



How to approach a Knee MRI

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HOME OF SIDNEY KIMMEL MEDICAL COLLEGE

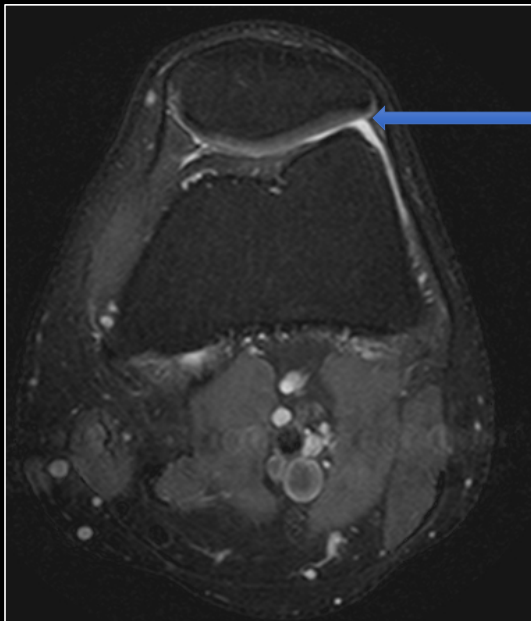
Routine Knee MRI Protocol

Seq.	FOV	Matrix/Nox	Slice	TR	TE	ETL	BW
Sag PD FSE NonFatSat	14-16	512 x 256 2	4/0.5	3000	15-20	8	16
Sag T2 FSE FatSat	14-16	256 x 256 2	4/0.5	2000	70-80	8	16
Cor T1 SE NonFatSat	16-18	256 x 192 1	3/0.5	400-800	Minimal		16
Cor T2 FSE FatSat	16-18	256 x 256 2	3/0.5	>2000	70-80	8	16
Axial T2 FSE FatSat	14-16	256 x 256 2	3/0.5	>2000	70-80	8	16

Step by step approach

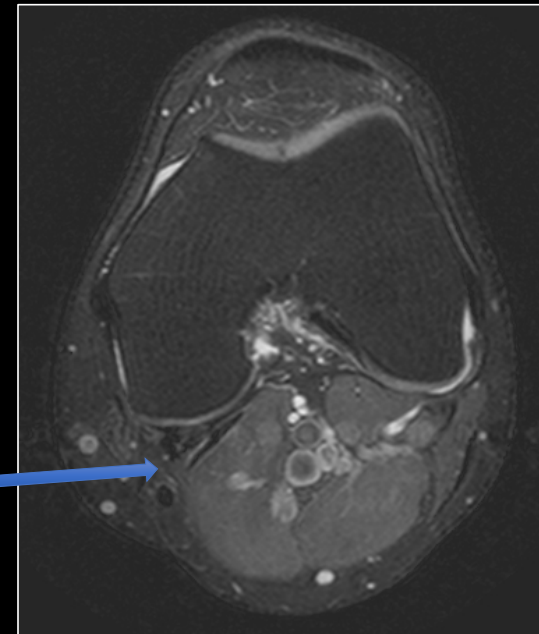
1. Evaluate for Fluid:

- *Axial T2 fat saturated* sequences
- Joint effusion: present or absent
- Baker's cyst: present or absent



Normal joint fluid.
No joint effusion.

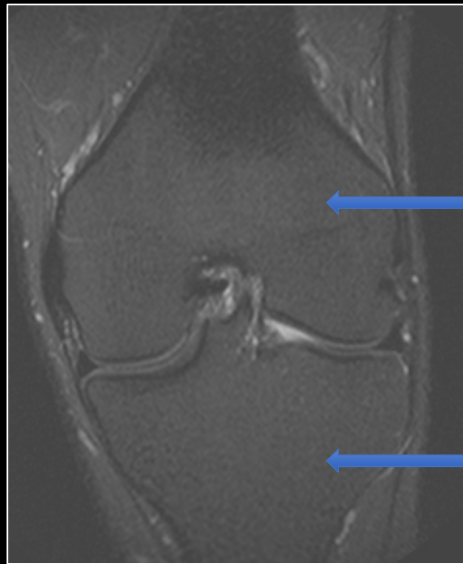
No Baker's cyst.
No fluid located between the
medial head gastrocnemius and
semimembranosus.



Step by step approach

2. Evaluate for Osseous Contusions or Fractures:

- Check *T2 fat saturated* sequences and confirm fractures on *Coronal T1 non-fat saturated* sequences



Normal marrow signal on coronal fluid sensitive imaging of the knee.

Step by step approach

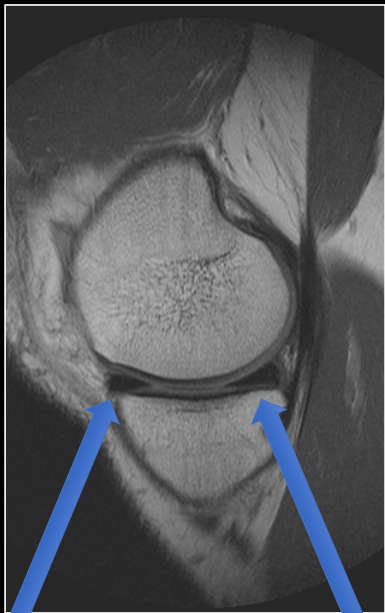
3. Evaluate the Medial Compartment:

- On the *Sagittal Proton Density (PD)* sequence: Check for the medial meniscus (MM) → tear present or absent
- Make sure to follow the posterior horn all the way to the posterior root attachment
- Check for abnormal meniscal morphology or displaced fragments

Medial Compartment



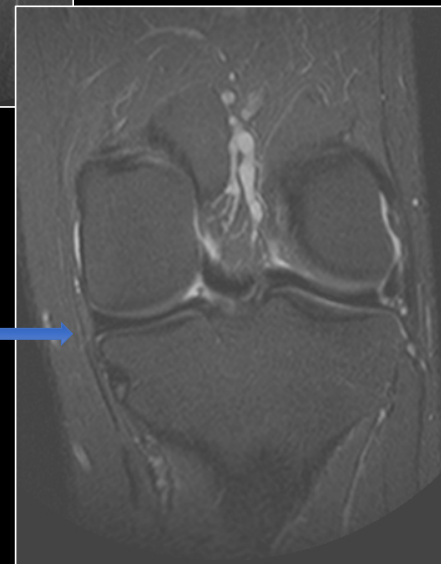
Normal appearance of the medial meniscus on sagittal proton density imaging



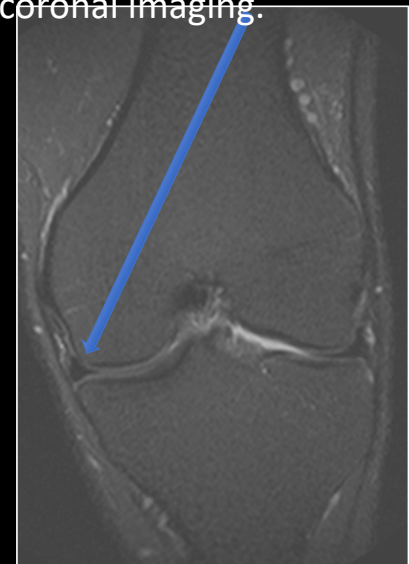
Normal appearance of the medial meniscus posterior horn and root on coronal imaging.



Normal insertion of the posterior root of the medial meniscus.



Normal appearance of the medial meniscus body and hyaline cartilage on coronal imaging.



Step by step approach

3. Medial Compartment (continued):

- On the *Coronal T2 fat saturated* sequence: MM → evaluate the meniscal body (not well seen on sagittal sequences)
- Look for secondary signs of meniscal tears: linear subchondral marrow edema, parameniscal cysts, parameniscal soft tissue edema, adjacent periligamentous edema, adjacent chondrosis
- Check the medial compartment hyaline cartilage for partial thickness and full thickness defects on the *Coronal and Sagittal T2 fat saturated sequences*

