The knee joint

Type

The knee joint is a synovial hinge joint

Articular surfaces

These are the condyles and the patellar surfaces of the femur, the tibial articular surfaces on the tibial plateau, and the deep surface of the patella

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Capsule

This is attached at the margins of the articular surface, except superiorly where the joint cavity communicates with the supra- patellar bursa (between quadriceps femoris muscle and the femur) and posteriorly where it communicates with the bursa under the medial head of gastrocnemius (semimembranosus bursa) Occasionally the joint cavity is also continuous with the bursa under the lateral head of the gastrocnemius muscle (pop-liteal bursa) The capsule is perforated by the popliteus muscle posteriorly
Synovium

The synovium lines the capsule and its associated bursae A fat pad in the joint deep to the ligamentum patellae is called the infrapatellar fat pad The synovium covering this fat pad is projected into the joint as two alar folds

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Ligaments

These are as follows:

- **The medial (tibial) collateral ligament** may be separated from the capsule by a bursa; the deep part of the ligament is attached to the medial meniscus
- **The lateral collateral ligament** is attached to the fibula and always clear of the capsule
- **The ligamentum patellae and medial and lateral patellar** retinacula

The oblique popliteal ligament posteriorly

Internal structures (Fig 8 13)

Anterior and posterior cruciate ligaments arise from the anterior and posterior parts of the intercondylar area of the tibia and are named by their tibial origin They are inserted into the inner aspect of the lateral and medial femoral

condyles, respectively The **anterior cruciate ligament resists hyperextension** of the knee and **the posterior cruciate resists hyperflexion**

The medial and lateral menisci (or semilunar cartilages) are two crescentic structures, triangular in cross-section, which slightly deepen the articular surface of the tibia Each is attached peripherally to the tibia and to the capsule The upper and lower surfaces of the menisci are free Each is described as having an anterior and posterior horn attached to the inter- condylar area of the tibia

The medial meniscus is bigger, less curved and thinner Its posterior horn is thick (14 mm) but it thins progressively to the anterior horn, which is 6 mm thick

The lateral meniscus is smaller, more curved (nearly circular rather than semicircular) and more uniform in thickness (10 mm) The lateral meniscus is less well attached to the capsule than the medial and is grooved posterolaterally by the tendon of popliteus, which passes between it and the capsule

Arthrography of the knee joint

Contrast medium and air are introduced into the joint deep to the patella and allow visualization of the synovial cavity of the joint as described above, including the suprapatellar bursa and some or all of the associated bursae that may be connected with the joint cavity a **Baker's cyst** Baker's cyst represents a medial outpouch- ing between the medial head of the gastrocnemius and the semimembranosus and semitendinosus tendons

The **menisci** are seen as filling defects, triangular in cross- section, whose upper and lower surfaces are outlined by con- trast Their bases are attached to the capsule (some contrast

Magnetic resonance imaging of the knee

MRI is used in the evaluation of internal derangements of the knee Using a dedicated quadrature surface coil images are acquired in the coronal plane to evaluate the collateral and cruciate ligaments, in the sagittal oblique plane to evaluate the cruciates and menisci, and in the axial plane to evaluate patellofemoral cartilage It is crucial that sagittal images are acquired in the sagittal oblique plane parallel to the axis of the anterior cruciate ligament prescribed off an axial localizer

The menisci

Anatomy. The menisci are C-shaped semilunar rings inter- posed between the articular surfaces of the femoral condyles and the tibial plateau They act as a buffer between the two surfaces, protecting articular cartilage, distributing the strain of weightbearing (they support 50% of load sharing), improv- ing stability and providing lubrication to facilitate joint flexion and extension

The menisci have an organized structure composed of an outer circumferential zone and an inner transverse zone divided by a middle perforating collagen bundle to superior and inferior leaves Menisci are poorly vascularized, only the outer third being vascularized in adulthood via a perimeniscal plexus

