D fat-saturated (fs) sagittal proton-density weighted (PD) and non-fs PD coronal sequences from knee MRIs in 40 patients were reconstructed with DCNN and CNN techniques. 3 MSK radiologists, blinded to the technique, independently evaluated the menisci, ligaments, articular cartilage, bones and image quality on the DCNN, CNN and standard images. Interchangeability was measured by comparing the frequency of agreement between 2 readers both evaluating the standard images (intramodality agreement) with the frequency of agreement between 1 reader evaluating the accelerated images and the other reader evaluating the standard images (intermodality agreement). The mean difference in intramodality and intermodality agreement was calculated with 95% confidence intervals (CI). A non-inferiority margin of 10% excess disagreement when using accelerated images was used.

**RESULTS**

Intramodality agreement between standard images and intermodality agreement between standard and DCNN and CNN images were very similar for all of the evaluated structures. The increased disagreement (mean, [95% CI]) when standard images were replaced with DCNN and CNN images was, respectively,: medial meniscus tears -2.5% [-6.1,+1.1%] and 0% [-5.7,+5.7%]; lateral meniscus tears +1.6% [-4.4,+7.8%] and 0% [-5.7,+5.7%]; ACL tears -0.8% [-2.4,+0.8%] and -0.8% [-2.4,+0.8%]; articular cartilage +2.2% [-0.7,+5.1%], +3.0% [-0.1,+6.1%]. The image quality using standard, DCNN, and CNN images was graded as excellent or acceptable in 97.5%, 95% and 60% of cases, respectively.

**CONCLUSION**

A highly accelerated knee MRI reconstructed using a novel machine learning DCNN is diagnostically interchangeable with a standard
knee MRI with acceptable to excellent image quality in most cases.

CLINICAL RELEVANCE/APPLICATION

Machine learning reconstruction techniques to achieve highly accelerated MRI acquisitions provide the opportunity to increase access and reduce costs of knee MRIs.

RC604-09 Using AI to Improve Case Finding of Vertebral Fractures in the Fracture Liaison Service Setting

Thursday, Dec. 5 11:10AM - 11:20AM Room: N228

Participants
Ramy Mansour, MD, Oxford OX3 9DU, United Kingdom (Presenter) Nothing to Disclose
Rachel Eckert, RN, Oxford OX3 7HE, United Kingdom (Abstract Co-Author) Nothing to Disclose
Eldad Elnekave, MD, Shefayim, Israel (Abstract Co-Author) Employee, Zebra Medical Vision Ltd
Sarah Connacher, RN, Oxford OX3 7HE, United Kingdom (Abstract Co-Author) Nothing to Disclose

PURPOSE

Identifying patients with fragility fractures allows for the administration of effective secondary fracture prevention. Case findings is reliant on manual, time-consuming review and a high frequency of radiological reporting, which is typically low. This study evaluates the impact of an automated algorithm for retrospective identification of vertebral fractures on routine CT scans to improve case finding in the FLS setting.

METHOD AND MATERIALS

11,012 eligible CT chest or abdominal scans performed for other clinical indications of patients aged > 50 years old were retrospectively analysed by an automated algorithm trained to detect compression fractures. Scans detected as positive for fracture were reviewed by FLS nurses who underwent specific radiological training on VCF detection and were confirmed by a radiologist or rheumatologist locally. Patients with a confirmed VCF were contacted by the FLS nurses and offered further assessment and subsequent treatment as appropriate. Recruitment to the FLS was reported along with outcomes of follow up patients.

RESULTS

1,305 scans were detected as positive by the algorithm, of which 24.3% (317) were confirmed as positive by the FLS. 50% of scans in patients >75 had a fracture vs. 32% in patients aged 50-75 (p<0.01). Of 55 negative cases reviewed, none had a VCF. Of 80 confirmed VCF cases reviewed by the FLS team, 49% (39) were not mentioned in the radiology report. Of 50 confirmed cases of VCF detected by the algorithm, 41% went on the receive Denosumab, 7% received oral bisphosphonates, 7% were referred to the metabolic bone clinic, 20% treatment was decided by their GP, and the remainder either refused, died before follow up or did not require treatment.

CONCLUSION

An automated algorithm is an effective and scalable method to increase recruitment fracture prevention programmes and can increase the number of patients commencing secondary fracture prevention.

CLINICAL RELEVANCE/APPLICATION

Vertebral compression fractures are frequently under-reported on CT scans performed for other indications and represent a valuable source of FLS case-finding.

RC604-10 Development and Validation of a Deep Learning Multi-Task Model for Severity Grading of Radiographic Hip Osteoarthritis Features

Thursday, Dec. 5 11:20AM - 11:30AM Room: N228

Participants
Claudio E. Von Schacky, Munich, Germany (Presenter) Nothing to Disclose
Jae Ho Sohn, MD, San Francisco, CA (Abstract Co-Author) Nothing to Disclose
Felix Liu, BS, San Francisco, CA (Abstract Co-Author) Nothing to Disclose
Eugene Ozhinsky, San Francisco, CA (Abstract Co-Author) Nothing to Disclose
Sarah C. Foreman, MD, San Francisco, CA (Abstract Co-Author) Nothing to Disclose
Magdalena Posadzy, MD, Poznan, Poland (Abstract Co-Author) Nothing to Disclose
Pia M. Jungmann, MD, Zurich, Switzerland (Abstract Co-Author) Nothing to Disclose
Lorenzo Nardo, MD, Sacrameto, CA (Abstract Co-Author) Nothing to Disclose
Michael C. Nevitt, PhD, San Francisco, CA (Abstract Co-Author) Nothing to Disclose
Thomas M. Link, MD, PhD, San Francisco, CA (Abstract Co-Author) Research Grant, General Electric Company; Research Consultant, General Electric Company; Research Consultant, InSightec Ltd; Research Grant, InSightec Ltd; Consultant, Springer Nature; Research Consultant, Pfizer Inc;
Valentina Pedoia, PhD, San Francisco, CA (Abstract Co-Author) Nothing to Disclose

For information about this presentation, contact:
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PURPOSE

To develop and to validate a multi-task deep learning model for grading radiographic hip OA features and compare its performance to attending-level radiologists.

METHOD AND MATERIALS

We included 15364 hip joints on 7738 weight-bearing anterior-posterior pelvic radiographs from the Osteoarthritis Initiative cohort. Femoral osteophytes (FOS), acetabular osteophytes (AOS), joint space narrowing (JSN) were graded as absent, mild, moderate, severe according to the OARSI atlas. Subchondral sclerosis (SUBSCL) and subchondral cysts (SUBCYST) were graded for presence
or absence. The data was split 80%/10%/10% for training, validation, and testing. The images were cropped around the femoro-acetabular joint through a RetinaNet. The multi-task neural network was based on a Densenet-161 that served as a shared convolutional features extractor trained with a multi-task loss function. Fully connected layers for each feature were fine-tuned separately. Model performance was evaluated on a test set from the Osteoarthritis Initiative and an external test set consisting of clinical routine radiographs. Grading reliability was assessed with linearly weighted Cohen’s Kappa and compared to two attending-level radiologists.

RESULTS
The RetinaNet for hip joint localization correctly placed bounding boxes around the joint in 100% of the cases with excellent intersection over union of 0.91±0.068 and 0.91±0.063 for validation and test set, respectively. Moderate to excellent grading reliability was achieved for the assessment of radiographic OA features on the external test set with FOS 0.78 (95% CI: 0.67, 0.88), AOS 0.76 (95% CI: 0.67, 0.86), JSN 0.85 (95% CI: 0.78, 0.93), SUBSCL 0.92 (95% CI: 0.80, 1.0), SUBCYST 0.46 (95% CI: 0.14, 0.77) and was comparable to those of attending-level radiologists (Figure A). Figure B shows an example of a heatmap for grading FOS.

CONCLUSION
This study demonstrates the feasibility of a multi-task deep learning model to assess radiographic hip OA features with attending-level grading reliability.

CLINICAL RELEVANCE/APPLICATION
A deep learning model might aid radiologists or non-radiologist-clinicians in reading hip radiographs to improve workflow and grading reliability.

PURPOSE
The detection of change is an important and common task in radiology. Siamese neural networks employ parallel neural networks with shared weights to rank similarity between input images. We develop and test a Siamese neural network architecture to automatically detect change in medical images, applied to the progression of osteoarthritis in knee radiographs.

METHOD AND MATERIALS
Knee radiographs from 3026 patients longitudinally followed in the Multicenter Osteoarthritis Study (MOST) were collected, from which 43,164 unique within-patient comparisons were generated. The data was partitioned at the patient level, with 80, 10, and 10% of patients used for algorithm training, validation, and testing respectively. A convolutional Siamese network was built using twinned ResNet18 networks, with a contrastive loss function. This algorithm takes paired knee radiographs as inputs and calculates the Euclidean distance between the twinned network outputs, giving a measure of image similarity. Binary change predictions (i.e. change versus no change) were assigned by setting a Euclidean distance threshold. The algorithm was trained to detect binary changes in Kellgren-Lawrence (KL) grade for osteoarthritis at different time points. Performance was evaluated on the separate test set.

RESULTS
The algorithm achieved a receiver operator characteristic area under the curve (AUC) of 0.91, accuracy of 88%, and Cohen’s Kappa of 0.55, when evaluated on the test set for detecting change in KL grade in paired knee radiographs at different time points. Prediction accuracy was higher for larger changes and for no change in KL grade. Lower accuracy was seen for KL grade changes from grades 0 to 1 and 3 to 4. The Siamese network output (Euclidean distance) was correlated with the magnitude of KL grade change (Spearman rank correlation = 0.52).

CONCLUSION
By using a Siamese neural network architecture, changes between medical images can be detected with high performance as demonstrated with osteoarthritis in knee radiographs. The output of the algorithm correlates with the magnitude of change, despite not training explicitly on that magnitude.

CLINICAL RELEVANCE/APPLICATION
A specialized neural network architecture can detect change between medical images, with potential application to any disease involving imaging at multiple time points (e.g. cancer, vascular imaging).
Participants
Michael P. Recht, MD, New York, NY (Presenter) Nothing to Disclose

LEARNING OBJECTIVES

1) Identify the potential advantages of machine learning MR image reconstruction. 2) Understand some of the challenges and unsolved problems with machine learning MR image reconstruction.

Printed on: 01/19/20
Best Cases from the AIRP (In Conjunction with the American Institute for Radiologic Pathology) (Interactive Session)

Thursday, Dec. 5 8:30AM - 10:00AM Room: S404CD

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

Participants
Mark D. Murphey, MD, Silver Spring, MD (Moderator) Nothing to Disclose
For information about this presentation, contact:
mmurphey@acr.org
laurabancroft.md@gmail.com

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

LEARNING OBJECTIVES
1) Describe the importance of radiologic-pathologic correlation in evaluation of lesions involving the chest, nervous system, abdomen and musculoskeletal regions. 2) Identify imaging features that can limit our radiologic differential diagnosis based on radiologic-pathologic correlation using a case-based interactive learning environment. 3) Understand the pathologic basis for the distinct imaging appearances utilizing the best cases from the AIRP.

Sub-Events
RC624A  Thoracic
Participants
Jeffrey R. Galvin, MD, Baltimore, MD (Presenter) Nothing to Disclose

RC624B  Neuroradiology
Participants
Kelly K. Koeller, MD, Rochester, MN (Presenter) Nothing to Disclose

RC624C  Genitourinary
Participants
Darcy J. Wolfman, MD, Washington, DC (Presenter) Nothing to Disclose

RC624D  Gastrointestinal
Participants
Maria A. Manning, MD, Silver Spring, MD (Presenter) Nothing to Disclose

RC624E  Musculoskeletal
Participants
Mark D. Murphey, MD, Silver Spring, MD (Presenter) Nothing to Disclose

For information about this presentation, contact:
mmurphey@acr.org
Printed on: 01/19/20
LEARNING OBJECTIVES

1) To introduce common spinal injection procedures that are used for the diagnosis and treatment of neck and back pain disorders.
2) To learn the indications and contraindications for these procedures.
3) To understand how imaging guidance is used to perform these procedures.
4) To introduce some of the equipment and techniques that are helpful in performing spine injection procedures in a hands-on format with an opportunity for attendees to address their specific questions and concerns with the course faculty.

