Learning Solutions from

GE Medical Systems

Program Supplement

CT/MR: Cross-Sectional Anatomy: Musculoskeletal

TiP-TV™

GE Training in Partnership Television

GEMS 1053

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PRESENTER BIOGRAPHIES

Roger Beck, GE Medical Systems CT TiP-TV Program Coordinator, TIP-TV

Roger Beck, from Madison, Wisconsin, has been with GE Medical Systems for eight years. Roger holds Bachelor's and Master's degrees in Public Administration and Management from the University of Wisconsin-Madison and Cardinal Stritch College in Milwaukee. He is also a registered radiologic technologist with the American Registry of Radiologic Technologists.

Roger's clinical background includes several years as a special procedures technologist which included work in computed tomography, angiography, and invasive procedures. After attaining his Masters degree, Roger became a radiology manager responsible for technical operations and quality improvement.

Roger began his career with GE as a CT Clinical Educator; he co-developed and taught the HiLight and HiSpeed Advantage headquarters customer classes. He is now the Program Coordinator for TiP-TV's CT broadcast network.

Susan Hooper, RT R(MR) - GE Medical Systems MR TiP-TV Program Coordinator

Susan joined GE Medical Systems as a West Region MR Field Applications Specialist in 1996. She became the MR TiP-TV Program Coordinator in 1999. She received her certification in Radiologic Technology in 1987 from the Gaston School of Radiologic Technology in North Carolina. She earned her advanced certification in Magnetic Resonance Imaging in 1995. Before joining GE Medical Systems, Susan was an MRI technologist at Valley Presbyterian Hospital in Van Nuys, California.

PROGRAM OBJECTIVES, TARGET AUDIENCE, AND PRODUCTIVITY STATEMENT

Program Objectives

By the end of this program, the viewer should be able to:

- Identify anatomical bone and joint characteristics as well as their appearance on computed tomagraphy CT and magnetic resonance MR images.
- Compare and contrast (CT) and (MR) imaging indications and strategies for musculoskeletal structures.
- Recognize soft tissue and muscular and bone imaging protocols for both modalities.
- Describe selected pathologic processes affecting muscle, joint, and bone tissue, to include traumatic injury.

Target Audience

Course objectives for this program specifically target CT and MR technologists. While not limited to this audience group, the technical content will be most effective when applied to people with this training.

NOTE: Viewers who apply for continuing education (CE) credit and meet the application requirements are eligible for credit, regardless of their audience status.

Productivity Statement

This program was developed to enhance your professional and educational level, and increase your productivity and skills.

PROGRAM OUTLINE

CT/MR: Cross-Sectional Anatomy - Musculoskeletal

I. Introduction
   A. General Indications for Both MR and CT
   B. Program Focus

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   B. Pathology
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IX. Extremities
   A. Wrist and Hand
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   C. Ankle and Foot

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INTRODUCTION

MR and CT may be used for the evaluation and definition of abnormalities and pathologic processes. In this program, we will focus on the use of these modalities for the musculoskeletal system.

MR is considered by some to be the definitive diagnostic test available for evaluation of the musculoskeletal system. At the time of its introduction in 1985, MR was rarely used to make critical decisions regarding surgical intervention and treatment. Things have changed since; MR is now routinely utilized to provide surgeons and clinicians with invaluable information concerning almost any underlying pathologic condition, greatly impacting the quality of patient care.

GENERAL INDICATIONS FOR BOTH MR AND CT

MR has been used to diagnose a multitude of disorders of the musculoskeletal system. The ability to acquire high-resolution images, in a wide variety of tissue contrasts, has made MR indispensable. MR is capable of imaging any extremity from the shoulder to the foot, in any unique plane. The indications for MR of the musculoskeletal system seem limitless, but this presentation will encompass those that you are most likely to encounter in your routine clinical setting.