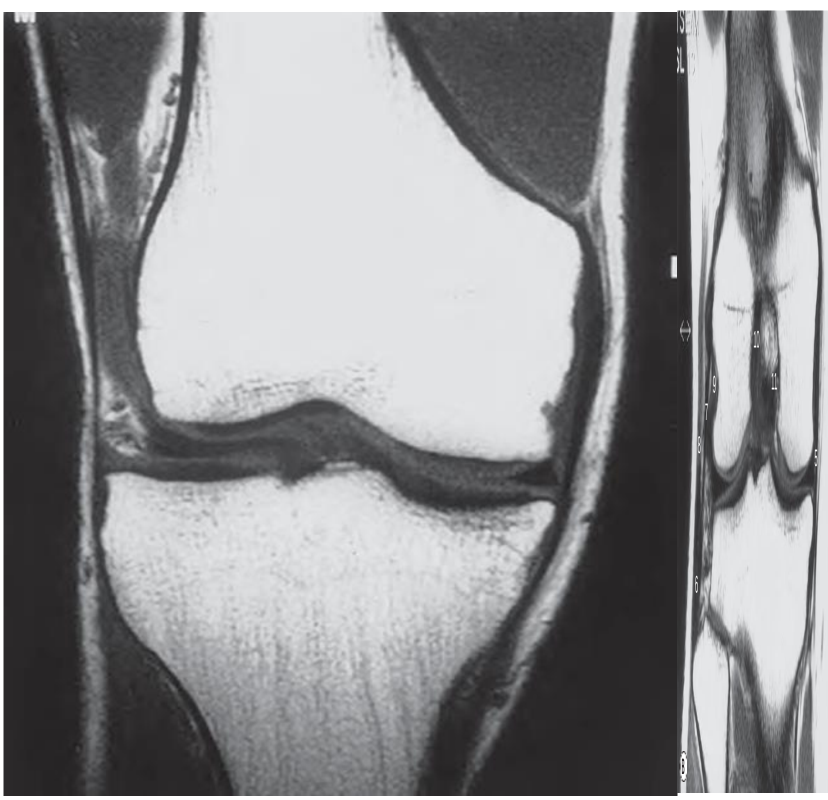
The medial meniscus has an open C shape and is attached to the intercondylar notch of the tibia both anteriorly and posteriorly, to the anterior horn of the lateral meniscus through the transverse meniscal ligament in 40%, to the posterior capsule and to the medial collateral ligament The lateral meniscus is more circular in shape, has anterior and posterior intercondylar notch attachments, transverse meniscal attach- ment to the anterior horn of the medial meniscus, menisco-femoral ligament attachments to the inner aspect of the medial femoral condyle (Wrisberg posteriorly, Humphrey anteriorly), and is loosely attached to the capsule but not the lateral collateral ligament It is separated from the posterior capsule by the popliteus tendon

Menisci are repeatedly subjected to rotational forces on flexion and extension In extension, the femur internally rotates as a locking screw home mechanism In flexion, the opposite occurs under the influence of the popliteus tendon As the popliteus contracts, the posterior horn of the lateral meniscus is pulled posteriorly to accommodate the posterior shift in load bearing as part of flexion

Meniscal tears. On MR imaging the compact menisci are hypointense on all sequences Traditionally, sagittal images are used to evaluate their integrity In the sagittal plane, the pos- terior horn of the medial meniscus is typically twice the size of the anterior horn In contrast, the anterior and posterior horns of the lateral meniscus are equal in dimensions Typi cally, the bodies of the menisci are seen on only the outer two slices

Menisci may tear both in the setting of acute trauma or in the setting of minor trauma superimposed on meniscal degeneration

Following repetitive trauma, as part of the ageing process the central portion of the meniscus undergoes first globular and then progressive linear mucoid degeneration Such changes have led to the application of a universally accepted grading system in which intrasubstance focal signal change (slight T_1 and T_2 hyperintensity) is classified as grade 1, linear or diffuse globular signal abnormality not extending to a surface is clas- sified as grade 2, and signal abnormality, either linear or globu- lar with definite extension to a surface, is classified as grade 3



MRI scan of the knee Coronal T1-weighted images of the anterior knee (A) and of the posterior knee (B)

(A, B)

1. Iliotibial band
2. Lateral meniscus
3. Gerdy's tubercle
4. Medial meniscus
5. Medial collateral ligament (superficial component)

6. Conjoined tendon
7. Fibular collateral ligament
8. Biceps femoris tendon
9. Popliteus insertion, notch
10. Anterior cruciate ligament
11. Posterior cruciate ligament

Criteria for diagnosis on MR images include identification of the body of the meniscus on more than three contiguous sagittal 4 mm slices, lack of rapid tapering from the periphery to the free edge of the meniscus, and an abnormally wide meniscal body on coronal images, encroaching further into the femorotibial compartment without the normal triangular con- figuration