ABSTRACT

Image guided spine interventions can be used for the diagnosis and/or treatment of painful conditions of the spinal access. Diagnostic procedures often include specific nerve blocks that can be performed with anesthetic agents. Facet joint and sacroiliac joint pain syndromes can likewise be managed with spine interventional techniques. Epidural steroid injections can be performed using interlaminar, caudal or transforaminal techniques in the management of focal back or neck pain with an associated radicular pain component. More advanced, longer-lasting treatments include radiofrequency neurolysis which can also be used to manage facet or sacroiliac joint-related pain that temporarily responds to diagnostic median branch blocks or specific joint injections. Spinal cord stimulator placement is another advanced technique that can be used to manage chronic pain syndromes. The workshop emphasizes patient selection, imaging evaluation, procedure indication and contraindications in order to optimize treatment outcome.
RC652

Live Ultrasound Interventional Procedures: Joint Injections, Cyst Aspiration, Abscess Drainage, Vascular Access, Core Biopsy, and Foreign Body Removal (Hands-on)

Thursday, Dec. 5 8:30AM - 10:00AM Room: E264

MK IR US

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

Participants
Leah E. Braswell, MD, Columbus, OH (Moderator) Nothing to Disclose
Veronica J. Rooks, MD, Honolulu, HI (Presenter) Nothing to Disclose
Stephen C. O’Connor, MD, Boston, MA (Presenter) Nothing to Disclose
James W. Murakami, MD, Columbus, OH (Presenter) Nothing to Disclose
Kal Dulaimy, MD, Springfield, MA (Presenter) Nothing to Disclose
Hisham A. Tchelepi, MD, Los Angeles, CA (Presenter) Nothing to Disclose
Christian I. Carlson, MD, MS, Jbsa Ft Sam Houston, TX (Presenter) Nothing to Disclose
Horacio M. Padua Jr, MD, Boston, MA (Presenter) Nothing to Disclose
Ebonee Carter, MD, Fort Stewart, GA (Presenter) Nothing to Disclose
Eric Royston, DO, MPH, Tripler Army Med Ctr, HI (Presenter) Nothing to Disclose
Shankar Rajeswaran, MD, Chicago, IL (Presenter) Nothing to Disclose
Mabel Garcia-Hidalgo Alonso, MD, Majadahonda, Spain (Presenter) Nothing to Disclose
Nikhil Madhuripan, MD, Springfield, MA (Presenter) Nothing to Disclose
Jonathan R. Wood, MD, Honolulu, HI (Presenter) Nothing to Disclose
Timothy S. Wulfestieg, DO, Honolulu, HI (Presenter) Nothing to Disclose
Adam S. Young, MD, MBA, Los Angeles, CA (Presenter) Independent Contractor, Voxel Cloud Inc
Samuel Douglass, DO, Tacoma, WA (Presenter) Nothing to Disclose
Carmen Gallego, MD, Madrid, Spain (Presenter) Nothing to Disclose
Nathan Fagan, MD, Columbus, OH (Presenter) Nothing to Disclose
Allison S. Aguado, MD, Wilmington, DE (Presenter) Nothing to Disclose
Michael E. Cick, MD, Olympia, WA (Presenter) Nothing to Disclose
Jennifer L. Nicholas, MD, Saint Louis, MO (Presenter) Nothing to Disclose

For information about this presentation, contact:
ronirooks@gmail.com

LEARNING OBJECTIVES

1) Identify basic skills, techniques, and pitfalls of freehand invasive sonography. 2) Define and discuss technical aspects, rationale, and pitfalls involved in musculoskeletal interventional sonographic care procedures. 3) Successfully perform basic portions of hands-on US-guided MSK procedures in a tissue simulation learning module, including core biopsy, small abscess drainage, cyst aspiration, soft tissue foreign body removal, vascular access, and intraarticular steroid injection. 4) Incorporate these component skill sets into further life-long learning for expansion of competency and preparation for more advanced interventional sonographic learning opportunities.

Printed on: 01/19/20
MSCS52

Case-based Review of Musculoskeletal Radiology (Interactive Session)

Thursday, Dec. 5 10:30AM - 12:00PM Room: S406A

KA

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

Participants
Stacy E. Smith, MD, Weston, MA (Director) Nothing to Disclose

For information about this presentation, contact:
ssmith@bwd.harvard.edu

LEARNING OBJECTIVES
1) Learn current techniques and advances in Musculoskeletal imaging and Intervention. 2) Become familiar with current guidelines for diagnosis and management of MSK imaging findings. 3) Review critical Musculoskeletal disorders/disease physiology and pathology as it is depicted by multiple modalities. 4) Understand the vital role of imaging in the broad array of Musculoskeletal disorders in order to achieve optimum patient care.

ABSTRACT
This course is designed to highlight the vital role multimodality imaging plays in the assessment and diagnosis of Musculoskeletal disorders. Special emphasis will be placed on technical advances including MRI, MSK Ultrasound, CT, including DECT, and interventional guidance. A wide range of anatomic topics will be covered during this course including: shoulder, foot/ankle, knee, hand and wrist, including soft tissue/bone lesions and sports imaging. Our goal is to provide a broad update in the field while addressing new opportunities and challenges for everyday practice in the Musculoskeletal arena.

Sub-Events
MSCS52A  Foot and Ankle

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

For information about this presentation, contact:
dr.abhk@gmail.com

LEARNING OBJECTIVES
1) Learn to identify common pathology encountered in imaging the ankle / hind-foot, mid- and forefoot; cases will be selected to encompass common osteochondral, ligamentous, myotendinous capsular and soft tissue pathology.

MSCS52B  Sports Imaging

Participants
Abdullah Alkhayat, MBCh,FFR(RCSI), Kuwait City, Kuwait (Presenter) Nothing to Disclose

For information about this presentation, contact:
dr.abhk@gmail.com

MSCS52C  Hand and Wrist

Participants
Jenny T. Bencardino, MD, Jericho, NY (Presenter) Nothing to Disclose

LEARNING OBJECTIVES
1) Learn current techniques and advances in Musculoskeletal imaging and Intervention. 2) Become familiar with current guidelines for diagnosis and management of MSK imaging findings. 3) Review critical Musculoskeletal disorders/disease physiology and pathology as it is depicted by multiple modalities. 4) Understand the vital role of imaging in the broad array of Musculoskeletal disorders in order to achieve optimum patient care.

ABSTRACT
This course is designed to highlight the vital role multimodality imaging plays in the assessment and diagnosis of Musculoskeletal disorders. Special emphasis will be placed on technical advances including MRI, MSK Ultrasound, CT, including DECT, and interventional guidance. A wide range of anatomic topics will be covered during this course including: shoulder, foot/ankle, knee, hand and wrist, including soft tissue/bone lesions and sports imaging. Our goal is to provide a broad update in the field while addressing new opportunities and challenges for everyday practice in the Musculoskeletal arena.

Active Handout: Jenny T. Bencardino

LEARNING OBJECTIVES

1) To review educational cases of meniscal, ligamentous and osteochondral conditions affecting the native and postoperative knee assessed on MR imaging.
LEARNING OBJECTIVES

1) Review normal anatomy of the hip. 2) Identify imaging features of congenital hip abnormalities, arthritis, trauma, labral tears and hip impingement.

Printed on: 01/19/20
Musculoskeletal (Hardware and Orthopedic Implants)

Thursday, Dec. 5 10:30AM - 12:00PM Room: N226

PURPOSE
To evaluate MRI findings of hip arthroplasty infection and determine their diagnostic accuracy

METHOD AND MATERIALS
This retrospective case control study was approved by the local ethical committee. Dedicated Compressed-Sensing Slice Encoding for Metal Artifact Correction (CS SEMAC) MR exams from 40 patients with proven hip arthroplasty infection and 100 patients with non-infected arthroplasty were evaluated by two musculoskeletal radiologists for bone (peri-implant osteolysis, edema, periosteal reaction), articular (effusion, capsule appearance and thickness) and periprosthetic soft tissue findings (collection, intramuscular edema, bursitis, adenopathy). Chi square test was used to compare the groups. Sensitivity, specificity, positive predictive value (PPV) and negative predictive value (NPV) were evaluated for each finding. Interobserver reliability was assessed with κ statistics.

RESULTS
Differences between infection and control group was highly significant (P<0.001) for the three following findings. Periosteal reaction was found in 31 of 40 patients with infection and in 10 of 100 in the control group, with a sensitivity of 77.5%, a specificity of 90.0%, a PPV of 75.6% and a NPV of 90.9%. Capsule edema was found in 33/40 (infection group) and in 5/100 (control group), with a sensitivity of 82.5%, specificity of 95.0%, PPV of 86.8% and NPV of 93.1%. Intramuscular edema was found in 38/40 (infection group) and in 14/100 (control group) with a sensitivity of 95.0%, a specificity of 86%, a 73.1% PPV and a NPV of 97.7%. The interobserver agreement was almost perfect with κ values between 0.88 and 0.92.

CONCLUSION
The presence of periosteal reaction, capsule edema and intramuscular edema at MRI of hip arthroplasty has a high sensitivity, specificity and negative predictive value for diagnosing infection.

CLINICAL RELEVANCE/APPLICATION
State-of-the-art MRI allows excluding hip arthroplasty infection and could avoid unnecessary joint aspiration.
The diagnosis of early prosthetic joint infection (PJI), defined as within six weeks after total knee arthroplasties (TKA), can be difficult due to expected post-surgical changes and elevated inflammatory markers. The role of radiographic evaluation in this situation carries unclear clinical significance. This study had two primary aims: 1) To determine when soft tissue gas is no longer an expected post-operative radiographic finding; and 2) To determine whether soft tissue gas is predictive of early PJI. The secondary aim was to determine if soft tissue gas correlated with microbiological culture results. To the best of our knowledge, this is the first study to address these questions in the literature.

METHOD AND MATERIALS

IRB approved retrospective study of patients who underwent TKA from 2008-2018, with available imaging between 5 days and 6 weeks post-operatively, and no interval intervention prior to imaging. All confirmed early PJI cases were included (n=25; 15 patients). For comparison, TKA patients without PJI (n=180; 150 patients) were selected randomly. Radiographs were reviewed by two musculoskeletal radiologists for presence of soft tissue gas. Comparative analysis was performed using Fisher's exact, binomial and nonparametric t-tests. A two-tailed p<0.05 was considered significant.

RESULTS

Soft tissue gas was identified in 13/25 (52.0%, 28.3±2.3 days post-op) cases with early post-operative PJI and 4/180 (2.2%, 15.3±7.3 days post-op) cases without PJI (p<0.0001, odds ratio 47.67 (95% Confidence Interval (CI): 13.79-143.1)). Presence of soft tissue gas had a sensitivity of 0.52 (95% CI: 0.36-0.70) and specificity of 0.98 (95% CI: 0.94-0.99). Staphylococcus species were the dominant organisms in cases with gas (45.0%) and in the absence of gas (50.0%), p = 0.66; but cases with gas demonstrated a wider variety of microbiology species (p = 0.01). 100% of cases with soft tissue gas prior to a suggested cut-off of 15 days post-op had no evidence of early knee PJI while 92.9% of cases with soft tissue gas after this cut-off had confirmed early knee PJI.

CONCLUSION

Post-operative soft tissue gas present on imaging performed fifteen days or more after TKA is predictive of early PJI and associated with a wider spectrum of cultured organisms.

CLINICAL RELEVANCE/APPLICATION

Soft tissue gas on post-operative radiographs fifteen days or more after TKA is predictive of early knee PJI as opposed to an expected post-operative finding.

SSQ13-03 Evaluation of a New Adaptive Iterative Metal Artifact Reduction Method in Clinical Whole-Body Low-Dose CT Skeletal Survey Examinations

Participants
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PURPOSE

Whole-body low-dose CT (WBLDCT) skeletal surveys contain many images and are being increasingly performed. Current iterative metal artifact reduction (iMAR) methods require parameters that are tailored to metal type and body region, requiring creation of many image sets in patients with multiple metallic implants. This study aims to evaluate an adaptive iMAR (AiMAR) algorithm, which automatically selects best parameters to allow a single image set to be used across all body regions, for use in WBLDCT.

METHOD AND MATERIALS

Projection data were collected from 25 patients, each with two types of metal implants, who underwent clinical WBLDCT on Siemens SOMATOM Definition Edge or Force scanners (120kV; CAREDose4D on with quality reference mAs of 110 or 70, respectively). Implants included dental, shoulder, spine, hip and knee prostheses, as well as pacemakers. Three AiMAR strength settings (2, 4, and 5) were considered, in addition to the original images without metal artifact reduction. For each setting, soft tissue and bone kernel images were reconstructed with a 3 mm image thickness and increment, resulting in eight image series. All series were anonymized and randomized for a reader study. Two musculoskeletal radiologists scored the images for artifact degree, anatomy visualization, and diagnostic quality (all p<0.01). AiMAR strength 4 was ranked highest in overall performance.

RESULTS

K-related sample Friedman test revealed statistically significant differences among the four settings in artifact degree, anatomy visualization, and diagnostic quality (all p<0.01). AiMAR strength 5 showed best artifact reduction but was noted to cause tissue/bone cortex blurring or loss in 10/25 patients. AiMAR strength 4 was ranked highest in overall performance.

CONCLUSION

AiMAR was evaluated in patients with multiple implants for WBLDCT skeletal surveys. Strength 4 provided excellent metal artifact reduction in a single reconstruction to address multiple implants in the same patient, overcoming current workflow limitations from body-part-specific iMAR techniques.
WBLDCT skeletal survey exams often suffer from metal artifacts. The evaluated adaptive iterative metal artifact reduction algorithm with strength 4 provided significant metal artifact reduction for multiple implants while improving clinical workflow.

**SSQ13-04 Effect of Radiofrequency Pulse Transmission Polarization on Metal Related Artifacts at 3T Magnetic Resonance Imaging: Circular versus Elliptical Polarization**

**Thursday, Dec. 5 11:00AM - 11:10AM Room: N226**

**Participants**
- Iman Khodarahmi, MD, PhD, New York, NY (Presenter) Nothing to Disclose
- William Walter, MD, New York, NY (Abstract Co-Author) Nothing to Disclose
- John Kirsch, PhD, Boston, MA (Abstract Co-Author) Nothing to Disclose
- Ivan Fritz, MD, Baltimore, MD (Abstract Co-Author) Institutional research support, Siemens AG; Institutional research support, Johnson & Johnson; Institutional research support, Zimmer Biomet Holdings, Inc; Institutional research support, Microsoft Corporation; Institutional research support, BTG International Ltd; Scientific Advisor, Siemens AG; Scientific Advisor, General Electric Company; Scientific Advisor, BTG International Ltd; Speaker, Siemens AG; Patent agreement, Siemens AG

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**PURPOSE**
To investigate the effect of circular and elliptical polarization of the radiofrequency (RF) pulse on the metal related artifacts of total hip arthroplasty implants during Metal Artifact Reduction Sequence (MARS) MRI at 3T.

**METHOD AND MATERIALS**
For this in-vitro study, we used a clinical cobalt-chromium total hip arthroplasty system with polyethylene liner immersed in a standard ASTM gel phantom. Clinical MARS MR sequences including high-bandwidth turbo spin echo (HBW-TSE), Slice Encoding for Metal Artifact Correction (SEMAC), and compressed sensing (CS) SEMAC were acquired in axial, coronal, and sagittal planes using proton density weighting. Each scan was acquired twice with circular (CP) and elliptical (EP) RF polarization, while keeping other sequence parameters identical. After anonymization and randomization, metal artifacts were volumetrically quantified for CP and EP images using manual segmentation. Additionally, observers compared the two modes for overall image quality through side-by-side display of each image pair and selection of the preferred polarization mode (tied selections allowed). A p-value of less than 0.05 was considered significant for all statistical analyses.