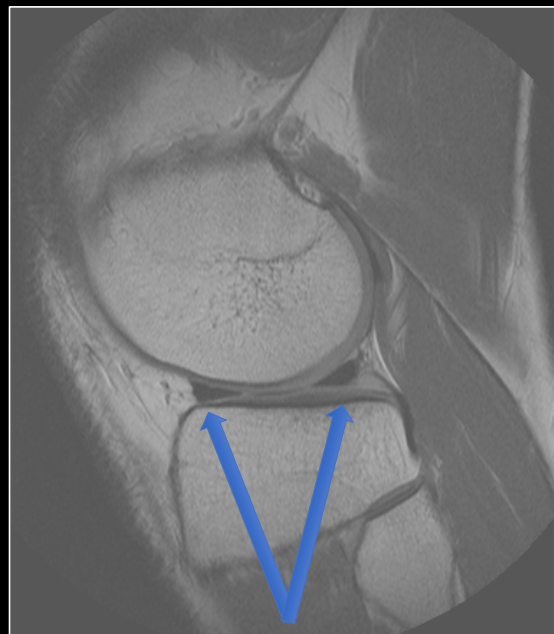
Step by step approach

4. Evaluate the Lateral Compartment:

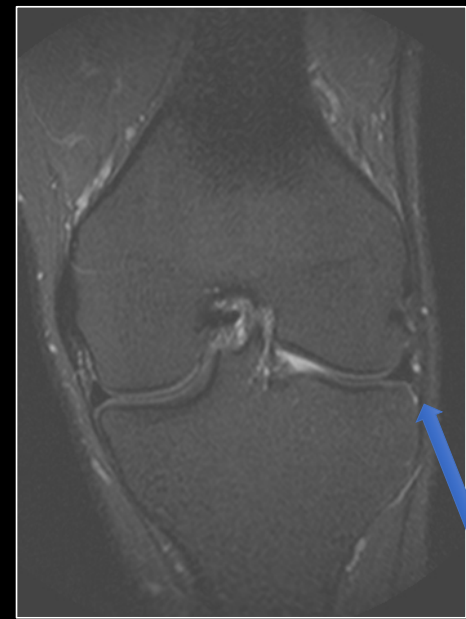
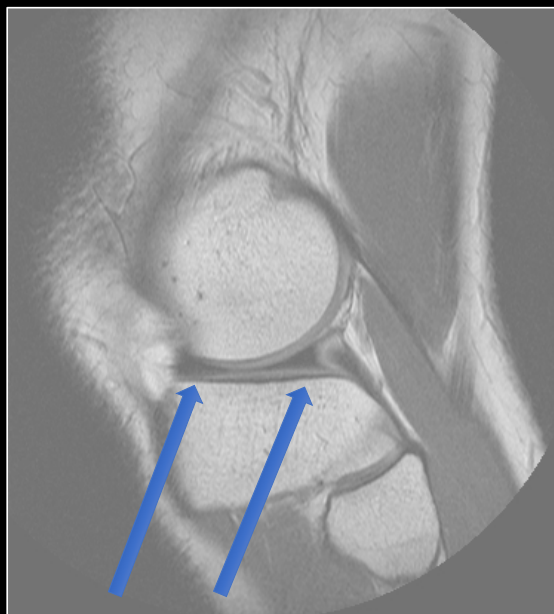
- On the *Sagittal PD* sequence: Check for the lateral meniscus (LM)
→ tear present or absent; remember the anterior root of the lateral meniscus blends with the fibers of the ACL (speckled appearance at the anterior root is normal)
- On the *Coronal T2 fat saturated* sequence: LM → evaluate the meniscal body
- Look for secondary signs of meniscal tear: linear subchondral marrow edema, parameniscal cysts, parameniscal soft tissue edema, adjacent periligamentous edema, adjacent chondrosis

Lateral Compartment

Normal appearance of the lateral meniscus
body, posterior horn, and hyaline
cartilage on coronal imaging.



Normal appearance of the lateral meniscus
on sagittal proton density imaging.



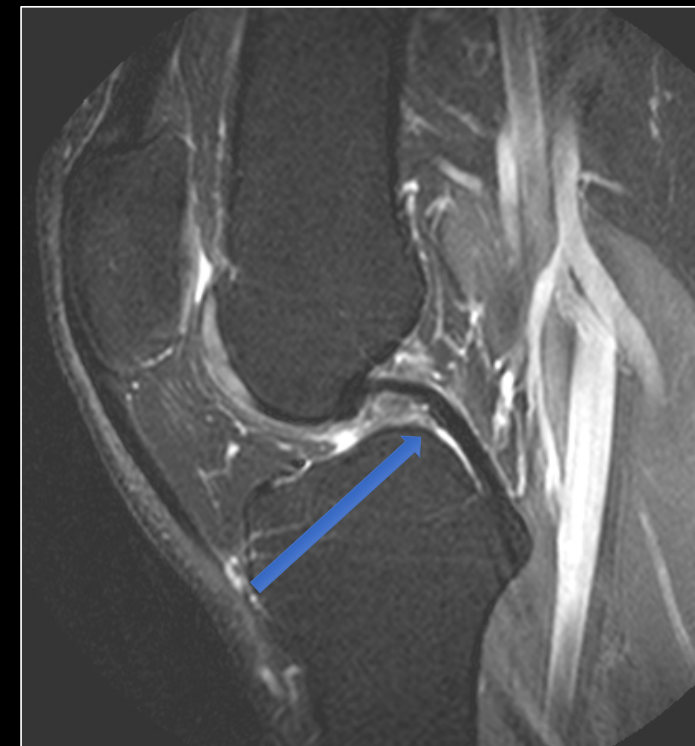
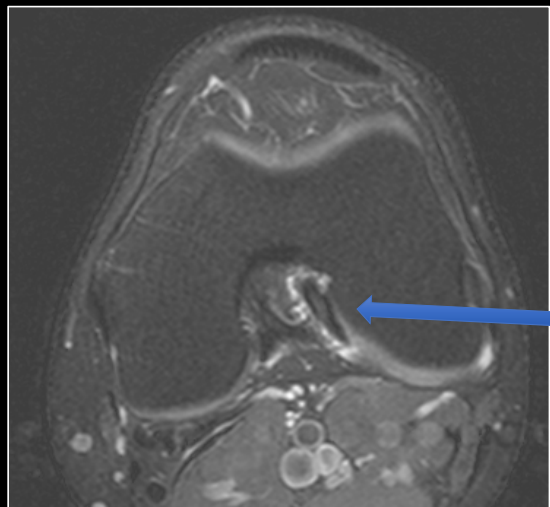
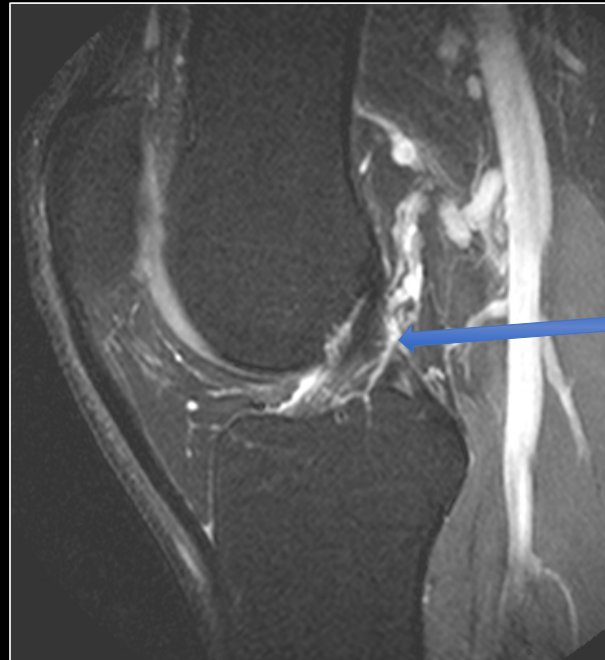
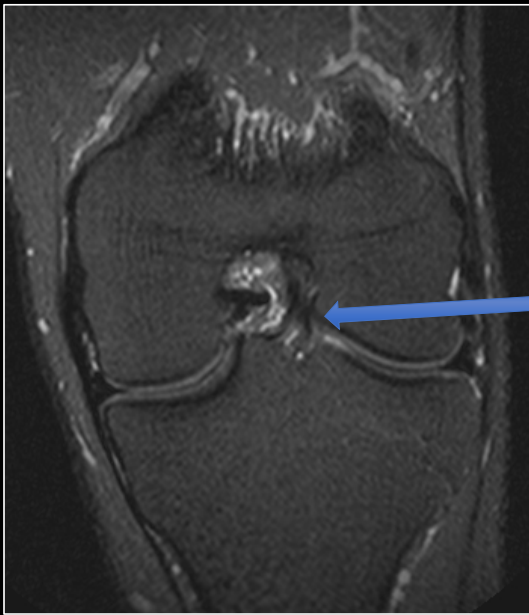
Step by step approach

4. Lateral Compartment (continued):
 - Check the lateral compartment hyaline cartilage for partial thickness and full thickness defects on the *Coronal and sagittal T2 fat saturated* sequences

5. Anterior and Posterior Cruciate Ligaments (ACL + PCL):
 - On the *Axial T2 fat saturated* and *Coronal T2 fat saturated* sequences check for the integrity of the ACL and PCL.
 - Origin of the ACL is found at the level of the lateral patellar facet
 - Follow both ACL bundles (anteromedial and posterolateral) to the insertion at the tibial eminence (confirm the ACL integrity on the *Coronal T2 fat saturated* sequence)
 - PCL Integrity can be evaluated on several sequences, including *Axial T2 fat saturated*, *Coronal T2 fat saturated*, or *Sagittal T2 fat saturated* sequences.

Anterior and Posterior Cruciate Ligaments

Normal appearance of the ACL on coronal, axial, and sagittal imaging.

