

MRI of the knee, shoulder and ankle

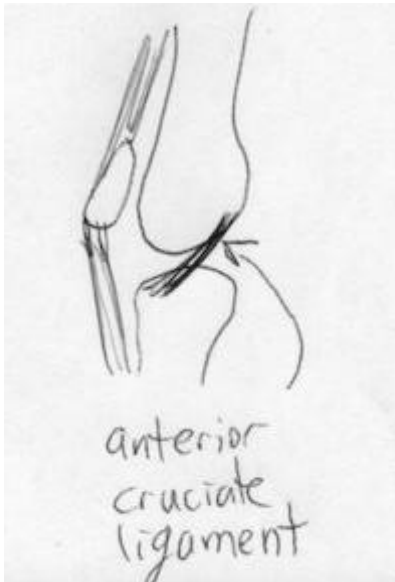
MRI of the knee

Introduction: The primary indication for MRI of the knee is evaluation of internal derangement . MRI primarily assesses the menisci and ligaments, but the integrity of the osseous structures and muscles also may be evaluated. MRI is helpful when physical examination findings are equivocal or are compromised because the patient is in pain from a recent injury. Meniscal injuries of the knee can present as a wide spectrum of MRI signal abnormalities. However, a meniscal tear usually appears as increased signal that reaches the articular surface within the normally dark menisci. Ligamentous injuries of the knee typically present as abnormal signal and lack of a normal course for the suspected injured ligament. MRI is the most requested method for evaluation of an anterior cruciate ligament tear. The mechanism of this injury often results in associated meniscal tears and a characteristic pattern of bone bruising at the posterior aspect of the lateral tibial plateau and mid portion of the lateral femoral condyle.

the Cruciate ligaments

The cruciate ligaments are intracapsular and extrasynovial. The Anterior cruciate ligament (ACL) limits anterior translation of the tibia and hyperextension. The posterior cruciate ligament (PCL) limits anterior translation of the femur and hyperflexion. ACL tears are far more common than PCL tears and are often associated with other injuries.

Anterior cruciate ligament injuries of the knee:



the normal anterior cruciate ligament

The anterior cruciate ligament is usually not a simple linear band. Instead, it is normally fan shaped, as shown below

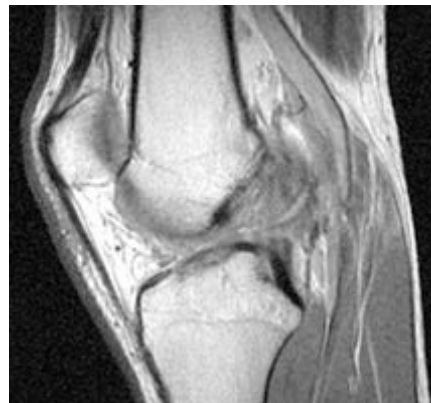


The anterior cruciate ligament usually lies in a plane 10 - 15 externally rotated to the sagittal plane. Therefore, if one obtains images in this plane, one can image the ACL in over 95% of the time.

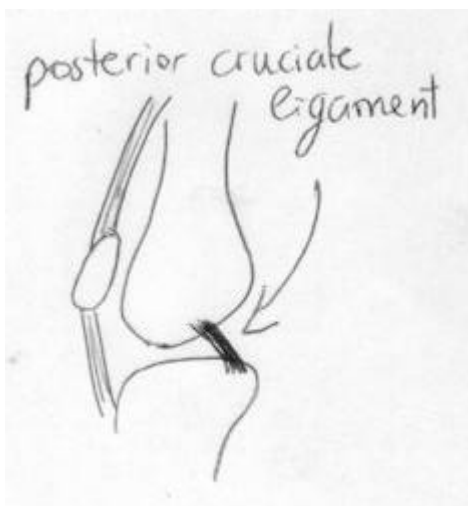
MRI Signs of Anterior cruciate tear

- high signal on T2
- wavy contour
- ACL not seen
- ACL discontinuity
- lateral femoral condyle bone bruise

On the following image the anterior cruciate ligament is completely obliterated



Posterior cruciate ligament injuries of the knee:



The normal course of the posterior cruciate ligament

The PCL is the major stabilizer of the knee.

