

Ultrasound and Magnetic Resonance Imaging of Meniscal and Collateral Ligament Injuries of the Knee: A Narrative Review

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Abstract

Background: There are two fibrocartilaginous menisci in the knee joint. Their main role is shock absorption, improvement of knee-joint stability, and load transmission. Collateral ligament injuries of the knee, encompassing the medial collateral ligament and lateral collateral ligament, are common in knee trauma.

Objective: To review the anatomy, imaging techniques, and ultrasound and magnetic resonance imaging features of meniscal and collateral ligament injuries of the knee.

Review: Magnetic resonance imaging is a noninvasive tool for the assessment of knee pathology, especially menisci and ligaments. Ultrasound is cheaper, available, non-ionic, dynamic, and has no contraindication. Meniscal tears include longitudinal, horizontal, radial, complex, and displaced tears. Collateral ligament injuries are categorized into three grades based on ligament disruption and associated findings.

Conclusion: Accurate grading of these injuries is essential for management and prognosis. MRI is the gold standard for soft-tissue assessment, with ultrasound serving as an adjunct in certain cases.

Keywords: Knee; meniscus; medial collateral ligament; lateral collateral ligament; ultrasound; magnetic resonance imaging.

Introduction

There are two fibrocartilaginous menisci in the knee joint; a medial meniscus (MM) within the medial tibiofemoral compartment and a lateral meniscus (LM) within the lateral tibiofemoral. Their main role is shock absorption, improve stability of the knee joint, and load transmission. They also play an important role in synovial fluid dynamic circulation and also considered by some to be involved in proprioception ⁽¹⁾. (Figure 1)

Collateral ligament injuries of the knee, encompassing the medial collateral ligament (MCL) and lateral collateral ligament (LCL), are common in knee trauma. Accurate grading of these injuries is essential for management and prognosis. MRI is the gold standard for soft tissue assessment, with ultrasound serving as an adjunct in certain cases ⁽²⁾.

The medial collateral ligament (MCL) and lateral collateral ligament (LCL) provide primary medial and lateral stability to the knee, respectively. Injuries vary from microscopic sprains to complete tears, categorized into three grades based on ligament disruption and associated findings. Precise imaging evaluation guides treatment planning ⁽²⁾.

Knee MRI is possible using a variety of magnet designs (closed, open, and dedicated extremity magnets) and field strengths (0.5, 1.5, and 3 Tesla). Regardless of magnet design, a local coil is mandatory to maximize signal-to-noise ratio. Typically, a cylindrical coil (often called an “extremity” or “knee” coil) surrounds the knee. Newer, multichannel knee coils containing eight or more coil elements will further increase signal-to-

noise ratios. They are especially required when using techniques like parallel imaging, which decrease the time of the scan and usually reducing the image signal ⁽³⁾.

Advantages: MRI has many advantages as; it is non-invasive imaging technique, it lacks ionizing radiation, good tissue characterization, non-iodinated contrast medium ⁽³⁾.

Advantages: Musculoskeletal ultrasonography MSKUS has many advantages over MRI; bed side exam, widely available, dynamic test for ligaments and tendons, and aspiration of synovial fluid ⁽⁴⁾.

Disadvantages: Operator dependent ⁽⁴⁾.

Meniscal Anatomy and Normal Imaging

Gross anatomy

The medial meniscus is approximately 1.4 inch (3.5cm) in length, wide semi-circular fibrocartilaginous structure almost larger than lateral meniscus with posterior horn (PHMM) substantially larger than anterior horn (AHMM). The medial meniscus can be divided into five anteroposterior zones. Zone 1 refers to the anterior root attachment. Zones 2a and 2b refer to the anteromedial zone between the posterior border of the anterior root and the anterior border of the superficial medial collateral ligament. Zone 3 refers to the portion of the medial meniscus that is next to the medial collateral ligament. Zone 4 refers to the posterior horn, and zone 5 refers to the posterior root. ⁽¹⁾ (Figure 2).

AHMM attaches immediately anterior to the tibial attachment of the anterior cruciate ligament (ACL) in the intercondylar area. PHMM is attached to the posterior intercondylar area in the area of the tibial plateau, between PCL insertion posteriorly and posterior root attachment of lateral meniscus anteriorly. The medial aspect attached to the deep (third) layer of the medial collateral ligament. ⁽¹⁾.

The lateral meniscus is almost circular and covers a larger portion of the tibial articular surface than the medial meniscus. Anterior horn of lateral meniscus (AHLM) is equal in size to posterior horn of lateral meniscus (PHLM) (Figure 3). AHLM blends into the attachment of the anterior cruciate ligament (ACL), whereas PHLM attaches just behind the intercondylar eminence, often blending into the posterior aspect of the ACL. There is no attachment of the lateral meniscus to lateral collateral ligament (LCL) as its peripheral attachment is interrupted posteriorly to where the popliteal tendon passes. figure4. ⁽¹⁾ The capsular components attach the lateral meniscus to the tibia less firmly than the medial meniscus so that the lateral meniscus is more mobile than the medial meniscus ⁽¹⁾

There are two menisci-femoral ligaments: anterior and posterior meniscofemoral ligament of Wrisberg that attaches PHLM to the lateral aspect of the medial femoral condyle. Other ligaments include transverse meniscal (or genua) ligament (of Winslow) attaches the anterior horns to each other, oblique menisco-meniscal ligament and superior and inferior menisco-popliteal ligaments. ⁽¹⁾

The medial meniscal flounce is a normal positional variant characterized by a single symmetric fold along the free edge of the meniscus. The flounce is less commonly seen on MRI compared to arthroscopy and is considered it to be the result of traction of the medial meniscus during tibial rotation (Figure 5). In these cases, the flounce is a transient finding and it may disappear during maximal knee extension or flexion. On MR images the body of the medial meniscus shows a wavy, irregular S-shaped along the free margin of the meniscus on sagittal planes. A similar appearance may be seen in patients with knee instability or joint effusion when the flounce can be also seen in the lateral meniscus. Although, the meniscal flounce is a rare anatomic variant, its presence should be recognized since a meniscal tear or a discoid meniscus may resemble same appearance. However, meniscal flounce and meniscal tears may coexist ⁽⁵⁾

Bone and Capsular Attachments⁽⁵⁾ The lateral meniscotibial ligament also known as the coronary ligament or the meniscocapsular ligament connects the lateral meniscus to the tibia along the entire circumference of the lateral meniscus ⁽¹⁾. The posterior horn of the lateral meniscus attaches to the medial femoral condyle through

the meniscomfemoral ligaments ⁽⁶⁾. The posterior meniscomfemoral ligament (Wrisberg ligament) extends from the posterior horn of the meniscus to the medial femoral condyle proximal to the posterior cruciate (PCL) insertion (Figure 6)⁽⁷⁾. The anterior meniscomfemoral ligament (Humphrey ligament) attaches on the medial femoral condyle, inferior to the PCL insertion (Figure 7) ⁽⁸⁾. Many variations of these ligaments have been reported and the incidence of the presence of one or the other ligament is 70–100 % ⁽⁹⁾.

Blood Supply: The menisci are vascularized only via the periphery and the root attachments and therefore the inner portions are avascular, this has important implications on the healing and surgical management of meniscal tears (Figure 8).⁽⁷⁾ The meniscus is divided into three vascular zones based on its blood supply. The outer one third, known as the red zone, is well vascularized and receives its blood supply from the peripheral meniscal plexus, which is formed by branches of the medial, lateral, and middle genicular arteries. In contrast, the inner two-thirds, referred to as the white zone, is avascular and depends on diffusion from synovial fluid for its nutritional needs. Between these two regions lies the red-white zone, a transitional area that reflects the gradual and variable reduction in vascularity, which may differ depending on the specific site within the meniscus and between individuals. Overall, the vascular supply of the menisci originates predominantly from the medial, lateral, and middle genicular arteries, which arise as branches of the popliteal artery.

Nerve Supply: The medial meniscus is innervated by branches of the posterior tibial nerve and the terminal branches of the obturator and femoral nerves⁽⁷⁾.

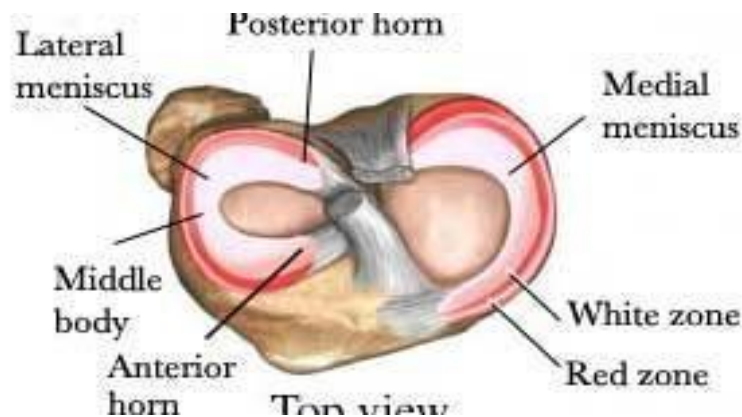


Figure 1: Each meniscus is C-shaped in the transverse plane and consists of the following parts (from anterior to posterior); anterior root attachment, anterior horn, body (located centrally), posterior horn and posterior root attachment. Quoted from ⁽¹⁾

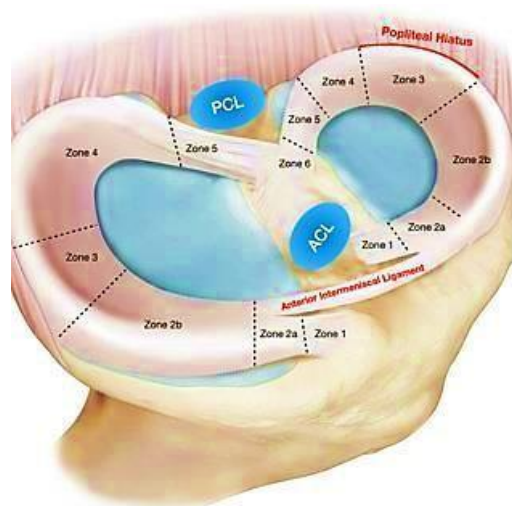


Figure 2: GRAPHIC IMAGE SHOWS ZONAL ANATOMY OF MENCI Quoted from ⁽¹⁾

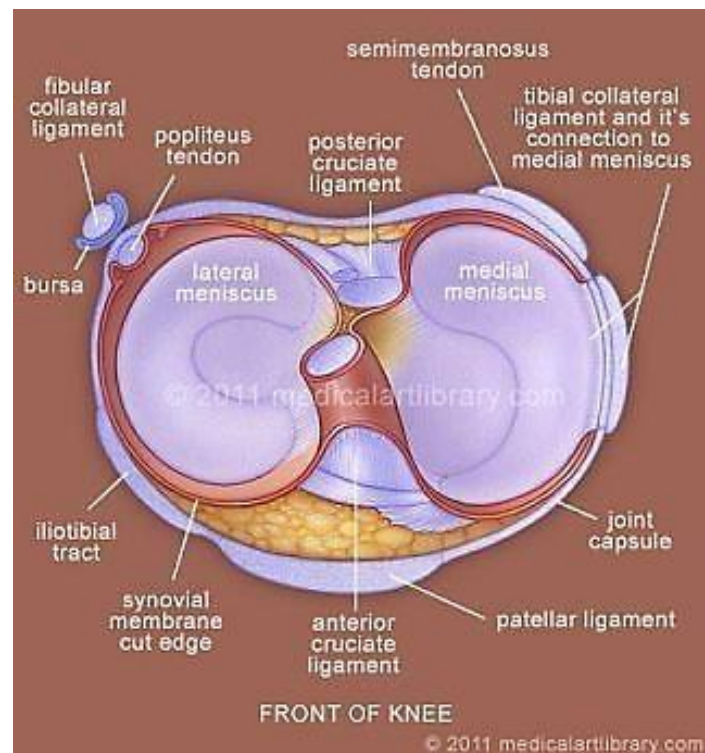


Figure 3: CROSS SCHEMATIC IMAGE SHOWS CIRCULAR SHAPE OF LATERAL MENISCUS WITH EQUAL HORNS Quoted from ⁽¹⁾.