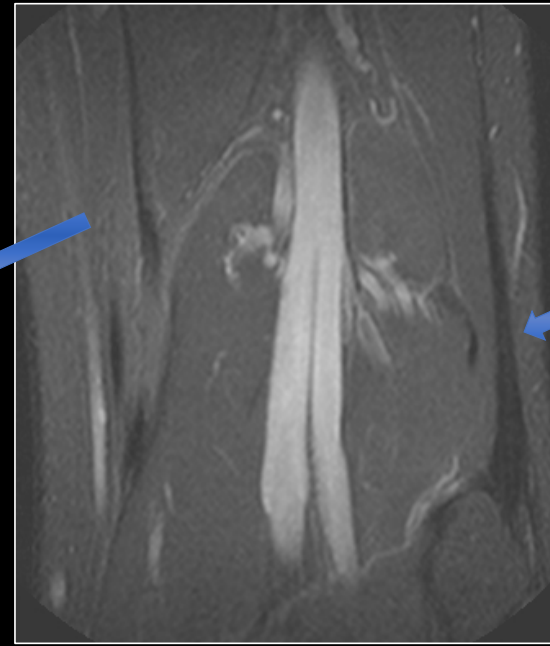
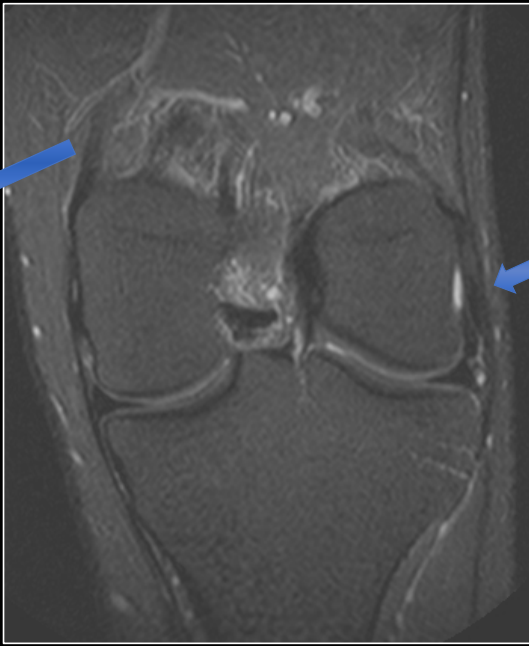
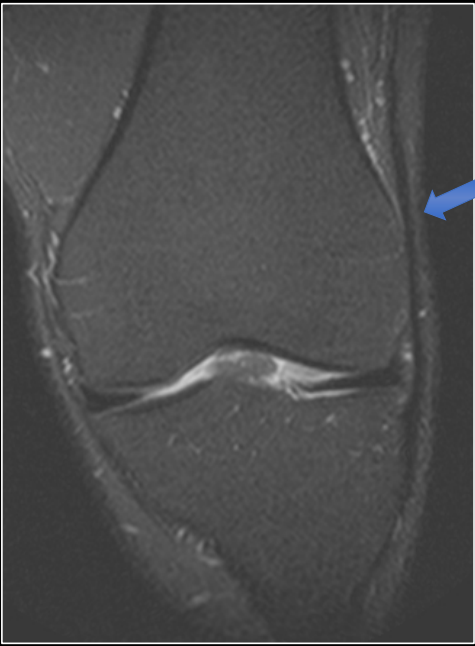


Normal appearance of the PCL on sagittal imaging.

Step by step approach

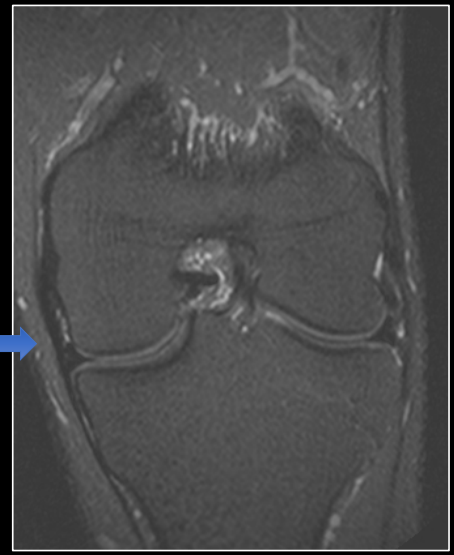
6. Medial Collateral Ligament (MCL) and Lateral Collateral Ligament (LCL) Complex:

- Follow the MCL on the *Coronal and Axial T2 fat saturated* sequences
→ evaluate both the superficial and deep components
- LCL complex is also evaluated on the *Coronal and Axial T2 fat saturated* sequences → evaluate the complex anterior to posterior:
 - Distal iliotibial band
 - Fibular collateral ligament
 - Popliteus tendon
 - Distal biceps femoris tendon
- Posterolateral corner: Evaluate smaller structures on all 3 imaging planes in the *T2 weighted fat saturated* sequences



LCL Complex
and MCL

Normal appearance of the lateral collateral ligament complex from anterior to posterior on coronal imaging: distal iliotibial band, fibular collateral ligament and popliteus tendon, and distal biceps femoris tendon.



Normal appearance of the
medial collateral ligament on
coronal imaging.

Step by step approach

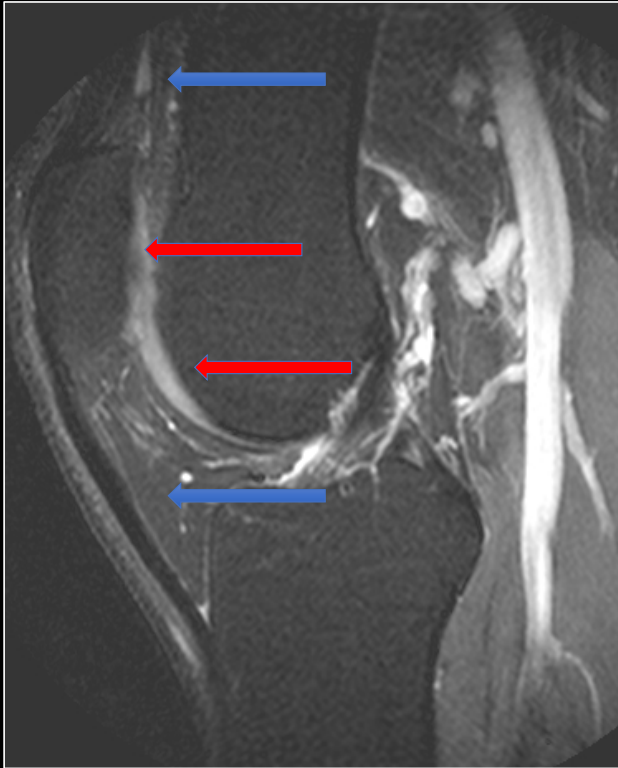
7. Extensor Mechanism:

- On the *Sagittal T2 fat saturated* sequence: Check the distal quadriceps and patellar tendon → any abnormalities can be confirmed or further characterized on the *Axial T2 fat saturated* sequence, including tendinosis or tearing

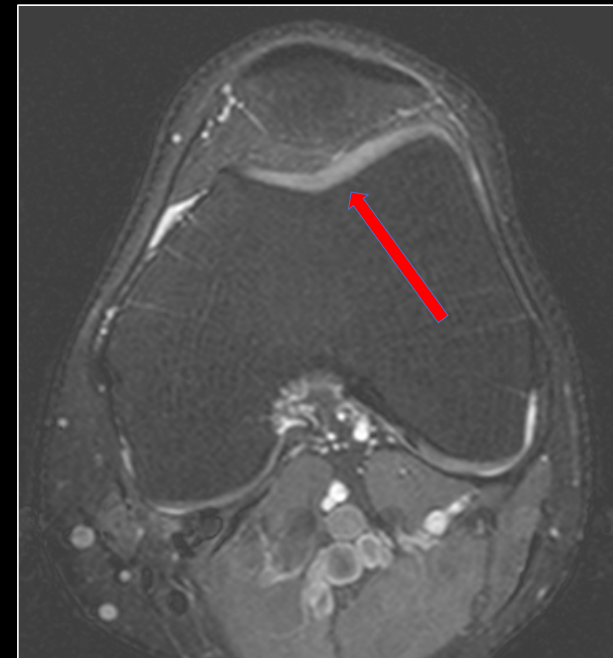
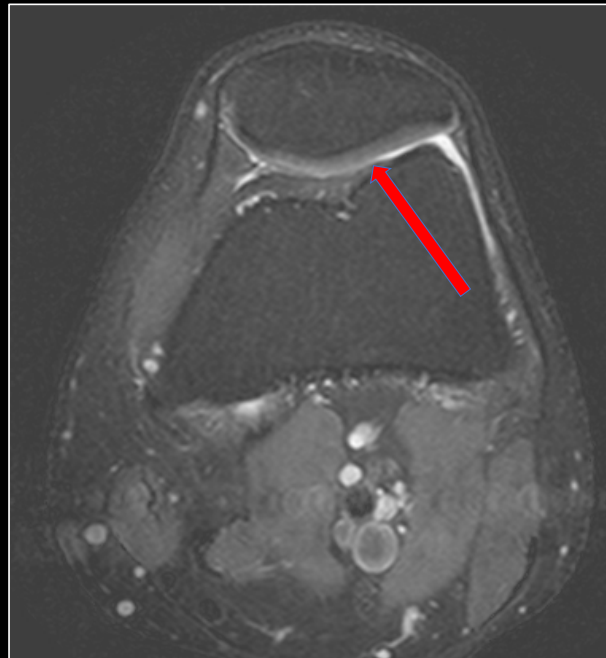
8. Patellofemoral Compartment:

- On the *Axial and Sagittal T2 fat saturated* sequence: Check the patellofemoral compartment cartilage for partial thickness or full thickness hyaline cartilage defects.
- Evaluate patellar and trochlear morphology
 - Assess for lateral patellofemoral maltracking (including an TT-TG distance, soft tissue edema in the superolateral aspect of Hoffa's fat, patella alta, etc.)

Extensor Mechanism and Patellofemoral Compartment



Normal appearance of the distal quadriceps and patellar tendons (blue arrows).
Normal appearance of the patellar and trochlear hyaline cartilage (red arrows).