Some of the more common indications for MR of the musculoskeletal system include:

- Fracture
- Ligament or tendon tear
- Infection
- Tumor
- Cartilaginous injury

Notes:

PROGRAM FOCUS

- Skeletal types
- Joint types
- Shoulder
- Hip
- Soft tissue structures
- Pathology
- Imaging characteristics
- Wrist and hand
- Knee
- Ankle and foot

CT/MR OF THE SKELETAL SYSTEM – BONE

ANATOMY REVIEW

Axial and Appendicular Skeleton

The human body contains 206 skeletal bones that are irregular, short, long, sesamoid, flat, and more. The bones of the skeleton are either axial or appendicular.

- Axial skeleton
  - Skull
  - Sternum
  - Ribs
  - Vertebrae
- Appendicular skeleton
  - Upper limbs
  - Lower limbs

NOTE: Refer to the program to view the humerus graphic, which demonstrates the following:

- Spongy internal bone called cancellous tissue
  - Within the cancellous tissue is a mineralized meshwork called trabecular bone
- Periosteum – fibrous, vascular membrane, surrounding bone, which is permeated by nerves and blood vessels
- Long bones contain fatty, yellow marrow in the shaft, and red marrow on the articular ends
  - Active red marrow produces red blood cells
  - Marrow also produces B-lymphocytes, important components of the immune system
- The shaft of long bones is called the diaphysis
- The end portion of the shaft is called the metaphysis
- The end part of a long bone is known as the epiphysis

In young bone, the epiphyseal plate intervenes between the diaphysis and epiphysis and is in contact with the metaphysis.

In bone growth, the metaphyseal sides of epiphyseal plates generate cartilage, which is ossified until adult size is achieved. Gradually, boney tissue will completely replace epiphyseal plates and the diaphysis will fuse with the epiphysis to form mature bone. This is completed by age 25.

Periosteum is vascular membrane, thick and very vascular in young bones, and thinner and less vascular in older bones.

TRAUMA

Common musculoskeletal uses for CT are primarily for evaluation of bone injury. With faster scanners, we are also seeing CT as the primary diagnostic tool for polytrauma, patients presenting with multiple injuries needing rapid assessment.

Traumatic injury is certainly a common indication for MR of the extremities or other structures of the musculoskeletal system. The joint or structure under examination determines just what that injury may be. For example, aside from fracture, if the area of interest is the knee, the clinician may also question an associated soft tissue injury. In the case of a traumatic injury to the knee, it may be a meniscal injury, or ligament, tendon tear, or cartilaginous derangement.

Traumatic Knee Injury

- Fracture
- Bone contusion
- Meniscal tear
- Anterior cruciate ligament tears
- Posterior cruciate ligament tears
- Medial and lateral collateral ligament tears
- Chondromalacia
- Quadriceps tendon rupture
- Muscle tears

Notes:

Image Review

- Tibial plateau fracture
- Bone contusion
- Anterior Cruciate Ligament (ACL) tear
- Meniscal tears

Meniscal tears, or abnormalities, have been assigned significance based on the signal intensity demonstrated. This grading system, which utilizes a scale ranging from grade 1-3, is based on the signal intensity distribution, as it relates to the articular meniscal surface.

- Grade 1 – focal intra-meniscal signal intensity correlates with early degeneration
- Grade 2 – lesion may present as a horizontal or linear intra-substance signal intensity, which extends from the capsular periphery of the meniscus, but does not involve the meniscal surface
- Grade 3 – when the area of increased signal intensity communicates with at least one articular surface; the meniscus may contain multiple areas of grade 3 signal intensity, or the entire horn of the meniscus may be involved

Meniscal Tear Patterns

- Vertical
- Horizontal
- Longitudinal
- Oblique
- Radial

Notes:

MR IMAGING CHARACTERISTICS

MR characteristics of bone are defined by the pulse sequence employed and the pathology demonstrated. Unlike other imaging modalities, MR offers the distinct advantage of producing direct bone marrow images. Thus, MR has become a primary method to evaluate diseases that involve or target the bone marrow.

Notes:

CT IMAGING CHARACTERISTICS AND CLINICAL INDICATIONS

CT of trauma to articular surfaces can be particularly useful for the determination of fracture extent and location of fragments within the joint.