**RESULTS**
On quantitative analysis, metal artifact degraded regions were significantly smaller on EP images compared to the corresponding CP images of the same location and pulse sequence (paired t-test: p < 0.02 for all pulse sequences). The overall artifact volume (including implant itself) calculated using axial HBW-TSE images was 19% lower for EP (510 cm3) compared to CP (608 cm3). Readers chose image quality of EP in 56% (95% CI: 51%-61%) and CP in 7% (95% CI: 4%-9%) of the cases with significantly superior image quality of EP (signed test: p-value < 0.001 for all pulse sequences).

**CONCLUSION**
MRI at 3T with elliptical RF pulse polarization results in stronger metal artifact reduction and overall superior image quality than circular polarization. Switching to elliptical polarization for 3T MARS imaging of metal containing body parts may eventually hold promise for in vivo clinical imaging.

**CLINICAL RELEVANCE/APPLICATION**
MARS MRI performed with elliptical polarization of the RF pulse has the potential to provide images with lower artifact and higher image quality instead of circular polarization.

**SSQ13-05 Impact of Stem Design and Cementation on Postoperative Femoral Antetorsion in 227 Patients with Total Hip Arthroplasty (THA)**

**Thursday, Dec. 5 11:10AM - 11:20AM Room: N226**

**Participants**
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- Benjamin Fritz, MD, Zurich, Switzerland (Abstract Co-Author) Nothing to Disclose
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**PURPOSE**
In total hip arthroplasty (THA), surgeons try to achieve a physiological antetorsion with a combined cup and stem approach. Still, postoperative antetorsion of the femoral stem is known to show large variabilities. The purpose of this study was to assess if postoperative femoral antetorsion is influenced by stem design or cementation.

**METHOD AND MATERIALS**
Following ethics approval, we analyzed the postoperative femoral antetorsion in metal suppressed MR examinations of 227 patients with THA and five stem (S) designs (S1-S5). S1 was cementless and short curved (n=32), S2 and S3 were cementless and standard straight (n=53 and n=51, respectively), S4 was collared cementless standard straight (n=48) and S5 cemented straight (n=43). Prostheses with suspected stem loosening were excluded. Two fellowship-trained musculoskeletal radiologists independently...
evaluated femoral antetorsion by measuring the angle between the axis along the proximal neck of the femoral component and a tangent aligned to the posterior femoral condyles. Statistical analysis included general descriptive statistics, univariate analysis and inter-reader reliability.

RESULTS

Inter-reader reliability was very good with an ICC of 0.98. The cementless collared S4 showed the highest antetorsion with 18.1° (SD ±10.5°; range -10° to 45°), which was significantly higher than the antetorsion of the collarless S3 with 13.9° (±8.4°; -4° to 29°) and the cemented S5 with 12.7° (±7.7°; -3° to 27°) with p=0.012 and p=0.007, respectively. S1 and S2 showed an antetorsion of 14.8° (±10.0°; 1° to 37°) and 14.1° (±12.2°; -20° to 41°), which did not differ significantly from S3-5 (all p>0.165). The combined standard deviation of the cementless stems (S1-4) was significantly higher compared to the cemented S5 with 10.5° and 7.7°, respectively (p=0.019).

CONCLUSION

Different patterns of femoral antetorsion exist for different stem types of THA, with some statistical differences between cemented and cementless stems as well as between cementless types with and without collar. The cemented stems demonstrated the lowest variability, suggesting the lowest rate of inadvertent malrotation during implant placement.

CLINICAL RELEVANCE/APPLICATION

This is the first study reporting the postoperative range of femoral antetorsion in patients with THA for different stem designs, and can be used as a reference dataset for clinical evaluation.

SSQ13-06  Loss of Reduction is Common After Coracoclavicular Ligament Reconstruction

Thursday, Dec. 5 11:20AM - 11:30AM Room: N226

Participants
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PURPOSE

Coracoclavicular ligament reconstruction is an increasingly common treatment for significant acromioclavicular joint injury. We have anecdotally noted loss of acromioclavicular joint reduction, coracoclavicular interval widening, distal clavicular osteolysis, and osseous tunnel widening on follow-up imaging. Our purpose is to report radiographic features and complications following coracoclavicular ligament reconstruction.

METHOD AND MATERIALS

Retrospective query of our imaging database identified 55 cases of coracoclavicular ligament reconstruction. Cases with at least one month of follow-up and available operative report were reviewed with attention to acromioclavicular joint alignment, coracoclavicular interval widening, distal clavicular osteolysis, widening of the osseous tunnel, and hardware complication. Two additional blinded radiologists reviewed the cases to assess for inter-reader agreement.

RESULTS

32 patients with post-operative imaging following coracoclavicular ligament reconstruction (23 male, 9 female; age range 24-64, imaged 1-34 months following surgery) were included. Loss of acromioclavicular joint reduction was the most common imaging finding at follow-up (n = 25), with 88% of cases seen within 6 months of surgery. 19 patients with loss of acromioclavicular reduction progressed to coracoclavicular interval widening. Distal clavicular osteolysis was seen in 21 patients, with 90% of cases seen within 6 months of surgery. Reconstruction tunnels widened on average 2 mm (range 0 - 4 mm). Hardware complication, including perihardware fractures, was seen in 6 patients. Loss of acromioclavicular joint reduction was found to have a statistically significant association with distal clavicular osteolysis (p = 0.032). Inter-reader agreement was substantial for coracoclavicular interval widening (k = 0.63), moderate for tunnel widening (k = 0.48) and hardware complication (k = 0.56), and fair for distal clavicular osteolysis (k = 0.40) and loss of acromioclavicular reduction (k = 0.39).

CONCLUSION

Loss of acromioclavicular joint reduction, distal clavicular osteolysis, and tunnel widening are frequently demonstrated after coracoclavicular ligament reconstruction.

CLINICAL RELEVANCE/APPLICATION

Radiologists should be aware of the common imaging findings following coracoclavicular reconstruction. Attention to early loss of reduction or distal clavicular osteolysis may guide treatment approach and impact patient outcomes.
To assess the clinical utility of a prototype metal artifact reduction sequence (MAVRIC-SL) at 3T. This sequence allows a surgical prosthesis-dependent spectral bin reduction. We compared the prototype MAVRIC-SL with conventional 2D FSE sequences and further compared MAVRIC-SL images acquired with all the spectral bins, and those with the optimized spectral bins.

**METHOD AND MATERIALS**

MAVRIC SL images were acquired in a total 25 subjects. For each subject, the optimized number of spectral bins were determined using a short spectral calibration scan. The MR image sets used for analysis consisted of MAVRIC-SL PD-weighted or MAVRIC-SL STIR or MAVRIC-SL PD-weighted acquired with all 24 spectral bins, the corresponding images with the optimized spectral bins, conventional image of PD-weighted FSE or STIR images. The images were reviewed by a musculoskeletal radiologist and were scored using a five-point scale for artifact reduction around the prosthesis, visualization of the prosthesis, and visualization of peri-prosthetic tissues. Quantitative evaluation of peri-prosthetic tissues was also done. For statistical analyses, Paired Sample t-test was used to test for significance.

**RESULTS**

The MAVRIC SL images enabled significantly improved metallic artifact reduction as compared with conventional 2D FSE sequences. The optimized spectral bin numbers calculated by the spectral calibration scan ranged from 6 to 20, and this depended on the prosthesis susceptibility, size, and the orientation to the B0 field. The scan times were significantly different (p=0.05, 20% reduced scan time). Compared to the MAVRIC SL images acquired with all 24 bins, artifact reduction, visualization of prosthesis and visualization of peri-prosthetic tissues was not significantly different.

**CONCLUSION**

Compared to the MAVRIC SL images acquired with all 24 spectral bins, MAVRIC SL acquired with an optimized number of spectral bins can reduce metallic implant induced susceptibility artifacts with no significant image quality degradation, while still providing a decrease in scan time. With fewer spectral bins, the patient convenience can be increased by reducing the scan time, or the reduced time can be used to increase the spatial resolution to obtain a higher resolution image.

**CLINICAL RELEVANCE/APPLICATION**

MAVRIC-SL with spectral bin modulation improved image quality and decreased metallic artifacts with similar scan times to conventional images.

**SSQ13-08 Comparison of Metal Artifact Reduction (MAR) Algorithms: Which is Better MAR for Hip Prostheses Evaluation**

Thursday, Dec. 5 11:40AM - 11:50AM Room: N226

Participants
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**PURPOSE**

To compare the effect of various metal artifact reduction (MAR) algorithms in CT imaging of patients with hip prostheses

**METHOD AND MATERIALS**

Total 47 patients with hip prostheses were enrolled who underwent dual-layer detector spectral CT (28 men and 19 women, mean age of 63.2±10.7 years). Conventional images (CI) with iterative reconstruction algorithm (iDose 2), CI with orthopedic metal artifact reduction algorithm (O-MAR), and a variable energy range of virtual monoenergetic image (VMI, 50~200 keV) were obtained from the dual energy CT data. The image quality was quantitatively assessed by comparing CT numbers, standard deviations (SDs), corrected image noise (CIN), contrast-to-noise ratios (CNRs) and artifact index (AIs) in the seven region-of-interests (ROIs) placed around the hip prostheses among three datasets. The structural similarity (SSIM) was used to quantitatively evaluate the performance of metal artifact correction in O-MAR and VMI using CI as a reference images. Qualitative evaluation included degree of metal artifact, conspicuity of bone trabeculation, and presence of pseudolesions.

**RESULTS**

The lowest image noise, AI, CNR were found in O-MAR, followed by high-keV VMI in most of the regions. VMI and O-MAR showed the similar SSIM values in periprosthetic region, but VMI showed significantly higher SSIM values than O-MAR in other soft tissue region, indicating lesser metal artifact reduction of VMI. On qualitative evaluation, O-MAR provided lesser metal artifact but induced new artifacts including lesser conspicuity of bone trabeculation, artefactual cortical thinning and pseudocemented appearance in the adjacent bone.

**CONCLUSION**

For evaluation of hip prostheses, O-MAR presented quantitatively and qualitatively favorable image quality than VMI and iDose 2, but it can generate new artifacts.

**CLINICAL RELEVANCE/APPLICATION**

As MAR algorithms are popularized in many institutions by technical advance, we need to know what the most favorable MAR algorithm is and to be aware of the new artifacts generated by MAR algorithm.
Metal-Artifacts in Orthopaedic Implants: How Can We Improve our CT-Scans and What About Tin-Filter Technology?

Thursday, Dec. 5 11:50AM - 12:00PM Room: N226

Participants
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PURPOSE
The purpose of the study was to assess, how to improve CT image quality in the presence of different orthopaedic implants while using various CT modalities, especially DECT and tin-filter technology vs conventional CT. Furthermore, we wanted to explore, if scanning at reduced dose can still provide good image quality in the presence of metal implants.

METHOD AND MATERIALS
4 cadavers (pelvis und lower L- spine) with different orthopaedic implants were tested, using 9 various scan-protocols, consisting of Full-dose (FD, CDTI 10 mGy) and low dose (LD, CDTI 3,3 mGy) scans. That included scans with tin-filter technique, DECT and conventional CT on a 3rd generation DECT scanner. Additionally, besides standard 3rd generation iterative reconstruction software (ADMIRE), a novel metal artefact reduction software (iMAR) was used. Evaluation was done by using a 6-part Likert scale for objective and subjective parameters.

RESULTS
In all 4 cadavers FD tin filter scans with 150 kV Sn showed the best overall results, which was improved by using MARS-software. Looking only at metal artefact reduction, the best results were obtained, using DECT technique (FD as well as LD), but these images suffered from high imaging noise, leading to a blurring of fine osseous structures as trabecular bone, which reduced their overall rating. Even low dose scans at 150 kV Sn, showed a good overall rating.

CONCLUSION
Tin filter technology did effectively reduce metal artefacts while providing good image quality of the adjacent bony structures near orthopaedic implants. While DECT showed the best metal artefact reduction it suffered from image noise, that obscured fine bony structures. Using a LD 150 kV tin filter program can significantly reduce dose (1/3 of normal dose) and still provide good image quality and good metal artefact reduction at the same time.

CLINICAL RELEVANCE/APPLICATION
Metal- artefact reduction is an important task in CT scanning. To explore the best possible way how to obtain this (by means of hardware-tools, software-tools or a combination of both) is important.
PURPOSE

To evaluate which MRI findings combined with clinical factors are characteristic of patients who undergo surgery for medial epicondylitis.

METHOD AND MATERIALS

In our retrospective study, 52 consecutive patients (mean age, 53.7 years; age range, 27 - 77 years; 16 men, 36 women) were included, who diagnosed as medial epicondylitis and performed elbow MRI between March 2010 and December 2018. Demographic and clinical data (age, gender, sides, initial VAS, symptom duration and history of injection therapy) were reviewed on electronic medical records. And MRI findings associated with medial epicondylitis (common flexor tendon [CFT] abnormality, ulnar neuropathy, joint effusion, MCL tear, traction spur, muscle edema and subchondral bone edema) were evaluated and measured. All review and image evaluation was performed by a radiologist who was blinded to the demographic data and patient’s ultimate treatment. Demographic and clinical data, MRI findings were compared between conservative treatment and surgical treatment groups, and logistic regression analyses were conducted to identify which was significantly associated with surgical treatment.

RESULTS

The CFT tear size showed statistically significant in both transverse and longitudinal planes (P < 0.001, P = 0.013, respectively) between the two groups. The grade of CFT abnormality on both transverse and longitudinal planes showed significant differences (P = 0.022 and P=0.003, respectively). A significant difference was also found for MCL tear grade (P = 0.025). The logistic regression showed that only the transverse diameter of the CFT tear size (P = 0.002; odds ratio: 1.864; 95% confidence interval [CI]: 1.264 - 2.750) was correlated with surgical treatment.

CONCLUSION

Patients diagnosed as medial epicondylitis with larger CFT tear size tend to ultimately undergo surgical treatment. Radiologists should pay attention to CFT tear size when interpreting elbow MRI for adequate treatment planning.