Step by step approach

9. Neurovascular Structures and surrounding soft tissues:
 - Perform a final survey of the neurovascular structures and surrounding soft tissues utilizing the *Axial T2 fat saturated* sequence

10. Localizer sequences:
 - Check for masses, tumors etc. → larger field of view

Common Cases

Meniscus tear

Criteria:

1. Intrasubstance signal alteration extending to the articular surface → on two consecutive images- 90% accuracy. On a single image only- 55% accuracy for medial meniscus and 30% accuracy for the lateral meniscus
2. Abnormal Morphology
 - Important to differentiate from *myxoid degeneration* (signal alteration NOT extending to the articular surface)
 - T1/PD weighted: Highly sensitive
 - T2 weighted: Highly specific

Vertical Tear

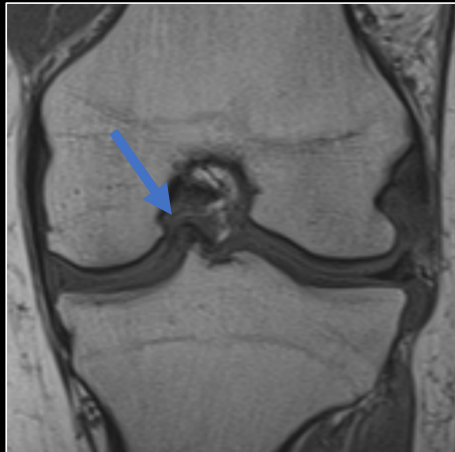
→ Peripheral vertical tear of the posterior horn of the lateral meniscus



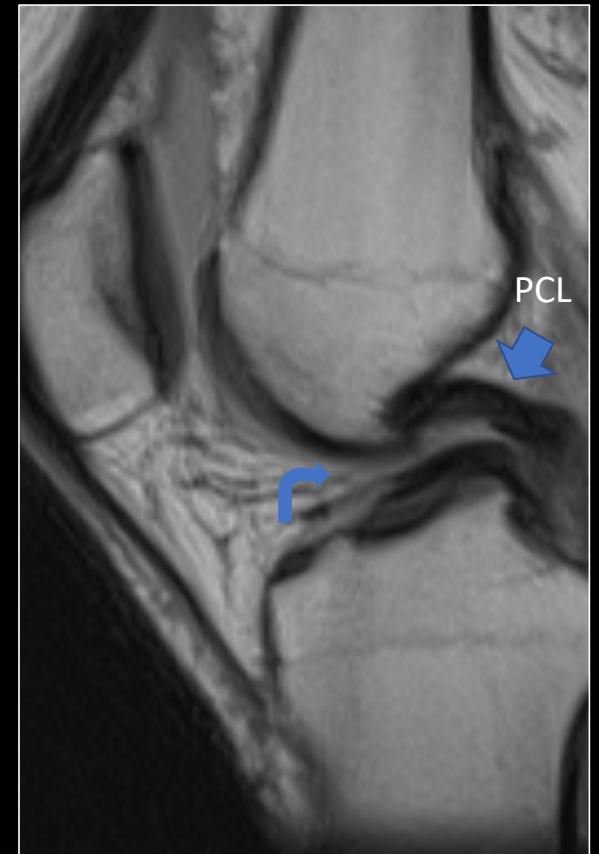
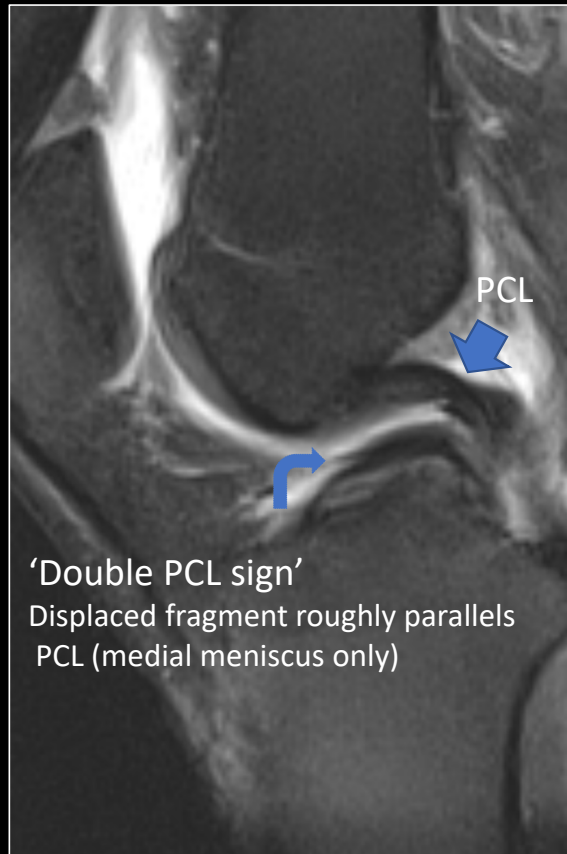
↪ Note also the Pivot shift osseous contusion pattern involving the posterior lateral tibial plateau and lateral femoral condyle (patient also had an ACL tear)



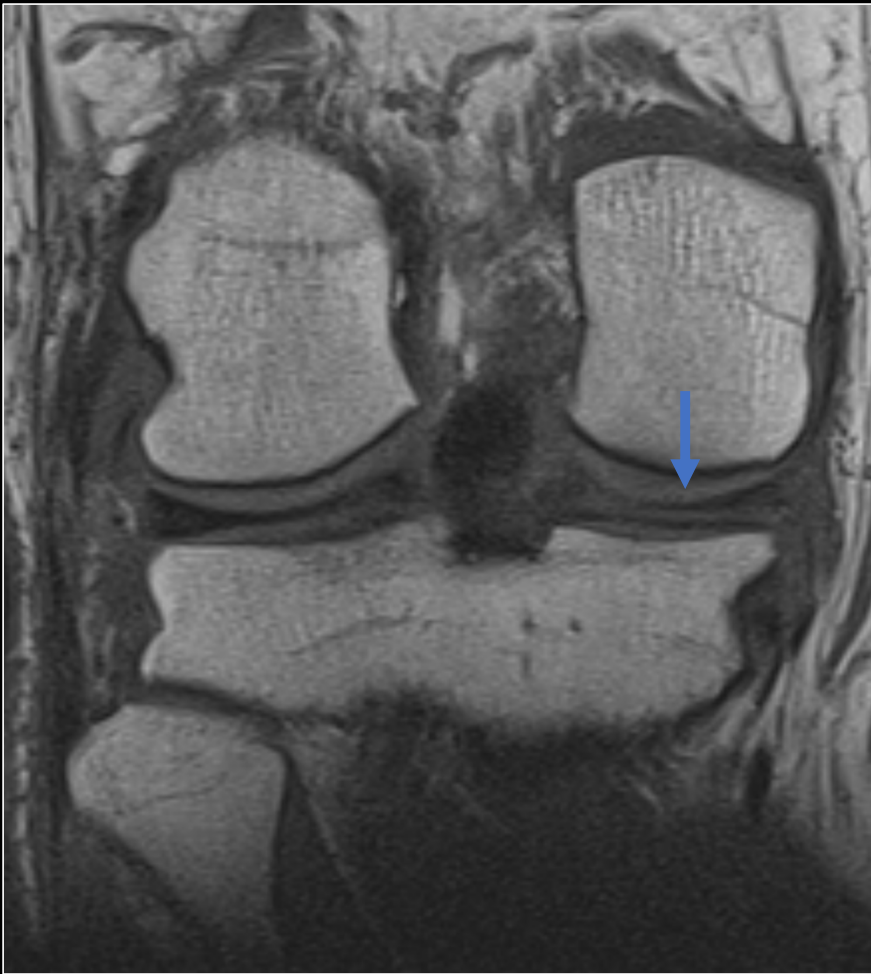
Bucket-Handle tear Medial Meniscus



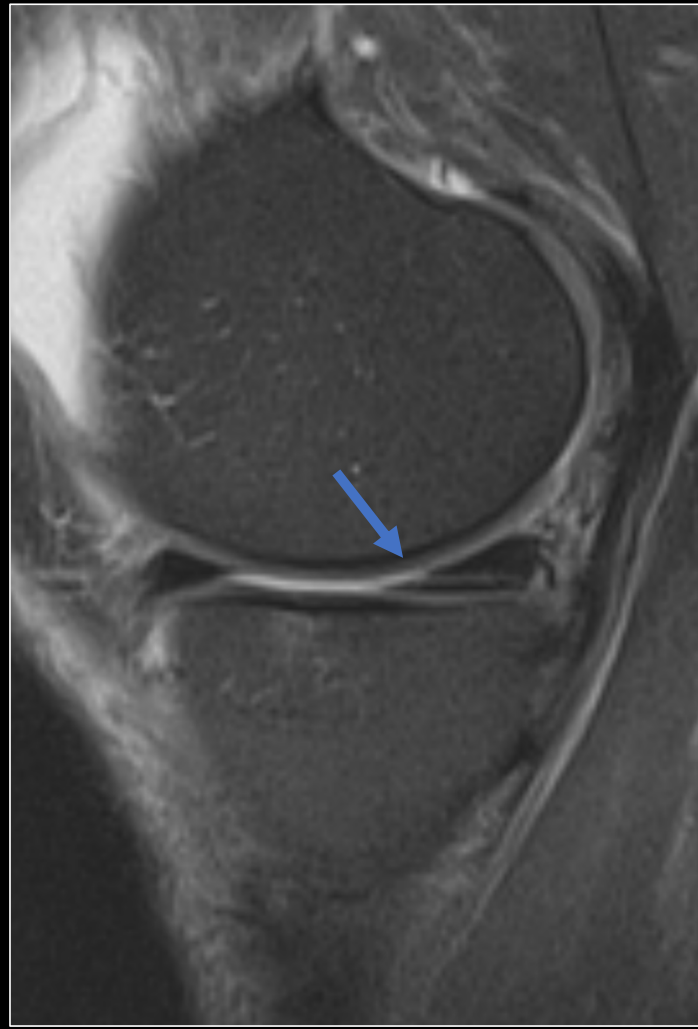
- Extensive vertical, circumferential tear with a flipped fragment into the intercondylar notch →, (most common location for displaced fragment)



