



Annual Scientific Meeting Abstracts of the Australasian Musculoskeletal Imaging Group (AMSIG) 2019, Queenstown, New Zealand

SPEAKER ABSTRACTS AND TALK SUMMARIES

All abstracts and talk summaries presented are as submitted. Minor formatting changes have been as required made to comply with the Journal's publication requirements. Abstracts are listed in the order of presentation.

Plenary 1: Metabolic Bone, March 30, 2019, 0800 - 0950

Bill Breidhal¹

Perth Radiological Clinic, Cottesloe, WA, Australia

IMAGING OF THE CLINICAL ENTITIES OF TRANSIENT OSTEOPOROSIS, REGIONAL MIGRATORY OSTEOPOROSIS AND TRANSIENT BONE MARROW EDEMA SYNDROME

Transient osteoporosis, regional migratory osteoporosis, and transient bone marrow syndrome are all terms used to describe a self-limiting clinical syndrome. The disorder is confined to the lower extremities. It tends to affect middle-aged males and younger females with a male predominance of 3:1. It is bilateral in 20–40%. It is characterized by the gradual or sudden onset of progressive pain and swelling with activity, rest, and at night, i.e., distinct from a bone stress injury. The pain usually peaks after 2–3 months and then gradually resolves over the ensuing 6–9 months. Recurrence at a different site at the same joint or at a different joint is usually within 12 months, but may be years later. The etiology is unknown, however, a regional accelerated phenomenon (RAP) has been proposed where a minor insult results in increased regional blood flow, cell turnover, and re-modeling with local osteopenia which recovers. Imaging is characterized by severe bone marrow at the end of a bone/epiphysis, a joint effusion and periarticular soft tissue edema. There is usually little or no osteoarthritis at the adjacent joint. Subchondral low signal intensity zones (SCLIZ) are variable but may be present in approximately 50%. These are usually short and thin and may affect the immediate subchondral bone or have a small zone of normal marrow between it and the overlying cartilage. Numerous examples of this condition will be shown at the hip, knee, ankle, and foot.

Anthony Doyle¹

Auckland DHB, University of Auckland, New Zealand

IMAGING OF METABOLIC BONE DISEASE

The skeleton is a dynamic organ system in which turnover is constant and bone structure is continually being remodeled and replaced. In homeostasis, this is an orderly process taking place over years. Disease states, both local and systemic, lead to disordering of the remodeling process with results that can be visible on imaging. This review will attempt to cover both common and uncommon metabolic bone disorders and their manifestation on various imaging modalities. The changing nature of metabolic bone disease over time will be

addressed, as environmental factors, population demographics, treatment regimens, and imaging methods evolve and alter the way in which radiologists are involved in the diagnosis of these conditions.

Avneesh Chhabra¹

UT Southwestern Medical Centre, Dallas, USA

ROLE OF CHEMICAL SHIFT AND DIXON BASED TECHNIQUES IN MSK IMAGING

Fat suppression is a valuable resource in musculoskeletal magnetic resonance (MR) imaging that is helpful in the diagnosis and differentiation of various pathologies.

This talk will highlight: (1) different fat-suppression techniques and their strengths and weaknesses in MSK imaging, (2) the principles of CSI and Dixon techniques for MSK imaging outlining the optimal imaging approach, and (3) advantages and artifacts associated with Dixon imaging with current utility in MSK imaging. Threshold differences on T1W and T2W Dixon imaging for marrow evaluation will be discussed.

David Panicek¹

Vice Chair for Clinical Affairs Department of Radiology, Memorial Sloan Kettering Cancer Center, New York, NY USA Professor of Radiology, Weill Medical College of Cornell University

CONTRIBUTIONS OF MRI IN CHARACTERIZING BONE TUMORS

Radiologic characterization of bone tumors involves consideration of numerous factors, including patient age, tumor location within bone, and tumor matrix and morphology. The major contributions of MRI are in demonstrating various types of tumor matrix, and assessing for extraosseous extension of tumor. A common pitfall is the extrapolation of the criterion "zone of transition" to the evaluation of bone tumors at MRI. The criterion refers to the Lodwick classification of trabecular destruction demonstrated on radiographs; conventional MR images demonstrate marrow replacement, not trabecular destruction. Most malignant bone tumors, because they replace marrow in a mass-like pattern, demonstrate a sharp margin with surrounding normal marrow. It would be misleading to interpret that margin as a "narrow zone of transition" (thereby erroneously implying a benign etiology).

MRI demonstrates various types of matrix in bone tumors, including cartilaginous, osseous, fibrous, lipomatous, and cystic. Enchondroma and low-grade chondrosarcoma, due to their hyaline cartilage matrix, both manifest as multiple small lobules with fluid-like signal at MRI. Dedifferentiated chondrosarcoma should be suspected when a soft tissue mass is present within an otherwise chondroid tumor. MRI also can contribute to the distinction between enchondroma and low-grade chondrosarcoma

(unfortunately, interobserver variability both of pathologists and of radiologists in making this distinction is low). At Memorial Sloan Kettering, the criteria considered suspicious for low-grade chondrosarcoma include endosteal scalloping, cortical buttressing, and of course, extraosseous extension of tumor. An intraosseous pneumatocyst can simulate a blastic bone lesion at MRI; the presence of susceptibility artifact at the margin of the pneumatocyst can be a useful diagnostic clue.

The bone marrow edema pattern present around a bone lesion can be helpful in producing a more specific differential diagnosis. The halo sign, consisting of a rim of high-signal edema around a lesion on fluid-sensitive MR images, has a high specificity for metastasis; this sign is more commonly observed with blastic metastases. Another pattern consists of a disproportionately large amount of marrow edema around a bone lesion, and has a limited differential diagnosis (which can be refined further using other imaging and clinical features): osteoid osteoma/osteoblastoma, chondroblastoma, Langerhans cell histiocytosis, osteomyelitis, and less commonly, aneurysmal bone cyst and giant cell tumor. A (perhaps counterintuitive) correlate is that, the larger the amount of marrow edema surrounding a bone lesion, the higher the probability that the lesion is benign.