CLINICAL RELEVANCE/APPLICATION

Earlier decision of surgical treatment for medial epicondylitis can help patients save both time and money because they can avoid having to first undergo conservative treatment, which delays surgery.
PURPOSE
The diagnosis of Parsonage-Turner syndrome (PTS) is usually based on medical history, physical examination and electrodiagnostic tests. Recently ultrasound studies have identified reduced caliber in or terminal branches of the brachial plexus, this has been confirmed surgically in some cases with implication in prognosis and therapy. Our purpose is to analyze if this morphological change is correlated with the images of the neurography by MR (MRN).

METHOD AND MATERIALS
We retrospectively reviewed clinical information and MRN images of 17 patients with confirmed diagnosis of PTS, who presented at our institution over a 5-year period. MRN were analyzed by two radiologists with experience in this technique. All brachial plexus images were obtained using 3T MR scanner (Discovery 750; GE Healthcare, Madison, WI, USA) with 16-channel neurovascular coil using 2D IDEAL coronal T2-WI, 3D IDEAL coronal T1-WI, 3D FIESTA axial and DWI axial sequences. Pathological nerve was defined as: hyperintense signal on T2-weighted images and changes in the nerve thickness.

RESULTS
17 patients met the inclusion criteria, media age was 42 years +/- 16.7 with 6 females and 11 males; the time between the symptoms and MRN was 90.5 +/- 78.9 days (range 8 to 240 days). 61.5% patients presented clinical symptoms in the right arm, 23% in the left arm, and 15.3% in both arms, however we founded bilateral pathological nerve at MRN in all patients. All of our patients have multifocal nerve involvement. We founded 4 types of nerve constrictions in our cohort patients type I: incomplete focal constriction, type II: complete focal constriction (hourglass-like), type III: multifocal constrictions (string of pearls like), type IV (segmental constriction) (fig 1); Inter-observer agreement was almost perfect (Cohen’s kappa = 0.87) between MRN readers for this nerve findings.

CONCLUSION
In our patients we found bilateral and multifocal nerve affection of brachial plexus in all patients and identified different types of constrictions; this findings suggest that MRN may play a role in distinguishing PTS from others polyneuropathies. Additional prospective studies to assess the prognostic and therapeutic value of these findings are necessary.

CLINICAL RELEVANCE/APPLICATION
MRN may be used as a diagnostic aid in PTS, which was hitherto a clinical and electrophysiological diagnosis. Nerve constrictions in the MRN may be highly accurate in the diagnosis of PTS.

MK375-SD-THA3
MRI-based Radiomics Signature: A Potential Imaging Biomarker for Prediction of Histologic Grade, Preoperative Prediction of Recurrence, and Prediction of Survival Outcome for Liposarcoma in Extremities

Participants
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PURPOSE
To develop MRI-based radiomics signature and assess its ability for preoperatively predicting tumor histology grade of extremity, the recurrence, and survival outcome of extremity liposarcoma.

METHOD AND MATERIALS
Following institutional review board approval, the database of a hospital information system (HIS) was queried for lists of MRI examinations for liposarcoma in extremities. A total of 78 patients who underwent preoperative MRI for liposarcoma were enrolled in this retrospective study. 42 patients were enrolled for model development, and all the patients were followed up at least within 5 years. 36 were enrolled for validation. Radiomics features were extracted from T1-weighted image (T1w), T2-weighted image (T2w), and contrast-enhanced T1-weighted MR images (CE), and a radiomics signature was built by the least absolute shrinkage and selection operator (LASSO) logistic regression model. Liposarcoma histologic grade, recurrence, and overall survivals were evaluated in the radiomics features. T1w+T2w model and combined with CE model were built, and the area under the curve (AUC) of operating characteristics (ROC) was used to explore for model validation in the 36 patients validation set.

RESULTS
For recurrence prediction, 7 radiomics features for T1w, 7 for T2w, and 6 for enhanced T1w were chosen. For overall survival prediction, 5 radiomics features for T1w, 4 for T2w, and 4 for enhanced T1w were chosen. Five radiomics features for T1w, 7 for T2w, and 5 for enhanced T1w were chosen from 315 candidate features to build a radiomics signature that was significantly associated with tumor histology of low or high grades (P < 0.001), and they presented good performance in the discrimination of low- and high-grades liposarcoma with AUC of 0.667 (95% CI: 0.415-0.918) and 0.744 (95% CI: (0.559-0.929) in two models (with no significance), respectively.

CONCLUSION
The radiomics features of MRI were significant predictors for tumor histology grade, recurrence prediction, and overall survival in liposarcoma.

CLINICAL RELEVANCE/APPLICATION
The radiomics features of MRI were significant predictors for tumor histology grade, recurrence prediction, and overall survival in liposarcoma. Incorporating radiomics signature into conventional radiologic reading can perform better for preoperative estimation of prediction recurrence and overall survival than with radiologic findings alone.

MK391-SD-THA4
Virtual Bone Mineral Density Imaging with Third-Generation Dual-Source Dual-Energy CT for Diagnosis of Osteoporosis: A Preliminary Study
**PURPOSE**
To quantitatively assess the diagnostic value of dual-energy computed tomography (DECT) virtual bone mineral density (VBD) imaging for osteoporosis (OP) in patients with vertebral trauma.

**METHOD AND MATERIALS**
Forty-five consecutive patients (14 male; mean age 66.3 ± 9.8 years) with vertebral trauma were prospectively enrolled and underwent non-enhanced DECT (90 kV/Sn150 kV). DXA examination of lumbar vertebrae from L1 to L4 was performed in each patient subsequently. VBD images were derived from a three-material decomposition algorithm using commercially available post-processing software (syngo via dual energy; Siemens Healthcare). CT attenuation value (VBD_Att), calcium density (VBD_CaD) and fat fraction (VBD_Fat) on VBD images were measured for further analysis. CT value on conventional linear-blended image (LB_0.5) was recorded as well. Bone mineral density (BMD) and T-scores of lumbar vertebrae measured with DXA served as the gold standard. Pearson correlation analysis was performed to compare the DECT and DXA results. Diagnostic performance of VBD imaging was assessed by receiver operating characteristic (ROC) analysis.

**RESULTS**
A total of 166 lumbar vertebrae were evaluated in the study. LB_0.5 and VBD_Att were both significantly different in vertebral body with and without osteoporosis (all P<.001) (Table 1). VBD_Fat had no significant difference between osteoporotic and non-osteoporotic vertebral bodies (P=0.62). VBD_Att (r=0.74) and VBD_CaD (r=0.70) were significantly correlated with T-scores obtained from DXA (all P<.001) (Fig 1). However, no significant correlation existed between VBD_Fat and DXA-measured T-scores (r=0.14, P=0.08). Furthermore, sensitivity and specificity of VBD_Att and VBD_CaD for diagnosis of OP were 86.00%, 80.17% and 84.00%, 81.03% with cut off values of 239.5 HU and 10.9 mg/(cm*cm*cm), respectively (Table 2). The diagnostic efficiency was significantly higher with VBD_Att and VBD_CaD (AUC, 0.89 vs 0.88; P=0.57) compared to LB_0.5 (AUC, 0.77; all P<.001) (Fig 2). Figure 3 showed VBD image of a 66-year-old male patient. VBD_Att (236.2 HU), LB_0.5 (172.5 HU), VBD_CaD (10.8 mg/(cm*cm*cm)) and VBD_Fat (39.2%) were calculated with a freehand ROI set in a vertebral body.

**CONCLUSION**
Dual-energy VBD imaging shows reliable diagnostic performance for OP in patients with vertebral trauma.

**CLINICAL RELEVANCE/APPLICATION**
VBD imaging at DECT is useful for the diagnosis of OP in patients with vertebral trauma.
Ultrasound-guided regional anaesthesia (UGRA) is a cognitively demanding procedure that requires a clinician to guide a needle to a target nerve to deliver anaesthetic. In this study, we investigate a real-time AI helper for UGRA. We show that an AI algorithm can be taught to recognise key anatomical features for the subsartorial femoral triangle block (also known as the adductor canal block). This potentially reduces the cognitive load of the clinician, simplifying the procedure and improving operator confidence.

**PURPOSE**

The selected block area on 84 healthy volunteers was scanned by a sonographer. Anonymised ultrasound video was recorded, resulting in 150,017 distinct images. These images were segmented by hand to identify the following key anatomical features: Subsartorial nerve complex, Femoral artery, Sartorius muscle, Adductor longus muscle and Femur bone. Data from 5 volunteers (9,745 images) were sequestered for validation. The remaining 140,272 images were used to train a deep-learning semantic segmentation model. The model was run on the validation set and the outputs used to highlight the original B-mode videos. These were validated by 1) clinical assessment by a consultant anaesthetist and 2) computation of mean pixel accuracy.

**RESULTS**

1) No clinically significant segmentation errors were found. 2) The model achieved the following mean-pixel accuracy scores on the validation data: Subsartorial nerve complex: 0.998 Femoral artery: 0.996 Sartorius muscle: 0.983 Adductor longus muscle: 0.971 Femur bone: 0.995 Figure 1 shows predicted segmentation on images from the validation set, where each row contains the original ultrasound image, the ground-truth segmentation and the predicted segmentation.

**CONCLUSION**

Our proof-of-principle shows that an AI algorithm can accurately highlight key anatomical features on an ultrasound image in real time, and that this produces clinically useful results. We believe this would be particularly useful to trainees or other clinicians who do not perform UGRA regularly. Future research will look to extend the model to other block regions, and to quantify the benefits of real-time anatomical feature display in clinical practice.

**CLINICAL RELEVANCE/APPLICATION**

A trained AI algorithm accurately highlights key anatomical features for ultrasound-guided regional anaesthesia, producing visually accurate and useful results.

**TEACHING POINTS**

- Define and characterize the ramp lesions in epidemiological, anatomical and biomechanical terms
- Demonstrate the image patterns in magnetic resonance imaging (MRI) and how the computerized arthrotomography can help in the diagnosis of doubtful cases
- Discuss the situations that make difficult the diagnosis of ramp lesions and how this impacts the therapeutic decision

**TABLE OF CONTENTS/OUTLINE**

Definition of Ramp lesion
- Epidemiology and risk factors
- Anatomical and biomechanical review
- Structures that compose the posteroomedial compartment of the knee
- Relationship between anterior cruciate ligament rupture and mechanical overload of the posterior horn of the medial meniscus
- Meniscal slope
- Characteristics in MRI and computerized arthrotomography of the knee, highlighting the role of this last method in visualizing lesions of difficult perception to MRI
- Correlate the findings in the imaging tests with the intraoperative diagnosis
- Discussion of situations that may hinder the diagnosis of Ramp lesions
- Time between injury and imaging tests
- Relationship of knee positioning with extension in imaging tests and reduction of meniscocapsular separation
- Vertical tear in the periphery of the posterior horn of the medial meniscus
- Review of treatments and how the absence of diagnosis will impact the therapeutic decision

**Conclusions**
Dancing Feet: Biomechanism and Imaging Findings of Foot and Ankle Musculoskeletal Injuries in Dancers

**Participants**
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**TEACHING POINTS**
- Biomechanism of foot and ankle musculoskeletal injuries in dancers' practice.
- Imaging findings of the most common and peculiar foot and ankle musculoskeletal injuries in professional and amateur dancers.

**TABLE OF CONTENTS/OUTLINE**
Dance is an art that combines athleticism with artistry. To meet the professional demands, dancers are subjected to strenuous training routines, which can lead to the development of injuries. Previous studies have reported injury incidence rates of 67% to 95% among professional ballet dancers and 17% to 24% in modern dancers. The foot and ankle of a dancer are particularly vulnerable to injury and represent 34% to 62% of all injuries reported. Although dancers develop overuse injuries common in other athletes, they are also susceptible to unique injuries. Our purpose is to review the biomechanism and imaging findings of common and peculiar foot and ankle injuries in professional and amateur dancers, with emphasis in information that influence treatment choice.

Beyond Musculoskeletal Imaging

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**TEACHING POINTS**
The aim of this presentation is to highlight significant vascular findings on musculoskeletal studies, particularly on modalities for which the vessels are not optimally imaged or may be overlooked.

1. Understand normal appearance of vasculature on all imaging modalities.
2. Incorporate assessment of vasculature in routine search pattern to avoid inattentional blindness.
3. Recognize urgent and unexpected vascular findings and review next steps to clinical management.

**TABLE OF CONTENTS/OUTLINE**
1. Normal vascular appearance and anatomy on CT, MR, and XR.
2. Significant vascular findings on routine musculoskeletal studies.
   a. Thromboembolic - fat embolism in popliteal vein (CT), deep venous thrombosis in popliteal vein (MR) b. Aneurysmal - mycotic aneurysm of the internal iliac artery (MR), aortic aneurysm with concern for active rupture (CT), splenic artery aneurysm (XR) c. Trauma - knee dislocation with popliteal artery transection (CT), cervical spine trauma with vertebral artery injury (CT) d. Anatomical variants - aberrant anterior tibial artery (MR)

Gluteal Pathology in the Kardashian Era: An Imaging Review

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**TEACHING POINTS**
At the end of this exhibit the learner should be able to understand the anatomy of the gluteal musculature and its relationship to the pelvis and hips. Be able to identify and accurately describe the CT and MR appearance in relation to the gluteal region (ranging from cosmetic procedures and their complications to other established pathologies including muscle nerve pathology, depositional diseases, neoplastic and non-neoplastic lesions).

**TABLE OF CONTENTS/OUTLINE**
Normal gluteal anatomy: CT and MR appearance Imaging of cosmetic procedures such as silicone injections, placement of gluteal implants, and complications Infectious pathologies (e.g., decubitus ulcers, abscess) Non-neoplastic mass lesions (e.g., keratinaceous cyst, tumoral calcinosis, amyloidoma, Klippel-Trénaunay syndrome, fibrolipomatous hamartoma) Low-grade neoplasms (e.g., myxoma) High-grade neoplasms (e.g., osteosarcoma, chondrosarcoma, myxoid sarcoma, high-grade sarcoma) Metabolic-related conditions (e.g., muscle necrosis after Tylenol overdose, rhabdomyolysis) Other miscellaneous pathology involving the gluteal region (e.g., sciatic neuritis, polio, dermatomyositis)

Anatomy of Bone Nutrient Vessels Related to Avascular Necrosis

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TEACHING POINTS

To visualize typical extraosseous and intraosseous small blood supply of susceptible bones vulnerable to avascular necrosis (AVN) by use of non-enhanced or enhanced MR angiography and cone beam CT. To understand the unique anatomy of bone nutrient vessels related to posttraumatic and non-traumatic AVN.

