Knee joint

MSK Imaging

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INDICATIONS

- Knee joint complaint
  - Pain
  - Swelling
  - Trauma
  - Osteoarthritis

- Suspected pathology [previous Examination]
  - Inflammation
  - Tumors
Examination Technique

- Patient preparation:
  - Fasting 4-6h
- Patient position: supine
- Procedure
  - Surface coil [one knee]
**Scanning parameters**

4mm slice thickness 1mm inter slice gap  
Field of view [FOV] = 16cm
Protocol of examination

- Axial T1 localizer
- Sagittal T1, PD, T2
- Coronal gradient echo, STIR
- If contrast is injected
  [ Axial, Sagittal, Coronal T1 WIs ]
How to know the pulse sequence?!

T1  T2  Gradient  STIR
Common MR appearances

<table>
<thead>
<tr>
<th></th>
<th>T1</th>
<th>T2</th>
<th>Structure or lesions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low</td>
<td>Low</td>
<td>Cortical bone</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Menisci (medial, lateral)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Ligaments (ACL, PCL, ...)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Calcification</td>
<td></td>
</tr>
</tbody>
</table>
# Common MR appearances

<table>
<thead>
<tr>
<th></th>
<th>T1</th>
<th>T2</th>
</tr>
</thead>
<tbody>
<tr>
<td>High</td>
<td>Low</td>
<td>Fat (subcutaneous, lipoma,...)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Bone marrow</td>
</tr>
<tr>
<td>Low</td>
<td>High</td>
<td>Fluid (effusion, cyst, ganglion)</td>
</tr>
<tr>
<td>High</td>
<td>High</td>
<td>Blood (heamoarthrosis)</td>
</tr>
</tbody>
</table>

![MRI images](image01.png) [A]  
![MRI images](image02.png) [B]
Kinematic MRI
<table>
<thead>
<tr>
<th>Items to be evaluated</th>
<th>Where?!</th>
</tr>
</thead>
<tbody>
<tr>
<td>▪ Menisci (medial &amp; lateral)</td>
<td>Sagittal PD</td>
</tr>
<tr>
<td>▪ Ligaments</td>
<td>Sagittal PD</td>
</tr>
<tr>
<td>- Cruciate (ACL, PCL)</td>
<td>Coronal</td>
</tr>
<tr>
<td>- Collateral</td>
<td>Axial</td>
</tr>
<tr>
<td>- Retinacular</td>
<td>Sagittal PD</td>
</tr>
<tr>
<td>▪ Tendons (Quadriceps, Patellar)</td>
<td>Sagittal T1 &amp; T2</td>
</tr>
<tr>
<td>▪ Bones</td>
<td>Sagittal T2</td>
</tr>
<tr>
<td>▪ Synovial effusion</td>
<td></td>
</tr>
</tbody>
</table>
Meniscus

Medial meniscus

- Banana-shaped
- Posterior horn wider, longer, taller than anterior horn
- Posterior horn tightly attached to the capsule
- Grade II degeneration more common
Lateral meniscus

- C- shape
- Posterior and anterior horns are symmetric
- Anterior horn may be hypo plastic, extremely thin
- Discoid meniscus and meniscal cysts more common
Lateral meniscus
Medial meniscus
Medial & lateral menisci
Cruciate ligaments
Patellar retinacular ligaments
Collateral Ligaments
Proton density coronal image shows the normal medial collateral ligament as a thin, taut, well-defined, low-signal structure extending from the medial femoral epicondyle to the medial tibial metaphysis.
Coronal and sagittal proton density image demonstrating the normal lateral collateral ligament in its entirety, from the femoral condyle origin to the fibular head insertion.
Meniscal Lesions
Meniscal Lesions

- Degeneration
- Tear
- Cyst
- Discoid
Normal

Type I

Type II

Simple Tear

Complex Tear
Types of Meniscal degeneration

- Grade I
- Grade II
- Meniscal fraying
Grade 1

Grade 2

Tear
Meniscal degeneration with free edge fraying
Meniscal degeneration with free edge fraying
Types of Meniscal Tears

- Simple
- Complex
- Special types
Simple Meniscal Tears

- Horizontal
- Vertical
- Radial
Horizontal tear
Horizontal tear
Horizontal tear
**Vertical tear**