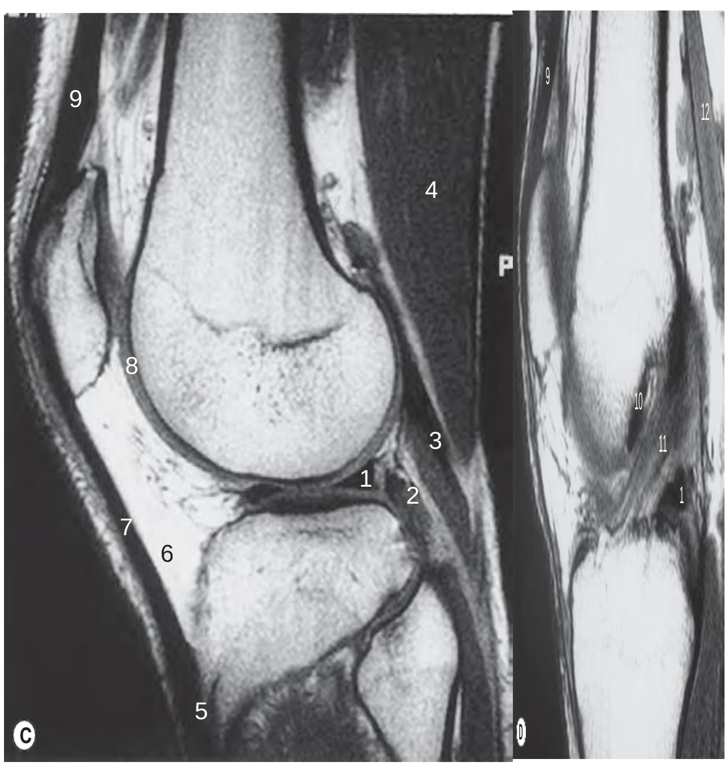
Collateral ligaments

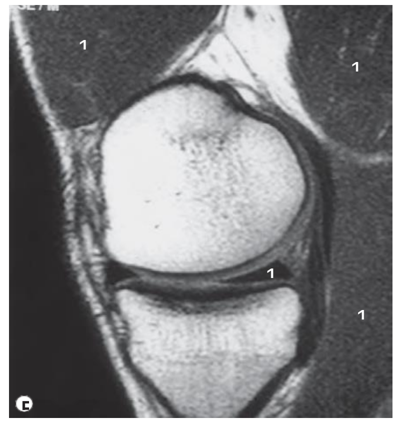
The lateral collateral ligament complex. Lateral knee sta- bility is through the joint capsule and structures of the lateral collateral ligament complex Traditional descriptions divide the lateral collateral ligament into three layers, including an outer layer, comprising the iliotibial band anteriorly, continu- ous posteriorly with the biceps femoris tendon; the middle layer, which is composed of the posterolateral fibular collateral ligament; and the deep layer composed of the popliteus tendon

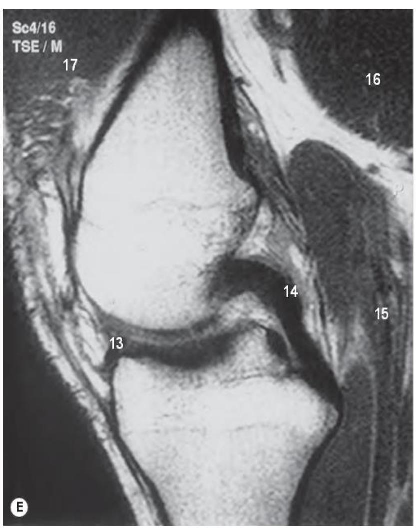
The medial collateral ligament

Medial knee stability is through subcutaneous fascial invest- ment, the distal sartorius and the medial collateral ligament

The medial collateral ligament is composed of deep fibres which are essentially meniscofemoral and meniscotibial ligamentous attachments separated from a thick superficial meniscotibial ligament by the medial collateral ligament bursa