TABLE OF CONTENTS/OUTLINE

Traumatic AVN related to small and few nutrient vessels Scaphoid and lunate bone enclosed in articular cartilage supplied by the radial carpal artery Talus bone without secondary blood supply related to tendon attachment supplied by the tarsal canal artery and deltoid vessels Femoral head supplied by the retinacular arteries in the femoral neck arisen from the medial circumflex femoral artery in flexed manner Vertebbral body collapse in Kümmell disease Non-traumatic AVN related to intramedullary pressure increase of the long bone Blockage of a communication in blood vessels between the epiphysis and metaphysis by the epiphyseal line in early childhood Bone shaft nutrient vessels in the humerus, femur and tibia Knee condyle nutrient vessels related to fragility fractures

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Intracortical Bone Mineral Density Correlates Well with Quantitative Susceptibility Mapping (QSM) Obtained from Cones Ultrashort Echo Time Magnetic Resonance Imaging (UTE-MRI)

PURPOSE
To implement Cones 3D ultrashort echo time MRI (UTE-MRI) for ex vivo quantitative susceptibility mapping (QSM) and to investigate the correlations of QSM with intracortical bone mineral density (BMD).

METHOD AND MATERIALS
9 tibial midshaft cortical bone specimens (61±15 yo) were embedded in 1% weight/volume agarose gel and then scanned on a clinical 3T MRI scanner (MR750, GE) using an eight-channel T/R knee coil for QSM measurement. The scans involved Cones 3D UTE-MRI sequences with the following TEs: 0.032, 0.2, 0.4, 1.2, 1.8, 2.4 ms. Other scanning parameters were as follows: bandwidth=83.3kHz, flip angle=10°, TR=30ms, matrix size=256×256x30, voxel size=0.5×0.5×2 mm3. A complex (magnitude and phase) 4D matrix was generated from the 6 single echo acquisitions. The preliminary field map and R2* were estimated using an iterative decomposition of water and fat with echo symmetry and least-squares estimation algorithm(1). Then, the inhomogeneity field map was obtained by fitting the complex 4D matrix to an R2* signal model-based iterative least-squares estimation with a multi-peak model(2). Specifically, the Projection onto Dipole Fields (PDF) algorithm was used to remove the background from the frequency shift and phase map(3). Specimens were scanned later using a Skyscan 1076 (Kontich, Belgium) μCT at 9 μm3 voxel size to measure bone porosity and BMD. Pearson's correlation coefficients were calculated between QSM and μCT measures.

RESULTS
Figs. 1a, b illustrate the Cones UTE-MRI QSM map and one representative μCT slice, respectively, of a representative tibial bone specimen. Figs. 1c, d illustrate the bone porosity and BMD maps, respectively. QSM showed significantly (p<0.01) strong correlations with BMD (R=-0.70). Scatter plots and linear regressions of QSM on BMD and bone porosity are shown in Figs. 1e,f, respectively.

CONCLUSION
Cones 3D UTE-MRI previously demonstrated a faster scanning process. The significant strong QSM-BMD correlations highlighted the Cones 3D UTE-MRI QSM technique as a useful method to assess intracortical BMD.

CLINICAL RELEVANCE/APPLICATION
A UTE-MRI-based QSM technique which correlates well with the intracortical BMD may be useful in future clinical bone studies while avoiding ionizing radiation.
PURPOSE

Accurate assessment of plasma cell infiltration of the bone marrow supports diagnosis and monitors treatment response in patients with multiple myeloma (MM). This study retrospectively investigated whole-body diffusion-weighted imaging (WB-DWI) in the evaluation of bone marrow infiltration in MM.

METHOD AND MATERIALS

Patients with MM who underwent WB-DWI between January 2016 and October 2018 were enrolled. Patients received high dose chemotherapy with autologous stem cell transplantation after an induction regimen. Treatment response was assessed by the National Comprehensive Cancer Network guidelines. WB-DWI was performed to measure the apparent diffusion coefficient (ADC) values. The degree of bone marrow infiltration was assessed by bone marrow biopsy within three days of WB-DWI.

RESULTS

Sixty-eight patients with MM who underwent WB-DWI after treatment were included in the study. Their mean age was 56.91 ±8.57 years and 67.6% were male. Durie-Salmon stage was IIA to IIIB. There was a negative correlation between the ADC value and the degree of bone marrow infiltration in the right ilium and this was statistically significant (r=-0.829, P<0.001). Eleven patients also underwent WB-DWI before starting treatment and 10 (91%) had complete response or very good partial response; their ADC values after treatment were significantly higher than those before treatment (P=0.004).

CONCLUSION

The ADC value was negatively correlated with the degree of bone marrow infiltration in the right ilium. In 11 patients also monitored before treatment the ADC values of the largest lesion were shown to increase after treatment.

CLINICAL RELEVANCE/APPLICATION

(Dealing with whole-body diffusion-weighted imaging) WB-DWI is important to patients with multiple myeloma in evaluation of intramedullary lesions.

MK378-SD-THB3  Clinical Utility and Economic Impact of Screening Follow-Up Upper Extremity Radiographs in Children with Uncomplicated Distal Radius Fractures

Station #3

Participants
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PURPOSE

The distal radius is one of the most common sites for pediatric fractures. Fractures that involve the physis have a theoretical risk for development of a physeal bridge with subsequent growth disturbance. Delayed radiographs are sometimes obtained in asymptomatic children with prior distal radius fractures to evaluate for development of a physeal bridge. The purpose of this study was to investigate the clinical utility and economic impact of obtaining routine delayed radiographs in asymptomatic patients with uncomplicated distal radius fractures.

METHOD AND MATERIALS

IRB approval was obtained. Radiology records were searched retrospectively between January 1, 2016 and January 1, 2018 to identify patients with a documented acute Salter-Harris type 2 (SH2) fracture of the distal radius and delayed wrist radiography at 3 to 6 months after the injury. Exclusion criteria included prior distal radius surgery, suspicion for a physeal bridge based on clinical symptoms, additional wrist trauma or history of infection. Radiography was correlated with MRI and clinical data as a reference standard for the presence of a distal radius physeal bridge. The financial cost associated with follow-up imaging was determined based on standard charges associated with wrist/forearm radiography, wrist MRI, and orthopedic clinical follow up.

RESULTS

A total of 381 children with SH2 fractures of the distal radius and delayed radiographs were identified. Four children were excluded due to clinical symptoms or surgery to the same wrist, for a total population of 377. Five patients (1.3%) were found to have a distal radius physeal bridge on delayed radiographs. Based on routine institutional charges for the delayed radiographs and orthopedic visit, total billed charges for the 377 patients would be approximately $245,804. This equates to approximately $49,161 per identified physeal bridge. Only 3 of the 5 cases with a physeal bridge went on to surgical treatment. The billed charges per identified physeal bridge, requiring surgery, equates to approximately $81,935.

CONCLUSION

In asymptomatic children, with uncomplicated SH2 fractures of the distal radius, detection of a physeal bridge on delayed radiographs is rare. Although it is common clinical practice, the financial burden of routine delayed follow up in asymptomatic patients is an important consideration.

CLINICAL RELEVANCE/APPLICATION

Need for follow-up radiography in wrist fracture.

MK348-SD-THB4  Comparison of the Clinical Value of Two MR Metal Artifact Reduction Sequences in Patients with Malignant Bone Tumor after Joint Replacement

Station #4

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PURPOSE
To compare the image quality and diagnostic value of two metal artifacts reduction sequences in patients with malignant bone tumor after joint replacement.

METHOD AND MATERIALS
MR scans with syngo-WARP sequences and simple parameter adjustment sequences were performed on 3 prosthesis phantoms and patients with malignant bone tumor after joint replacement. The artifact area of the prosthesis was measured on the largest plane of the artifact in each sequence of MR images, and the MR image quality of patients in each sequence is evaluated. Wilcoxon signed rank test was used to evaluate the differences of image quality between syngo-WARP sequences and simple parameter adjusted sequences. The sensitivity, specificity, and consistency rate of syngo WARP sequences were compared with simple parameter adjusted sequences in diagnosing local recurrence of malignant bone tumors. The Kappa test was used to assess the consistency of syngo WARP and simple parameter adjusted sequences with pathology in diagnosing recurrence, respectively.

RESULTS
The artifact areas of the 3 prosthesis phantoms were all larger in the simple parameter adjusted sequences than the syngo-WARP sequences. MR scans with syngo WARP sequences were performed for 94 patients, and simple parameter adjusted sequences for 60 patients. There was no statistical difference in the image quality of the coronal T1WI (P=0.642) and coronal STIR (P=0.337) between the two sequences. However, the image quality of transverse STIR in the syngo-WARP sequences was better (P=0.004). The sensitivity, specificity, coincidence rate and Kappa value in diagnosing local recurrence of malignant bone tumors were 93.9%, 91.8%, 92.6%, and 0.840 for syngo WARP sequences, and 94.7%, 85.4%, 88.3% and 0.748 for simple parameter adjusted sequences.

CONCLUSION
Syngo-WARP sequences can reduce metal artifact more effectively than simple parameter adjusted sequences, and have higher specificity, coincidence rate and Kappa value in diagnosing local recurrence of malignant bone tumors after joint replacement.

CLINICAL RELEVANCE/APPLICATION
Syngo-WARP sequences can reduce metal artifact more effectively than simple parameter adjusted sequences, and have higher specificity, coincidence rate and Kappa value in diagnosing local recurrence of malignant bone tumors after joint replacement.

MK395-SD-THB6 Self-Improving AI-Assisted Semiautomated Musculoskeletal MR Image Segmentation

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PURPOSE
Organ segmentation is crucial for the development of anatomical models used to facilitate complex therapy planning, interdisciplinary communication, and patient-physician interactions. It can aid quantitative imaging in the assessment of early cartilage damage. Current segmentation approaches are relatively time-consuming, limiting clinical throughput and adoption of advanced visualization and 3D printing. Emergent AI-assisted segmentation methods do not currently have a built-in capacity to capitalize on AI self-improvement after deployment, limiting improvement or extension across organ systems.

METHOD AND MATERIALS
We demonstrate AI-boosted software for MR-based patellofemoral compartment cartilage segmentation. We trained 2D V-Net CNN on 15872 3T CUBE and SPACE PDFS 0.3mm axial and sagittal manually MSK radiologist-segmented knee images from 31 patients with normal and abnormal cartilage (75% training, 20% validation, 5% testing). Resultant CNN-based initial segmentation was presented in an interactive Unity engine-based GUI with advanced segmentation tools, developed in house. Following manual correction, cases are added to a dataset for CNN retraining at regular intervals. We compared randomly ordered cartilage segmentation times using existing and proposed approaches for 20 patients segmented by two experts. Dice and agreement coefficients were used to evaluate our segmentation accuracy against manual standard.

RESULTS
Our method results in a significantly shorter segmentation time, 12.9+/−9.2 min compared to manual 139.5+/−46.0 min (p << 0.001). This improvement results in minimal segmentation disagreement, with a mean dice coefficient of 0.90 (0.79 - 0.94), which is not significantly different from the inter-observer variability using manual segmentation (p=0.18). Additional cases submitted for CNN retraining resulted in modest and variable segmentation time and accuracy gains.

CONCLUSION
We present accessible, self-improving AI-boosted software to dramatically facilitate segmentation without significant accuracy loss, using patellofemoral cartilage as an example, given the previous relative paucity of AI studies of its anatomy.

CLINICAL RELEVANCE/APPLICATION
MK346-ED-THB7

Bone Injury Patterns and Pseudofractures of the Knee: Are You Familiar with Them?

Station #7

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TEACHING POINTS

The purpose of this study is: To review the imaging appearance of typical trauma contusion patterns, avulsion fractures and pseudofractures of the knee, using radiographs and MRI. • To review the anatomy of the knee and discuss the relations of bone injuries with trauma mechanism and soft tissue damage. To instigate people to test their knowledge about the topic, using a quiz format.

TABLE OF CONTENTS/OUTLINE

The knee has typical bone contusion patterns and avulsion fractures, with well-known relation to trauma mechanism and soft tissue injury. Identifying avulsion fractures on radiographs, although sometimes difficult, may predict the underlying soft-tissue abnormality and lead to proper treatment, and thus avoiding chronic instability. Identifying typical bone injury patterns on MRI also increases the diagnostic confidence for associated lesions. The most typical avulsion fractures include Segond fracture, reverse Segond fracture, Osgood-Schlatter disease, Sinding-Larsen-Johansson syndrome, arcuate complex avulsion and avulsion of the anterior and posterior cruciate ligaments. The radiologist also plays a role identifying common anatomical variants of the knee which may mimic fractures causing unnecessary treatment, including patella dorsal defect, bipartite patella, variations in femoral condyle ossification, cystemella and meniscal ossicle.

MK347-ED-THB8

Left Foot, Right Foot, Feet, Feet, Feet: Imaging Evaluation of Ankle and Foot Instrumentation and Reconstruction

Station #8

Awards
Certificate of Merit

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TEACHING POINTS

To review and understand current concepts in foot and ankle reconstruction and the orthopedic hardware utilized. To review the radiographic evaluation of foot and ankle malalignment. To become familiar with the prostheses and instrumentation utilized, and understand the physiology of the corrective surgical techniques. To review normal post-operative imaging findings.