A number of other features at MRI may help in characterization of a bone lesion. A tumor may originate in bone marrow and extend through cortical Haversian canals into the subperiosteal space without substantially destroying the cortex; this sign has been reported as being common in lymphoma, although it also can occur with other types of bone tumors. Osseous metastases from renal cell carcinoma may contain flow-voids at MR imaging, a useful sign for suggesting the primary site of the metastasis. An important MRI pitfall is calcific tendinitis, which can erode the subjacent bone and cause a marrow edema pattern, resulting in a focal bone lesion that mimics a primary bone tumor at MRI.

Plenary 2: Tumors and Rheumatology, March 30, 2019, 1020 - 1220

Graeme Anderson¹

Middlemore Hospital, Auckland, New Zealand

CHEST WALL LESIONS FOR THE MSK RADIOLOGIST

Chest wall lesions sit uncomfortably between the domains of the chest radiologist to whom they often present and the MSK radiologist who may have more expertise with the benign and malignant entities that occur here. This presentation looks at anatomical and imaging features of these lesions to guide the radiologist to a more refined differential diagnosis.

David Panicek¹

Vice Chair for Clinical Affairs Department of Radiology, Memorial Sloan Kettering Cancer Center, New York, NY USA Professor of Radiology, Weill Medical College of Cornell University

PITFALLS IN SOFT TISSUE TUMOR IMAGING

Some soft tissue masses (such as lipoma, ganglion cyst, hemangioma) can be specifically diagnosed at MRI. However, various pitfalls exist; for example, a hemangioma may be confused for myxoid liposarcoma or dedifferentiated liposarcoma if its fatty septa are mistaken for the primary matrix of the mass. Myxoid tumors may be misinterpreted as cysts unless gadolinium contrast is administered to demonstrate internal enhancement. Tails of tumor are commonly present at MRI in undifferentiated pleomorphic sarcoma and myxofibrosarcoma. These tails, which track along fascial planes and enhance at MRI, represent macroscopic tumor spread; microscopic spread extends beyond the visible tails. Recurrence of these tumors can manifest as only a tail of tissue on MRI.

Extension of tumor into adjacent major vessels is critical to detect at MRI. The furthest extent of intravascular extension can be difficult to determine during surgery, and such extension may necessitate involvement of a second surgical team with different expertise.

Tumor mimics are important to consider when MRI features are not entirely typical of a soft tissue tumor. For example, even in the absence of a relevant clinical history or visible scar, a foreign body is sometimes unexpectedly found during surgery to account for a mass in soft tissues. A retracted muscle belly can mimic a soft tissue tumor, both clinically and at biopsy (associated scarring after the tear can be misinterpreted as fibromatosis at histopathologic exam). During the initial phase of myositis ossificans, extensive surrounding soft tissue edema is present at MRI. If re-injured repetitively, the mass may continue to enlarge, and even subjacent bone marrow changes may develop. Myositis ossificans-like ABC manifests as peripheral ossification within a soft tissue mass, resembling myositis ossificans at imaging; it has been postulated to represent an early phase in formation of soft tissue ABC, and shows the characteristic *USP6* gene rearrangement (found in primary, but not secondary, ABC). This is an example of a true tumor mimicking a tumor-mimic.

Findings at MRI obtained after surgery and/or radiation therapy for a soft tissue tumor can present potentially confusing interpretive challenges. The "stipple" sign, representing foci of enhancement within otherwise nonenhancing muscle, is a characteristic MRI finding in myonecrosis. In an oncologic population, its most common cause is radiation therapy; other causes include intraoperative immobilization, trauma, therapeutic embolization, ablation therapy, and diabetes. Rarely, poorly defined, mass-like hyalinized fibrous tissue and fat necrosis can develop slowly in subcutaneous tissues after radiation therapy and continue to enlarge, mimicking recurrent tumor or radiation-associated sarcoma. In a small percentage of postoperative seromas, one or more enhancing nodules develop along the inner wall. These nodules consist of postoperative changes, including granulation tissue; interval follow-up MRI should be performed for further evaluation, rather than immediate biopsy. A uniformly enhancing mass located in the region of a major vessel on postoperative imaging should be scrutinized for the possibility of its representing a pseudoaneurysm. Patients sometimes undergo cosmetic surgery at another facility, performed in the region of prior surgery; imaging findings related to such procedures may complicate assessment for recurrent tumor.

Fiona McQueen¹

Southern DHB, Invercargill, New Zealand

ARTHROPATHIES OF THE CHEST WALL

The chest wall can be affected by many inflammatory and non-inflammatory musculoskeletal disorders. The spondyloarthropathies including SAPHO syndrome are an important group and CT imaging is especially helpful to define pathology. ¹⁸F-FDG PET/CT evidence suggests that polymyalgia rheumatica (PMR) is a cause of synovitis at the sternoclavicular joints. Rheumatoid arthritis may also target sternoclavicular and acromioclavicular joints. In these inflammatory arthropathies, MRI can provide information about bone edema, synovitis, and erosions. Osteoarthritis commonly involves the chest wall and is an important cause of morbidity. Gout has been investigated recently using DECT imaging and interesting data will be presented suggesting that monosodium urate could be deposited within the costochondral junctions (although the possibility of artifact has not been excluded).

Katie Glazebrook¹

Mayo Clinic Rochester, Minnesota, USA

DUAL-ENERGY CT GOUT

The objective of this talk is to discuss the use of dual-energy CT in the assessment of gout. I will outline the technique of material decomposition with dual-energy CT and show examples of monosodium crystal deposition within joints, tendons, and soft tissues. There will be a review of the literature for sensitivity and specificity of the study with false-negative cases and artifacts emphasized. I will also discuss the clinical impact of the DECT for gout in our institution.

Ian Best¹

Pacific Radiology Group, Wellington NZ

IMAGING OF CHEST WALL INJURIES

Plenary 3: Cartilage/Injectable Therapies, March 30, 2019, 1330 - 1510

Wayne McIlwraith¹

Barbara Cox Anthony Chair in Orthopaedics, Founding Director of Orthopaedic Research Center, Colorado State University

INTRAARTICULAR THERAPIES FOR POST-TRAUMATIC OSTEOARTHRITIS AND CARTILAGE REPAIR

Arthroscopic surgery revolutionized equine orthopedics as it did human orthopedics with changing the prognosis for elite equine athletes coming back from musculoskeletal injuries. However, as with experience in human athletes, limitations were recognized particularly with acute articular cartilage loss and the development of post-traumatic osteoarthritis (OA). This led to a quest for better regenerative therapies. Post-traumatic joint disease is a common clinical problem in the horse with surveys estimating up to 60% of lameness and retirement of athletes is due to OA. Synovitis plays a major role in the pathogenesis in addition to structural damage; this was recognized in the early 1980s in horses and, more recently, in people.