The PCL originates from the lateral surface of the medial femoral condyle. It generally lies in the sagittal plane, and can usually be seen in its entirety on a single sagittal MR slice.

The PCL is twice as strong as the ACL. It contains a larger cross-sectional area and possesses a higher tensile strength, explaining its lower rate of injury. Note the ligament of humphrey that looks like a small dark lump, such as seen below. It may occasionally be seen as separate from the PCL and mimic an intraarticular body.



Types of PCL injuries



- Complete tears - Approximately 40%
- Partial tears - Approximately 55%
- Avulsion tears - 7%

The following is a proton-density-weighted sagittal image that shows an extensive partial tear of the midsubstance of the posterior cruciate ligament (large black arrow). High signal intensity is seen in the region of injury.

The normal ligament of Humphrey (small arrow) is visualized better because it is adjacent to the high signal intensity edema around the torn posterior cruciate ligament



Meniscal tears

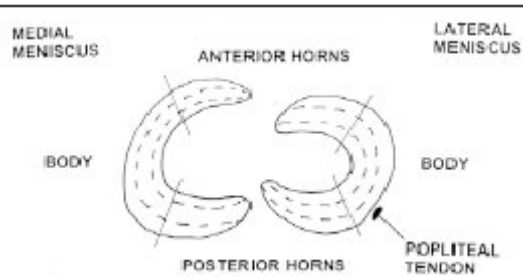
Menisci normally seen as a bowtie configuration and homogeneously black. Posterior horn of medial meniscus should normally be largest. Lateral meniscus should not be larger or else consider discoid meniscus (prone to tear).

The next images show the meniscii of the right knee:



A bucket handle tear is present in the lateral meniscus. The bucket handle tear fragment is displaced anteriorly on the sagittal view





The medial and lateral menisci are C-shaped structures, which are fixed firmly at their roots to the central portion of the tibial articular surface. The menisci are also anteriorly connected to each other. The posterior horn of the lateral meniscus is linked to the medial femoral condyle via the menisofemoral ligaments of

Humphrey or Wrisberg. Laterally, the menisci are attached to the capsule of the knee, except at the postero-lateral aspect, where the popliteus tendon is interposed. The medial meniscus is larger in size with a C-curve shape when viewed from supero-inferiorly, while the lateral meniscus is more circular in shape. In cross-sections taken in the coronal and sagittal planes, they are triangular in shape, with the apex pointing towards the centre of the knee.

Degeneration

The two criteria for diagnosis of a meniscal tear are (i) intrameniscal signal that comes into contact with the articular surface of the meniscus, and (ii) abnormal meniscal configuration



- **grade 1** central white signal
- **grade 2** central signal that extends to nonarticular surface and more extensive than grade 1-95% of grade 1 or 2 menisci correlate with an arthroscopically intact meniscus, except when clinically suspicious grade 2 lesions are vigorously probed
- **grade 3** signal that extends to articular surface
- **grade 4** no recognizable meniscus, usually macerated or severely degenerated-95% arthroscopic correlation

Shoulder MRI

Normal axial anatomy of the shoulder joint



1. Long Head of Triceps
2. Teres Minor Muscle
3. Long Head of Triceps
4. Subscapularis Muscle
5. Tendon of Long Head of Biceps
6. Glenoid labrum.

Rotator cuff tear is the most typical shoulder indication for MRI. The supraspinatus tendon sustains injury more often than the other muscles and tendons that make up the rotator cuff. Unlike a tear, tendinitis or tendinosis may respond to conservative therapy and not require an invasive procedure, so it is important to distinguish between these entities.