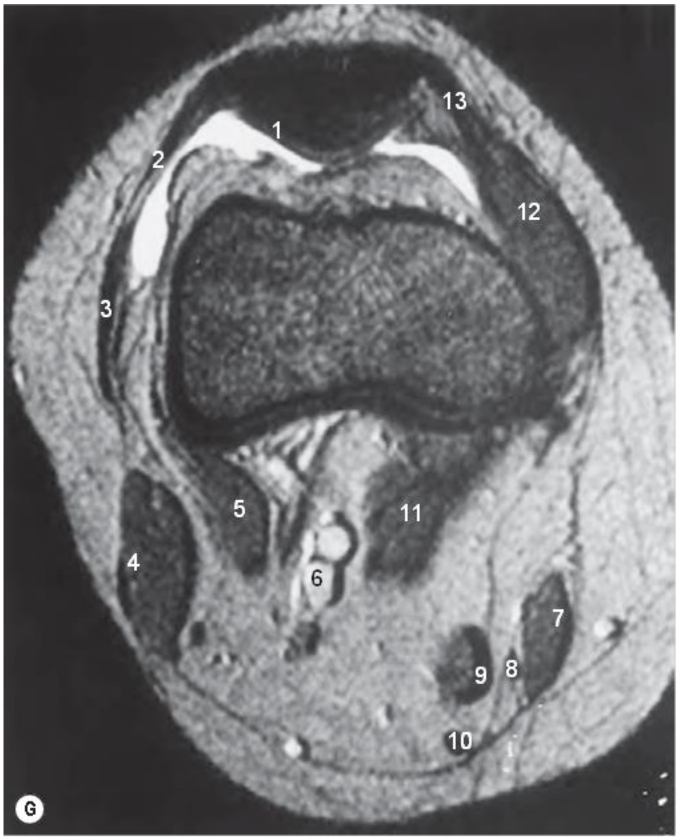
1. Lateral meniscus (posterior horn)
2. Popliteus tendon
3. Lateral head of the gastrocnemius
4. Biceps femoris, muscle belly
5. Tibial tuberosity

6. Hoffa’s fat pad

7. Patella tendon
8. Articular cartilage (of the lateral femoral condyle)
9. Quadriceps tendon
10. Intercondylar notch (Blumensatt’s line)
11. Anterior cruciate ligament
12. Popliteal vessels

13. Medial meniscus (anterior horn)
14. Posterior cruciate ligament
15. Medial head of gastrocnemius
16. Semimembranosus muscle belly
17. Vastus medialis muscle belly

18. Medial meniscus posterior horn



1. Lateral articular facet of the patella
2. Lateral retinaculum
3. Iliotibial band
4. Biceps femoris muscle
5. Lateral head of the gastrocnemius muscle
6. Popliteal vessels
7. Sartorius muscle
8. Gracilis muscle
9. Semimembranosus muscle
10. Semitendinosus muscle
11. Lateral head of the gastrocnemius
12. Vastus medialis muscle
13. Medial retinaculum

Cruciate ligaments

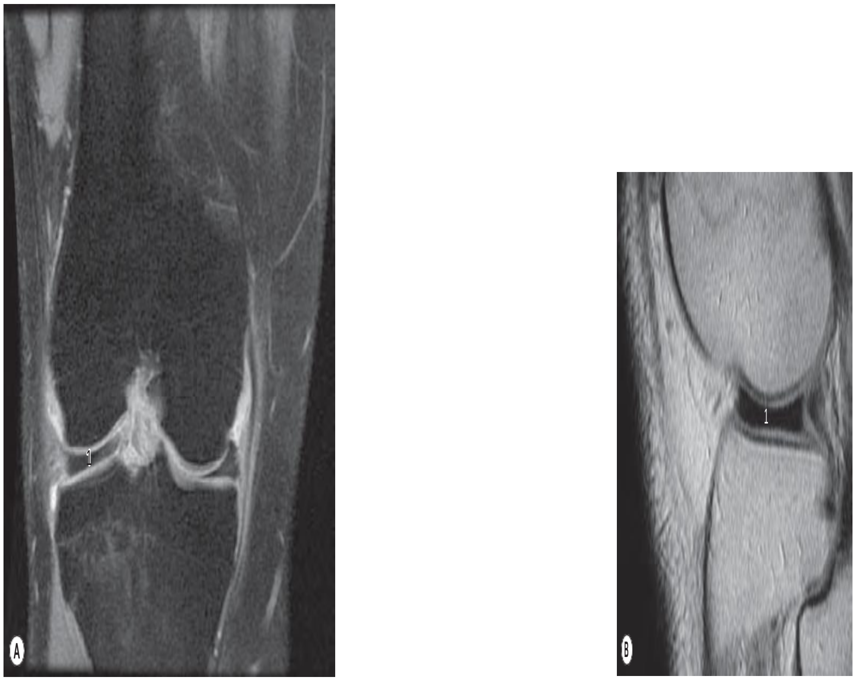
The anterior cruciate ligament (ACL)