The importance of multiplanar reformat and 3D is well understood. The acquisition of contiguous “volumes” of data is the key to optimal creation of post-processed images. If performed properly, these procedures can be particularly helpful in classifying fractures and planning surgical treatment. Follow-up of bone healing is effectively accomplished with CT as well.

Epiphyseal, or articular lesions, are very well seen with CT, as are very subtle fractures, which can be elusive using other diagnostic methods. An example of this is the cortical lines indicating stress fractures of the lower third of the tibia.

CT identification of bone fragments in places where they are not normally located is critical to successful healing, particularly in joints. Surgical approaches must take into account the existence of bone fragments, either to plan reduction to former positions, or to remove them altogether. If not removed, arthritic conditions are widely associated with residual bone fragments.

Motor vehicle accident victims requiring evaluation of complex fractures of extremities are the most often requested extremity evaluation with CT.

Notes:

READ ME FILES

Notes:

JOINTS

ANATOMY OF CARTILAGINOUS AND SYNOVIAL JOINTS

Joints are classified according to their structure as fibrous, cartilaginous, or synovial.

Joint Classification by Movement

- Synarthrodial – No movement
- Amphiarthrodial – Slight movement
- Diarthrodial – Free movement

The joints exhibiting the widest range of motion are the synovial joints. Synovial joints are formed when two bones unite and are enclosed within a joint capsule. The capsule itself is filled with synovial fluid, thus the name.

Synovial joints have several distinguishing features:

- Joint capsule
- Articular cartilage
- Synovial membrane
- Synovial fluid produced by the synovial membrane

We can further classify synovial joints based on their type of movement. Examples of those classifications are:

- Gliding joints – including the articulations between the carpal and tarsal bones
- Hinge joints – including the elbow, knee, and phalanges
- Pivot joints – including the atlas and odontoid
- Saddle joints – including the articulation between the carpal and metacarpal of the thumb
- Ball and socket joints – including the hip and shoulder

Notes:

SHOULDER

MR Imaging Considerations and Anatomy

We'll begin our anatomic review of the shoulder with the structures comprising the rotator cuff tendon or tear. The rotator cuff is actually not one, but four different tendons:

- Supraspinatus
- Infraspinatus
- Teres minor
- Subscapularis tendons

The rotator cuff is, in essence, a group of tendons whose primary function, along with their associated muscles, is to stabilize the shoulder joint and hold the humeral head in position within the glenoid fossa and limit superior translation with abduction.

Notes:

Classification of Rotator Cuff Tears (RCT)

RCT of the shoulder can be difficult to evaluate.

- Partial tears – involving the articular and bursal surfaces, and the tendons themselves to varying degrees of depth
- Complete tears – extending through the entire thickness of the rotator cuff

Notes:

Common Labral Lesions

The labrum is structure formed by the attachment of the glenohumeral ligaments and joint capsule to the rim of the glenoid fossa. Tears of the labrum are another common indication for MR evaluation of the shoulder joint.

Some of the more common labral lesions you may encounter are:

- Bankart lesion – represents avulsion of the inferior glenohumeral ligament labral complex from the glenoid rim
- Perthes lesion – presents as an avulsion of the labroligamentous complex
- Glenolabral Articular Disruption (GLAD) lesion – involves a tear of the anterior inferior labrum; this is also commonly associated with cartilage injury as well
- Superior Labrum from Anterior to Posterior (SLAP) lesion – includes several different classifications from type I to type VII

Notes:

CT Imaging Considerations and Anatomy

CT is useful for the evaluation of fractures and dislocations or other complex injuries of the shoulder. Glenohumeral injury, pseudosubluxation, scapular, acromioclavicular, and even sternoclavicular abnormalities are very well demonstrated.

The glenoid labrum is composed of a ring of fibrocartilage attached to the rim of the glenoid cavity of the scapula, which increases the depth of the cavity.

Torn labra cause shoulder instability. The joint is most vulnerable to trauma when fully abducted and a major force is applied from above.