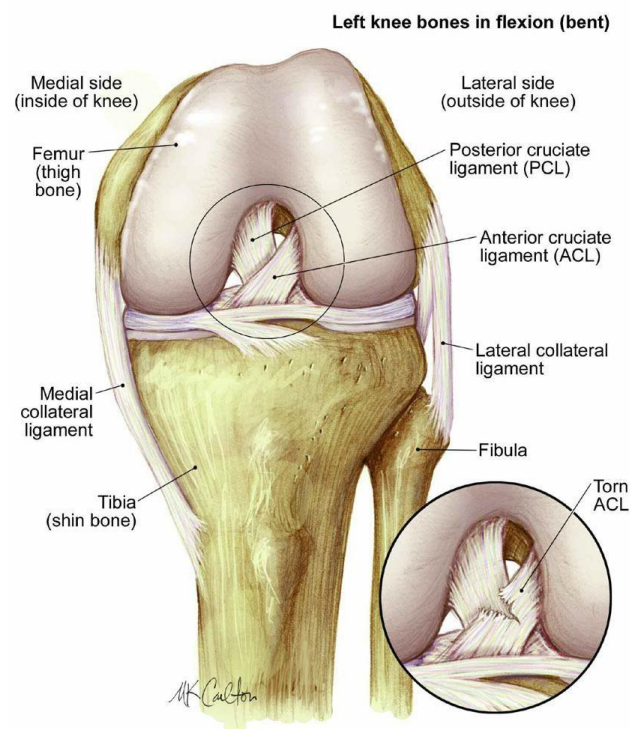


Figure 4: attachments of lateral menisci. Quoted from ⁽¹⁾

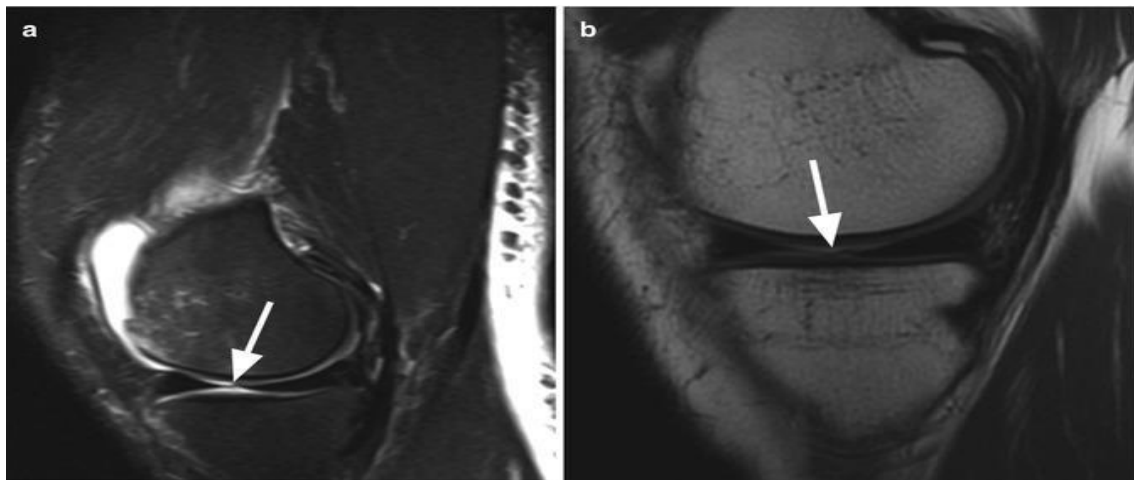


Figure 5: Two different patients with internal meniscal flounce. Sagittal proton-density (PD) FSE fat suppressed image (a) in a 23 year old patient and sagittal proton-density (PD) FSE image (b) in a 22 year old patient show in both cases a wavy, irregular meniscus (arrow) Quoted from ⁽⁹⁾.

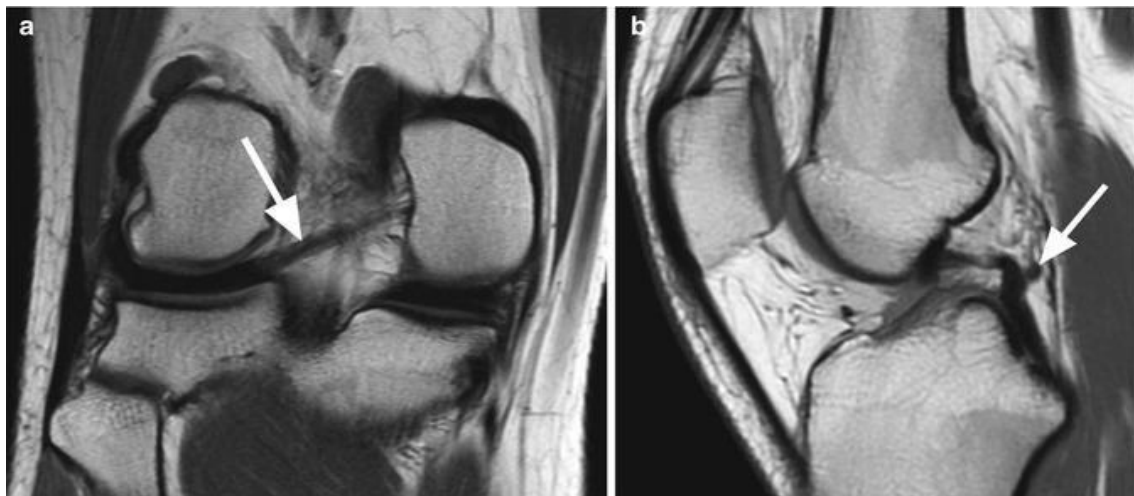


Figure 6: Posterior meniscofemoral ligament (Wrisberg ligament). Coronal proton-density (PD) FSE image (a) and sagittal proton-density (PD) FSE image (b) show the posterior meniscofemoral ligament (arrow). Quoted from ⁽⁹⁾



Figure 7: Anterior meniscofemoral ligament (Humphrey ligament). Coronal proton-density (PD) FSE image (a) and sagittal proton-density (PD) FSE image (b) show the anterior meniscofemoral ligament (arrow) Quoted from ⁽⁹⁾

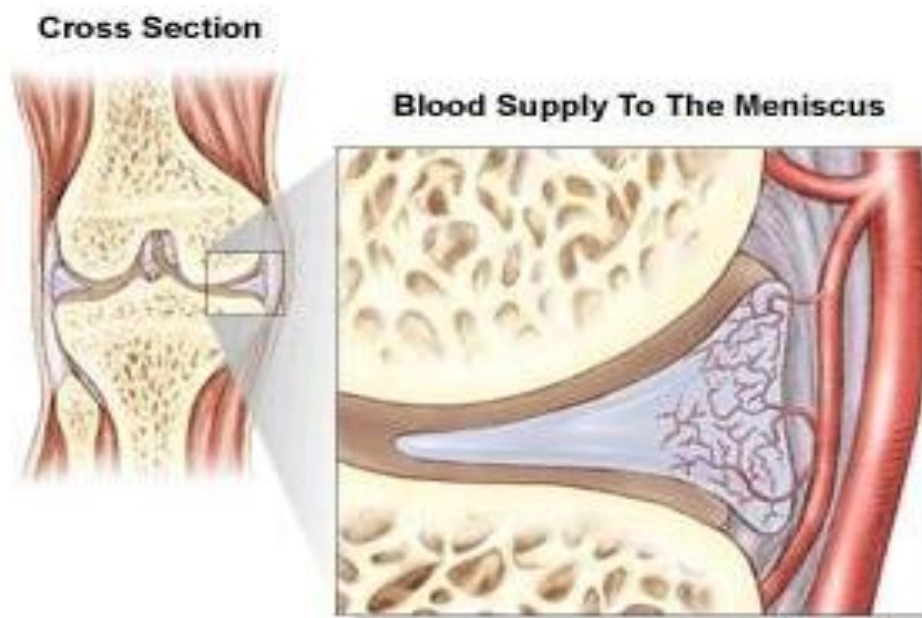


Figure 8: SCHEMATIC DIAGRAM SHOWS MENISCAL BLOOD SUPPLY ZONES Quoted from ⁽⁵⁾

Normal ultrasound and MRI appearance

Ultrasound evaluation of healthy menisci reveals triangular homogenously hyperechoic structures between the bony cortices of the femur and tibia, The anterior horn, outer rim of the meniscal body, and the posterior horn can be easily visualized. ⁽⁸⁾(Figure 9)

Normal menisci appear as homogenously hypointense structure on proton density (PD) images (Figure10.