Horizontal (cleavage) tear Medial Meniscus



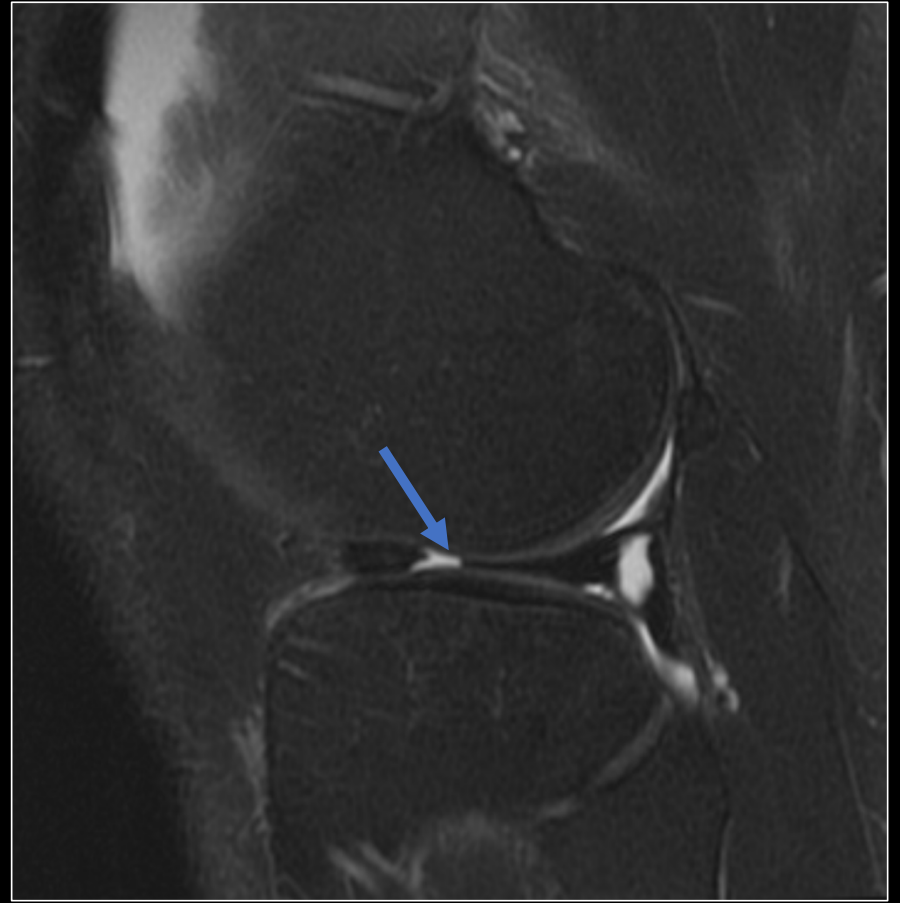
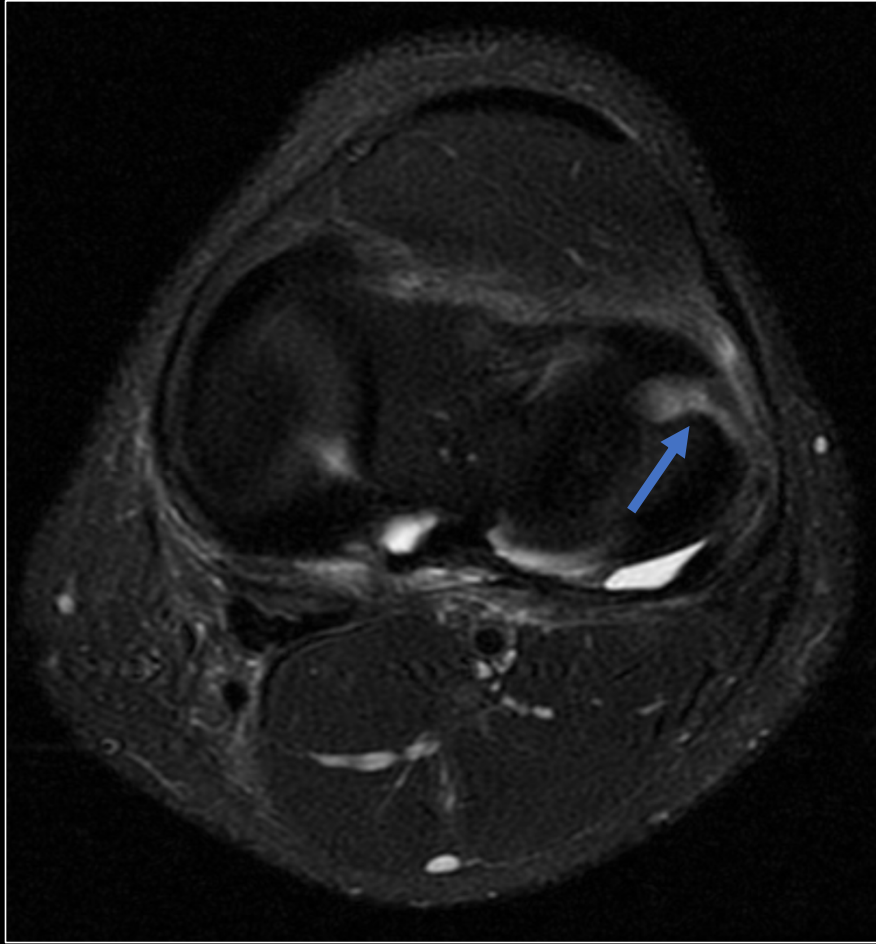
→ Horizontal cleavage tear
of the body and
posterior horn
extending into the
posterior root
of the medial meniscus



Radial tear Lateral Meniscus



Consecutive images of a coronal T2 fat saturated sequence demonstrates truncation involving the body of the lateral meniscus , indicating a radial tear



Note that the axial plane can be very helpful in assessing radial tears

Complex tear

Meniscal tear extending into more than one plane

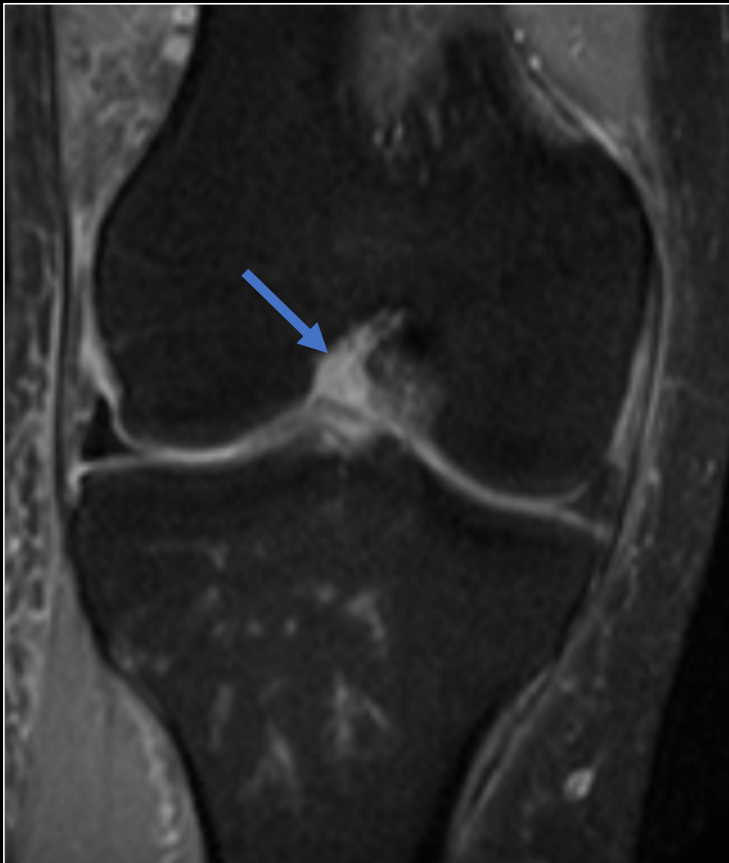
→ Complex tear of the posterior horn and body of the medial meniscus



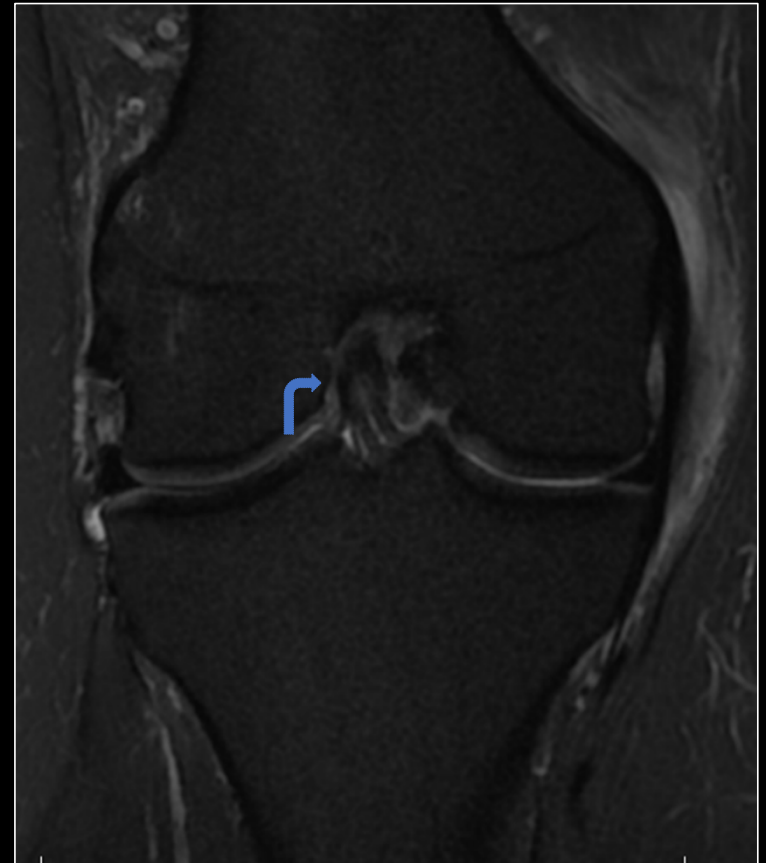
ACL tear



'Empty sulcus sign'
in a different patient with
a complete tear of the
ACL



Normal appearance of the
ACL in the coronal plane
in a patient with an
intact ACL