There has been an evolution of conventional therapies to biologic therapies with intra-articular treatment of OA. This evolution has included a progression starting with intra-articular corticosteroids to hyaluronic acid (HA) to both protein products (autologous conditioned serum, platelet rich plasma, amniotic/chorionic membrane tissue and fluid, as well as autologous protein solution to cellular therapies and in particular adult-derived mesenchymal stem cells.

The field of biologics has stimulated much excitement in the orthopedic arena. While there are a number of significant anabolic growth factors, evidence at the moment would indicate that a combination of these is better. Inhibition of catabolic processes is critical and through gene therapy studies in equine OA it has been shown that interleukin-1 (IL-1) is the major therapeutic target. There has been considerable progress with gene therapy using adeno-associated viral vectors, but we do not have a clinical treatment yet. It is also notable that promotion of articular cartilage repair has been demonstrated with gene therapy using IL-1 receptor antagonist. The most popular option in the horse for inhibiting IL-1 receptor antagonist is autologous conditioned serum. This was initially a human product (Orthokin®) (Orthogen, Germany) and more recently equine products IRAP™ and IRAP II™ have been used frequently. Efficacy has been demonstrated in a controlled study in experimental OA in the horse. There are now two controlled studies in people out of Europe that have shown benefit but because of the 24-h incubation process in preparation of a conditioned serum precludes it passing under the standard of minimal manipulation that the FDA requires. Platelet-rich plasma (PRP) is the most commonly used. There are a number of important issues because of the variability of different products. Both growth factor release as well as anticatabolic cytokine release both play a role with PRP and there are a number of controlled studies now demonstrating efficacy in people.

The other major area for discussion are mesenchymal stem cells. In equine orthopedics, the use of bone marrow-derived stem cells has been shown to be of great benefit with both articular cartilage repair and OA in both experimental and clinical studies and these will be presented. At the present time, we are able to use cultured stem cells and these are the ones where we have shown great value. Unfortunately, regulatory restrictions have not enabled the use of cultured bone marrow-derived stem cells in human OA; there was for a period before the FDA tightened down the levels of minimal manipulation they would accept without getting a drug license. Comparative studies that we have done show that bone marrow-derived mesenchymal stem cells (MSCs) tend to be more effective and placed intra-articularly rather than put in a hydrogel or scaffold within a

cartilage defect. The closest technique simulating bone marrow-derived stem cell therapy (but unfortunately should not be confused with cultured MSCs) is the use of bone marrow aspirate concentrate. The MSCs level is quite low (1700/ml compared to when we put 10,000,000 MSCs/ml into an equine joint) but recent work from Cornell University shows that there are very high levels of interleukin-1 receptor antagonist (IL-1 Ra).

Adipose-derived stem cells when cultured can be effective therapeutics. This is definitely not extrapolable to stromal vascular fraction (collagenase-digested fat). A new product, Lipogems, is being used and has recently been licensed as a device because it falls below the level of minimal manipulation. There are some encouraging results with this product.

Julien Freitag¹

Melbourne Stem Cell Centre, Melbourne, AUST

AN UPDATE ON INJECTABLE THERAPIES - WITH A FOCUS ON ORTHOBIOLOGICALS

With an increasing awareness of the pathophysiology involved in osteoarthritis (OA), there has been renewed focus on development of therapies for symptom relief and disease modification. This has seen an increase in intra-articular therapies which are currently being researched and used in the active management of OA. With OA being recognized as the fourth leading cause of disability worldwide, the use of these therapies has perhaps outpaced the appropriate robust scientific research to validate their benefits prior to broader clinical use. Importantly, ongoing research and positive outcome results has justified the early clinical translation of many these promising therapies.

Hamish Love¹

Southern Sports and Orthopaedics, Christchurch, NZ

SURGICAL PERSPECTIVE ON INJECTABLE THERAPIES AND TREATMENT OF CHONDRAL INJURIES WILL BE PRESENTED.

Bill Breidhal¹

Perth Radiological Clinic, Cottesloe, WA, Australia

AUTOLOGOUS TENOCYTE INJECTION (ATI)

Autologous tenocyte injection (ATI) is a three-stage procedure for the treatment of tendon pathology. Tenocytes are harvested either with a core biopsy needle from a patellar tendon or surgically using palmaris longus. The tenocytes are then cultured by Orthocell and re-implanted into the symptomatic site under ultrasound control approximately 6 weeks later. To date, 665 patients have been treated. There have been three studies published so far showing efficacy (references 1, 2, 3). There are two more studies which are in progress—one on ATI in tennis elbow in workers compensation cases who have failed all conservative measures, and another comparing ATI to subacromial bursal steroid injection in partial thickness intra-substance (i.e., without bursal or articular surface extension) supraspinatus tendon tears.

Plenary 4, March 30, 2019, 1530 - 1745

Avneesh Chhabra¹

UT Southwestern Medical Center, Dallas, USA

MR NEUROGRAPHY-TIPS/TRICKS/UPDATE

MR neurography (MRN) techniques lead to excellent demonstration of peripheral nerve anatomy and pathology. This talk will highlight: (1) technical perspectives and recommendations to obtain the best possible high-resolution imaging of the peripheral nerves in various areas of the body, (2) current roles of MRN and diagnostic criteria will be discussed,

(3) pattern analysis will be highlighted with cases depicting classic and suggestive findings of different neuropathies and disease states, and (4) future directions will be outlined.