TABLE OF CONTENTS/OUTLINE

Review the radiographic evaluation of foot and ankle malalignment including: Hindfoot varus/valgus Pes planovalgus Pes cavovarus Hallux Valgus Hammertoes/claw toes Illustrate examples of procedures performed for end-stage osteoarthritis or malalignment reconstruction. Explain the physiology goals and the instrumentation utilized: Ankle / Hindfoot Arthroplasty Arthrodesis Talar replacement Calcaneal Osteotomy Midfoot Arthrodesis Navicular replacement Tendon transfer Forefoot Arthroplasty Hammertoe repair Bunionectomy Arthrodesis Review the expected normal postoperative appearances of hindfoot and forefoot reconstruction, and illustrate examples of hardware failure

MK344-ED-THB9

Elusive Complications in Hip Arthroplasty - Dare to Spot It: Imaging Features of Uncommon Postoperative Complications

Station #9

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TEACHING POINTS
Total hip arthroplasty (THA) is most frequently performed for advanced osteoarthritis (OA) of the hip, with >1 million estimated procedures undertaken worldwide annually. The incidence of complications is low, but due to the frequency of the procedure, they are quite commonly seen images in daily radiology practice and require accurate interpretation for early necessary intervention by the surgeon. Modern Total Hip Arthroplasty (THA) systems are modular, with a variety of newer bearings and coating surfaces making it more challenging to identify early complications. This exhibit will serve as a primer for radiologists about what to look for in immediate postoperative evaluation, clearly elaborate normal and abnormal findings on follow up evaluation and what not to miss while looking for elusive complications in follow up imaging studies.

**TABLE OF CONTENTS/OUTLINE**

Brief review of various types of hip implants and it’s imaging features. Normal / Acceptable radiological anatomy of artificial hips. Radio-opacity, artifacts in different material types. Abnormal Imaging findings in common and rare elusive complications at follow up visits.

**MK343-ED-THB10  Piriformis Muscle Variants: Not Always the Culprit!**

**Wards**

Certificate of Merit

**Participants**

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**TEACHING POINTS**

* Determine the major anatomical variations of the piriformis muscle and sciatic nerve * Exemplify with mri exams most of the variations and findings associated with deep gluteal pain syndrome

**MK345-ED-THB11  Spaces and Interfaces: An Approach to Tendon Pathology in MR Imaging of the Hand and Wrist**

**Wards**

Cum Laude

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**TEACHING POINTS**

1. Review the normal and abnormal appearance of tendons in the hand and wrist on MRI2. Present the anatomy and pathology of tendons in the context of fibro-osseous interfaces and soft tissue spaces3. Review the pathology that occurs at these interfaces and spaces through MRI examples

**TABLE OF CONTENTS/OUTLINE**

1. MRI appearance of normal and abnormal tendons in the hand and wrist2. Anatomy of Interfaces3. Pathology and Pathomechanics of Interfaces4. Pathology and Pathophysiology of Spaces - allow spread of tenosynovial processes (infectious, inflammatory, or neoplastic) throughout the hand and wrist

**MK008-EB-THB  Hands Up! Systemic Diseases with Characteristic Imaging Findings in the Hand**

**Hardcopy Backboard**

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TEACHING POINTS

1) Systemic diseases can involve several organ systems and have characteristic imaging findings in the hand. 2) It is important to be familiar with these imaging findings in order to diagnose these systemic diseases.

TABLE OF CONTENTS/OUTLINE

Background A systemic disease is any disorder that affects multiple organ systems and the hands can be the initial presenting site. Recognition of these hand findings on imaging, including those discovered incidentally, will aid in early diagnosis and prevent unnecessary workup. Imaging considerations: Hand findings can be well evaluated on radiography; however, CT and MRI can also be helpful. It is important to have a systematic approach by evaluating for abnormalities of the joint space, bones, and soft tissues. The bones can be further assessed for congenital deformities and periostitis. Systemic diseases with hand findings: Arthritis (osteoarthritis, psoriatic, rheumatoid, gout), Neoplastic (multiple enchondromatosis, hypertrophic pulmonary osteoarthropathy, acromegaly, thalassemia), Inflammatory/Autoimmune disorders (SLE, scleroderma, sarcoidosis, dermatomyositis), Congenital (Marfan’s, Down’s, Hadju Cheney, Turner), Metabolic Bone Disorders (hemochromatosis, hyperparathyroidism, osteoporosis, renal osteodystrophy, tumoral calcinosis, mucopolysaccharidosis), Infectious (tuberculous).

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Interventional Oncology Series: Musculoskeletal Intervention
Thursday, Dec. 5 1:00PM - 3:00PM Room: S405AB

Participants
Steven Yevich, MD, MPH, Houston, TX (Moderator) Speakers Bureau, Endocare, Inc
Matthew R. Callstrom, MD, PhD, Rochester, MN (Moderator) Research Grant, EDDA Technology, Inc Research Grant, Galil Medical Ltd Consultant, Medtronic plc Consultant, Endocare, Inc Consultant, Johnson & Johnson Consultant, Thermedical, Inc

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LEARNING OBJECTIVES
1) To describe common complications that occur with MSK intervention. 2) To share tips and tricks to facilitate effective MSK interventions. 3) To highlight necessary pre-procedural patient preparation and post-procedural expectations.

VSI051-01 Treatment of Non-malignant MSK Tumors
Thursday, Dec. 5 1:00PM - 1:10PM Room: S405AB

Participants
Steven Yevich, MD, MPH, Houston, TX (Presenter) Speakers Bureau, Endocare, Inc

VSI051-02 Top 10 Lessons Learned in MSK Ablation and Embolization
Thursday, Dec. 5 1:10PM - 1:20PM Room: S405AB

Participants
Anil N. Kurup, MD, Rochester, MN (Presenter) Research Grant, Galil Medical Ltd; Research Grant, EDDA Technology, Inc; Royalties, Wolters Kluwer nv

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LEARNING OBJECTIVES
1) To describe common complications that occur with MSK intervention. 2) To share tips and tricks to facilitate effective MSK interventions. 3) To highlight necessary pre-procedural patient preparation and post-procedural expectations.

VSI051-03 Ablation in the Spine and Paraspinal Tissues
Thursday, Dec. 5 1:20PM - 1:30PM Room: S405AB

Participants
Jack W. Jennings, MD, Saint Louis, MO (Presenter) Speakers Bureau, Merit Medical Systems, Inc; Consultant, Merit Medical Systems, Inc; Consultant, Medtronic plc; Consultant, Galil Medical Ltd; Consultant, BTG International Ltd; Consultant, C. R. Bard, Inc

VSI051-04 Spine SBRT: Local Control and Fracture Risks
Thursday, Dec. 5 1:30PM - 1:40PM Room: S405AB

Participants
Sean S. Park, MD, PhD, Rochester, MN (Presenter) Nothing to Disclose

LEARNING OBJECTIVES
1) Describe spine SBRT: indications and patient selection, technique and delivery, and oncologic outcomes and toxicities.

VSI051-05 Transarterial Embolization with Microsphere for Treatment-Refractory Malignant Bone and Soft-Tissue Tumors
Thursday, Dec. 5 1:40PM - 1:50PM Room: S405AB

Participants
Junichi Taniguchi, Nishinomiya, Japan (Presenter) Nothing to Disclose
Haruyuki Takaki, MD, Nishinomiya, Japan (Abstract Co-Author) Nothing to Disclose
Ryo Kunimoto, Nishinomiya, Japan (Abstract Co-Author) Nothing to Disclose
Hiroyuki Yokoyama, Nishinomiya, Japan (Abstract Co-Author) Nothing to Disclose
Atsushi Ogasawara, Kitakyushu, Japan (Abstract Co-Author) Nothing to Disclose
Hiroshi Kodama, MD, Nishinomiya, Japan (Abstract Co-Author) Nothing to Disclose
Yasukazu Kako, Nishinomiya, Japan (Abstract Co-Author) Nothing to Disclose
Kaoru Kobayashi, MD, Nishinomiya, Japan (Abstract Co-Author) Nothing to Disclose
Hiroyuki Futani, Nishinomiya, Japan (Abstract Co-Author) Nothing to Disclose
Koichiro Yamakado, MD, PhD, Nishinomiya, Japan (Abstract Co-Author) Nothing to Disclose

**PURPOSE**

To retrospectively evaluate the clinical utility of transarterial embolization using microsphere (MS) in patients with treatment-refractory malignant bone and soft tissue tumors.

**METHOD AND MATERIALS**

Between 2014 and 2018, 11 patients (7 female and 4 males) with a median age of 69 years (range, 49-89 years) underwent embolization using MS for the treatment of treatment-refractory malignant bone and soft tissue tumors. Tumors were located in the body trunk in 8 patients (73%) and in the limb in 3 patients (27%) with a median maximum tumor diameter of 9.2 cm (range, 2.1-24.6 cm). Seven patients (64%, 7/11) complained of pain caused by tumors before embolization. The response [complete remission (CR) + partial remission (PR)] and the disease control [CR + PR + stable disease (SD)] rates were evaluated by modified Response Evaluation Criteria in Solid Tumor (mRECIST) criteria, adverse events by Common Terminology Criteria for Adverse Events (CTCAE) version 5.0, and survival rate after embolization by Kaplan-Meyer method. Visual analog scale (VAS) scores were evaluated before and within 1 week after embolization.

**RESULTS**

The response rate was 36% [CR, 18% (2/11); PR, 18% (2/11)], and disease control rate 82% [SD, 45% (5/11)] at 1 month after embolization. Grade 3 skin ulcer developed in 2 patients (18%, 2/11), and paresthesia in a patient (9%, 1/11). The cumulative overall survival rates were 40% (95% confidence interval (CI), 6-74%) at 1 year and 20% (95% CI, 1-58%) at 3 years, and with a median survival time of 11 months. VAS scores decreased 2 or more in 5 patients (71%, 5/7).

**CONCLUSION**

This preliminary study demonstrated possibility that MS embolization may help to control treatment-refractory bone and soft tissue tumors and relieve pain caused by tumors.

**CLINICAL RELEVANCE/APPLICATION**

Transarterial embolization with microsphere for treatment-refractory malignant bone and soft tissue tumors can be effective for local tumor control and pain relief.

**VSIO51-06 Vertebral Augmentation in Cancer Patients**

Thursday, Dec. 5 1:50PM - 2:00PM Room: S405AB

Participants
Rahul A. Sheth, MD, Houston, TX (Presenter) Nothing to Disclose

**VSIO51-07 Ablation-Osteoplasty-Reinforcement-Internal Fixation (AORIF) for Osteolytic Skeletal Metastases**

Thursday, Dec. 5 2:00PM - 2:10PM Room: S405AB

Participants
Nariman Nezami, MD, New Haven, CT (Presenter) Nothing to Disclose
Francis Y. Lee, MD, PhD, New Haven, CT (Abstract Co-Author) Nothing to Disclose
Igor Latich, MD, New Haven, CT (Abstract Co-Author) Nothing to Disclose

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**PURPOSE**

Open surgical repair is often not feasible or safe in patients with osseous metastatic disease, particularly in areas at risk for pathologic fracture adjacent to weight-bearing articular surfaces. However, percutaneous cementoplasty and internal fixation with screws have each shown to be effective independently. This study reports Ablation-Osteoplasty-Reinforcement-Internal Fixation (AORIF) technique and technical success for osteolytic skeletal metastases adjacent to weight-bearing articular surfaces.

**METHOD AND MATERIALS**

This is a retrospective analysis of 18 patients who underwent image guided percutaneous internal screw fixation, radiofrequency ablation, balloon osteoplasty, and cementoplasty in 16 sites of osseous metastasis. Post-procedural outcomes, improvement of pain and mobility were evaluated. All of the patients had advanced osseous metastatic disease with impending pathologic fractures and persistent pain refractory to radiotherapy or systemic treatment.

**RESULTS**

100% of the procedures were technically successful without post-procedural complications. All of the patients who received the modified technique were found to have improved pain and mobility after the procedure. Importantly, all patients, except for one, were treated on outpatient basis and none required conversion to open repair.

**CONCLUSION**

The AORIF is an effective strategy in improving pain and reducing the risk of pathologic fracture in patients with advanced osteolytic metastatic disease near articular surfaces. Concomitant RFA provides a degree of local tumor control and in conjunction with balloon osteoplasty creates increases the penetration of cement within the diseased bone.

**CLINICAL RELEVANCE/APPLICATION**

The AORIF is an effective strategy in improving pain and reducing the risk of pathologic fracture in patients with advanced...
osteolytic metastatic disease near articular surfaces.

VSIO51-08  **MSK Immuno-Oncology: Talk the Talk**
Thursday, Dec. 5 2:10PM - 2:20PM Room: S405AB

**Participants**
Muneeb Ahmed, MD, Boston, MA (Presenter) Research Grant, General Electric Company Stockholder, Agile Devices, Inc Scientific Advisory Board, Agile Devices, Inc

VSIO51-09  **Pediatric MSK Interventions**
Thursday, Dec. 5 2:20PM - 2:30PM Room: S405AB

**Participants**
Allison S. Aguado, MD, Wilmington, DE (Presenter) Nothing to Disclose

VSIO51-10  **Advanced Imaging Techniques for MSK IO**
Thursday, Dec. 5 2:30PM - 2:40PM Room: S405AB

**Participants**
Julien Garnon, MD, Strasbourg, France (Presenter) Proctor, Galil Medical Ltd

**LEARNING OBJECTIVES**
1) To understand the role of multimodality image guidance for MSK procedures to see the clinical benefit of combined fluoroscopy and CT-scan for complex bone procedures. 2) To understand how ultrasound and MRI can improve the precision of soft tissue interventions.

VSIO51-11  **Approach to Pelvic Fixation**
Thursday, Dec. 5 2:40PM - 2:50PM Room: S405AB

**Participants**
Frederic Deschamps, Villejuif, France (Presenter) Research Consultant, Medtronics plc; Research Consultant, BTG International Ltd; Research Consultant, General Electric Company

VSIO51-12  **Fixation Outside of the Pelvis**
Thursday, Dec. 5 2:50PM - 3:00PM Room: S405AB

**Participants**
Sean M. Tutton, MD, Milwaukee, WI (Presenter) Consultant, BTG International Ltd; Consultant, Galil Medical Ltd; Consultant, Biocompatibles International plc; Consultant, IZI Medical; Consultant, Stryker Corporation; Researcher, Siemens AG; Consultant, Siemens AG;

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Printed on: 01/19/20
Participants Thomas M. Link, MD, PhD, San Francisco, CA (Director) Research Grant, General Electric Company; Research Consultant, General Electric Company; Research Consultant, InSightec Ltd; Research Grant, InSightec Ltd; Consultant, Springer Nature; Research Consultant, Pfizer Inc;

For information about this presentation, contact: thomas.link@ucsf.edu

LEARNING OBJECTIVES
1) Specify a systematic approach to classify inflammatory and degenerative arthropathies. 2) Identify pitfalls in interpreting imaging studies obtained in inflammatory arthropathies. 3) Describe imaging findings in spondylarthropathies with a focus on MRI. 4) Develop cartilage mapping protocols that can be implemented in clinical practice. 5) Apply advanced osteoarthritis imaging techniques clinically.