The ACL is an intracapsular extrasynovial ligament that is primarily responsible for restraining anterior displacement o the tibia on flexion–extension The ligament runs in a ‘hand in pocket’ axis from medial to lateral and from anterior to pos- terior, from the intercondylar notch hugging the inner aspect of the lateral femoral condyle The ligament has two identifiable bands, the anteromedial (AMB) and the posterolateral (PLB), according to insertion on the tibial spine The AMB is stronger and, being taut, resists anterior displacement in flexion The PLB is taut in extension, resisting hyperextension and hence posterior femoral displacement Being taut throughout the gait cycle, both flexion and extension, the ACL maintains functional isometry

Posterior cruciate ligament (PCL)

The PCL, like the ACL, is an intrasynovial extracapsular liga- ment, primarily responsible for resisting posterior translation of the tibia The ligament is on average 13 mm long and is composed of a dominant anterolateral bundle and a smaller posteromedial band Arising from the inner aspect of the medial femoral condyle the ligament runs posteriorly in a C-shaped configuration to attach in a midline depression in the posterior margin of the tibial plateau Being tightly bound, the PCL is uniformly hypointense, although some signal hyperintensity is often seen at the apex of the C where fibres run at the magic angle (55° to the Z axis

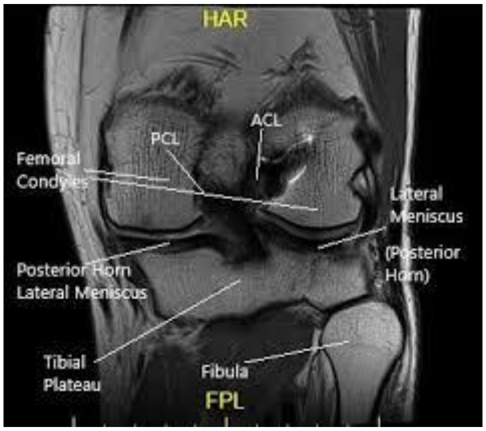
Injury to the posterior cruciate ligament is uncommon, and best visualized in the sagittal plane when it occurs