Robert Wright¹

Denver Pain Management, Colorado USA

TREATMENT APPROACH FOR TREATMENT OF COCCYDYNIA

Thomas Moritz¹

Canterbury DHB, Christchurch, NZ

ULTRASOUND PERIPHERAL NERVES

K. Nwawka¹

Hospital for Special Surgery, New York City, United States of America

ULTRASOUND OF THE BRACHIAL PLEXUS

Magnetic resonance imaging is currently the preferred method to image the brachial plexus, however, there are some limitations to its use. With appropriate technique and knowledge of anatomy, ultrasound (US) now provides a viable alternative for brachial plexus imaging. US provides high soft tissue resolution, real-time and dynamic imaging evaluation, and is cost-efficient. High-resolution transducers are recommended (> 12 MHz) for optimal imaging of these nerve structures. The nerves should be imaged in multiple planes, and cine loops should be acquired for spatial reference. The brachial plexus roots can be imaged in the paravertebral region and traced to the interscalene triangle. The trunks are visualized in the interscalene triangle and traced to the divisions at the immediate supraclavicular region. Below the clavicle, the cords can be seen, and the major terminal branches identified as they extend into the upper extremity. Of note, outside the brachial plexus proper, ultrasound can reliably identify the suprascapular, spinal accessory, long thoracic and phrenic nerves in the neck. There are some limitations of US with respect to brachial plexus imaging, but this overview demonstrates that US can provide effective evaluation of this complex anatomy.

Plenary 5, March 31, 2019, 8.45 – 10.10

PROFFERED PAPERS and SCIENTIFIC PRESENTATIONS

Lara Bamsley¹, Leslie Bamsley^{2,3}

¹Orthopaedic Department Western Health, Footscray, Australia,

²Department of Rheumatology Concord Repatriation General Hospital,

Concord, Australia, ³Associate Professor, Department of Medicine University of Sydney, Camperdown, Australia

DETECTION OF ASEPTIC LOOSENING IN TOTAL KNEE REPLACEMENTS

AIM: The aim of this study was to compare the diagnostic accuracy of available nuclear medical imaging modalities in the detection of aseptic loosening of knee prostheses.

METHODS: MEDLINE, EMBASE, and the Cochrane Database of Systematic Reviews were searched from database inception to December 2018 in accordance with Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines. Included studies compared the results of a single imaging modality against an appropriate reference standard of prosthetic total knee arthroplasty (TKA) loosening, with sufficient information to determine either sensitivity and/or specificity. The methodological quality of the studies included was assessed using the QUADAS-2 tool.

RESULTS: The search strategy identified a total of 572 abstracts. Of these, 12 studies comprising 401 patients across four modalities (bone scintigraphy, ¹⁸F-FDG-PET, SPECT/CT arthrogram, radionuclide arthrogram) met the inclusion criteria. All included studies used operative findings, a period

of clinical or radiographic observation or both as a reference standard for aseptic loosening. Sixteen comparisons with the reference standards were extracted. All studies were at risk of bias across patient selection, the index test, reference standard and flow and timing of patients. Most studies were small, so the confidence intervals around the point estimates of sensitivity and specificity were wide. The most accurate test for diagnosis of aseptic loosening in TKA was SPECT/CT arthrography demonstrated by the summary receiver operating characteristic curve.

CONCLUSIONS: The best available evidence suggests that the most diagnostically accurate modality for the detection of aseptic loosening in TKA is SPECT/CT arthrography.

Brian Carey¹, Tom Entwisle¹, Paul Marovic¹, Michal Schneider², David Connell²

¹Imaging@Olympic Park, Melbourne, Australia, ²Monash University, Melbourne, 3800

RECTUS FEMORIS INJURIES IN PROFESSIONAL ATHLETES - MRI ANALYSIS CORRELATED WITH TIME INTERVAL TO RETURN TO PLAY

AIM: The integrity of connective tissue scaffolding (such as the epimysial envelope and central intramuscular tendon rachus) supporting rectus femoris muscle fibers, are vital to muscle function and recovery. Our aim was to determine whether a correlation exists between connective tissue injury as graded on MR imaging and return to play (RTP).

METHODS: A retrospective review of all acute rectus femoris muscle injuries reported to the AFL soft tissue registry between 2013 and 2018 was undertaken. Severity of muscle and connective tissue structural injury was graded (0–3), by three musculoskeletal radiologists by consensus in each case: Grade 1 - myofibril disruption/detachment with connective tissue intact; Grade 2 - myofibril disruption/detachment with connective tissue delamination/partial tear; Grade 3 - myofibril disruption/detachment with connective tissue defect/full-thickness tear. Rehabilitation data was provided by the AFL Research Board. Subsequently, the correlation between injury grade and RTP was determined.

RESULTS: There were 60 rectus femoris injuries with a complete data set included for analysis. In terms of injury location, 22 of the 60 (37%) injuries involved the central intramuscular tendon rachus (indirect head origin); and 32 (53%) involved the epimysial envelope. Grade 1 injuries were found in 21/60 (35%); grade 2 in 24/60 (40%) and the remaining 15 cases (25%) had grade 3 tears. Injury grade was found to have a direct correlation with RTP. The median RTP for grade 1, 2, and 3 injuries were 14 days (range, 7–29); 28 days (14–82) and 41 days (20–82) respectively ($p < 0.001$).

CONCLUSIONS: This study demonstrates a direct correlation between connective tissue injury severity and RTP. An MRI grading system based on connective tissue integrity has the potential to guide appropriate and safe rehabilitation for acute rectus femoris injuries in elite athletes participating in kicking and sprinting sport.

Alastair Eason¹, Jerome Boyle¹, Paul Marks¹

Imaging Associates, Box Hill, Australia

SONOGRAPHIC EVALUATION OF THE INFRAPATELLAR BRANCH SAPHENOUS NERVE: ANATOMY, TECHNIQUE, AND INTERVENTION

AIM: The purpose of our study is to describe the sonographic assessment of the infrapatellar branch saphenous nerve (IPBSN), its clinical relevance, and technique for image-guided diagnostic and therapeutic interventions.

INTRODUCTION: The IPBSN is a purely sensory nerve providing innervation to the anterior knee capsule, and skin of the anterior knee and anteromedial upper leg¹. Its superficial course renders the nerve susceptible to iatrogenic injury in open and arthroscopic knee procedures². Nerve injury can cause a post-operative neuropathy and pain syndrome

that has been well described in orthopedic and pain literature, but receives little attention from radiologists^{3,4}. Our study reviews the anatomy of the IPBSN nerve, its normal variations, technique for assessment, and image-guided diagnostic and therapeutic injections.