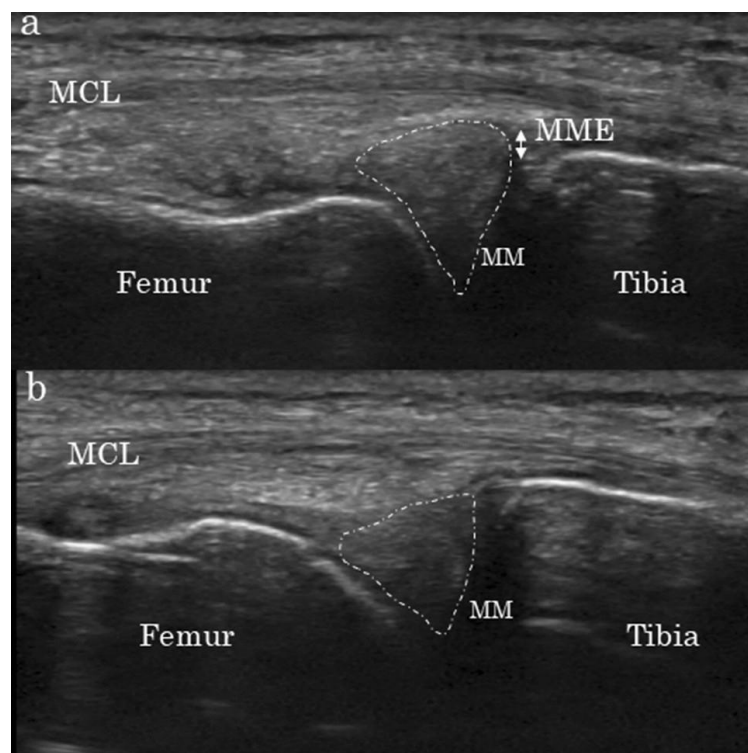


Figure 9: normal ultrasound appearance of menisci. Quoted from ⁽²⁾

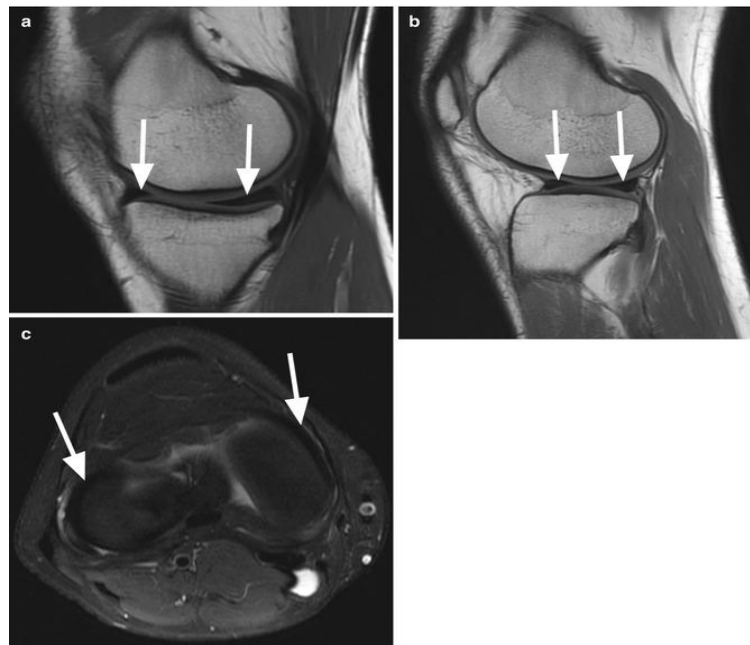


Figure 10: Quoted from ⁽¹⁰⁾Normal menisci in a 19 year old female. Sagittal proton-density (PD) FSE image through the medial compartment (a) shows the medial meniscus which is wider posteriorly than anteriorly (arrows). Sagittal proton-density (PD) FSE image through the lateral compartment (b) shows the normal homogeneous hypointense anterior and posterior horn of the lateral meniscus (arrows). A complete evaluation of the meniscus should include axial images as shown in the axial proton-density (PD) FSE fat-suppressed image (arrows in c).

Collateral Ligament Anatomy and Normal Imaging

Medial collateral ligament

MCL is a key ligament in the knee joint that provides stability and prevents excessive valgus movement of the knee, and measures 8-10 cm in length⁽¹⁾. The MCL is a broad, flat ligament located on the medial side of the knee. It extends from the medial femoral epicondyle to the medial tibial condyle and the proximal medial shaft of the tibia. It has superficial and deep portions (Figure 11) ⁽²⁾.

The superficial MCL, also known as a tibial collateral ligament or vertical component of the MCL, is part of the middle layer of the medial capsuloligamentous complex of the knee. Its proximal attachment is the posterosuperior aspect of the medial femoral epicondyle, anteroinferior to the adductor tubercle. Distally it has two insertion sites (proximal and distal) at the upper medial surface of the tibia: anterior band of the semimembranosus tendon (principally a soft tissue attachment) tibial periosteum posterior to the pes anserine attachment at the posteromedial crest of the tibia. The posterior aspect of the medial collateral ligament blends into the posterior oblique ligament and knee capsule.

The deep MCL, also known as the mid-third capsular ligament, is part of the deep layer of the medial capsuloligamentous complex of the knee, and is a thickening of the medial joint capsule, and is divided into meniscofemoral and meniscotibial ligaments.

Arterial supply Branches of the superior and inferior genicular arteries ⁽⁷⁾.

Innervation medial articular nerve, a branch of the saphenous nerve⁽⁷⁾.

The medial collateral ligament has a three-layered aspect on sonography, with a hyperechoic superficial layer, a hypoechoic intermediate layer, and a hyperechoic deep layer (Figure 12) ⁽¹⁰⁾.

Three layers of medial collateral ligament appear as low signal band seen at medial aspect of knee joint (Figure 13) ⁽¹⁰⁾.

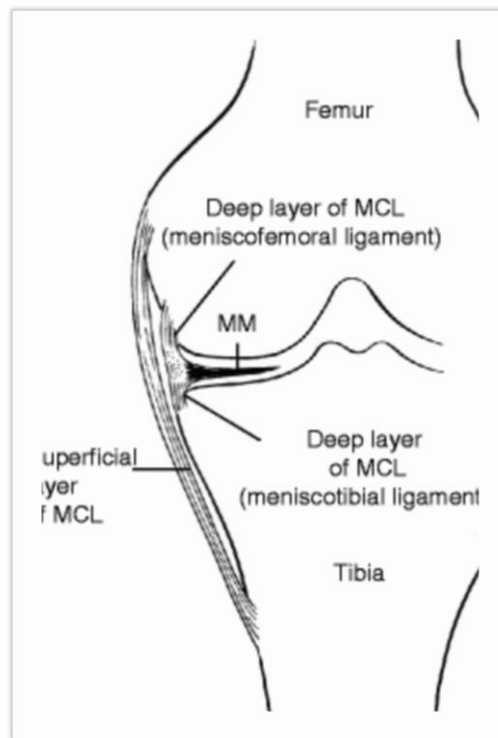


Figure 11: schematic diagram shows superficial and deep MCL layers Quoted from ⁽⁶⁾.

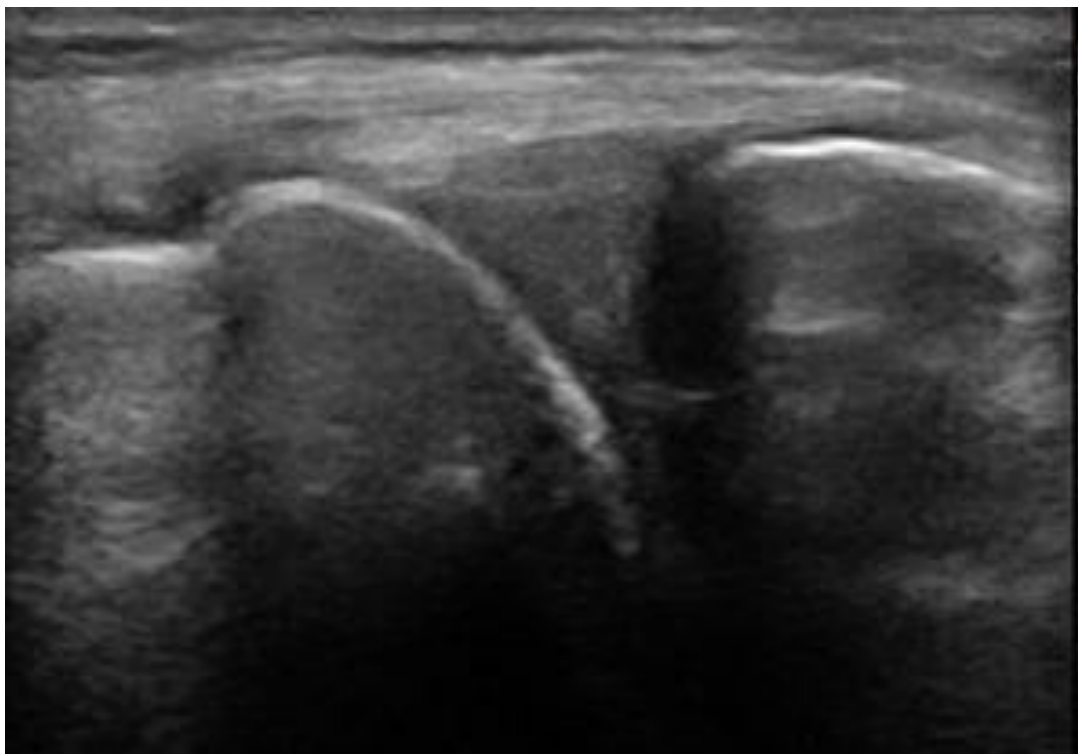


Figure 12: US image shows the MCL is a flat, band-like ligament approximately 9 cm long, extending from the femoral epicondyle to the antero-medial tibia Quoted from ⁽¹¹⁾.

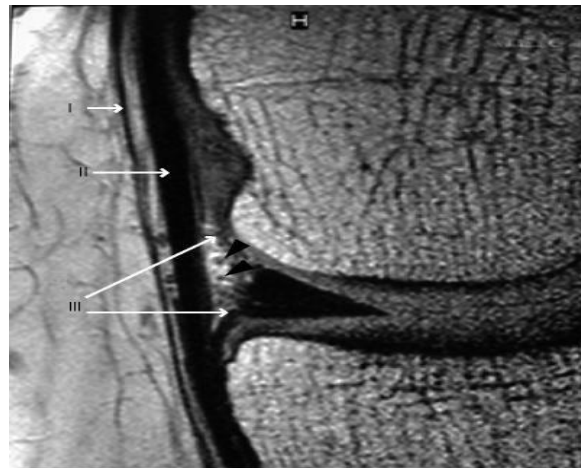


Figure 13: coronal PDW image of left knee joint shows three layers of normal MCL Quoted from ⁽¹¹⁾.

Lateral collateral ligament

The lateral collateral ligament (LCL), long external lateral ligament or fibular collateral ligament) is an extrinsic ligament of the knee located on the lateral side of the knee. *Its superior attachment is at the lateral epicondyle of the femur; its inferior attachment is at the lateral aspect of the head of fibula. The LCL is not fused with the joint capsule. Inferiorly, the LCL splits the tendon of insertion of the biceps femoris muscle (Figure 14) ⁽¹¹⁾.