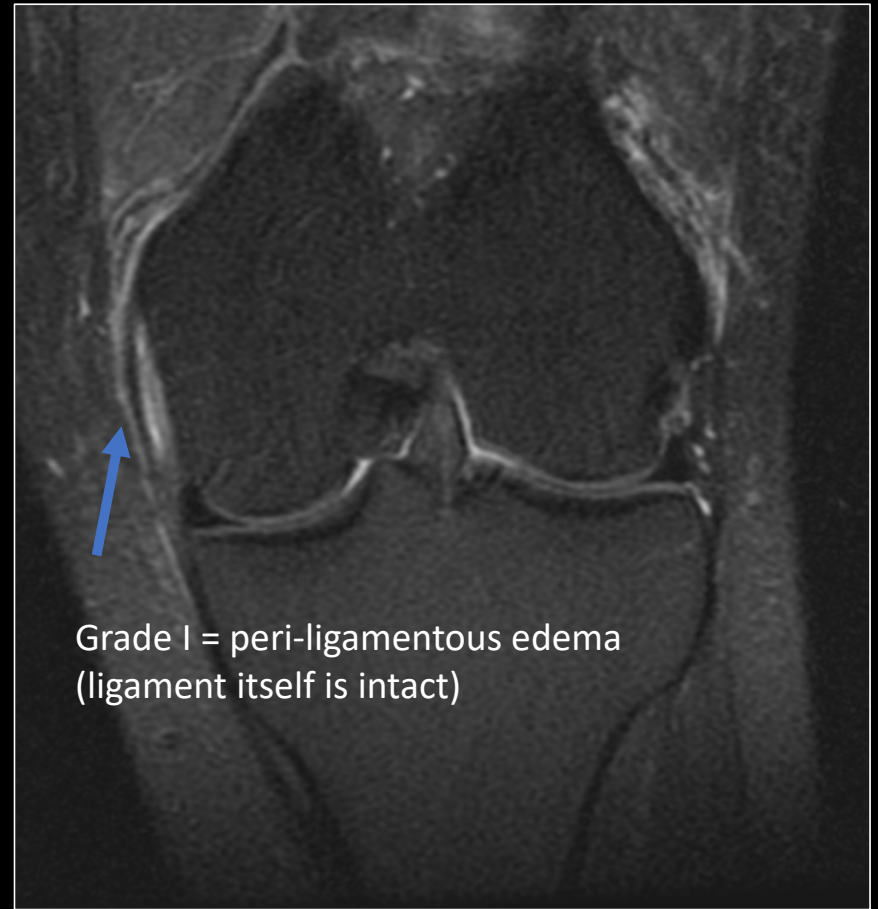


Secondary signs of ACL rupture

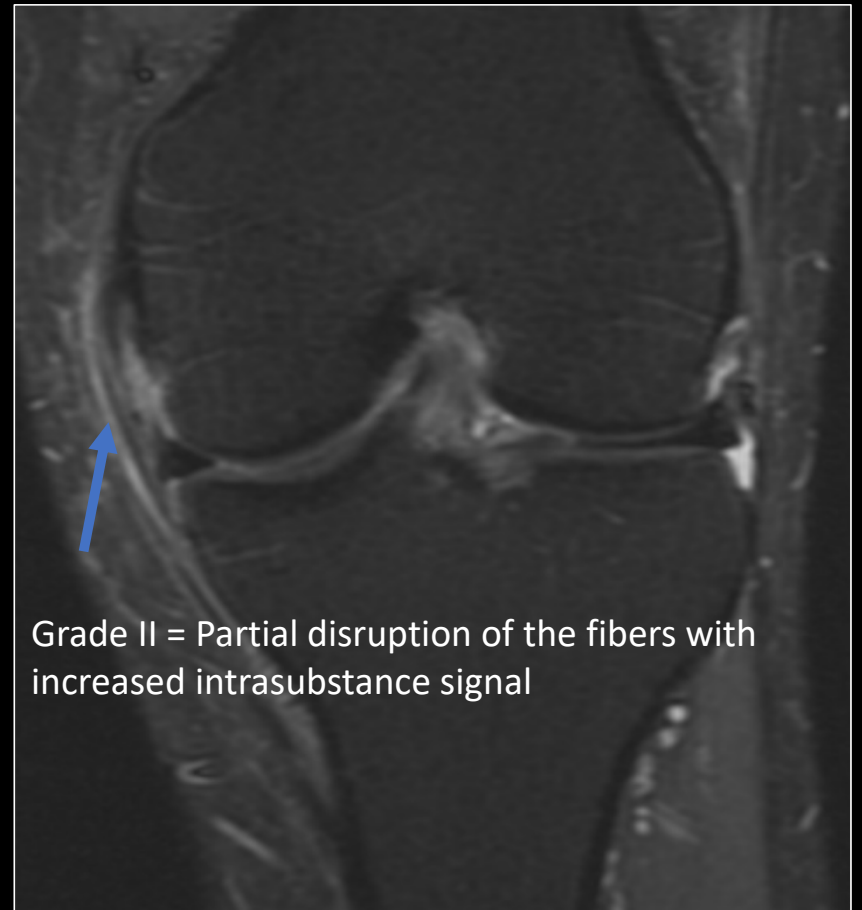
- Best: Characteristic osseous contusion pattern ('Pivot-shift' mechanism)
- Bone marrow edema in the lateral femoral condyle and posterolateral tibial plateau