CONCLUSIONS: Ultrasound is an excellent tool for assessing peripheral nerves. Increased awareness of the IPBSN amongst radiologists, its clinical relevance, knowledge of the nerves anatomy, and technique for assessment are important tools for radiologists involved in the care of patients with post-operative anterior knee pain. Sonographic assessment of the IPBSN provides patients and clinicians with important information in what can be a challenging diagnostic setting.

James Linklater¹, David Parker², Samuel Grasso², Dr. Li Qing³
¹Castlereaugh Imaging, St Leonards, Australia, ²Sydney Orthopaedic Research Institute, Chatswood, Australia, ³School of Aerospace, Mechanical & Mechatronic Engineering, University of Sydney, Sydney, Australia

VALIDATION OF AN MRI PROTOCOL FOR ROUTINE QUANTITATIVE ASSESSMENT OF TUNNEL POSITION IN ANTERIOR CRUCIATE LIGAMENT RECONSTRUCTION

BACKGROUND: No standardized methodology and objective criteria currently exist to accurately and objectively assess tunnel placement and consequent graft orientation in anterior cruciate ligament (ACL) reconstruction (ACLR) through a single imaging modality. Advances in magnetic resonance imaging (MRI) technology have enabled the use of volumetric high spatial and contrast resolution proton density-weighted sequencing, which allows precise delineation of graft orientation, tunnel position, and quantitative assessment of tunnel position relationship to adjacent reproducible anatomic landmarks.

PURPOSE: To establish an MRI protocol that would provide an accurate alternative to three-dimensional computed tomography (3DCT) for standardized assessment of bone tunnel placement in ACLR, as a component of assessing ACLR outcomes and to assist in presurgical planning for revision ACLR.

STUDY DESIGN: Cohort study (diagnosis); Level of evidence, 2.

METHODS: Twenty-four participants diagnosed with a failed ACLR underwent MRI and CT, in which the acquired data were converted to 3D models. The bone tunnels of the previous ACLR were then intraoperatively digitized at the tunnel aperture and along the length of the tunnel (barrel) and used as the reference standard to evaluate the accuracy of high-resolution MRI and 3D-CT. Differences in geometry between the image based model and the reference point cloud were calculated through point-to-point comparison.

RESULTS: At the tunnel apertures, no significant differences were detected between the MRI and 3D-CT models versus the reference models for the femur ($P = 0.9472$) and tibia ($P = 0.5779$). Mean \pm SD tunnel barrel deviations between MRI and 3D-CT were 0.48 ± 0.28 mm (femur) and 0.46 ± 0.27 mm (tibia). No significant differences were detected between the MRI and 3D-CT models versus the reference models for the femoral ($P = 0.5730$) and tibial ($P = 0.3002$) tunnel barrels.

CONCLUSIONS: This study demonstrated that, in addition to being the optimum modality for assessment of soft tissue injury of the knee, a high-resolution 3D turbo spin-echo proton density sequence can provide an accurate assessment of tunnel placement, without the use of ionizing radiation. Therefore, this protocol provides the foundation for an objective standardized platform to quantitatively evaluate the location of ACL bone tunnels and graft orientation for routine postoperative assessment, presurgical planning, and evaluation of clinical outcomes.

Plenary 6, March 31, 2019, 1040 - 1230

Katie Glazebrook¹
 Mayo Clinic Rochester, Minnesota, USA

DUAL-ENERGY CT BONE MARROW EDEMA AND OTHER APPLICATIONS

The objectives of this talk are to outline the dual-energy technique of virtual non-calcium and to show examples of its clinical applications. DECT allows for material decomposition and so calcium can be removed allowing demonstration of marrow and soft tissue abnormalities. VNCA is useful in cases of trauma to identify marrow edema associated with occult or subtle fractures of the wrist, spine, pelvis and hip, and knee. The technique can also be used to identify marrow-replacing lesions such as metastases and marrow infiltration with multiple myeloma. It can be used to help guide CT biopsies occult on conventional CT but seen on PET/CT or MR and to guide ice ball formation within the bone for cryoblations. Color-coded VNCA has also been applied to spine CT, better identifying lumbar disc herniation compared to standard CT.

K. Nwawka
 Hospital for Special Surgery, New York City, United States of America

MRI ADVANCES PERTINENT TO MSK RADIOLOGY

Quantitative MR imaging techniques: There are continued advancements in conventional MR imaging techniques. Higher-resolution imaging allows for more detailed characterization of morphologic changes to musculoskeletal anatomy, particularly pertinent when evaluating cartilage and nerves. Quantitative MRI techniques attempt to detect biochemical and ultrastructural changes to these tissues, beyond morphologic change. T2 mapping and T1rho have been shown to detect changes in collagen orientation and PG content in cartilage, respectively. Ultra short echo time (UTE) MRI can capture signals from short T2 tissues like tendon and ligaments to provide a biochemical assessment of these structures. These techniques, their clinical applicability, and their limitations were reviewed.

Paul Marks¹
 Imaging Associates, Box Hill, VIC, Australia

A MASTERCLASS ON ACL INJURIES

This talk will cover the anatomy of the ACL bundles in some detail. I will describe the posterolateral and anteromedial bundles function and show examples of bundle tears. I will discuss how I assess these bundles in all three planes. Typical bone contusion patterns will be reviewed. A reasonable part of the talk will look at ACL grafts. An example of different types of graft will be shown and some of the common and uncommon complications of surgery discussed. This will include tunnel widening, what causes it, and also graft impingement and cyclops lesions. Injury to the saphenous nerve during hamstring harvest will also be discussed. There will be a brief review of muscles used to kick a ball using a novel MRI technique and how this impacts on ACL recovery. This talk aims to offer stimulus to all radiologists who report MRI knee cases.

Avneesh Chhabra¹
 UT Southwestern Medical Centre, Dallas, USA

PERCUTANEOUS NEURAL INTERVENTION

Percutaneous neural interventions include nerve blocks, perineural adhesion lysis, hydrodissection, ablation, and nerve biopsy. This talk will highlight: (1) the spectrum of percutaneous interventions and different agents available for injections, (2) the roles of different modalities including- fluoroscopy, US, CT, and MRI-guided interventions, (3) current perspectives on different approaches for superficial and deep injections and ablations (diagnostic and therapeutic), and (4) future direction

POSTER ABSTRACTS

Nicholas D'arcy¹, John Blazak¹, James Challen²

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²*Sunshine Coast Radiology, Sunshine coast, Australia*

ADHESIVE CAPSULITIS IN THE KNEE FOLLOWING ARTHROSCOPY

AIM: Adhesive capsulitis is a rare entity outside of the shoulder, particularly in the knee. This case study describes a patient who presented with ongoing knee pain and limited range of motion following a left knee arthroscopy. His post-operative MRI demonstrated new findings consistent with adhesive capsulitis.