While MR remains an optimal procedure for evaluation of the shoulder joint, there are many radiologists who believe shoulder arthrography with CT is underutilized and can provide a very cost effective, timely, reliable evaluation of labral disorders, rotator cuff tears, and status of the biceps tendon.

Refer to the program to view an image depicting a double contrast study using air and iodinated contrast media. You'll see a full thickness rotator cuff tear, with contrast and air, present in the subacromial-subdeltoid bursa.

CT arthrography protocols can include single or double contrast technique. The double contrast technique is used most often with older scanners. With the development of multidetector systems, the need for two contrast agents is lessened significantly. In those cases, air will not be used.

- For CT arthrography, the double contrast technique includes the instillation of approximately 6 – 10 ml of air, along with about 1 ml of iodinated contrast material
- The amount of air will vary from protocol to protocol; iodinated contrast levels are kept low, so as not to overdistend the joint
- Common positioning will place the patient supine in a head first orientation, either with both arms at the sides or with the contra-lateral arm raised above the head
- Slices are acquired from just below the acromioclavicular (AC) joint to the axillary recess
  - 3 mm slice thicknesses are used with spacing equal to the thickness
  - A 50% retrospective overlap is desired for these studies
- Need about 20 to 25 slices to completely capture the area

If the overlap is used, you'll end up with about 50 slices, which will be an excellent data set to begin creating reformatted planes of interest.

When coated with contrast, the anterior labrum is sharp with smooth and regular margins, while the posterior labrum is thicker and more rounded.

Acromioclavicular (AC) Joint

The AC joint joins the lateral end of the clavicle, with medial margin of the acromion of the scapula. The clavicle forms a strut, holding the point of the shoulder out away from the trunk, facilitating its free movement.

Supraclavicular (SC) Joint

The SC joint is sometimes referred to as a "blind" area, which is an area of small size or complex shape that is quite difficult to image with plain films.

CT is becoming more valuable in sorting out questions pertaining to injuries, inflammation, or indeterminate diagnoses of the clavicle and sternum. At the sternal extremity, the clavicle articulates with the sternum via the sternoclavicular ligaments. An articular disk is placed centrally and both clavicles are joined together by this interclavicular ligament.

The SC joints are areas where use of multiplanar reformat and 3D reconstruction techniques are quite useful, particularly in trauma where posterior dislocation can affect the aorta and great vessels.

Notes:

HIP

CT Imaging Considerations and Anatomy

Most texts will define the hip to be made up of the ilium, ischium, and pubis. Prior to puberty, the ilium, ischium, and pubis are separated by cartilage and begin a fusion process at around age 16, to ultimately form what appears to be one single bone by age 23.

The hip bone is also called the coxal bone. It has a cup-shaped socket called the acetabulum, which by accepting the femoral head, becomes the hip joint. The acetabulum has a labrum just as the shoulder does.

Acetabular fractures are often classified by their extension and region. Refer to the program to see the anterior column and posterior column of the acetabulum. Fractures are referred to using those terms.

CT images showing the anterior and posterior columns of the acetabulum, and a fracture line in the anterior column of the acetabulum, are also shown in the program. Also see a CT image demonstrating a comminuted (crushed or broken into a number of pieces) posterior column fracture.

Notes:

MR Imaging Considerations and Anatomy

Common MR Imaging Indications

- Avascular necrosis (AVN)
- Arthritis
- Fracture
- Loose bodies
- Dislocation
- Labral tears

The hip is another synovial joint which is often imaged in MR, to rule out avascular necrosis, arthritis, fracture, loose bodies, dislocation, and labral tears.

AVN most commonly involves the femoral head. Necrosis of the femoral head usually occurs secondary to traumatic injury of the femoral neck, thus disrupting the vascular supply. MR has a specificity of approximately 98% in the detection of AVN of the hip, making it the imaging modality of choice.

AVN is typically demonstrated by a low signal intensity area on T1 weighted images as seen in the program, and an increased signal on fat suppressed T2 or STIR images.