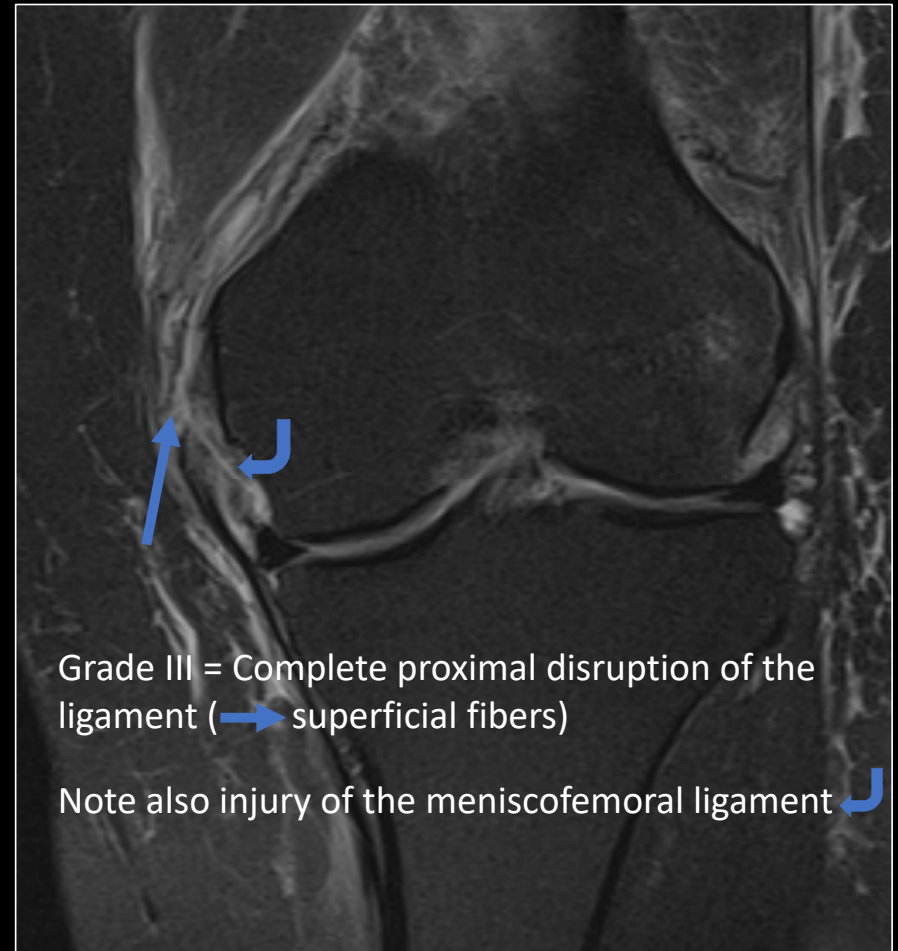
MCL Sprain: Grade I



MCL Sprain: Grade II

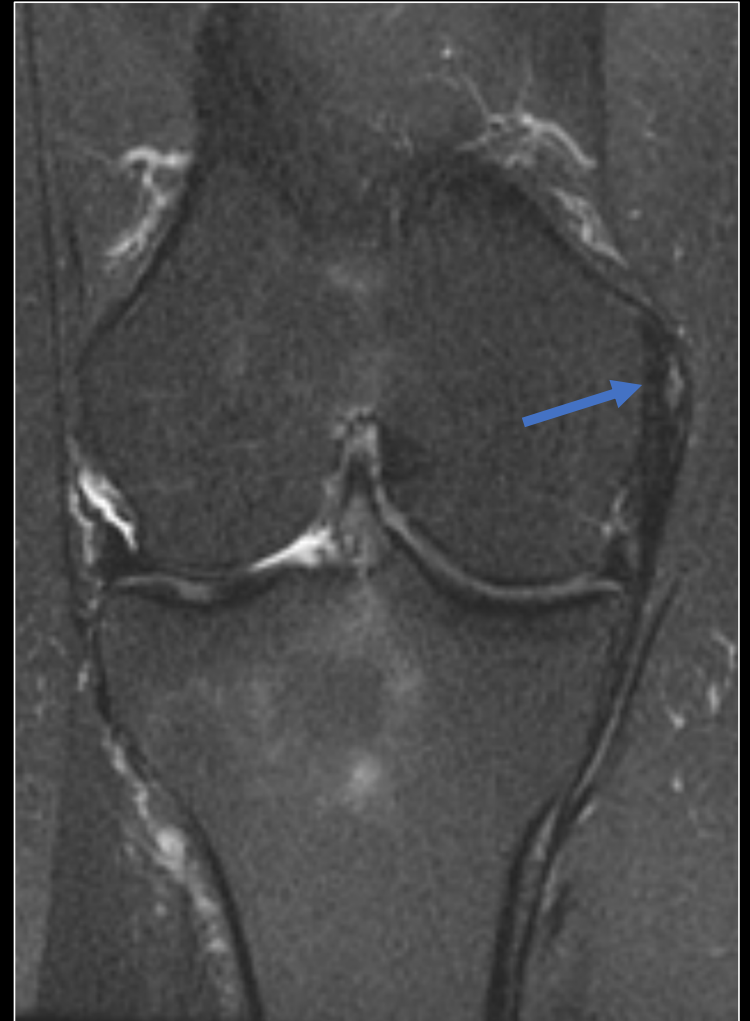


MCL Sprain: Grade III



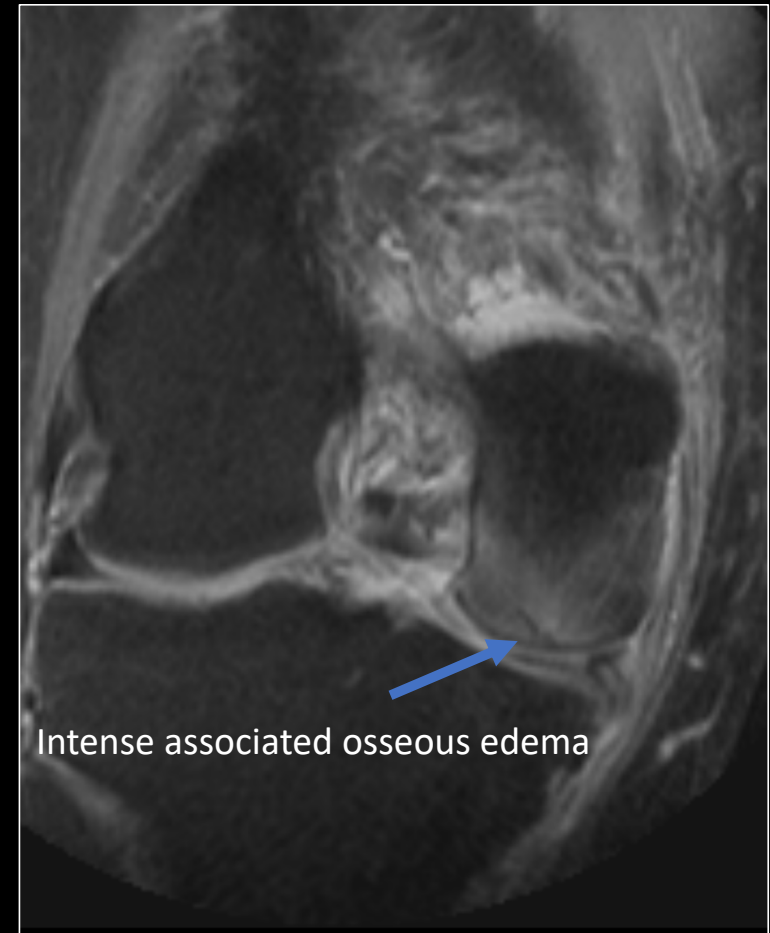
Pellegrini-Stieda lesion

- Ossification/calcification of MCL in a typical location →
- Result of remote MCL injury
- Best seen on radiographs

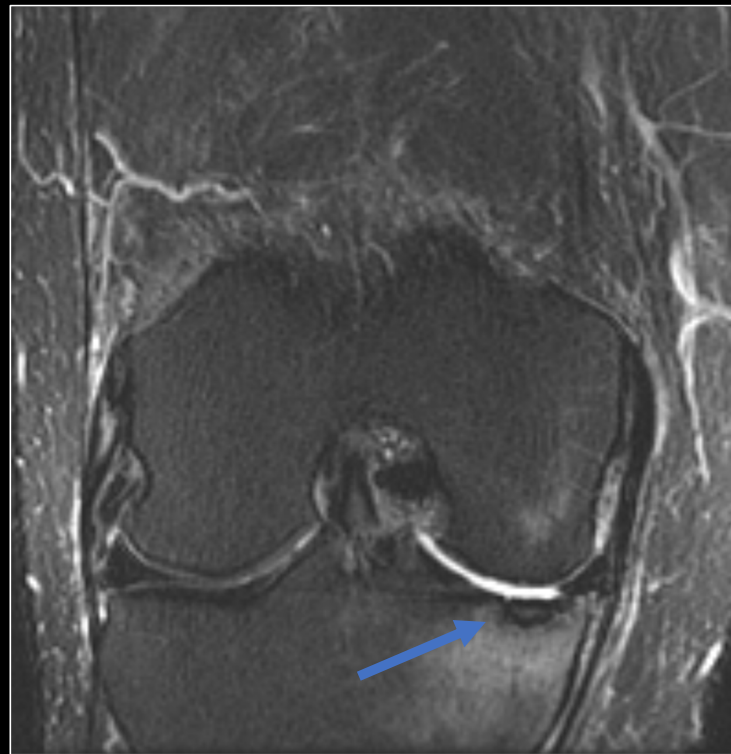


Subchondral insufficiency fracture (formerly 'SONK')

- Subchondral insufficiency fracture of the medial femoral condyle →
- In osteoporotic bone
- Weight-bearing surfaces
- Often associated with meniscal tear



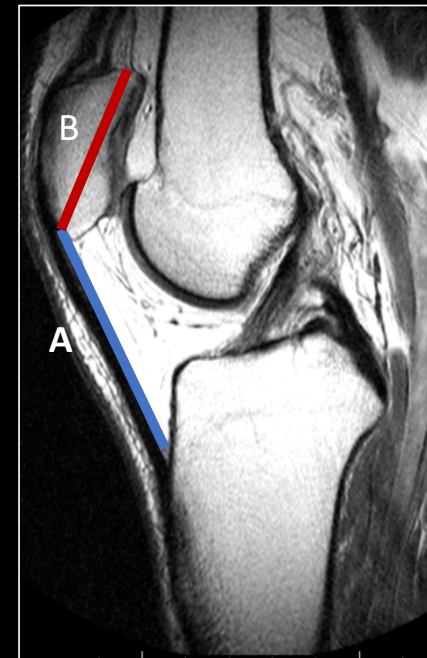
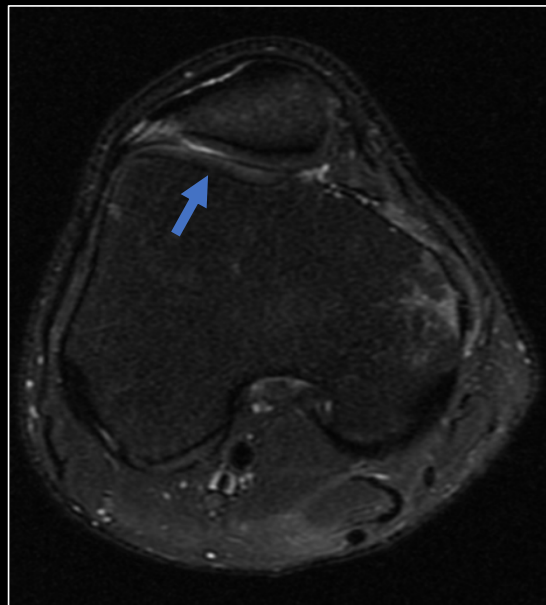
Subchondral insufficiency fracture of the medial tibial plateau



Lateral patellofemoral maltracking

- Lateral patellofemoral maltracking = patellar instability, which increases risk for recurrent patellar dislocations
- Most common risk factors: trochlear dysplasia, patella alta (high position of the patella), and lateralization of the tibial tuberosity

Patellar and trochlear dysplasia with an elongated lateral patellar facet and a shallow trochlear groove