Occurs typically in the outer 1/3 of the posterior horn or body of the meniscus

[rare in the anterior horn]
Radial tear

Vertical tear of the free edge of the meniscus [ Root tear ]

Ghost meniscus
Ghost meniscus

If there is no history of Meniscal surgery and the posterior horn is absent near the intercondylar notch.
Special Meniscal Tears

- Flap
- Bucket handle
- MC separation
Flap tear [Oblique]

Should have two components, horizontal and vertical.
Common in the medial meniscus.
Flap tear [Oblique]

Should have tow components, horizontal and vertical
Common in the medial meniscus
Bucket handle tear
Small sized posterior horn [ sagittal ]
Medially displaced fragment[ coronal]
Double  PCL sign [ sagittal ]
Bucket Handel tear
Bucket Handel tear, Lateral meniscus

Flipped meniscus : Double Delta Sign
Flipped meniscus : Double Delta Sign
MENISCOCAPSULAR SEPARATION
**Discoid meniscus**

Dysplastic meniscus with loss of normal semi lunar shape.
50% or more coverage of the tibial plateau.
Meniscal body segment seen in 3 or more sagittal images
Meniscal cyst

A Cyst extending from a meniscal tear

Common sites: Anterior horn LM, Posterior horn MM
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Thank you

Mamdouh Mahfouz MD
Ligamentous Lesions

- ACL
- PCL
- Collateral
- Retinacular
Anterior cruciate ligament
MRI shows the normal linear low signal intensity ACL adjacent to the lateral bony wall of the upper intercondylar notch (arrow). The normal ACL moves away from the wall and diverges into multiple fascicles on more distal images.
Partial-volume inclusion of the lateral femoral condyle causing a false appearance of an ACL tear. T1-weighted sagittal MRI shows an ill-defined pseudomass about the proximal ACL that could be taken as evidence for ACL injury.
Anterior cruciate ligament injury

Primary signs [In the ligament]
- Total discontinuity
- Abnormal signal
- Abnormal configuration
  - Abrupt angulation
  - Wavy appearance
  - Abnormal axis
Normal ACL
Non visualization of the ACL with a cloud of edema and hemorrhage
Anterior cruciate ligament injury

Secondary signs [Outside the ligament]

- Bone contusions [Pivot-shift bruises]
- Anterior translocation of the tibia
- Uncovered meniscus sign
- Avulsion fracture of the tibial insertion
- Segond fracture 70-100% with ACL tear
- PCL buckling
- PCL line sign

Hyperextension ACL tear with "kissing bone bruises."
The probability of an ACL tear is **very high** if both such bone bruises are present, only **slightly lower** if the tibial bone bruise is present in isolation, and still **slightly lower** with an isolated femoral bone bruise of this appearance.
Anterior cruciate ligament injury

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Hyperextension ACL tear with "kissing bone bruises."
Anterior tibial translocation
Anterior tibial translocation with "uncovered meniscus sign"
Segond fracture

An elliptical vertically 3x10mm bone fragment parallel to the lateral tibial cortex, about 4mm distal to the plateau. Best seen on AP or tunnel radiographic views.

75 -100% association with ACL tear
Segond fracture in patient with ACL tear. T1-weighted coronal MRI shows a small, low-signal elongated fracture fragment that is parallel to the lateral tibia. The association of Segond fractures with ACL tears approaches 100%.
+ve PCL LINE SIGN
PCL redundancy as a secondary sign of ACL tear. This is a relatively unreliable secondary sign of ACL tear.
Partial ACL tear

- Common about 10-43% of ACL tears
- Suboptimal accuracy of MRI
- Subtle 1ry and 2ry signs
- Focal angulations
- Focal increase T2 signal [non specific]
- Single bundle sign

Sagittal MRI shows an abruptly angulated mid-ACL (arrow). A wavy or sharply angulated appearance is abnormal.
T1-weighted sagittal MRI shows a normal-appearing ACL.