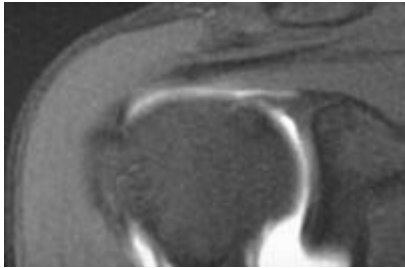
On MRI, rotator cuff tears appear as areas of increased signal in the tendon. Tears can be full thickness or partial. In full thickness tears, the

muscle can pull away from the joint because the tendon no longer anchors it to the humerus. MRI also reveals the extent of impingement on the rotator cuff from the acromioclavicular joint, findings that are important to note when surgical repair is being considered



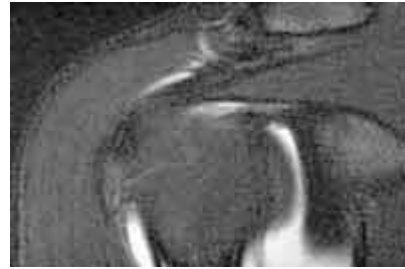
MR Arthrogram of the shoulder

The following sequence was performed following gadolinium injection into the shoulder, T1-weighted with fat suppression. There is no fluid in the subacromial/subdeltoid bursa.



Therefore the supraspinatus tendon must be intact.

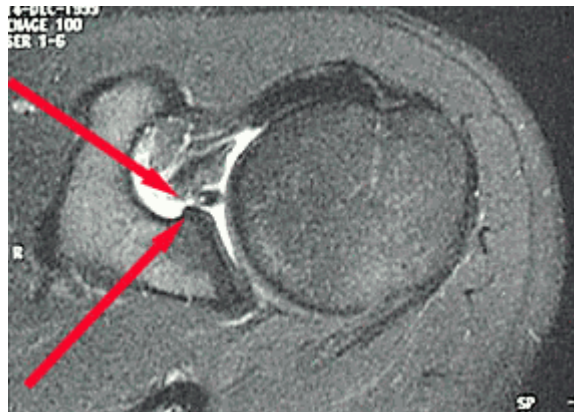
The next image is a fast spin-echo T2-weighted image in the same patient. In this image there is fluid in the subacromial bursa. It's clear that this fluid didn't come from the injection into the joint because it's not visible after the arthrogram.



Instability of the shoulder joint

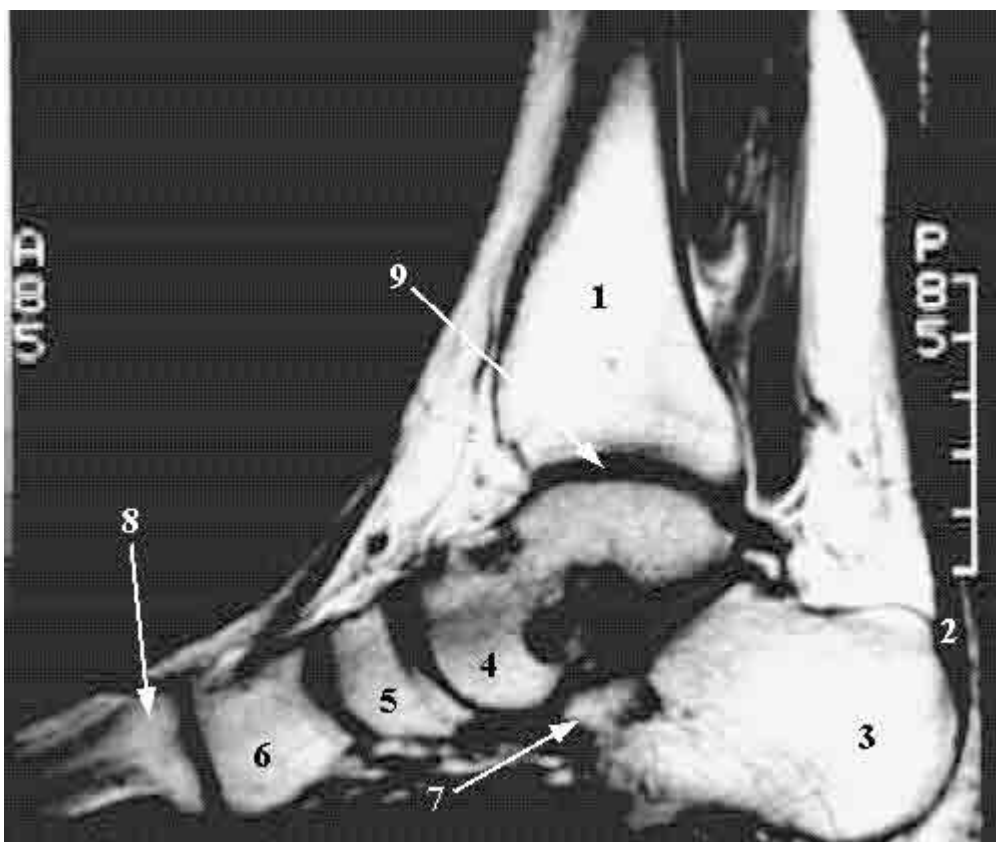
When the labrum of the shoulder joint is torn, the stability of the shoulder joint is compromised. A specific type of labral tear is called a Bankhart lesion, and is due to dislocation of the shoulder causing the tear. The Bankhart lesion is located in a specific area of the labrum (anterio-inferior), and makes the shoulder prone to recurrent dislocation.