The LCL measures some 5 cm in length. It is rounded, and is more narrow and less broad compared to the medial collateral ligament. In contrast to the medial collateral ligament, it is not fused with either the capsular ligament nor the lateral meniscus. Because of this, the LCL is more flexible than its medial counterpart, and is therefore less susceptible to injury. ⁽¹¹⁾

The lateral collateral ligament appears on sonography as a hyperechoic band at lateral aspect of knee joint space (Figure 15) ⁽¹²⁾.

The lateral collateral ligament appear as low signal band seen at lateral aspect of knee joint (Figure 16) ⁽¹³⁾.

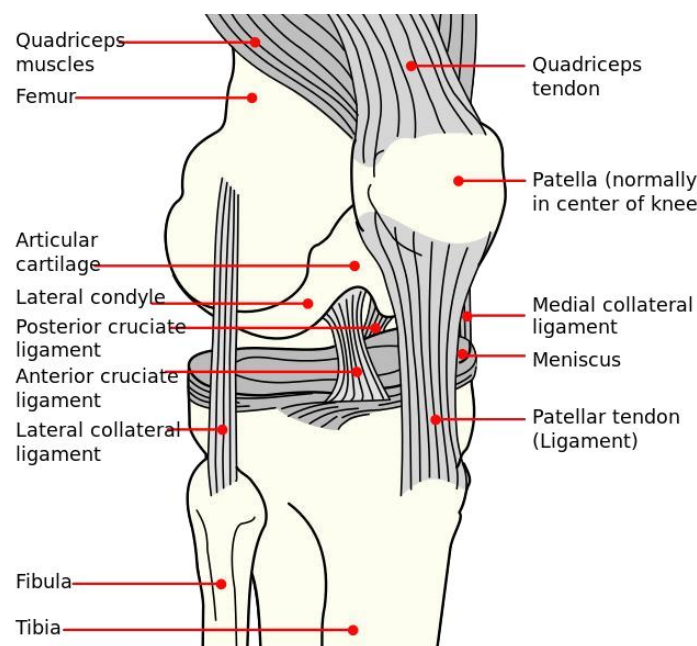


Figure 14: schematic diagram shows extension of LCL Quoted from ⁽¹²⁾



Figure 15: US IMAGE OF LCL Quoted from ⁽¹³⁾.



Figure 16: showing normal LCL appearance in MRI. Quoted from ⁽³⁾.

Knee Magnetic Resonance Imaging Technique

Indications: There are several indications for knee MRI include; acute trauma, swelling, suspected meniscal or ligamentous injury, osteoarthritis and suspected marrow disorders ⁽³⁾.

Contraindications: Any electrically, magnetically or mechanically activated implant [e.g. cardiac pacemaker, insulin pump biostimulator, neurostimulator, cochlear implant, and hearing aids], intracranial aneurysm clips [unless made of titanium], pregnancy [risk vs benefit ratio to be assessed] ⁽³⁾.

Patient preparation ⁽³⁾: No certain patients preparation; however ask the patient to remove all metal object including keys, coins, wallet, any cards with magnetic strips, ferromagnetic jewellery, hearing aid and hairpins.

Positioning ⁽³⁾: Feet first supine Position the semi-extended knee in the knee coil and immobilise with cushions Give cushions under the ankle for extra comfort Centre the laser beam localiser over the lower border of patella [Figure 17].

Disadvantages: Long exam time, it is not available in many health care hospitals, it is not used in many patients [ferromagnetic devices] ⁽³⁾.

KNEE LOCALIZER A three-plane localizer must be taken at the beginning to localize and plan the sequences. Localizers are usually T1-weighted low-resolution scans that last less than 25 seconds [Figure 18].The imaging should cover all knee supporting structures, including anterior, posterior, medial, and lateral aspects, and should include the distal quadriceps tendon, suprapatellar bursa, patellar tendon, and pes anserine tendons. The field of view (FOV) should be ≤ 16 cm, adjustable for knee size and suspected abnormalities, possibly using larger FOV. Sagittal and coronal slice thickness should be ≤ 4 mm to detect subtle meniscal and cartilage issues ⁽³⁾.

Sequences(A standard MRI knee protocol for internal derangement such as meniscal tear might look something like): PD fast spin-echo (FSE) sequences are acquired in the sagittal and coronal planes, with axial imaging performed when required, using a slice thickness of 3–4 mm. This sequence provides detailed anatomical visualization and good tissue contrast, allowing clear delineation of anatomical structures. It demonstrates fluid as high signal intensity, hyaline cartilage as intermediate signal intensity, and ligaments, tendons, and menisci as low signal intensity, facilitating assessment of the normal anatomy and detection of pathological changes.

2- PD-weighted fat-saturated (PD-FS) fast spin-echo sequences are obtained in the sagittal, coronal, and axial planes (Figure 19), with a slice thickness of 3–4 mm. This sequence is particularly useful for the detection and characterization of meniscal tears, especially on sagittal images. Fat suppression enhances the visibility of fluid-sensitive abnormalities by increasing the contrast between fluid and surrounding tissues, facilitating the detection of bone marrow edema, fat-pad edema, bursae, joint effusion, and parameniscal cysts.

3- T2-weighted fat-saturated (T2-FS) fast spin-echo sequences are obtained in the coronal plane, with axial imaging performed when required, using a slice thickness of 3–4 mm. This sequence is particularly useful for the detection and characterization of meniscal root tears, especially on coronal images. Fat suppression enhances the conspicuity of fluid-sensitive abnormalities, facilitating the visualization of bone marrow edema, fat-pad edema, bursae, joint effusion, and parameniscal cysts.as figure 20

4- T1-weighted fast spin-echo sequences are obtained in at least one plane, typically the axial or coronal plane, using a slice thickness of 3–4 mm. This sequence is primarily used to characterize the T1 signal characteristics of bone and soft tissues and is particularly useful for evaluating and further characterizing any incidental bone or soft-tissue lesions as figure 21.



Figure 17: Photo shows positioning of knee in knee MRI exam Quoted from ⁽⁷⁾.



Figure 18: 3 localizer planes of knee MRI exam Quoted from ⁽⁷⁾

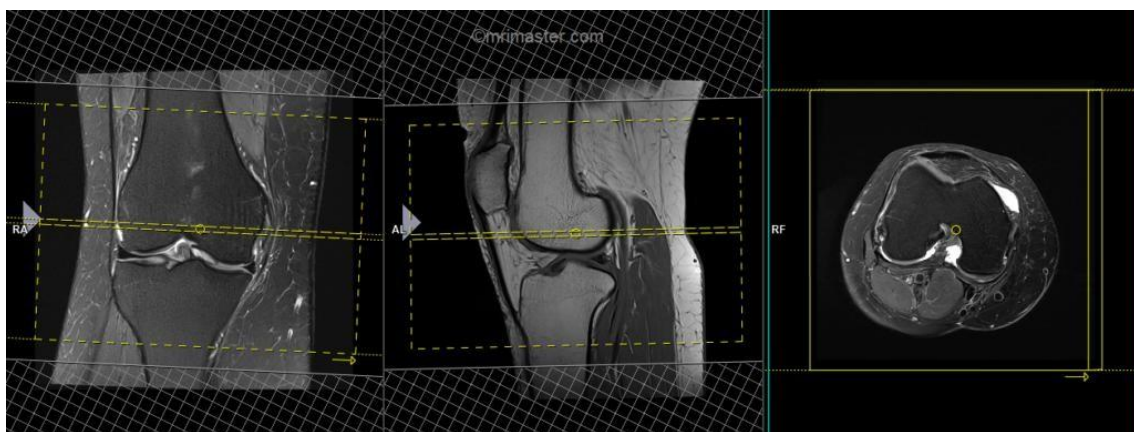


Figure 19: axial PD fat sat knee MRI image Quoted from ⁽⁷⁾



Figure 20: Sagittal STIR knee MRI image Quoted from ⁽⁷⁾.

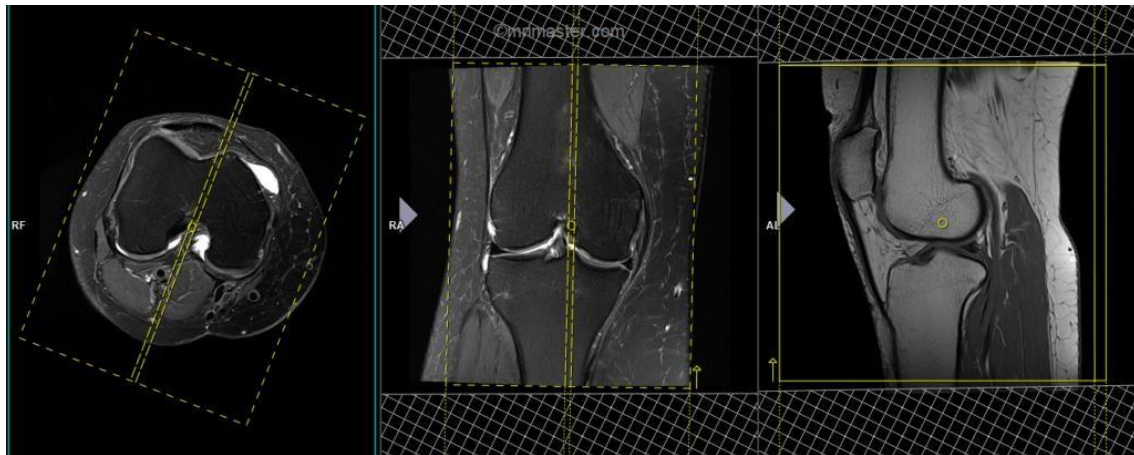


Figure 21: Sagittal T1 TSE knee MRI image Quoted from (7).

Knee Ultrasonography Technique

Indications: Meniscal and ligamentous assessment, evaluation of osteoarthritis, and knee swelling⁽⁴⁾.

Probe: High frequency linear probe (7.5-20 MHz) ⁽⁴⁾.

MRI and Ultrasound Features of Meniscal Injuries

A. Meniscal Tear ⁽¹⁴⁾ Most common pathology, especially in athletes and older adults. Causes: o Traumatic (twisting injury, often in sports) o Degenerative (age-related wear)

Longitudinal tears

****Ultrasound Appearance:** On ultrasound, longitudinal tears may appear as hypoechoic clefts within the meniscus, aligned with the circumferential fibers. Loss of the normal echogenic meniscal outline or a hypoechoic line extending through the meniscus can diagnose a tear ⁽¹⁵⁾ (Figure 22).

MRI Appearance: Longitudinal tears run parallel to the circumferential fibers of the meniscus, often appearing as hyperintense lines on proton density images within the meniscal substance. They are typically visible as a vertical hyperintense line extending from the superior to inferior articular surfaces, often parallel to the meniscal rim. The "displaced fragment" sign may be seen if the tear is unstable ^(16, 17) (Figure 23).



Figure 22: Coronal ultrasound image of medial meniscal body showing vertical fluid cleft; Quoted from ⁽⁴⁾.