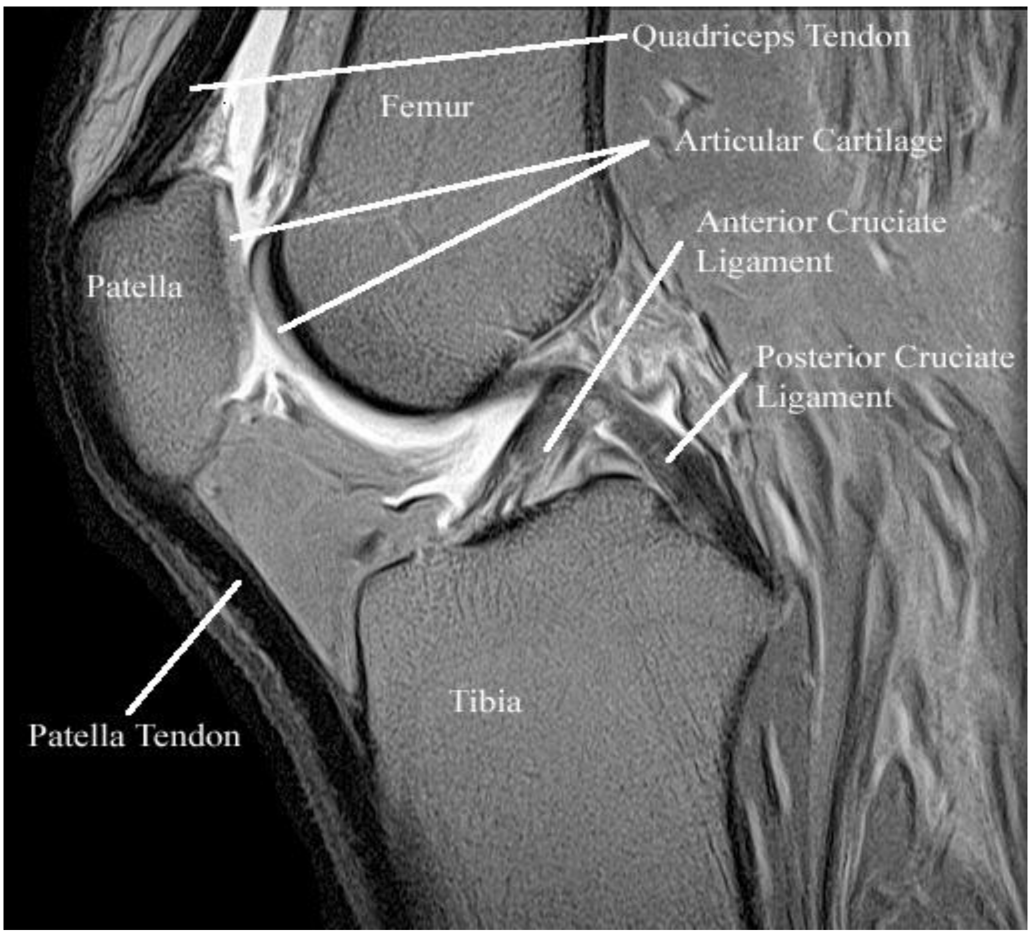


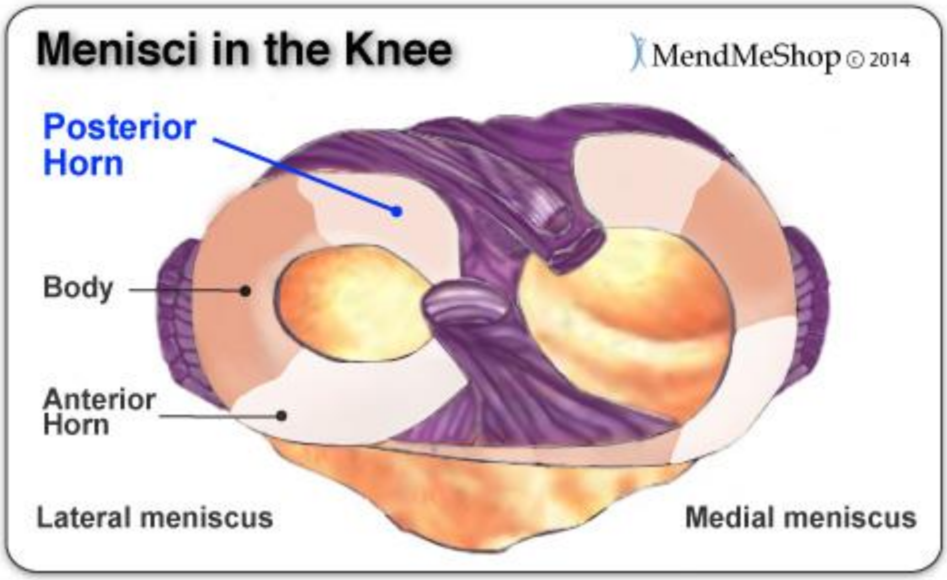
(A) Coronal fat suppressed MRI and (B) sagittal T_1-weighted image of the knee showing a discoid lateral meniscus (1)

Popliteus tendon

The popliteus muscle extends from its inferomedial insertion in the Achilles tendon superiorly through the calf and laterally to buttress the posterolateral aspect of the knee at its tendi- nous insertion in the popliteus recess of the posterolateral aspect of the lateral femoral condyle Two additional insertion sites are the posterior fibular head (popliteofibular ligament) and the posterior horn of the lateral meniscus EMG studies have determined that the popliteus is the primary internal rotator of the tibia on the femur in the non-weightbearing state In the weightbearing state it rotates the femur externally on the leg


HAR
ACL
PCL
Femoral
Condyles
Lateral
Meniscus
(Posterior
Horn)
Posterior Horn
Lateral Meniscus
Tibial
Plateau
Fibula
FPL


Quadriceps Tendon
Femur
Articular Cartilage
Anterior Cruciate
Ligament
Patella
Posterior Cruciate
Ligament
Tibia
Patella Tendon