METHODS: This poster discusses a case of proposed secondary adhesive capsulitis in the knee following arthroscopic medial meniscal debridement. A literature review was performed to find previous episodes of adhesive capsulitis outside of the shoulder, particularly in the knee. The MRI findings of adhesive capsulitis in these cases were reviewed. The MRI findings of this case are then discussed, along with the typical MRI findings of adhesive capsulitis.

RESULTS: Adhesive capsulitis has been reported with some frequency in the wrist [1, 2] and hip [3], however there is only one previously reported case of adhesive capsulitis in the knee [4]. Typical findings of adhesive capsulitis include focal or diffuse joint capsule thickening with increased T2 signal. This patient's MRI demonstrated diffuse thickening in the suprapatellar joint capsule, not present on pre-operative MRI, consistent with diffuse capsulitis. No other cause for the patient's pain was demonstrated or accounted for in the clinical context.

CONCLUSIONS: MRI of the knee is commonly performed in patients with knee pain post arthroscopy. Common causes for ongoing knee pain on MRI include: residual/recurrent meniscal tears or osteonecrosis secondary to insufficiency fractures due to altered biomechanics [5], however, to our knowledge, this is the first time radiological findings consistent with adhesive capsulitis have been described in the knee following arthroscopy.

Namit Mathur¹, Bhumika Sood², Aarushi Sood³, Bimal Sood¹

¹*Toowoomba Hospital, South Toowoomba, Australia,* ²*Monash University, Australia,* ³*James Cook University, Australia*

HOW ACCURATE IS THE SHOULDER MRI SCAN AT DETECTING ROTATOR CUFF PATHOLOGY? A COMPARISON OF MRI AND ARTHROSCOPY

AIM: To determine the accuracy of shoulder MRI to detect rotator cuff pathology, by comparing it with shoulder arthroscopy.

METHODS: While arthroscopy is considered the 'standard of reference' to diagnose cuff pathology, MRI is a non-invasive investigation that provides excellent evaluation. A retrospective study was conducted at the Toowoomba Hospital. Patients who underwent shoulder arthroscopy over a 3-year period between September 2015 and November 2018 had their MRI and arthroscopy reports compared. All the MRI and arthroscopy were reported by a radiologist and an orthopedic surgeon, respectively. Inclusion criteria: 18 years old, suspected rotator cuff or labral pathology. Exclusion criteria: No MRI available, septic arthritis, previous arthroplasty. Statistical analysis was performed using the SAS database. The confidence intervals and *p* values calculated using Fisher's exact test.

RESULTS: A sample of 163 patients was generated; a final size of 66 met the above criteria (44 male, 22 female). The average age was 47 (range, 15–73). Four cases demonstrated cuff tears on arthroscopy that were not seen on MRI (false negative); three of these cases had a > 1-year interval between the MRI and arthroscopy dates. In 29 cases, cuff tears were detected on both the MRI and arthroscopy (true positive). However, 14 of these cases demonstrated further tears in other muscles on the MRI that were not seen on arthroscopy. Furthermore, MRI reported ten patients with cuff tears in patients who had a normal shoulder arthroscopy (false positive). Twenty-three cases

demonstrated no cuff tears on both the MRI and arthroscopy (true negative). Statistical analysis revealed a sensitivity of 87.9%, specificity of 69.7%, positive predictive value of 74.4%, and a negative predictive value of 85.2%. All *p* values were statistically significant (< 0.05).

CONCLUSIONS: MRI has a high sensitivity and moderate specificity in the detection of cuff tears. It has a better NPV than a PPV. This is likely due to MRI scans detecting cuff tears that may not be significant surgically. We conclude that the shoulder MRI is a useful screening and pre-operative test that detects positive cuff findings.

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HOW ACCURATE IS THE WRIST MRI AT DETECTING TFCC TEARS? A COMPARISON OF MRI AND WRIST ARTHROSCOPY

AIM: To determine the accuracy of wrist MRI at detecting TFCC tears by comparing it with arthroscopy. The triangular fibrocartilage complex (TFCC) is a complex of wrist ligaments that provide stability during movement. TFCC tears are a treatable cause of wrist pain. TFCC tears can be traumatic (type 1) or degenerative (type 2). Wrist MRI is a non-invasive test to detect TFCC tears; however the reported accuracy of MRI is variable in the literature – with sensitivity 44–93%, specificity 54–100%, NPV 37–90%, PPV 71–100%⁽¹⁾.

METHODS: A retrospective study was conducted at the Toowoomba Hospital. A list of patients who underwent wrist arthroscopy between Jan 2015 and December 2018 was generated. The patient's arthroscopy reports were compared with MRI reports. All the MRIs were reported by a radiologist; while all the arthroscopies were performed by an orthopedic hand surgeon.

Inclusion criteria: 18 years old with a suspected TFCC or scapholunate tear. Exclusion criteria: No MRI available, septic arthritis.

Statistical analysis was performed using 'MedCalc Diagnostic calculator'⁽⁹⁾.

RESULTS: A sample of 27 patients was generated. Three patients were excluded as no MRI results were available. Twelve cases demonstrated a TFCC tear on both MRI and arthroscopy (true positive). Four cases demonstrated a tear on MRI but not on arthroscopy (false positive). Four demonstrated a normal TFCC, but were found to have a tear on arthroscopy (false negative), while four patients had a normal TFCC on MRI and arthroscopy (true negative). Statistical analysis revealed a sensitivity of 75%, specificity of 50%, positive predictive value of 75%, and a negative predictive value of 50%.

CONCLUSIONS: Our study shows that wrist MRI has moderate sensitivity and a poor negative predictive value at detecting TFCC tears. Our data is consistent with the published literature. We conclude that a normal wrist MRI cannot reliably exclude a TFCC injury and a wrist arthroscopy should be considered in patients with a clinical suspicion.