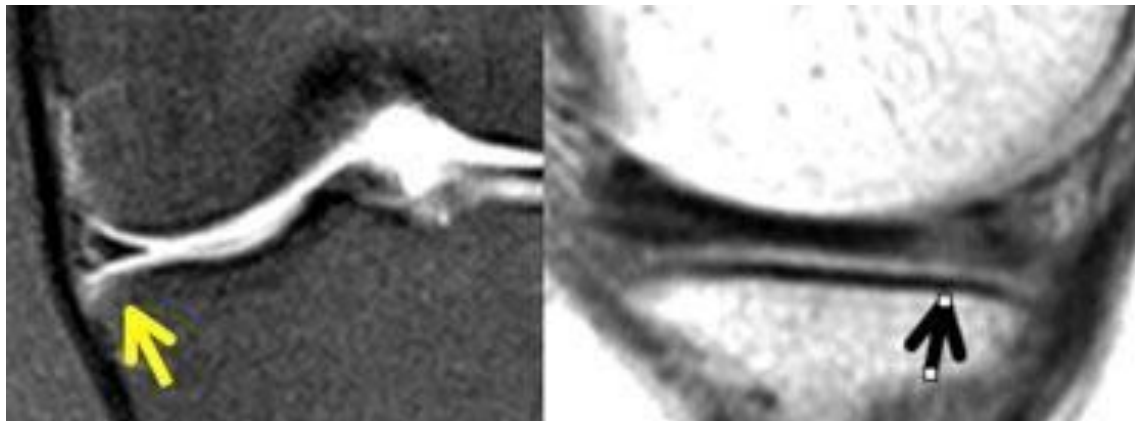


Figure 23: Coronal PD fat sat and Sagittal PD images show longitudinal tear of medial meniscus body, Quoted from ^(16, 17)

Horizontal tears

Ultrasound Appearance: Transverse tears may manifest as an anechoic or hypoechoic line within the meniscus, creating a splitting appearance across its width ⁽¹⁵⁾ (Figure 24).

MRI Appearance: Transverse tears run perpendicular to the circumferential fibers, often appearing as a horizontal proton density hyperintense line dividing the meniscus into superior and inferior fragments. They are best visualized on coronal or sagittal images as a horizontal cleft ⁽¹⁷⁾ (Figure 25).

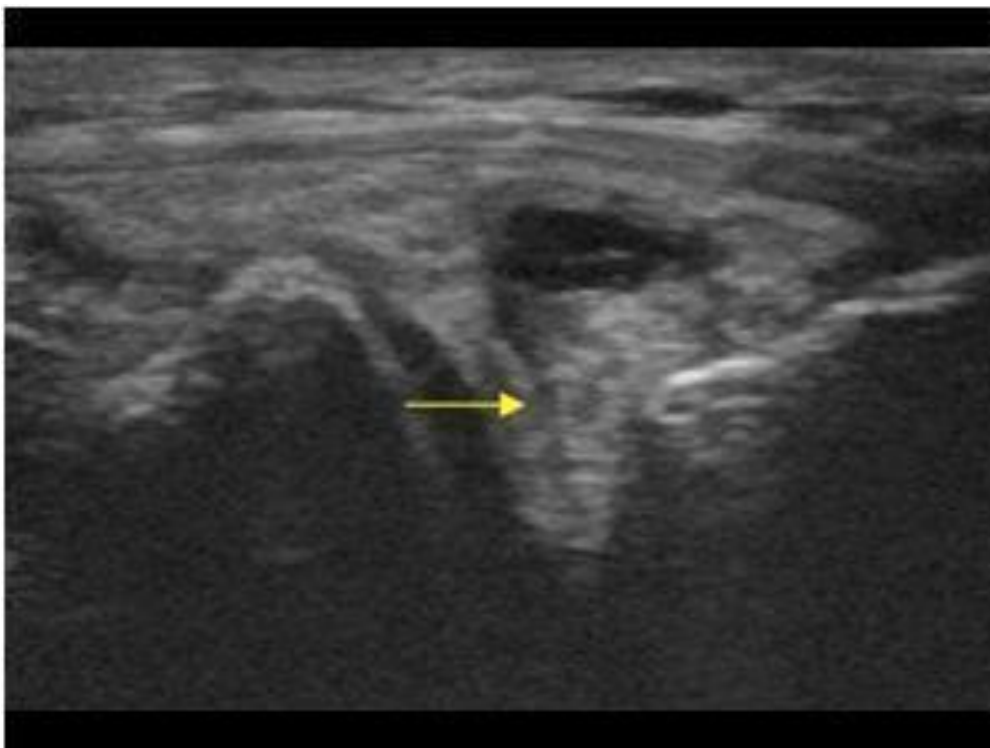


Figure 24: Sagittal ultrasound image of PHMM showing horizontal fluid cleft with para meniscal cyst, Quoted from ⁽⁴⁾.

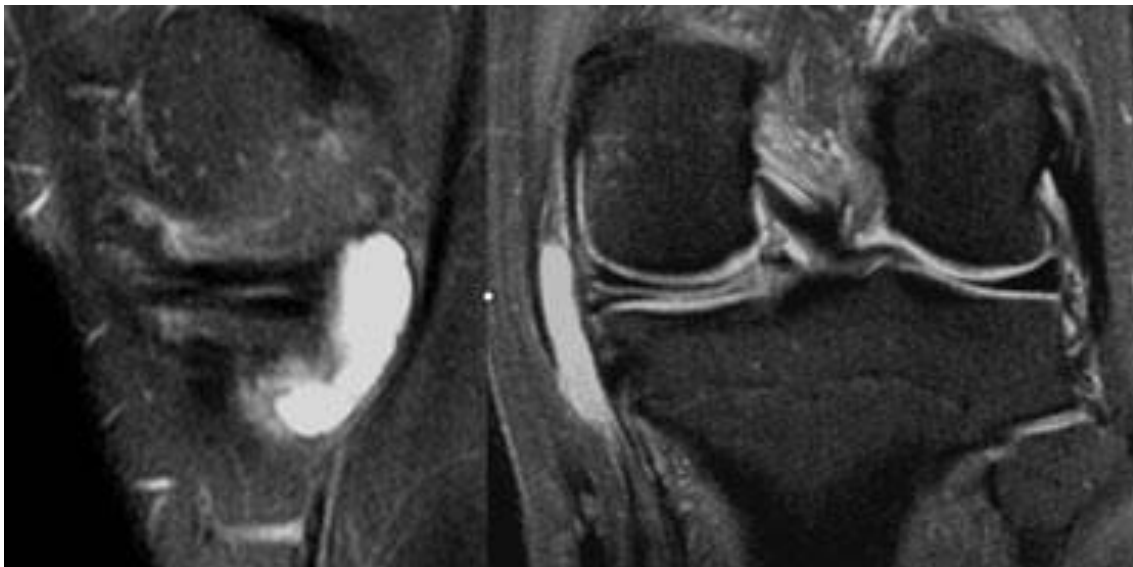


Figure 25: sagittal PD fat sat and coronal PD fat sat images show horizontal tear of medial meniscus body, Quoted from ⁽¹⁷⁾

Radial tears

Ultrasound Appearance: These tears may appear as hypoechoic radial lines ☐ originating at the meniscal rim, but they are challenging to detect due to their orientation ⁽¹⁵⁾.

MRI Appearance: Radial tears extend from the free edge toward the periphery, often disrupting the circumferential fiber architecture. They appear as linear proton density hyperintense signals extending radially from the meniscal free edge, often leading to a "flag sign" or "parrot beak" appearance when displaced ⁽¹⁷⁾ (Figure 26).

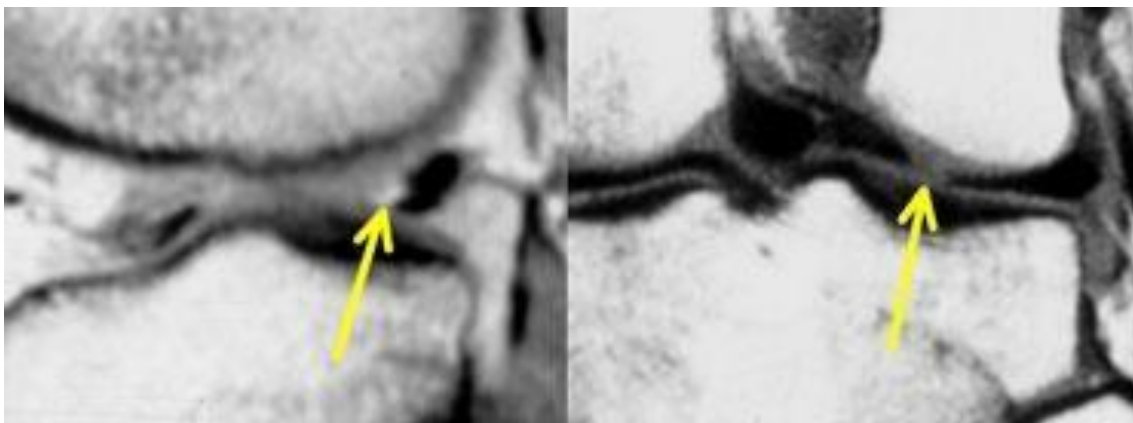


Figure 26: sagittal PD and coronal PD images show radial tear of posterior horn of lateral meniscus, Quoted from ⁽¹⁷⁾.

Complex and displaced tears

Complex tears ⁽¹⁴⁾ **Ultrasound Features:** Ultrasound may reveal irregular, hypoechoic areas with multiple clefts, fragment dislocation, or abnormal contour of the meniscus ⁽¹⁵⁾ **MRI Features:** Complex tears produce irregular, multilayered proton density hyperintense signals with disrupted meniscal architecture. They often show a combination of tear types, with possible fragments, displaced meniscal tissue, or flaps. The "fragmented meniscus" and "bucket-handle" configurations are typical examples ⁽¹⁷⁾ (Figure 27)

Displaced tears: o Bucket-handle tear which is can result in the migration of a large meniscal fragment into the intercondylar notch that remains attached to the anterior and posterior horns of the meniscus, Bucket-handle lesions in the intercondylar notch show a “double PCL” appearance on sagittal images at the intercondylar notch⁽¹⁷⁾. (Figures 28 and 29)

Parrot beak which is a displaced radial tear.^(17,16) Flap tear which is a displaced horizontal tear: whereas the remaining cases are usually in the superior or inferior recesses above and below the body of the medial meniscus may show a “double medial collateral ligament (MCL)” sign on axial sections.^(17, 16) Flipped tear: Approximately two thirds of medial meniscus displaced fragments are found in the posterior aspect of the joint near or behind the PCL.^(17,16)

****Important considerations about meniscal fragments:** Fragments that displace from the MM are much more common than those from the LM.