Sub-Events

RC704A My Approach to Imaging of Arthritis

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

For information about this presentation, contact: thomas.link@ucsf.edu

LEARNING OBJECTIVES
1) Differentiate inflammatory and degenerative arthropathies based on the anatomic location of findings. 2) Identify radiographic findings in arthropathies and list their differential diagnoses. 3) Classify MRI findings in inflammatory and degenerative arthropathies.

RC704B Pitfalls of Inflammatory Arthritis Imaging

Participants
Connie Y. Chang, MD, Boston, MA (Presenter) Nothing to Disclose

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LEARNING OBJECTIVES
1) To know the differential diagnosis for inflammatory arthritis in large and small joints. 2) To analyze the distinguishing clinical and imaging features of the inflammatory arthritis pitfalls. 3) To apply this knowledge to formulating recommendations for next steps (imaging, clinical tests).

RC704C Imaging of Spondyloarthritis

Participants
Robert G. Lambert, MBBCh, Edmonton, AB (Presenter) Nothing to Disclose

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LEARNING OBJECTIVES
1) Describe the imaging findings commonly seen in spondyloarthritis with a focus on MRI. 2) Distinguish the patterns of disease that occur in spondyloarthritis from degeneration. 3) Identify pitfalls in interpreting imaging studies obtained in spondyloarthritis.

RC704D Implementing Cartilage Mapping in Clinical Practice

Participants
Carl S. Winalski, MD, Rocky River, OH (Presenter) Institutional service agreement, Medical Metrics, Inc Institutional service

For information about this presentation, contact: cswinalski@rockyriver.org
LEARNING OBJECTIVES

1) To evaluate advanced imaging based biomarkers for diagnosis and risk assessment for OA outcomes. 2) To list the MRI-based anatomical imaging techniques for cartilage imaging. 3) To introduce novel CT imaging techniques for OA imaging and their potential role in routine clinical practice.

Printed on: 01/19/20
**LEARNING OBJECTIVES**

1) Discuss and demonstrate spine biopsy techniques including CT and fluoroscopic approaches, anatomic landmarks, needle selection, special technical considerations for dealing with soft tissue masses, and fluid accumulations, lytic and blastic lesions, and hypervascular conditions. 2) Hands on exposure will be provided in order to familiarize participants with the vast number of biopsy devices that are clinically available. 3) Training models will also be used in order to teach technical skills with respect to approach and technique. 4) Advantages and disadvantages of various biopsy devices and techniques, and improve their understanding of how to maximize the reliability and safety of these spine biopsy procedures.

**Sub-Events**

**RC731A Pre- and Post Biopsy Assessment**

Participants
Michele H. Johnson, MD, New Haven, CT (Moderator) Scientific Advisory Board, iSchemaView, Inc; Medical Advisory Board, iSchemaView, Inc

**LEARNING OBJECTIVES**

1) Be familiar with all required aspects of the pre-biopsy work-up, including medications, laboratory values, and review of relevant prior imaging. 2) Be familiar with solutions to address complications or other unexpected events which may arise during the course of spine biopsy. 3) Be comfortable in performing the post procedure assessment of the patient after spinal biopsy.

**RC731B Equipment Used for Image-guided Biopsies of the Spine**

Participants
Michele H. Johnson, MD, New Haven, CT (Presenter) Scientific Advisory Board, iSchemaView, Inc; Medical Advisory Board, iSchemaView, Inc

**LEARNING OBJECTIVES**

1) Demonstrate the types of needles used for spine biopsy. 2) Selecting the proper types of needles used for spine biopsy. 3) Case demonstration of the proper use of single or coaxial needle sets for spine biopsy and the advantages or disadvantages of each.

**RC731C Thoracic and Lumbar Biopsies**

Participants
John L. Go, MD, Los Angeles, CA (Presenter) Nothing to Disclose

**LEARNING OBJECTIVES**

1) Review the anatomy of the thoracic and lumbar spine relevant to spine biopsy. 2) Describe the approaches used to approach various anatomical regions within the thoracic and lumbar spine. 3) Provide case examples of various approaches used to biopsy the thoracic and lumbar spine.

**RC731D Cervical Spine Biopsies**

Participants
A. Orlando Ortiz, MD, MBA, Bronx, NY (Presenter) Nothing to Disclose

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ortizo@nychhc.org

**LEARNING OBJECTIVES**

1) Demonstrate the various approaches used to biopsy lesions of the cervical spine. 2) Determine the selection of the proper needles to use to biopsy the spine. 3) Provide case examples of cervical biopsies and the thought process used to perform these procedures.

**ABSTRACT**

Cervical spine biopsies can be challenging procedures to perform, hence they tend to be performed by a limited number of proceduralists. C-spine biopsy is often performed to evaluate potential neoplastic or infectious processes of the cervical spine. The key to performing these procedures effectively and safely is in appropriate patient selection, careful image analysis in order to
properly position the patient and choose an approach, identification of critical structures (such as the carotid artery) and neck spaces that should be avoided, and use of coaxial biopsy techniques. The procedure can be safely performed with CT and/or CT fluoroscopy. Specimen sampling principles and specimen handling are also discussed they can help to optimize this procedure.

**Disc Biopsy and Aspiration**

Participants
Amish H. Doshi, MD, New York, NY (Presenter) Speaker, Merit Medical Systems, Inc

**LEARNING OBJECTIVES**

1) To review the indications for spinal biopsies in the setting of discitis and osteomyelitis of the spine. 2) The various techniques and imaging modalities for these biopsies will be reviewed. 3) Sample collection and analysis as well as typical diagnostic yield will also be reviewed.

**ABSTRACT**

The lecture will focus on the indications for imaging guided biopsy in the setting of discitis/osteomyelitis and describe a variety of CT and Fluoroscopic guided techniques in obtaining aspirate and tissue sample. Additionally, the lecture will review of the various types of needles used in the procedures and in what setting specific needles should be used. A brief review of current literature on yield of imaging guided biopsy will also be discussed.

Printed on: 01/19/20
Avulsion Injuries of the Upper and Lower Extremities

Friday, Dec. 6 8:30AM - 10:00AM Room: E451B

Participants
Zehava S. Rosenberg, MD, Hoboken, NJ (Director) Nothing to Disclose

Sub-Events

RC804A  Upper Extremity

Participants
Lee F. Rogers, MD, Tucson, AZ (Presenter) Nothing to Disclose

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lfrogers@comcast.net

LEARNING OBJECTIVES
1) Obtain appropriate radiographs, AP, lateral and obliques; oblique views are essential as certain fractures may be visible only on this projection. 2) Certain fractures and dislocations are notorious for being overlooked; know these injuries and be certain to identify or exclude them. 3) Certain ligamentous avulsion of the digits are associated with characteristic deformities allowing a definitive diagnosis of the underlying abnormality. 4) Be aware of the potential for satisfaction of search and the potential of diagnostic oversights in certain injuries; once such an injury is noted look closely for the commonly associated injury. 5) When the clinical diagnosis is not apparent or uncertain on the initial radiographs, do not hesitate to obtain CT or MRI to confirm or exclude an injury.

RC804B  Avulsion Injuries of the Pelvis and Hip

Participants
Omer A. Awan, MD, Baltimore, MD (Presenter) Nothing to Disclose

LEARNING OBJECTIVES
1) Outline the spectrum of avulsive injuries in the pelvis and hip. 2) Delineate imaging characteristics of pelvic and hip avulsive injuries, with emphasis on radiography and MRI. 3) Elucidate practical and clinical applications to pelvic and hip avulsive injuries.

ABSTRACT
n/a

RC804C  Knee

Participants
Thomas L. Pope, MD, Denver, CO (Presenter) Nothing to Disclose

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LEARNING OBJECTIVES
1) Delineate the most common avulsion injuries in the knee. 2) Outline the most common imaging features of avulsion injuries in the knee. 3) Describe the complimentary role of radiography, CT and MR imaging in the diagnosis of avulsion injuries of the knee. 4) Provide some hints on keys to avoid missing these lesions in your clinical practice.

RC804D  Foot and Ankle

Participants
Zehava S. Rosenberg, MD, Hoboken, NJ (Presenter) Nothing to Disclose

LEARNING OBJECTIVES
1) Familiarize the radiologist with radiographic findings of common avulsion injuries of the ankle and foot with emphasis on frequently missed entities. 2) Provide cross sectional imaging correlation for all the described entities. 3) Provide the radiologist with tools for distinguishing radiographic evidence of pathology from mimickers of disease.

Printed on: 01/19/20
**SST05-02 Dose Optimization in Spinal Computed Tomography for Planning of Scoliosis Surgery**

Participants
Shlomit Goldberg-Stein, MD, Bronx, NY (Moderator) Nothing to Disclose
Jan From, MD, Baltimore, MD (Moderator) Institutional research support, Siemens AG; Institutional research support, Johnson & Johnson; Institutional research support, Zimmer Biomet Holdings, Inc; Institutional research support, Microsoft Corporation; Institutional research support, BTG International Ltd; Scientific Advisor, Siemens AG; Scientific Advisor, General Electric Company; Scientific Advisor, BTG International Ltd; Speaker, Siemens AG; Patent agreement, Siemens AG

Sub-Events

**SST05-02** Dose Optimization in Spinal Computed Tomography for Planning of Scoliosis Surgery

Participants
Yan Klosterkemper, Dusseldorf, Germany (Presenter) Nothing to Disclose
Markus Konieczny, Dusseldorf, Germany (Abstract Co-Author) Nothing to Disclose
Tobias Hesper, MD, Dusseldorf, Germany (Abstract Co-Author) Nothing to Disclose
Joel Aissa, MD, Dusseldorf, Germany (Abstract Co-Author) Nothing to Disclose
Christoph K. Thomas, MD, Dusseldorf, Germany (Abstract Co-Author) Nothing to Disclose
Gerald Antoch, MD, Dusseldorf, Germany (Abstract Co-Author) Nothing to Disclose
Johannes Boos, MD, Dusseldorf, Germany (Abstract Co-Author) Nothing to Disclose

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**PURPOSE**

To assess the potential for dose optimization in patients undergoing spinal CT for planning of scoliosis surgery.

**METHOD AND MATERIALS**

Ten patients (3 male, 7 female, 18±11 years) were included in this prospective, IRB-approved study. CT examinations were performed with automated exposure control (mean CTDIvol 4.1±0.9mGy; DLP: 192±50mGyxcm). Dose reduction to 50%, 20%, 10% and 5% was simulated using dedicated reconstruction software. Two spinal surgeons blinded to the dose level independently and randomly measured the length and the width of each pedicle for screw size selection. Additionally, the confidence in the measurements was assessed (5=very confident in the measurement, 1=measurement cannot be performed with any confidence). Two radiologists rated the image quality for the assessment of bone and soft tissue structures (5=excellent, 1=non-diagnostic). Bonferroni was used to correct for multiple testing (p<0.0125).

**RESULTS**

Pedicle length and width measurements were comparable between 100% and 50% reconstructions (36.4mm/4.1mm vs 36.6mm/4.1mm) whereas both measurements decreased with further dose reduction (20%: 36.1mm/4.1mm; 10%: 35.5mm/4.0mm; 5%: 34.6mm/3.9mm). Confidence in the measurements was excellent at 100% and 50% (all ratings of 5) and decreased with further dose reduction (20%: 4.7; 10%: 3.7; 5%: 2.5). Image quality decreased with decreasing dose (4.9±0.4 for 100 % to 1±0 for the 5% reconstructions; p<0.001, respectively). For bone assessment, image quality was comparable between 100% and 50% reconstructions (4.9±0.4 vs 4.7±0.5).

**CONCLUSION**

Dose of preoperative spinal CT for planning of scoliosis surgery can be reduced to 50% without impairment of pedicle size measurements or surgeons' confidence in planning the operation.

**CLINICAL RELEVANCE/APPLICATION**

CT dose in preoperative spine CT can be reduced to 50% for patients undergoing scoliosis surgery.
collaboration, Predible Health; Research collaboration, Oxipit.ai; Research collaboration, Synapsica; Research collaboration, Quibim
Sriram Rajan, MD, New Delhi, India (Presenter) Nothing to Disclose
Vasanthakumar Venugopal, MD, New Delhi, India (Abstract Co-Author) Consultant, CARING; Research collaboration, General Electric Company; Research collaboration, Koninklijke Philips NV; Research collaboration, Qure.ai; Research collaboration, Predible Health; Research collaboration, Oxipit.ai; Research collaboration, Synapsica; Research collaboration, Quibim
Harsh Mahajan, MD, MBBS, New Delhi, India (Abstract Co-Author) Director, Mahajan Imaging Pvt Ltd; Research collaboration, General Electric Company; Research collaboration, Koninklijke Philips NV; Research collaboration, Qure.ai; Research collaboration, Predible Health

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PURPOSE
MR reports have been unchanged for a long time, and clinical relevance of MR findings are being challenged in literature. We assess the weightage that spine surgeons give to certain aspects of the MR report, their preference for report structure and towards different modalities.

METHOD AND MATERIALS
An anonymous online survey, created in consultation with 5 spine surgeons, which included questions related measurement of spinal canal dimensions, information about nerve root impingement, anomalies and take-off, annular fissures, Modic changes, scoliosis and listhesis, was circulated amongst sub-specialist spine surgeons. Preference for report format (every level reported, significant levels reported, pain chart diagram), and modality of investigation before surgery for lumbar degenerative disc disease was also recorded.