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3-D SPINAL IMAGING WITH THE EOS® system: A PICTORIAL REVIEW

AIM: The primary aim of this presentation is to educate the general radiologist about the EOS® system for imaging the spine. In

particular, we aim to demonstrate: (1) how EOS® works, (2) advantages of EOS® over more conventional spinal imaging methods, (3) capabilities of EOS® software in generating spinal alignment parameters, (4) 3-D reconstructions, and (5) clinicopathologic relevance of the above parameters.

METHODS: A brief overview of EOS®, its advantages, and software capabilities will be given. Using a variety of EOS®-acquired radiographs, EOS® software-generated 3-D images, and original graphics, various parameters of spinal balance and alignment will be demonstrated and explained. Where relevant, more detailed explanation of the biomechanics and pathology of the spine will be discussed in order to convey clinical relevance.

RESULTS: Using the EOS® system, 3-D radiographic imaging of the spine can be performed with ease, rapidity, and at much lower radiation doses compared to more conventional methods of 3-D imaging. Software analysis allows for a multitude of parameters to be calculated from a single acquisition with high accuracy, however some are of greater clinical importance than others.

CONCLUSIONS: As the EOS® system gains popularity, and our understanding of pathologic spine biomechanics improves, it will be important for the general radiologist to have an understanding of the most clinically important spinal alignment parameters in order to provide the referring clinician a relevant report.

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INJURY PATTERNS IN E-SCOOTER TRAUMA; DON'T DRINK AND SCOOT

AIM: Standing electric scooters (e-scooters) are a relatively new trend in personal transportation, growing exponentially since the launch of Lime © in New Zealand and Australia late last year. Due to their speed and use patterns, e-scooters have the potential to cause more significant injuries than their 'traditional', non-motorized counterparts. In order to ensure effective and timely diagnosis, radiologists must be aware of the severity, frequency, and breadth of possible injuries due to this mechanism. As such, the aim of this study was to characterize the incidence and injury patterns of e-scooter-related trauma in Brisbane.

METHODS: A retrospective case series was conducted on e-scooter-related trauma during a 3-month period, from mid November 2018 to mid February 2019 at the Royal Brisbane and Women's Hospital, Brisbane, Australia. Data analyzed included patient demographics, radiological modalities utilized, and injury patterns.

RESULTS: Eighty-two patients met our criteria, with an average age of 33 (37 females and 45 males); 87% underwent some form of radiological investigation: 42 X-ray only, nine CT only, 19 X-ray + CT, X-ray + MRI for a total of 71. Radiologically significant injuries were located in the: upper-limb (21), lower-limb (8), head and neck (6), and thorax (4).

CONCLUSIONS: Radiologists play a crucial role in the evaluation and management of trauma patients. E-scooter trauma victims appear to have high rates of radiologically significant injury, ranging from minor to life-threatening. Upper limb fractures were the most common, followed by lower limb, cranial, and thoracic injuries. Early, appropriate radiological input is critical to good functional outcomes, especially considering the younger demographic of these patients. Further research is necessary to ensure that we effectively regulate these new methods of transportation, maximizing utility while minimizing risk to their riders.

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ROLE OF DWI IN MUSCULOSKELETAL INFECTIONS: A PICTORIAL ESSAY

The presence of fluid in the subcutaneous and deep planes is a non-specific MRI finding for diagnosis of musculoskeletal (MSK) infections. Adding diffusion-weighted imaging (DWI) to routine MRI sequences increases the accuracy of the diagnosis. It is particularly very useful in patients with impaired renal function who cannot be given IV MRI contrast media. In this pictorial essay, we present examples of DWI findings in subcutaneous, deep fascial, intramuscular, tenosynovial, bone and joint infections. Our examples also show the ability of DWI to detect early evolving MSK infection, multifocal infection, abscess in the background severe cellulitis, and the limitations DWI imaging. With our DWI experience, we hope to limit the future use of IV MRI contrast media for diagnosis or exclusion of MSK infections.

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OSSIFICATION OF POSTERIOR LONGITUDINAL LIGAMENT (OPLL): INCREASED PREVALENCE IN THE PACIFIC ISLAND POPULATION. MOST AT-RISK POPULATION IN THE WORLD?

AIM: OPPL is a hyperostotic condition of the spine that can be associated with severe neurological deficit and increased risk of spinal cord injury [1–3]. Although OPLL can be encountered in any patient population, it has been found to be more common in Asians [1–3]. The aim of this study is to investigate the prevalence of OPLL in the Auckland region, especially in the Pacific Island population.

METHODS: Using PACS, all the cervical spine and neck computed tomography (CT) examinations between a 2-month period were retrospectively assessed for the presence of OPLL. Basic demographic data were recorded: gender, age, ethnicity, presence of cervical diffuse skeletal hyperostosis (DISH), and the presence or absence of diabetes mellitus.

RESULTS: 1692 CT examinations were included in the study. Distribution of the ethnic groups was 57.3% European, 12.09% Pacific peoples, 11.9% Maori, 11.53% Asian, 0.95% Middle Eastern/Latin American/African, and 6.3% not specified. Overall, 47 cases of OPLL were identified (2.78%). Prevalence of OPLL in the Pacific ethnic groups was significantly higher compared to the European ethnic group (8.47% versus 0.62%, $p < 0.05$). The prevalence of OPLL was also significantly higher in the Asian (6.9%) and Maori (3.6%) populations compared to the European ethnic group, $p < 0.05$. A significantly higher proportion of the patients with OPLL had underlying diabetes 20/47 (42.55%) compared to the study population 196/1692 (11.58%), $p < 0.05$. Seven cases of OPLL (14.89%) had associated cervical DISH, which was significantly higher compared with the study group (23/1692), $p < 0.0002$. Using the Japanese Ministry of Health and Welfare classification system, segmental type was the most common (34/47, 72.3%), followed by mixed (14.9%) and continuous types (12.8%).

CONCLUSIONS: Prevalence of OPLL is significantly higher among the Pacific populations in Auckland. There is also increased prevalence in the Asian and Maori populations. This has important clinical implications given the ethnic diversity within the region.