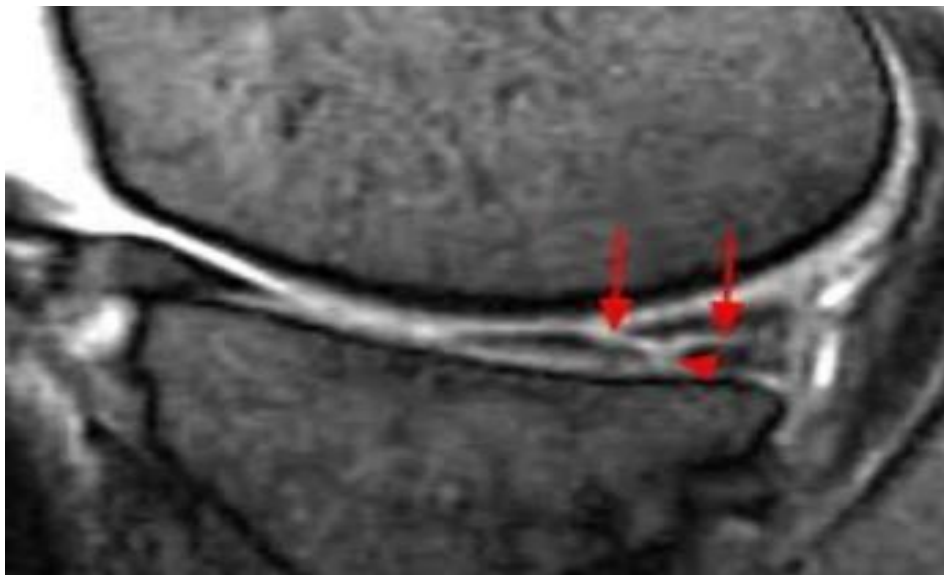


Figure 27: complex meniscal tear of longitudinal and transverse component...Quoted from ⁽¹⁷⁾

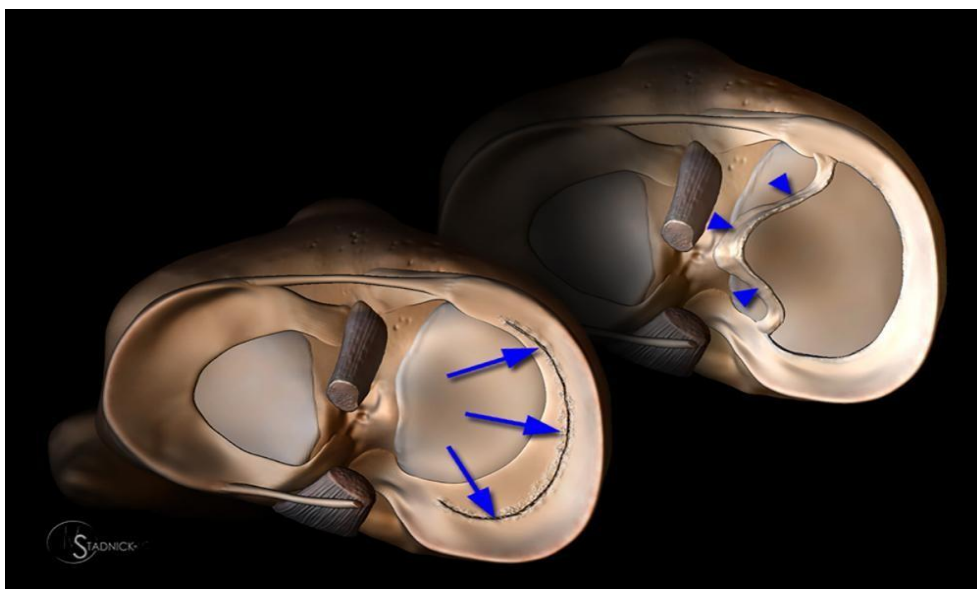


Figure 28: A 3D illustration of a bucket handle tear demonstrates that these tears actually are longitudinal in nature (arrows), coursing parallel to the c-shaped fibers of the meniscus. Displacement of the inner rim of the tear (arrowheads) results in the classic "bucket-handle" configuration...Quoted from ⁽¹⁷⁾

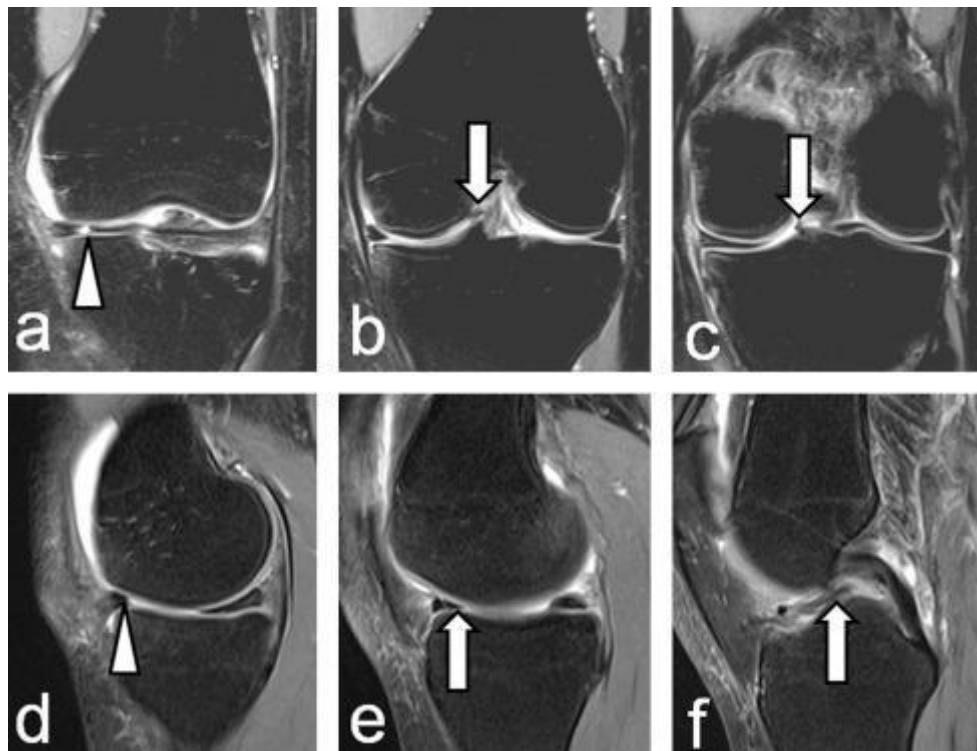


Figure 29: A 32-year-old man with an old history of knee trauma. A small medial meniscus fragment with bucket-handle displacement into the intercondylar notch is shown. Coronal (a–c) and sagittal (d–f) fat suppressed proton-density magnetic resonance images show the subtle loss of substance in the anterior horn of the medial meniscus (arrowheads in a and d) and a fragment displaced into the intercondylar notch (arrows in b, c, e, f) on the superior aspect of the medial intercondylar tubercle. Note (in b) the practically intact middle segment of the medial meniscus and the edematous infiltration at the margin of the medial tibial plateau (menisco-capsular separation)...Quoted from ⁽¹⁷⁾

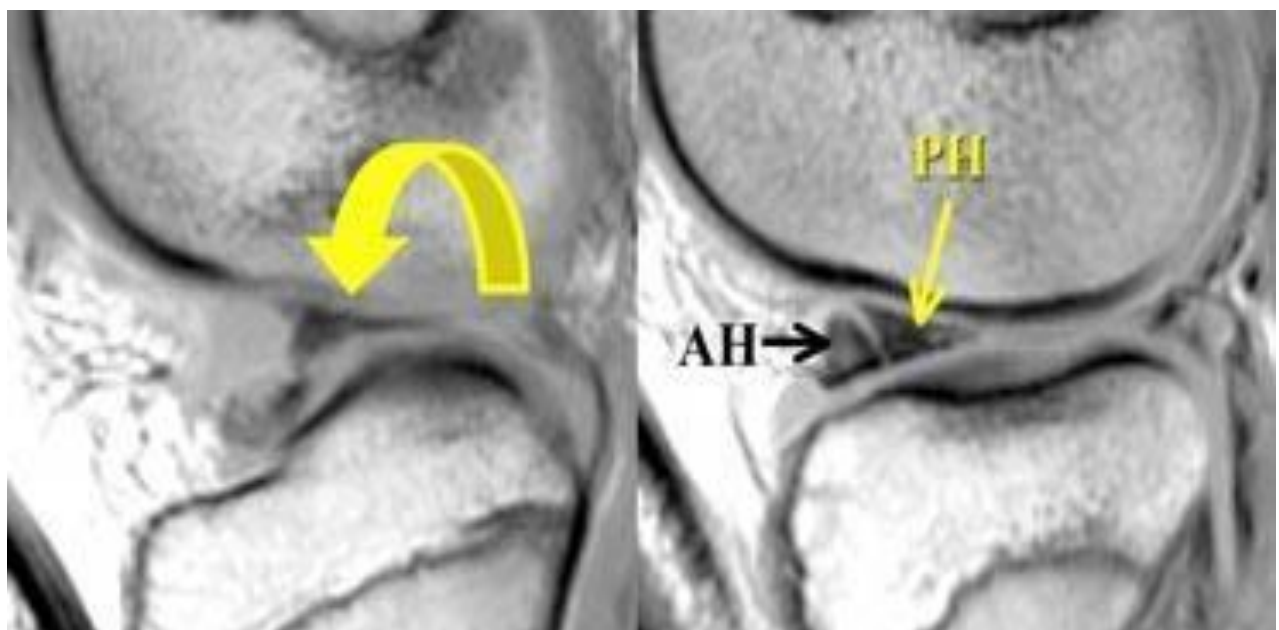


Figure 30: sagittal PD images show flipped tear of PHLM, Quoted from ^(16,17)

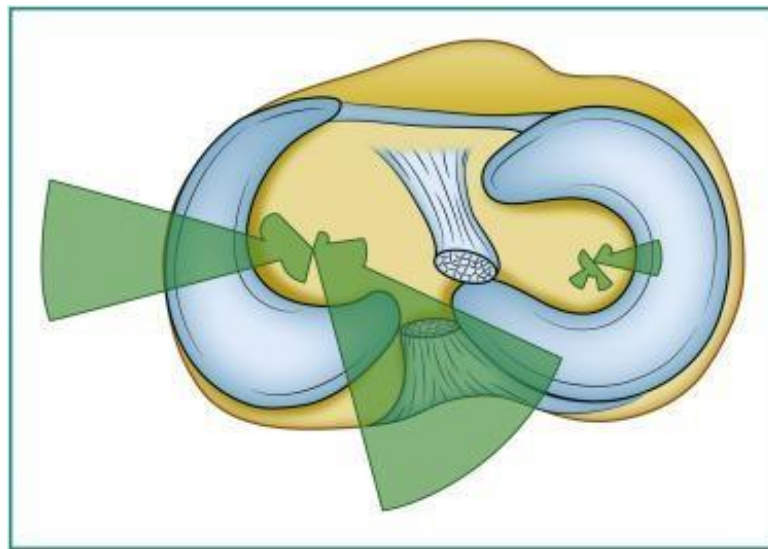


Figure 31: Illustration of the most common locations (direction of the green “sectors”) and relative proportions (sizes of the green sectors) of fragments that originate from the medial (left) and lateral (right) menisci. Note the higher frequency of medial meniscal fragments and their most common locations: the posterior intercondylar notch and perimeniscal recess ...(.Quoted from ⁽¹⁴⁾)

Other meniscal abnormalities

Meniscal Cyst ⁽¹⁸⁾: Fluid-filled sac adjacent to a meniscus, often associated with a horizontal meniscal tear. (Figure 32), Can cause localized swelling and tenderness.