Osteoarthritis is the most common form of articular cartilage degeneration. While the diagnosis of osteoarthritis can often be obtained by x-ray examination, MR is frequently used to aid in the early detection of this disease. Articular cartilage is typically best demonstrated on either sagittal or coronal fat suppressed T2 weighted images. Osteoarthritis can be identified by joint space narrowing and osteophyte formation.

MR arthrography (discussed later) may occasionally be used to identify small focal chondral lesions when utilized with fat suppression on T2 coronal images.

As with the shoulder joint, the hip is also subject to labral tears. Like the shoulder, the labrum of the hip is well demonstrated on a coronal image as a low signal intensity triangular shaped structure located at the lateral aspect of the acetabulum.

Symptoms of labral tear include:

- Pain
- Decreased range of motion
- Clicking with joint rotation or flexion

Notes:

CONTRAST MEDIA – INTRA-ARTICULAR

MR Arthrography

Intra-articular gadolinium in the assessment of joint structures and pathology; interview with Dr. Tuite of the University of Wisconsin, Madison.

Notes:

IMAGE OF THE MONTH

Notes:

SOFT TISSUE

ANATOMY REVIEW OF MUSCLE, TENDON, LIGAMENT AND CARTILAGE

Muscle

Muscle constitutes the "red flesh" of the body. Tendons, fasciae, and aponeuroses all serve to attach ends of muscles and play a role in determining the direction of movement.

Three muscle types:

- Smooth
- Striated
- Cardiac

Striated muscle, which comprises all muscles attached to the skeleton, is most applicable to the musculoskeletal system.

To perform work, a muscle needs two attachment points:

- Origin – relatively fixed
- Insertion – more moveable

When a muscle contracts, the insertion is brought nearer the origin.

There are two muscle attachment methods:

- Direct – fascia is attached directly to the periosteum of bone, or to the perichondrium of cartilage
- Indirect – require tendons, or aponeuroses, to connect to bone

Tendon

Tendons are white, flat, dense cords of collagenous fibers that are very strong and inelastic.

Aponeuroses are flat, broad sheets of connective tissue, which are white and similar to tendons.

Fasciae are either superficial or deep and largely comprised of fibrous connective tissue.

- Superficial fascia is located under the skin, over most of the surface of the body.
  - Connect the skin to underlying structures
  - Protect and insulate
  - To form a reservoir for storage of food and water
- Deep fascia forms the sheaths of muscles as well as intermuscular septa in some instances; in other cases, fascia will attach muscle to bone or cartilage.
  - Is instrumental in enclosing blood vessels, lymphatics, and nerves

Learning Point

What is a bursa and what does it do?

Notes:

Ligament

Ligaments are white, flexible, shiny bands holding joints together, primarily connecting bone to bone.

Refer to the program to see an example of how tendons and ligaments may look very similar, but have very different functions.

Cartilage

Cartilage is the precursor to most bone growth, but it is also a binding substance between joint components. There are different kinds of cartilaginous joints, which are mentioned in the program.

PATHOLOGY

Arthritis

Degenerative joint disease is a term used to describe most degenerative alterations in fibrous, cartilaginous, and synovial articulations.

- Degenerative arthritis describes non-synovial joint degeneration (cartilage and fibrous)
  - Common sites of cartilaginous involvement are the intervertebral disc, symphysis pubis, and manubriosternal articulation
- Osteoarthritis is reserved for the same process in synovial joints
  - It affects the synovial joints of the hand (interphalangeal joints), wrist, acromioclavicular joints, hip, and knee

The presence of osteophytes (bony outgrowths), seen as irregular contours near the edges of articulations, are the most common characteristic finding in degenerative joint disease.

Osteoporosis is a skeletal state of decreased mass per unit volume of mineralized bone, second only to arthritis as a cause of musculoskeletal morbidity. It is seen more frequently in post-menopausal women, in sedentary or immobilized individuals, and patients on long-term steroid therapy.