MRI of an Anterior Inferior Labral Tear after a Shoulder Dislocation



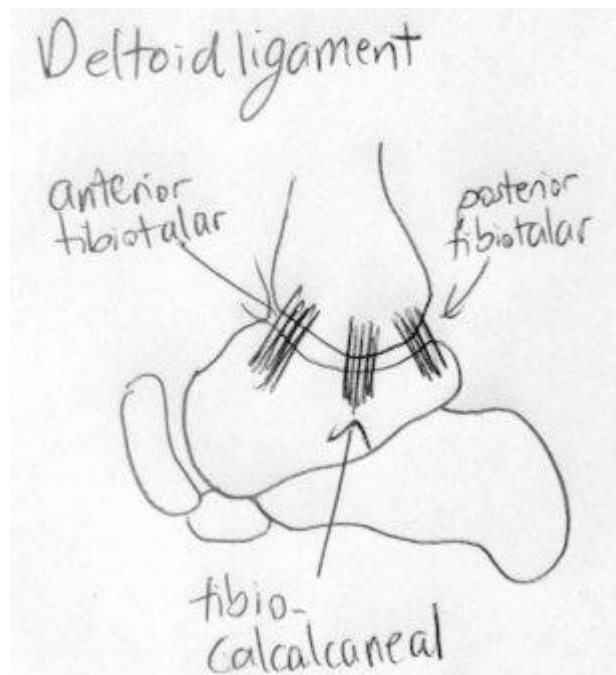
Ankle MRI

Normal Ankle Anatomy

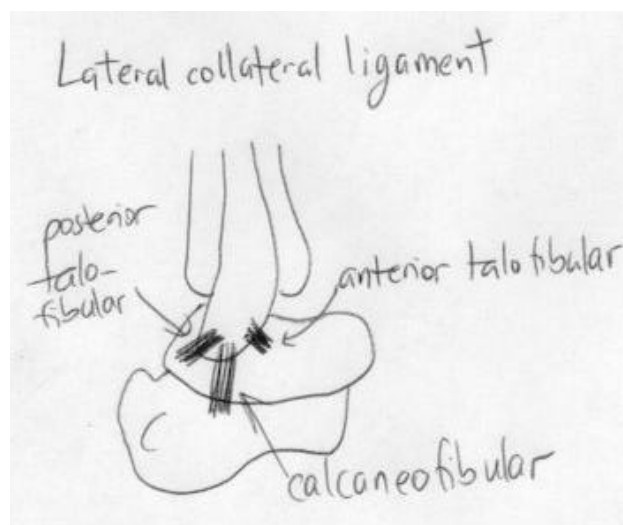


- 1 Lower end of tibia
- 2. Calcaneal tendon
- 3 Calcaneus
- 4. Talus
- 5. Navicular
- 6. Medial cuneiform
- 7. Sustentaculum tali
- 8. First metatarsal bone
- 9. Talocrural joint (ankle)

The medial collateral (deltoid) ligament is divided into four parts.