T1-weighted sagittal MRI image immediately adjacent to the previous image shows a partially disrupted ACL.
Partial ACL tear ?!
Chronic ACL Tear

- Fragmented ACL [ common finding ]
- Absent bone edema and contusions
- Empty notch sign
- ACL attached to PCL
ACL tear on axial image showing nonvisualization of the anterior cruciate ligament (ACL) in the upper intercondylar notch. A large knee effusion and a Baker cyst are noted incidentally.
Chronic ACL tear, empty notch sign. T1-weighted coronal MRI shows fat in the lateral intercondylar notch, ACL is absent. This is a frequent MRI appearance of a chronic ACL tear after resolution of acute edema and hemorrhage.
Intercondylar notch cyst

- 1% of knee MRIs
- Usually an incidental finding
- Painful if erodes the bone
- Post-traumatic chronic partial cruciate ligament tear with internal degeneration
- More common in the ACL
- Oval, rounded may be multilocular
- Rim enhancement if inflamed
- Arthroscopic drainage
ACL Degeneration

- Intra ligamentous cyst
- May be mistaken for a tear
- Arthroscopic decompression
TORN ACL
Torn ACL at femoral attachment
Supportive signs of ACL tear
Torn ACL at femoral attachment
Intraligamentous ganglion cyst
Torn ACL with supportive signs
High signals in the ACL and PCL
The major stabilizer of the knee
- Uniform low signal, no striations
- Twice strong as the ACL
- The menisco-femoral ligaments are intimately related to the PCL. They connect the posterior horn of the lateral meniscus to the medial femoral condyle.

Ligament of Humphrey anterior to PCL
Ligament of Wrisberg posterior to PCL
Proton-dense sagittal image demonstrates the normal tibial insertion of the PCL. The insertion site is a vertically inclined posterior to the articular surface.
Posterior cruciate ligament

- PCL injuries represent about 12% of knee injuries
- Combined PCL injuries represent 97%
  - With ACL 65%
  - With MCL 50%
  - With MM 30%

**TYPES OF PCL INJURES**

- Complete tear 40%
- Partial tear 55%
- Avulsion tear 7%
MR FINDINGS

- Increased signal due to hemorrhage and edema
- Diffuse enlargement of PCL
An enlarged, intermediate signal (obviously torn) PCL
**AVULSION TEAR**

- Involves the tibial insertion
- Retracted bone fragment
- Bone marrow edema at avulsion site
- The actual PCL may be normal
AVULSION PCL TEAR
PARTIAL PCL TEAR
PD sagittal image shows partial tear of the midsubstance of the PCL. The normal ligament of Humphrey (small arrow) is visualized better because it is adjacent to the high signal intensity edema of the torn PCL.
Collateral ligaments

- MCL is about 8-11 cm
- LCL is about 5-7 cm
- Isolated injuries are rare, usually with ACL and MM
Collateral ligaments

**GRADING SYSTEM**

- Grade I: microscopic tear
- Grade II: partial tear
- Grade III: complete tear

Grade I, II and isolated grade III are treated conservatively, while grade III tears associated with ACL tears are treated by repairing ACL only.
Proton density coronal image shows the normal medial collateral ligament as a thin, taut, well-defined, low-signal structure extending from the medial femoral epicondyle to the medial tibial metaphysis.
Coronal and sagittal proton density image demonstrating the normal lateral collateral ligament in its entirety, from the femoral condyle origin to the fibular head insertion.
Grade I medial collateral ligament tear with surrounding edema (straight arrows) on a T2WI. Note the normal thickness and signal of the medial collateral ligament and continued close apposition to the femoral and tibial cortices.
Grade II medial collateral ligament tear seen on a coronal proton density image shows slight thickening of the medial collateral ligament and separation from the underlying cortices. Bone marrow edema of the lateral tibial plateau is seen due to valgus stress 7 months after conservative treatment.
Grade II medial collateral ligament tear seen on a coronal T1 and STIR images showing slight thickening of the medial collateral ligament and separation from the underlying cortices.
Grade III medial collateral ligament tear on a coronal fast spin-echo T2-weighted image demonstrates a disrupted ligament that is thickened and retracted with surrounding edema (black arrow).
Acute grade III tear with a folded ligament (arrow) and surrounding edema on a coronal proton density image.
Acute tear of the proximal portion of the lateral collateral ligament is seen on this coronal proton density image (white arrow). Note the associated grade II medial collateral ligament tear.
Grade III MCL tear with retraction
Grade III MCL tear with abnormal signal and edema
Normal MCL
سبحانك اللهم و بحمدمك نشهد ان لا اله الا انت نستغفرك و نتوب اليك

Thank you

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