- The skeleton is a mineral reserve bank in which the body stores its calcium and phosphorus in a metabolically stable environment
- When this stability fails and mineral stores fall below normal levels, osteoporosis is the result

Osteoporotic fractures can occur with minimal trauma in ribs, proximal femur, the humerus, distal radius, and in spinal bodies.

IMAGING

MR is the gold standard for depiction of soft tissue structures of the musculoskeletal system, but CT is a very close second in many instances and can, at times, become a primary evaluation mechanism.

There are some situations where CT can provide information that MR cannot, such as in cases where soft tissue gas is present (such as that found in necrotizing fasciitis) and in processes where small amounts of calcium are present.

CT IMAGING CHARACTERISTICS

For malignancies of the extremities, CT is capable of defining vascular lesions quite well, due to circulating iodinated contrast media. Diseases such as musculoskeletal tumors, cellulitis, lymphedema, abscess, fasciitis, osteomyelitis, avascular necrosis, and dysplasia are all within the purview of CT.

MR IMAGING CHARACTERISTICS

- Intrinsic – signal intensities that are tissue dependent
- Extrinsic – signal intensities that are operator controlled

Notes:

We typically describe the factors effecting signal intensity on MR images as falling into two categories, those that are intrinsic, which are tissue dependent, and extrinsic, those that the MR technologists control, or vary, through parameter selection.

The intrinsic factors are Proton Density and Tissue Relaxation times known as T1, T2, and T2*.

The extrinsic factors are operator selectable and include TR, TE, and Flip Angle.

MR technologists can control the signal intensity produced in accordance with the parameters selected.

For instance, on T1and T2 weighted images, tendons and ligaments are hypointense, or dark. However, articular cartilage signal intensity is a little more complex. There are actually two layers, a superficial layer and a deeper layer.

On T1 weighted images, the superficial layer displays higher signal intensity than the deeper layer. On T2 and Proton Density weighted images the opposite is true. The superficial layer is of lower signal intensity than the deeper layer.

Muscle tissue tends to be relatively low in signal intensity on both T1 and T2, unless there is some associated pathology that increases water content, which often occurs in conjunction with muscle injury, due to necrosis or bleeding.

Fat signal is very bright on T1 weighted sequences due to its very short T1 recovery time. Signal from fat on standard T2 weighted images is much darker.

We can either choose to suppress fat or water in the image, if we like. Even though the pulse sequence itself would have produced bright fat signal, we can send in RF pulses tuned to resonant frequency of fat to decrease its signal intensity.

Learning Point

In MR of musculoskeletal imaging, most pathologies enhance after contrast administration. Is this also true of CT?

Notes:

CONTRAST AGENTS

Gadolinium speeds up two relation processes known as T1 and T2. T1 is a signal re-growth process and T2 is a signal decay process. If we select our scanning parameters to give us a T1 weighted sequence, what we see is an increase in signal intensity in areas of Gadolinium accumulation. We can also measure T2 signal decay, after contrast administration, as is the case in perfusion imaging of the brain.

MR FILES

Idiopathic Bone Marrow Edema Lesion of the Femoral Head: Predictive Value of MR Imaging Findings

August 1999 – *Radiology*

Notes:

MR/CT UPLINK

Notes:

EXTREMITIES

CT/MR Imaging Considerations and Anatomy

- Wrist
- Hand
- Knee
- Ankle
- Foot

WRIST AND HAND

MR is an excellent modality for imaging the small and complex anatomy of the hand and wrist.

The wrist is composed of eight small bones, known as the carpal bones.

- Navicular
- Lunate
- Triquetrum
- Pisiform
- Trapezium
- Trapezoid
- Capitate
- Hamate

The carpal-metacarpal joint forms the articulation between the osseous structures of the wrist and those of the hand. The articulation between the wrist and radius is known as the radiocarpal joint, and is defined by the Triangular Fibrocartilage (TFC), the distal radius, and the proximal surface of the lunate, triquetrum, and scaphoid. The radius and ulna also articulate with each other, at the radioulnar joint.

The hand itself is comprised of five phalanges, each of which is comprised of a proximal, middle, and distal phalanx.