Discoid Meniscus⁽¹⁹⁾ A congenital anomaly (usually lateral meniscus), where the meniscus is abnormally thick and disk-shaped Prone to tearing; common in children.figure 33)

Meniscal Degeneration⁽¹⁴⁾ Seen in older individuals, often part of osteoarthritis.Meniscus loses elasticity and becomes more prone to tears without significant trauma.(Figure 34).

Post-Meniscectomy Syndrome After partial or total meniscectomy, the knee may develop chronic pain and early osteoarthritis due to increased load on articular cartilage ⁽²⁰⁾ (Figure 35).

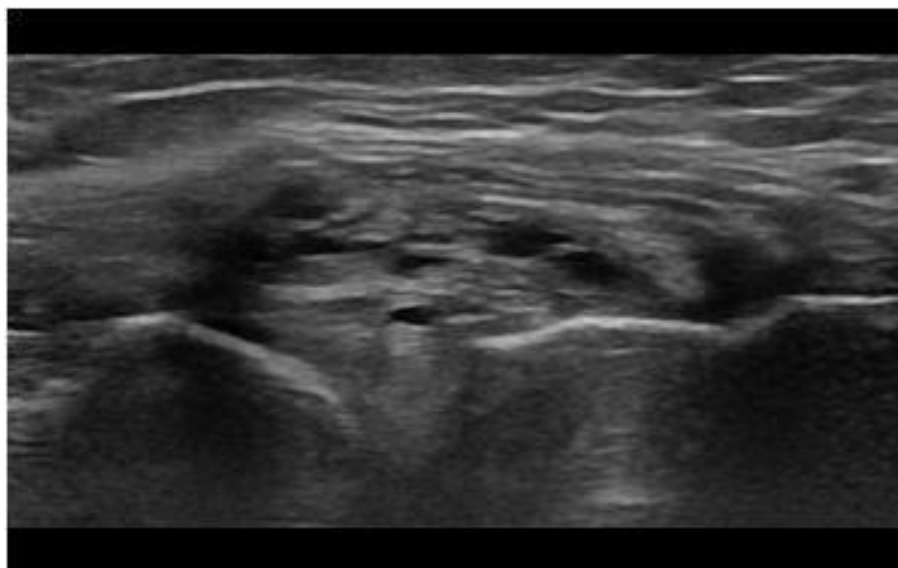


Figure 32: Coronal ultrasound image show lateral meniscal cysts, Quoted from ⁽¹⁸⁾



Figure 33: showing discoid menisci of lateral menisci Quoted from ⁽¹⁹⁾.

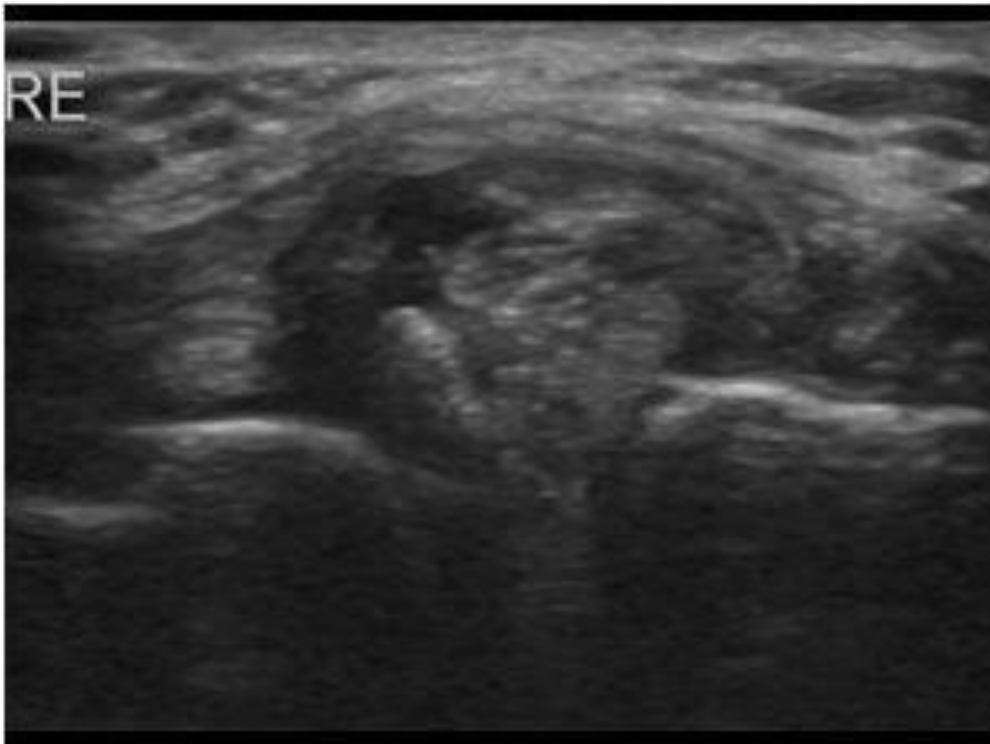


Figure 34: Coronal ultrasound image show abnormal mixed echogenicity, protrusion and cysts of PHLM, Quoted from ⁽¹⁴⁾

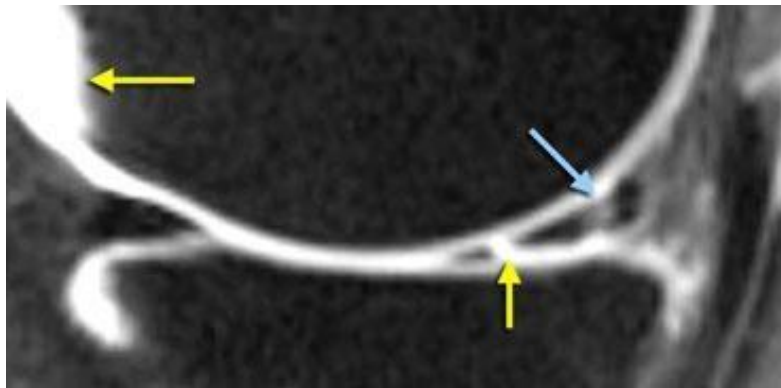


Figure 35: Sagittal PD fat sat arthrogram image show fluid signal (new tear yellow arrow) and intermediate signal (old suture blue arrow), Quoted from ⁽²⁰⁾

MRI and Ultrasound Features of Collateral Ligament Injuries

Collateral ligament injuries of the knee, encompassing the medial collateral ligament (MCL) and lateral collateral ligament (LCL), are common in knee trauma. Accurate grading of these injuries is essential for management and prognosis. MRI is the gold standard for soft tissue assessment, with ultrasound serving as an adjunct in certain cases ⁽²⁾.

The medial collateral ligament (MCL) and lateral collateral ligament (LCL) provide primary medial and lateral stability to the knee, respectively. Injuries vary from microscopic sprains to complete tears, categorized into three grades based on ligament disruption and associated findings. Precise imaging evaluation guides treatment planning ⁽²⁾.

Ultrasound grading

Grade I / Sprain ⁽²¹⁾ Ligament appears normal or shows slight hypoechogenicity. No fiber discontinuity. Mild surrounding hyperechoic edema may be present.

Grade II /partial tear ⁽²¹⁾ Hypoechoic areas indicating partial fiber disruption. Thinning or irregularity of the ligament. Increased surrounding soft tissue edema. No complete discontinuity.

Grade III / complete tear ⁽²¹⁾ Complete discontinuity with absent or retracted ligament fibers. Hypoechoic or anechoic gap where the ligament should be. Possible hematoma or fluid collection around the site. Increased surrounding soft tissue edema.

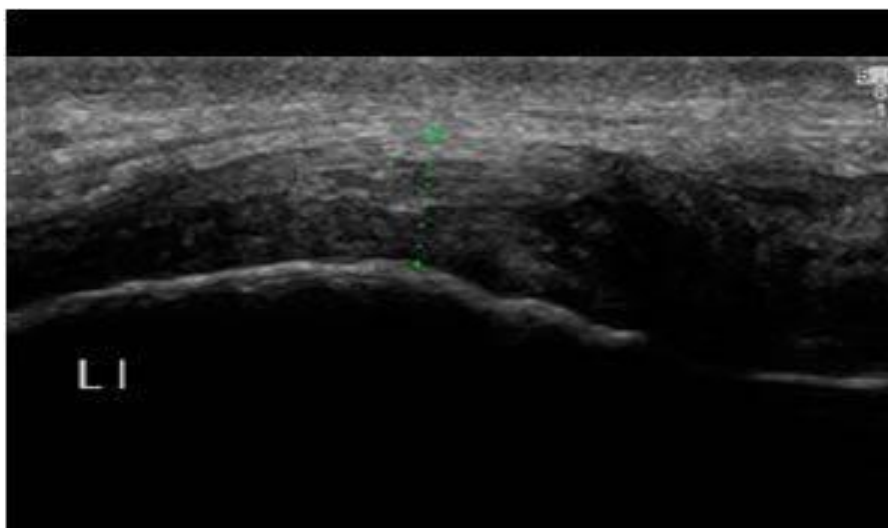


Figure 36: Coronal ultrasound showing thickened MCL ligament denoting sprain, Quoted from ⁽²¹⁾.