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CERVICAL SPINAL CANAL AP DIAMETER IN THE PACIFIC ISLAND AND MAORI POPULATIONS

AIM: A congenitally narrow cervical spinal canal is an important risk factor for spondylotic myelopathy and spinal cord injury in the setting of trauma [1–2]. There is a perception in the orthopedic and radiology

communities that Pacific Island and Maori patients have congenitally narrow cervical spinal canal diameter. However, there is a paucity of information on the spinal canal diameters in these ethnic groups. The aim of this study is to investigate the mean cervical spinal canal diameter in the Pacific Island and Maori populations in the Auckland region.

METHODS: Cervical spine and neck computed tomography (CT) examinations performed during a 2-month period were retrospectively reviewed. Maximal anterior-posterior (AP) of the spinal canal of was measured at 5th cervical vertebra (C5). Demographic data were collected including ethnicity, sex, and age.

RESULTS: A total of 1411 examinations were included in the study, with a mean age of 58.1 years. Ethnic composition was: 58% European (819/1411), 12.2 % Pacific Island (172/1411), 12.3% Maori (173/1411), 11.1% Asian (157/1411), 1%, Middle Eastern/Latin American/African (14/1411), and 5.39% not specified (76/1411). Overall, the mean AP diameter of the cervical spine at C5 was 12.82 mm (range, 7.2–19.3 mm). Mean AP diameter in the Pacific Island group was 11.86 mm, which was significantly lower compared to the European group (13.22 mm), $p < 0.05$. The mean AP diameter was also significantly lower in the Asian (11.97 mm) and the Maori (12.62 mm) populations when compared to the European group. The Samoan population has the lowest mean AP spinal canal diameter (11.49 mm) amongst all the ethnic subgroups.

CONCLUSIONS: There are significant differences in the mean AP cervical canal diameter between the ethnic groups within Auckland. The Pacific Island, Maori, and Asian populations have significantly smaller AP diameter compared with the European population. Samoan had the smallest mean AP canal diameter amongst the ethnic subgroups.

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THE IMPACT OF ANTIBIOTIC PRE-TREATMENT ON DIAGNOSTIC YIELD OF CT-GUIDED BIOPSY FOR SPONDYLODISCITIS: A MULTICENTER RETROSPECTIVE STUDY.

AIM: Optimal treatment of spondylodiscitis requires accurate microbiological information, and radiology-guided percutaneous biopsy plays an important role in directly sampling lesion material. However, patients undergoing percutaneous biopsy have often undergone partial treatment with antibiotics at the time of procedure. Previous studies linking antibiotic treatment and microbiological yield have been inconclusive. The aim of this study was to assess the impact of antibiotic pre-treatment on the microbiological yield of CT-guided biopsy in patients with spondylodiscitis.

METHODS: Consecutive adult patients with spondylodiscitis undergoing CT-guided biopsy were included retrospectively from two New Zealand centers between 2010 and 2016. Discharge diagnoses of spondylodiscitis and of the causative organism were used as gold standard. Information regarding biopsy technique, and clinical and demographic data were obtained from patient medical records. Antibiotic treatment was ascertained from review of patient drug charts. Statistical analysis was performed with Stata 13.

RESULTS: A total of 113 patients were included, with 54 (47.8%) having positive microbiological diagnoses on biopsy. Patients without antibiotic pre-treatment were significantly more likely to have a positive microbiological diagnosis on biopsy than those with antibiotic treatment (41 patients (54.7%) versus 13 patients (34.2%); $p = 0.042$). This association was independent of clinical and demographic variables.

CONCLUSIONS: Antibiotic treatment prior to CT-guided biopsy is associated with a lower rate of diagnostic microbiological yield in patients with spondylodiscitis, and this appears to be independent of clinical and demographic factors. If antibiotics are able to be safely withheld prior to

biopsy in spondylodiscitis, this may lead to improved microbiological diagnostic yield.

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DIAGNOSTIC YIELD AND ACCURACY OF IMAGE-GUIDED BIOPSY IN MUSCULOSKELETAL LESIONS

AIM: Biopsy of suspicious musculoskeletal lesions is important in guiding medical and surgical management. Image-guided biopsy is a well-established first-line investigation as it is minimally invasive, cheaper, has fewer complications, and can be undertaken in an outpatient setting (1–3). Previous studies report diagnostic yield ranging from 66 to 98% (1), however there has been no study investigating local outcomes to date. The aim of this study is to evaluate all image-guided biopsies for musculoskeletal lesions undertaken at this tertiary center, and to calculate the diagnostic yield and accuracy of these biopsies.

METHODS: A retrospective review of all image-guided biopsies undertaken at Middlemore Hospital between 2005 and 2018. Demographic and procedural data, including any complication, was collected. Initial and subsequent histology, as well as clinical outcome was examined using clinical records. A biopsy was defined as diagnostic if the histology had a definitive pathological diagnosis or was clinically useful. For those biopsies that had subsequent tissue sampling, a biopsy was defined as accurate if the initial histology was concordant with ultimate diagnosis with respect to tumor subtype and grade.

RESULTS: 190 biopsies in 174 patients were included over the 13-year period; 47% of patients were female and 53% were male. Modality of biopsy was ultrasound in 113 (59%), computed tomography (CT) in 76 (40%) and fluoroscopy in 1 (5%). Six (3%) of biopsies were done under general anesthesia. There were reported complications in 19 (10%), however these were all minor (for example pain, bleeding, vasovagal episode) except for in one (0.5%) where the patient had a pneumothorax. Diagnostic yield was 151/190 (79%) and diagnostic accuracy was 44/61 (72%).

CONCLUSIONS: Image-guided biopsies are effective in the management of majority of patients with soft tissue lesions, with a portion requiring further tissue diagnosis. It is a safe procedure with very few major complications.

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COMPLICATIONS OF REVERSE TOTAL SHOULDER REPLACEMENT: A RADIOLOGIST'S GUIDE

AIM: To outline the common radiological findings of complications of reverse total shoulder replacements. Reverse total shoulder replacements are now relatively common in orthopedic practice and used for patients with cuff tear arthropathy, complex fractures, tumor invasion, and instability. There are a number of complications that can occur after this procedure that will be outlined in this e-poster including instability or dislocation, post-operative infection, peri-prosthetic fracture, and aseptic loosening of the reconstructed shoulder. The poster will demonstrate common findings of abnormal post-operative reverse total shoulder replacements and summarize important aspects of imaging to observe.

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