The ligaments of the wrist are classified as either extrinsic or intrinsic. The extrinsic ligaments extend from the radius, ulna, and metacarpals. The intrinsic ligaments both originate and insert within the carpal bones themselves.

In general, the intrinsic ligaments support and maintain the relationships between the carpal bones. The extrinsic ligaments maintain the relationship of the carpal bones to the radius and ulna. We can also classify the extrinsic ligaments, according to their point of origin, as either radiocarpal or ulnocarpal.

Common Indications for MR of the Wrist and Hand

- Ligament or tendon tear
- Fracture
- Avascular necrosis (AVN)
- Carpal tunnel syndrome

- Arthritis
- Ganglion cysts
- Triangular Fibrocartilage Complex (TFCC) Injury

MR of the wrist is best performed with a dedicated surface coil to allow for small field of view (FOV) and thin slice, to produce high-resolution images.

Coronal images are usually obtained for demonstration of cartilage and ligament structures, while sagittal images are useful for the evaluation of wrist stability.

AVN of the navicular is most frequently due to traumatic injury or fracture that results in disruption of the arterial blood supply. AVN can occur without the presence of fracture, in which case, it is called Preiser's Disease.

The Triangular Fibrocartilage Complex (TFCC) is composed of:

- The dorsal and volar radioulnar ligaments
- The ulnolunate ligament
- The ulnotriquetrial ligament
- The meniscus homologue
- The TFC, or articular disk

The TFCC is considered to be within the ulnocarpal extrinsic group. Injuries of the TFCC are classified as either traumatic (type-1) or degenerative (type-2) lesions.

Carpal tunnel syndrome is defined as an impairment of function of the median nerve within the carpal tunnel. This syndrome is often secondary to fractures, dislocation infection, tumor, or soft tissue injuries. It is most common in patients between the ages of 30 – 60, and occurs bilaterally in 50% of the cases identified.

The concave boney contour of the carpal bones forms the floor of the carpal tunnel; the flexor retinaculum forms the roof.

Carpal tunnel syndrome is produced by compression on or swelling within this tunnel, resulting in pressure upon the median nerve.

Notes:

CT Imaging Considerations

Notes:

KNEE

Notes:

Indications for MR of the knee

- Popliteal cysts
- Osteonecrosis
- Tumor
- Infection
- Osgood Schlatter Disease
- Bone infarction
- Plicae syndrome

Osteonecrosis can occur spontaneously or secondary to steroid use or certain medical conditions, such as renal transplant, alcoholism, Gaucher’s Disease, or Lupus. Those lesions occurring secondary to steroid use tend to be larger than those that occur spontaneously.

The spontaneous presentation of the disease tends to occur in older female patients, and will usually affect the weight-bearing surface of the knee, which includes the medial femoral condyle and the medial tibial plateau.

Patients with synovial plicae will usually present with anterior knee pain and associated clicking, catching, or locking of the joint. Plicae are actually remnant structures from embryologic development of the three septal divisions of the knee, and are most commonly observed in one of three locations: suprapatellar, medial patellar, or infrapatellar.

CT Imaging Considerations

Notes:

ANKLE AND FOOT

The ankle is a synovial joint formed by the articulation of the tibia, fibula, and talus. The joint has a tendon and mortise configuration. The ankle joint is defined by the same terminology used to define woodwork joints. The tenon is a projection of a piece of wood that fits into a slot (mortise) of another piece of wood.

Refer to the program to view the body of the talus, a tarsal bone; the tibial plafond, which is the horizontal articular surface at the distal end of the tibia; the medial malleolus of the tibia; and the lateral malleolus of the fibula. The curved articular surface of the talus is called the trochlea, articulating with the plafond above.

An example of a comminuted fracture of the talus with a rotated posterior fragment and a cast peripherally is shown in the program. CT clearly gives us the picture and can be placed in other viewing planes, essentially changed at will.

Tarsal bones

- Talus
- Calcaneous
- Cuboid
- Cuneiforms
- Navicular

There are numerous tendons and ligaments in place to maintain the articular integrity of the bones of the foot and ankle.