RESULTS
24 sub-specialist spine surgeons, with average 13.9 years’ experience (range: 3 - 30 years) from 6 cities, completed the questionnaire. Responses were weighted towards surgically relevant details such as effective spinal canal measurement (79%), nerve root impingement (91%), obvious anomalies at the level of significant disc (61%), level of nerve root take-off (75%), only details of posterior annular fissures (50%), and 25% surgeons preferred "hyperintense zone terminology". Surprisingly, equal number of responses for Modic changes (62%), and for the possibility of inflammatory spondyloarthropathy (58%) or infection (67%) we obtained. On reporting formats, majority asked for only involved levels (71%) while 33% asked for every level. 33% asked for a diagrammatic pain chart. There was no consensus on reporting of scoliosis cases. Also, majority asked for information about cause of listhesis. As expected, for presurgical assessment for degenerative disc disease, MR (87%) with and X ray spine with flexion and extension (75%) was preferred while only 8.3% asked for plain CT and none asked for CT myelography.

CONCLUSION
These results highlight clinically relevant information that should be included on an MR report, including effective spinal canal dimensions, details of nerve root anomalies at the level of disc herniation, details of nerve root impingement. There was lack of consensus on Modic changes, format of report, and scoliosis assessment.

CLINICAL RELEVANCE/APPLICATION
Two-way communication between spine surgeons, and radiologists helps in generation of effective reports, that improve clinical outcomes.

SST05-04 Deep Learning-Based Reconstruction of Osseous Structures of the Cervical Spine Using Bone MRI: A Qualitative Analysis

Friday, Dec. 6 11:00AM - 11:10AM Room: E450B

Participants
Brigitta van der Kolk, MD, Zwolle, Netherlands (Presenter) Research Grant, MRIGuidance
D.J. (Jonk) Slotman, BSC, Zwolle, Netherlands (Abstract Co-Author) Nothing to Disclose
Tess J. Snoeijink, BSC, Zwolle, Netherlands (Abstract Co-Author) Nothing to Disclose
Jochen van Osch, Zwolle, Netherlands (Abstract Co-Author) Nothing to Disclose
Ingrid M. Niholt, Zwolle, Netherlands (Abstract Co-Author) Nothing to Disclose
Martin Podlogar, MD, PhD, Zwolle, Netherlands (Abstract Co-Author) Nothing to Disclose
Boudewijn A.A.M. van Hasselt, MD, Zwolle, Netherlands (Abstract Co-Author) Nothing to Disclose
Henk J. Boelhouwers, MD, Zwolle, Netherlands (Abstract Co-Author) Nothing to Disclose
Mirjam van Stralen, MSc, PhD, Utrecht, Netherlands (Abstract Co-Author) Co-founder, MRIGuidance BV; Stockholder, MRIGuidance BV; CTO, MRIGuidance BV
Peter R. Seevinck, MSc, PhD, Utrecht, Netherlands (Abstract Co-Author) Nothing to Disclose
Marijn van Hasselt, MSc, PhD, Amsterdam, Netherlands (Abstract Co-Author) Nothing to Disclose
Martijn F. Boomsma, MD, Zwolle, New Caledonia (Abstract Co-Author) Nothing to Disclose

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PURPOSE
To qualitatively assess deep learning-based synthetic CT (BoneMRI) derived from MRI scans of the cervical spine.

METHOD AND MATERIALS
Paired MRI and CT data were collected from 25 consecutive outpatients of 50 years or older presenting with cervical radiculopathy. Patients with osteosynthesis material in the cervical spine or known pathological bone disorders were excluded. The MRI exam (Ingenia 1.5T, Phillips Healthcare, the Netherlands) included a T1 multiple gradient echo sequence for BoneMRI reconstruction (3 minutes, 53 seconds). The deep learning-based method (BoneMRI, MRIGuidance, the Netherlands) was previously developed based on data from 25 patients from a similar cohort. In this study we qualitatively assessed BoneMRI on an independent cohort. BoneMRI images and conventional CT images were independently evaluated by a neurosurgeon, neuroradiologist and musculoskeletal radiologist. A four-point Likert scale (1=poor, 4=excellent) was used to assess image quality of various structures at two cervical
levels (C3-C4 and C6-C7: cortical delineation, intervertebral joints, neural foramina, trabecular bone). Cut-off value for the qualitative assessment in BoneMRI images was a score of 3 or higher in 80% of the assessed components.

RESULTS
A score of 3 or higher for BoneMRI was achieved for cortical delineation (C3-C4 100%, C6-C7 93.3%), intervertebral joints (both levels 100%) and neural foramina (both levels 100%). The cut-off value of 3 or higher was not met for visualization of the trabecular bone (C3-C4 65.3%, C6-C7 48%).

CONCLUSION
BoneMRI of the cervical spine is a promising tool for 3D morphological assessment of osseous structures without the need for ionizing radiation. Implementation of BoneMRI could facilitate an easier workflow, provide additional information for clinicians, reduce costs and lower patient burden by obviating the CT; and therefore contribute to value-based healthcare. Future work will prospectively investigate BoneMRI in an unrestricted population to further explore the performance of the method.

CLINICAL RELEVANCE/APPLICATION
BoneMRI of the cervical spine offers osseous visualization without the use of ionizing radiation and provides structural information regarding both soft and osseous tissues in a single examination.

SST05-05  
Dixon Imaging of the Spine - Comparison of T1 VIBE and T2 TSE Derived Relative Fat Fraction

Participants
Ricardo Donners, MD, Basel, Switzerland (Presenter) Nothing to Disclose
Anna Hirschmann, MD, Basel, Switzerland (Abstract Co-Author) Nothing to Disclose
Dorothee Harder, Basel, Switzerland (Abstract Co-Author) Nothing to Disclose

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PURPOSE
A comparison between the quantitative relative fat fraction (rFF) derived from T1 VIBE Dixon and T2 TSE two-point Dixon MRI of vertebral metastases and healthy vertebrae.

METHOD AND MATERIALS
MRI of the spine including T1 VIBE (10° flip angle) and T2 TSE (120° flip angle) two-point Dixon sequences with dedicated in- on opposed echo timing of 25 patients with vertebral metastases of known primary tumor and 25 healthy individuals without conspicuous vertebral lesions were retrospectively reviewed. MRIs were performed on the same 1.5T scanner. Patients with history of malignancy were excluded from the healthy cohort. rFF was calculated by dividing the fat-only through the water- plus fat-only images. Volumes of interest (VOIs) of one vertebral metastasis of each patient of the tumor group and one vertebra of each patient in the healthy cohort were generated. The VOI was created on the T1 VIBE Dixon rFF image and copied onto the T2 TSE rFF image. Mean rFF value and VOI volume were noted. Additionally a region of interest (ROIs) was drawn in the VOI and the subcutaneous gluteal fat and copied onto the T2 TSE rFF image. Mean rFF values were noted. Intraclass correlation coefficients testing for absolute agreement and t-tests were performed comparing rFF mean values in the healthy and malignant cohort. A p-value <0.05 was deemed statistically significant.

RESULTS
For malignant vertebrae VOI measurement based mean T1 VIBE rFF was 11%, mean T2 TSE rFF was 9% (p < 0.001). In healthy patients mean vertebral T1 VIBE rFF was 67% and T2 TSE rFF was 73% (p < 0.001). There was no significant difference in mean VOI size between the malignant and healthy cohort (p = 0.53). Mean T1 VIBE and T2 TSE rFF were significantly smaller in the malignant cohort (each p < 0.001). Mean T1 VIBE rFF of the subcutaneous fat was 93% and T2 TSE rFF was 91.5% (p = 0.02). There was moderate correlation between T1 VIBE and T2 TSE VOI, T1 VIBE VOI and ROI and T2 TSE VOI and ROI rFF measurements (each intraclass correlation coefficient > 0.67). Less correlation was found between subcutaneous T1 VIBE rFF and T2 TSE rFF (pearson correlation coefficient = 0.55).

CONCLUSION
There was significant difference between the T1 VIBE Dixon rFF and T2 TSE Dixon rFF in vertebral metastases as well as healthy vertebrae. While each technique allows approximatization of fat content absolute values are not comparable.

CLINICAL RELEVANCE/APPLICATION
While T1 VIBE and T2 TSE Dixon rFF each allow approximatization of the fat content and aid characterization of vertebral lesions, absolute rFF values cannot be compared between both sequences.

SST05-07  
Machine Learning Classification of Spinal Lesions: Compared Accuracy of Texture Parameters Extracted with Different Software

Participants
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Angelo Corazza, MD, Genova, Italy (Abstract Co-Author) Nothing to Disclose
Luca Maria Sconfienza, MD, PhD, Milano, Italy (Abstract Co-Author) Travel support, Bracco Group; Travel support, Esaote SpA; Travel support, ABIOPEN PHARMA SpA; Speakers Bureau, Fidia Pharma Group SpA
To develop automatic detection methods to identify abnormal segments.

Deep learning using ResNet yields a high accuracy to distinguish benign from malignant fracture on CT, but more research is needed.

**CLINICAL RELEVANCE/APPLICATION**

When the abnormal area was identified as inputs, differentiation of benign and malignant fracture on CT using deep learning was performed using different software. An ROI was placed, and the smallest square bounding box containing the entire affected vertebra was used as input in ResNet50. The diagnostic performance was tested using 10-fold cross-validation. After obtaining the malignancy probability for all slices of one patient, the highest probability was assigned to that patient, and the prediction of benign or malignancy was done by using the threshold of 0.5.

**RESULTS**

In per-patient diagnosis, sensitivity=0.95, specificity=0.80, and accuracy=0.88. In differentiation of normal vs. abnormal segments, the accuracy was much worse.

**CONCLUSION**

ML algorithms show good accuracy in spinal lesion classification based on non-contrast MRI exams. Furthermore, feature extraction performed using different software has shown consistent results at subsequent ML analysis.

**CLINICAL RELEVANCE/APPLICATION**

This is the first study that compares the accuracy of different softwares for texture analysis in msk field.

**SST05-08  Automatic Spine Segmentation for Detection of Abnormal Vertebra and Differentiation of Benign and Malignant Fracture on CT Using Deep Learning**

Participants

Ning Lang, MD, Beijing, China (Presenter) Nothing to Disclose
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**METHOD AND MATERIALS**

A dataset of 296 patients with malignant and 137 patients with benign fracture was generated from our spinal CT database. The CT was acquired using a GE Discovery CT 750HD scanner with 120 kV, 137~543 mAs, and 3 mm thickness. The acquired images were reformatted to Sagittal view for further analysis. An experienced radiologist performed reading by evaluating eight features. A subset of 69 benign and 76 malignant patients with a clearly distinguishable abnormality involving only one spinal segment were selected for deep learning analysis. An ROI was placed, and the smallest square bounding box containing the entire affected vertebra was used as input in ResNet50. The diagnostic performance was tested using 10-fold cross-validation. After obtaining the malignancy probability for all slices of one patient, the highest probability was assigned to that patient, and the prediction of benign or malignancy was done by using the threshold of 0.5. In order to develop an automatic detection scheme, the spine was segmented first, and then ResNet50 was applied to detect the abnormal vertebra. The labeled vertebral fractures and randomly selected normal vertebral bodies were used for training.

**RESULTS**

The entire dataset of 433 patients were randomly presented to a radiologist for reading, and the accuracy was very high at 99%. The soft tissue mass and bone destruction were highly suggesting malignancy; the presence of transverse fracture line and trauma history were highly suggesting benign. In per-slice diagnosis using ResNet50, sensitivity=0.90, specificity=0.79, and accuracy=0.85. In per-patient diagnosis, sensitivity=0.95, specificity=0.80, and accuracy=0.88. In differentiation of normal vs. abnormal segments, the accuracy was much worse.

**CONCLUSION**

When the abnormal area was identified as inputs, differentiation of benign and malignant fracture on CT using deep learning achieved a high diagnostic accuracy. When the entire spine was evaluated, the automatic detection of abnormality was challenging.

**CLINICAL RELEVANCE/APPLICATION**

Deep learning using ResNet yields a high accuracy to distinguish benign from malignant fracture on CT, but more research is needed to develop automatic detection methods to identify abnormal segments.
Clinical-Radiomics Nomograms for Preoperative Prediction of Tumor Type of Sacrum Based on Computed Tomography and Multiparametric Magnetic Resonance Imaging

Friday, Dec. 6 11:50AM - 12:00PM Room: E450B

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PURPOSE
To develop and validate clinical-radiomics nomograms based on 3D computed tomography (CT) and multiparametric magnetic resonance imaging (mpMRI) for preoperative differentiation of sacral chordoma (SC) and sacral giant cell tumor (SGCT).

METHOD AND MATERIALS
A total of 83 SC and 54 SGCT patients diagnosed through surgical pathology were retrospectively analyzed and divided into a training set and validating set by the ratio of 7:3. We built six models based on CT, CT enhancement (CTE), T1-weighted, T2-weighted, diffusion weighted imaging (DWI), and contrast-enhanced T1-weighted features, two radiomics nomograms and two clinical-radiomics nomograms combined radiomics mixed features with clinical data. The area under the receiver operating characteristic curve (AUC) and accuracy (ACC) analysis were used to assess the performance of the models.

RESULTS
SC and SGCT presented significant differences in terms of age, sex, and tumor location (tage = 9.00, Χ²sex = 10.86, Χ²location = 26.20; P < 0.01). For individual scan, the radiomics model based on DWI features yielded the highest AUC of 0.889 and ACC of 0.885, followed by CT (AUC=0.857; ACC=0.846) and CTE (AUC=0.833; ACC=0.769). For the combined features, the radiomics model based on mixed CT features exhibited a better AUC of 0.942 and ACC of 0.880, whereas mixed MRI features achieved a lower performance than the individual scan. The clinical-radiomics nomogram based on combined CT features achieved the highest AUC of 0.948 and ACC of 0.920.

CONCLUSION
The radiomics model based on CT and mpMRI present a certain predictive value in distinguishing SC and SGCT, which can be used for auxiliary diagnosis before operation. The clinical-radiomics nomograms performed better than radiomics nomograms.

CLINICAL RELEVANCE/APPLICATION
Clinical-radiomics nomograms based on CT and mpMRI features can be used for preoperative differentiation of SC and SGCT.

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