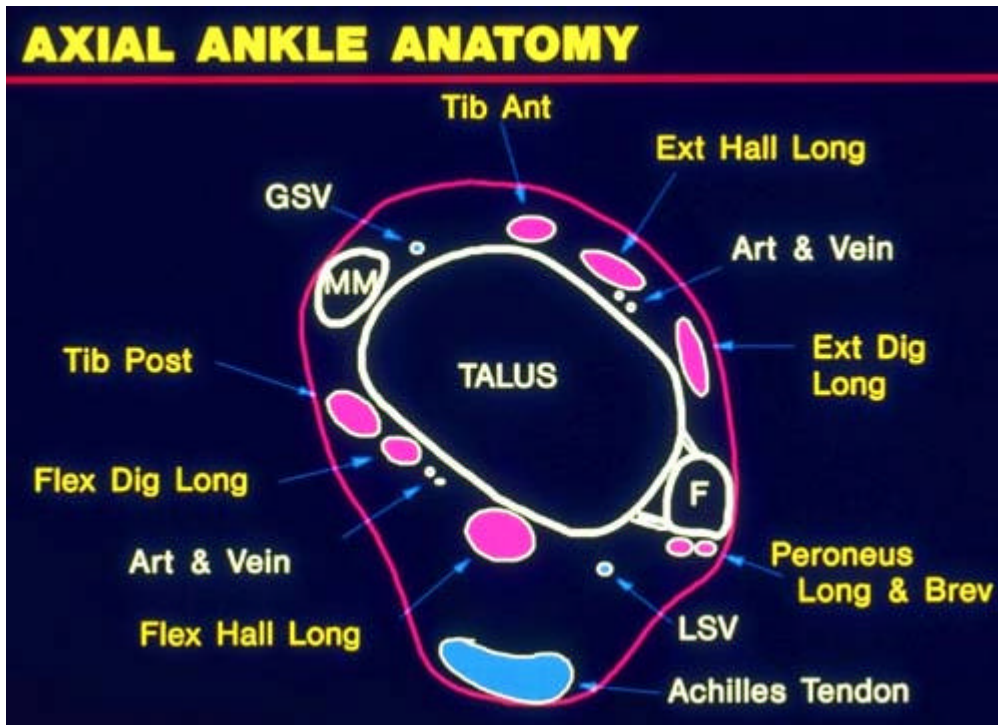


The lateral collateral ligament is made up of three parts as shown below. The anterior talo-fibular ligament is the most frequently injured ankle ligament.

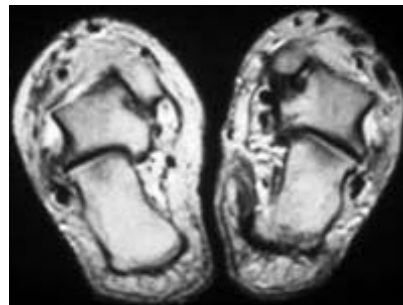
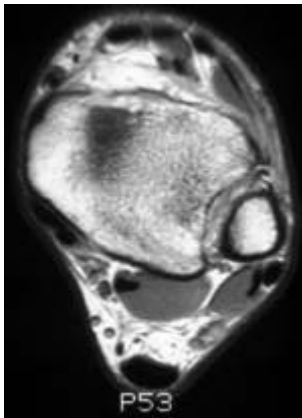


Evaluating injuries to the tendons around the ankle joint

Most injuries only occur in a few areas: the Achilles, the tibialis posterior, the flexor hallucis longus (occasionally), the peroneal tendons (occasionally), and the tibialis anterior (very uncommonly). The following image is an axial T1-weighted image, and can be used to find the aforementioned tendons: the Achilles, peroneus longus and brevis (the brevis often has a small slip of muscle associated with it), the flexor hallucis longus (the muscle of which can be used as a guide for finding the flexor hallucis longus), the sustentaculum talus (just above the flexor hallucis longus, further down in the calcaneal region), and the flexor hallucis.



It would seem that complete tendon disruption would be easy to see, but disruption is frequently missed because these tendons (with the exception of the Achilles) run obliquely through the plane of imaging: as they are not orthogonal, they are best seen on the axial images. On the axial images, one must realize that there is a tendon missing in order to recognize the rupture. Unless you are familiar with the anatomy, a missing tendon is easily overlooked. Not only do you need to know that these tendons are present, you also need to look for their size and ensure that there is no signal in or around them.



The following image shows an example of a complete tear of the the tibialis posterior. In this T2-weighting the tibialis posterior is present on the left side but is absent on the right. . On the right is an empty tendon sheath, with perhaps one string of fibrous tissue remaining. This scan shows a complete tear of the tibialis posterior.