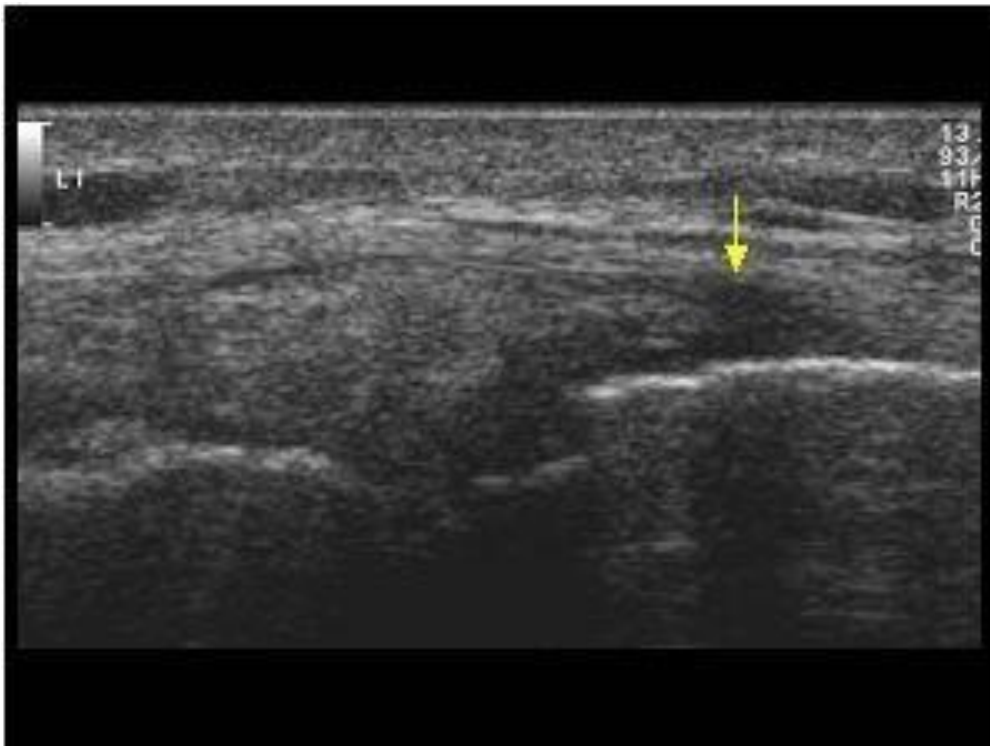


Figure 37: coronal ultrasound showing partial tear of deep fibers of distal MCL ligament, Quoted from ⁽²¹⁾.

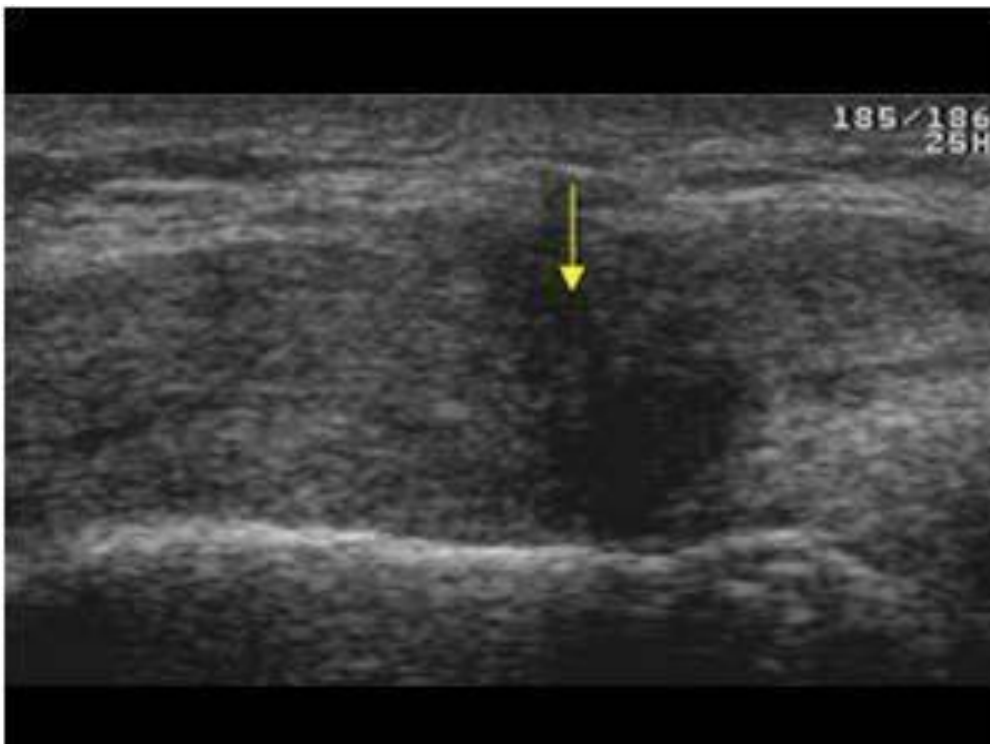


Figure 38: Coronal ultrasound showing complete tear of MCL ligament, Quoted from ⁽²¹⁾

MRI grading

Grade 1 (Mild Sprain/Stretch) ⁽²²⁾ Ligament Signal: normal ligament signal. Ligament Morphology: Intact fibers with no significant thickening or abnormal laxity. - Periligamentous Edema: surrounding soft tissue edema seen. Additional Findings: No associated related findings.

Grade 2 (Partial Tear) ⁽²²⁾ Ligament Signal: Increased T2/PD hyperintensity involving part of the ligament, with partial fiber discontinuity. Morphology: Thinning or irregularity of the ligament fibers. Periligamentous Edema: Moderate surrounding edema and hemorrhage. Additional Findings: Possible small joint effusion or minor avulsion fragments if avulsion occurs.

Grade 3 (Complete Tear or Rupture) ⁽²²⁾ Ligament Signal: Complete disruption with absence of continuous fibers; ligament appears as a gap or absent. Ligament Morphology: Widened, irregular, or retracted ligament ends. Periligamentous Edema/Hematoma: Significant edema, hematoma, and possibly surrounding soft tissue injury. Associated Injuries: Often associated with other ligament injuries, meniscal tears, or fractures.

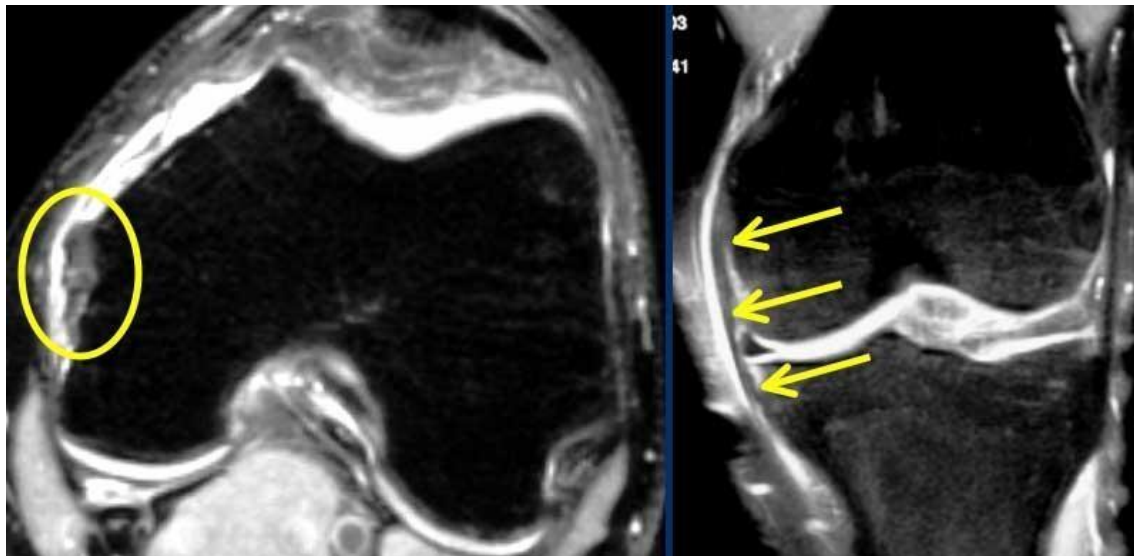


Figure 39: Axial and coronal PD fat sat images show grade I MCL injury, Quoted from ⁽²²⁾.

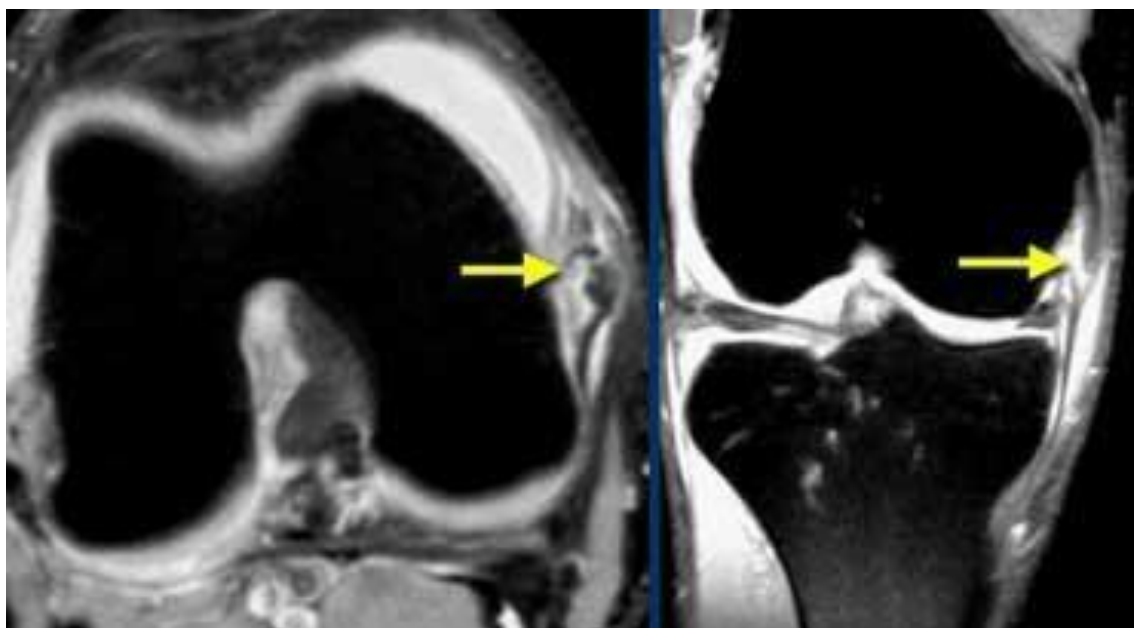


Figure 40: Axial and coronal PD fat sat images show grade II MCL injury, Quoted from ⁽²²⁾.



Figure 41: coronal PD fat sat images show grade III MCL injury, Quoted from ⁽²²⁾.

Conclusion

Collateral ligament injuries of the knee, encompassing the medial collateral ligament (MCL) and lateral collateral ligament (LCL), are common in knee trauma. Accurate grading of these injuries is essential for management and prognosis. MRI is the gold standard for soft tissue assessment, with ultrasound serving as an adjunct in certain cases ⁽²⁾.

The medial collateral ligament (MCL) and lateral collateral ligament (LCL) provide primary medial and lateral stability to the knee, respectively. Injuries vary from microscopic sprains to complete tears, categorized into three grades based on ligament disruption and associated findings. Precise imaging evaluation guides treatment planning ⁽²⁾.

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