CT has been extremely effective in demonstrating complex relationships of bone fragments and joint disruption in the calcaneous and its surrounding bodies. A good example of this is in tarsal coalition.

Calcaneal fractures are often very debilitating and long term, so multiple viewing planes with excellent spatial resolution are instrumental in planning surgical reduction.

CT technology is advancing with the development of slip-ring architecture, which provides contiguous volumes of data, reduces misregistration, and study times. CT has continued to be a cost effective alternative to more costly diagnostic studies.

A second monumental development currently taking place is the multi-detector CT scanner, which provides incredible speed and anatomical coverage while improving image detail.

In musculoskeletal imaging, CT is effective for evaluation of complex disease processes, to include bone infections, malignancies, and complex fractures.

MR Imaging Considerations

MR of the foot and ankle is often performed to rule out traumatic injury to ligaments or tendons, fractures, osteochondral lesions, tumor, or osteomyelitis.

Indications for MR of the foot and ankle

- Ligament injury
- Tendon injury
- Fractures
- Osteochondral lesions
- Tumor
- Osteomyelitis

Osteochondral lesions of the talus actually include a variety of disorders, including:

- Transchondral fracture
- Osteochondral fracture
- Osteochondritis dissecans
- Talar dome fracture

The achilles tendon is the largest tendon in the body and is typically injured by the male population, in middle age, subject to athletic injury.

Rupture of the achilles tendon will most often occur 2 – 6 cm superior to the calcaneus. Make certain your FOV will include this area.

MR can greatly improve the degree of accuracy in detection of achilles tendon tear. It is estimated that up to 25% of all achilles tendon tears are missed when clinical examination is the primary method of patient evaluation.

When imaging the ankle for achilles tendon rupture, remember to use at least a 16 cm FOV to evaluate the entire tendon, and thin slices, of approximately 3 mm. Your coil selection should allow adequate signal-to-noise ratio (SNR) for the selected FOV.

Injury to the ligaments of the foot and ankle usually occur secondary to inversion and internal rotation of the foot, combined with plantar flexion.

MR provides direct imaging of the ligaments, which is not possible with any other imaging modality. This ability to provide a means of direct imaging makes MR a very valuable tool. Clinical diagnosis of tendon tear can be difficult, due to excessive soft tissue swelling and joint effusion.

Ankle sprains may be classified from Grade 1 to Grade 3.

- Grade 1 sprains are described as a stretching or partial tearing of the anterior talofibular ligaments
- Grade 2 sprains are considered moderate sprains, associated with edema and a partial tear of the anterior talofibular ligament
- Grade 3 sprains have tearing of both the anterior talofibular ligament and calcaneofibular ligaments resulting in joint instability

Morton's Neuroma is another pathology you may encounter when scanning a patient's forefoot.

Patients with this tumor will usually complain of pain and tenderness between the third and fourth metatarsal heads. This tumor usually involves the lateral branch of the medial plantar nerve.

Your radiologist will most likely request coronal and sagittal planes in both T1 and T2 contrast. Fat suppression or tissue nulling with STIR is also frequently employed. Confirmation of the lesion is easily made with STIR to suppress surrounding fatty tissue.

It is reported that MR provides a 99% sensitivity rate and 94% accuracy rate in the detection of osteomyelitis. Osteomyelitis is typically associated with the diabetic extremity. There is usually extensive involvement of all midtarsal joints, with associated fracture and other soft tissue abnormalities, such as subaponeurotic edema, cellulitis, abscess, sinus tracts, and ulcers.

Osteomyelitis is usually identified as an area, or areas, of low signal intensity on T1 and increased signal intensity in T2 fat suppressed images.

Indications for intravenous contrast administration:

- Morton's Neuroma
- Inflammation
- Partial tendon tears
- Osteochondral lesions

TALKBACK – QUESTION AND ANSWER

Notes:

APPENDIX A: BIBLIOGRAPHY – CT/MR MUSCULOSKELETAL

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