Menisci in the Knee
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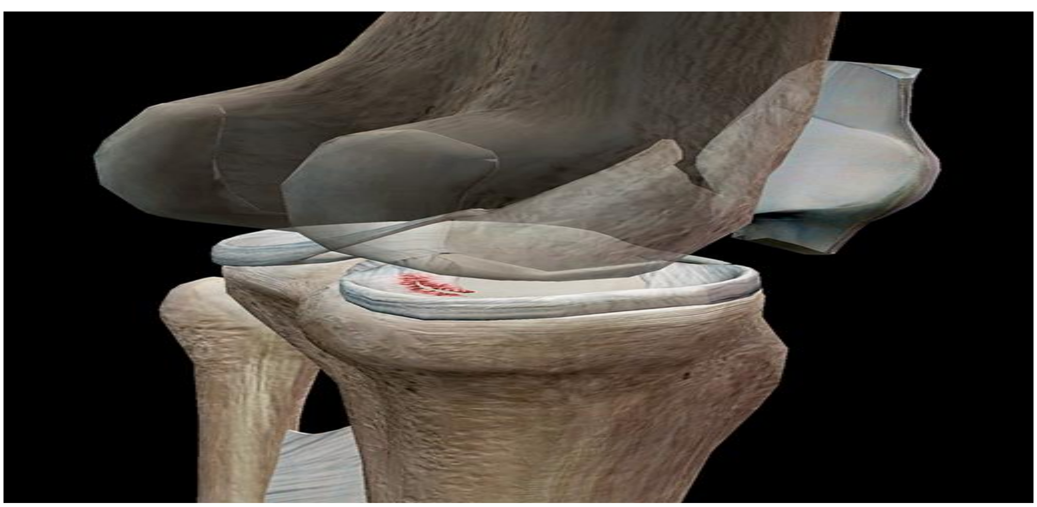
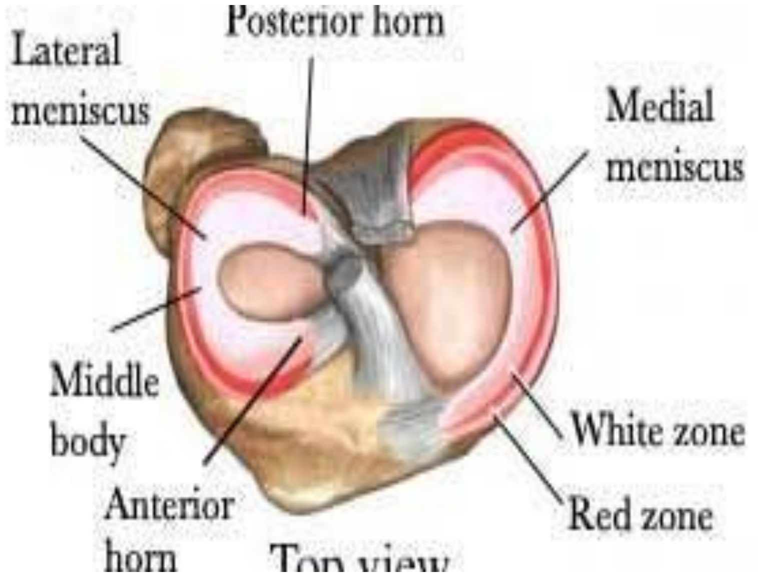
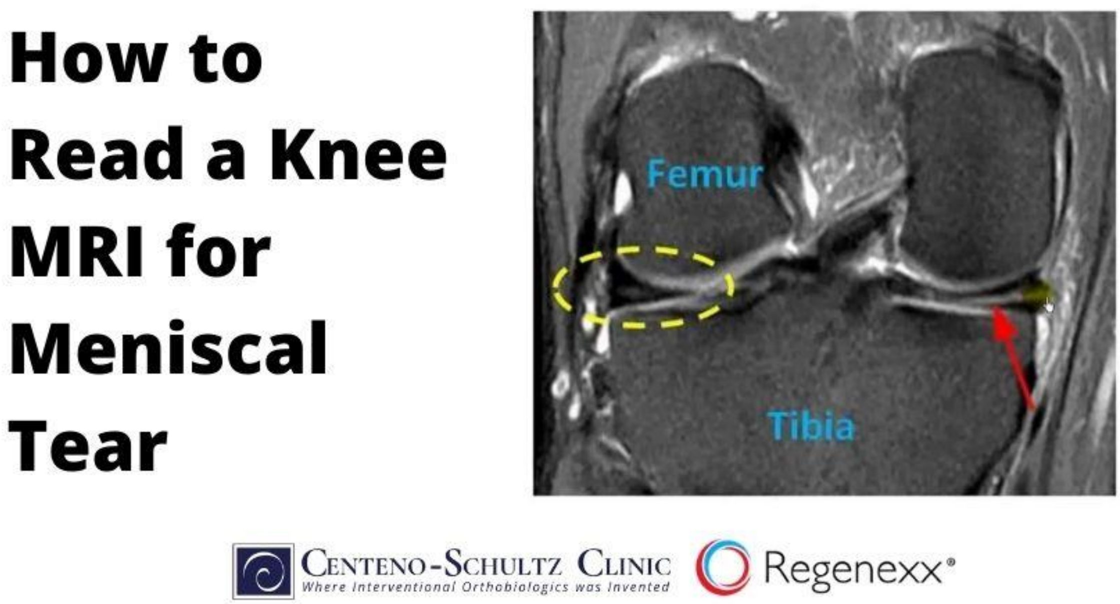
Posterior Horn
Body
Anterior Horn
Lateral meniscus
Medial meniscus




Posterior horn
Lateral meniscus
Medial meniscus
Middle body
Anterior horn
White zone
Red zone


How to Read a Knee MRI for Meniscal Tear
Femur
Tibia
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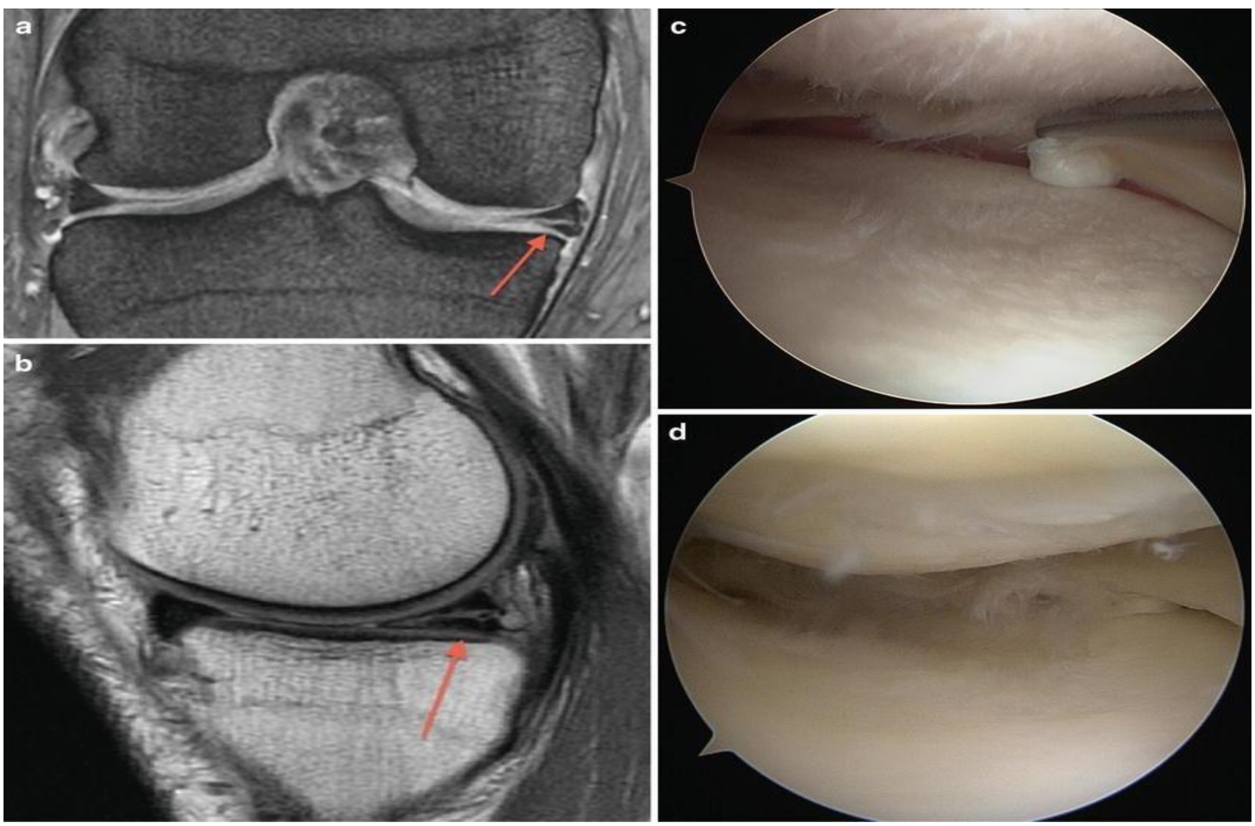
Meniscus Tear


a
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c
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