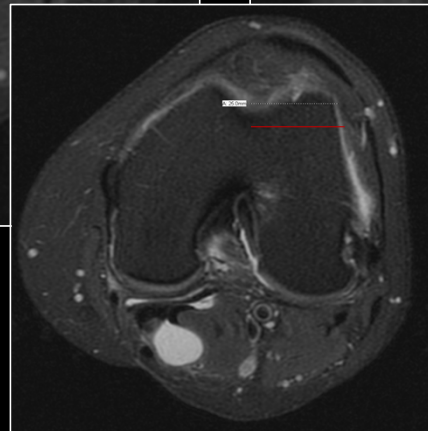
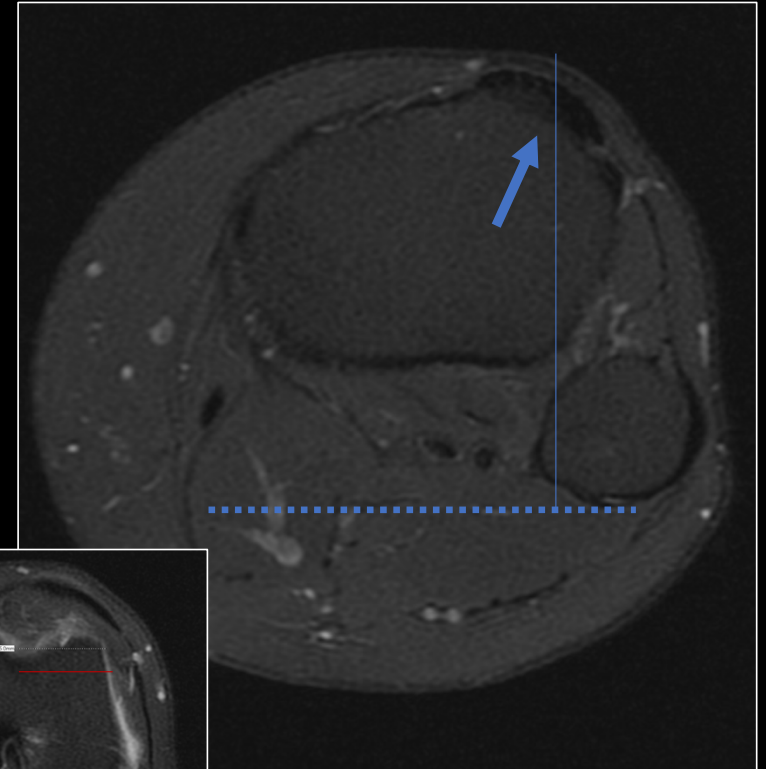
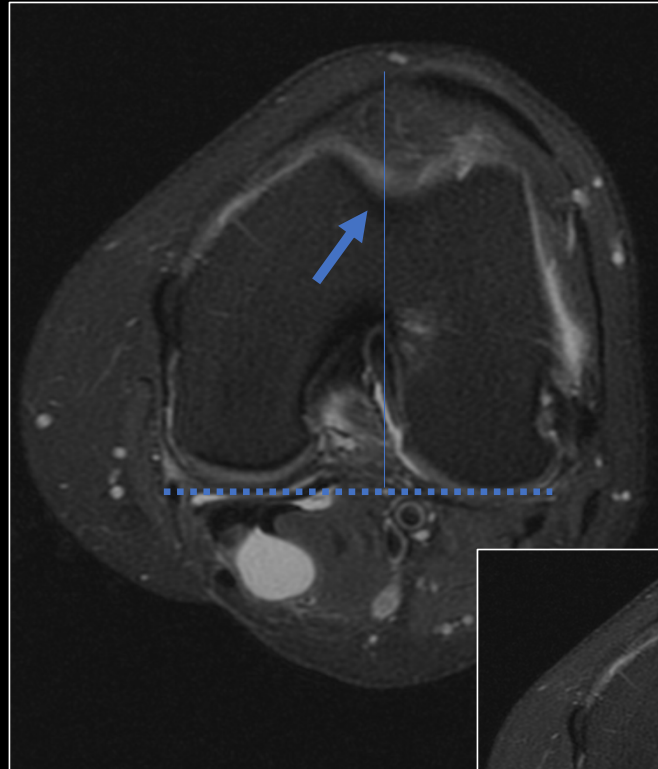


Patella alta

- $A/B =$ Insall-Salvati Index
- $> 1.3 =$ patella alta
- 1.5 in this case

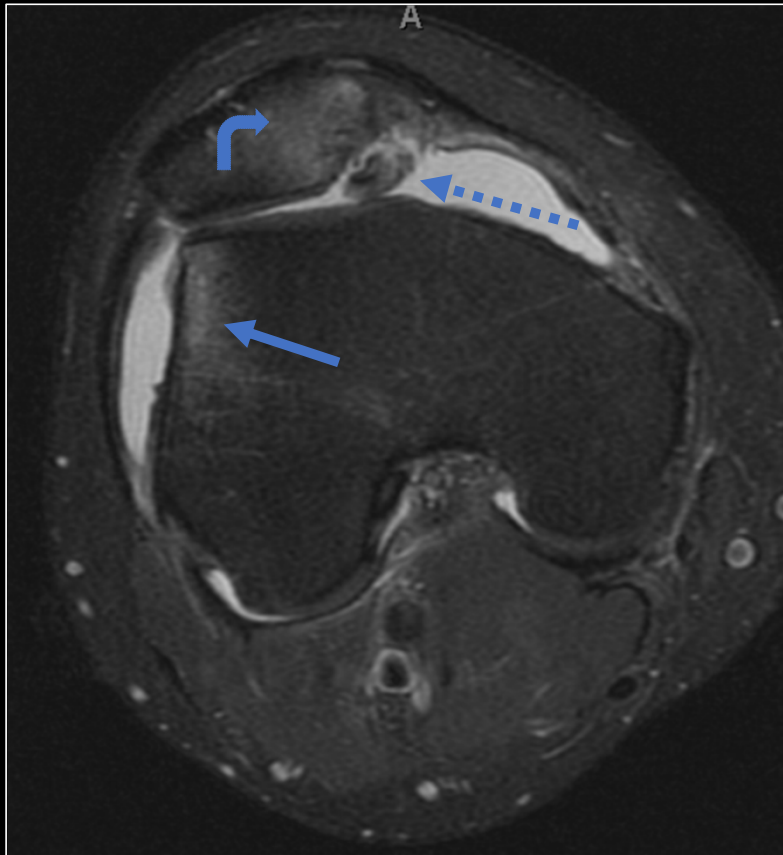
TT-TG Distance

- Distance from the middle of the tibial tuberosity (TT) and deepest point of the trochlear groove (TG)
- A line along the posterior femoral condyles is used as a reference
- < 15 mm = normal
- 15-20 mm = borderline
- > 20 mm = marked lateralization of the TT
- TT-TG in this case 25mm ———



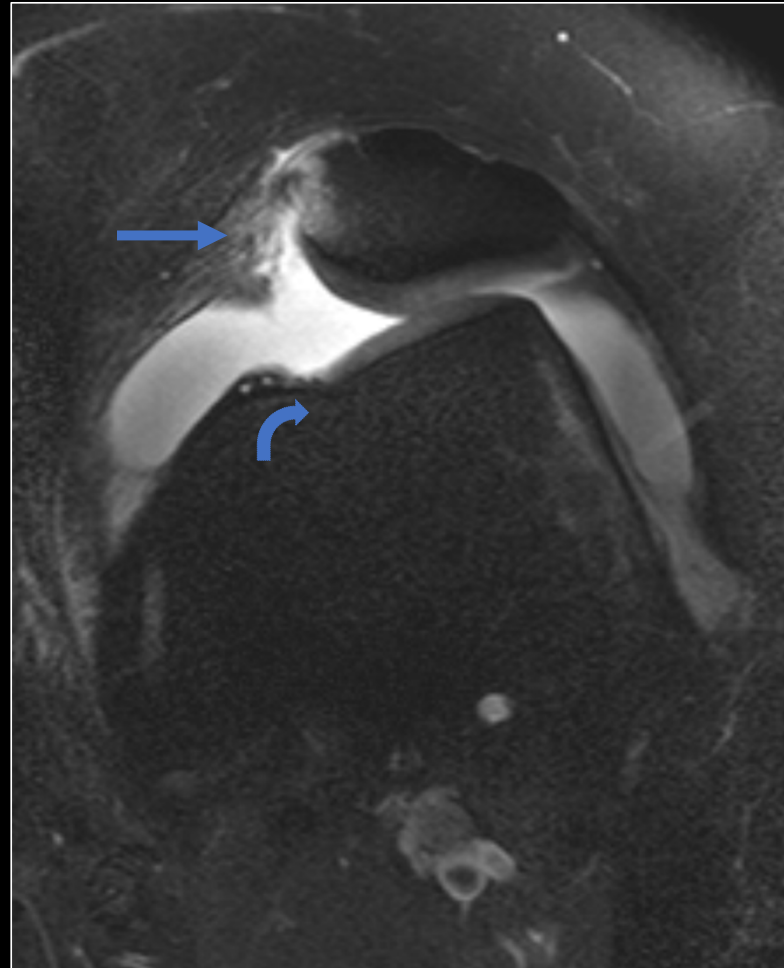
Transient patellar dislocation

- Lateral transient patellar dislocation out of the trochlear groove (usually a twisting injury)
- Findings include typical osseous contusion pattern in the lateral femoral condyle \rightarrow , and medial patellar facet \curvearrowright
- Chondral shear fracture of the medial patellar facet is a common finding \dashrightarrow

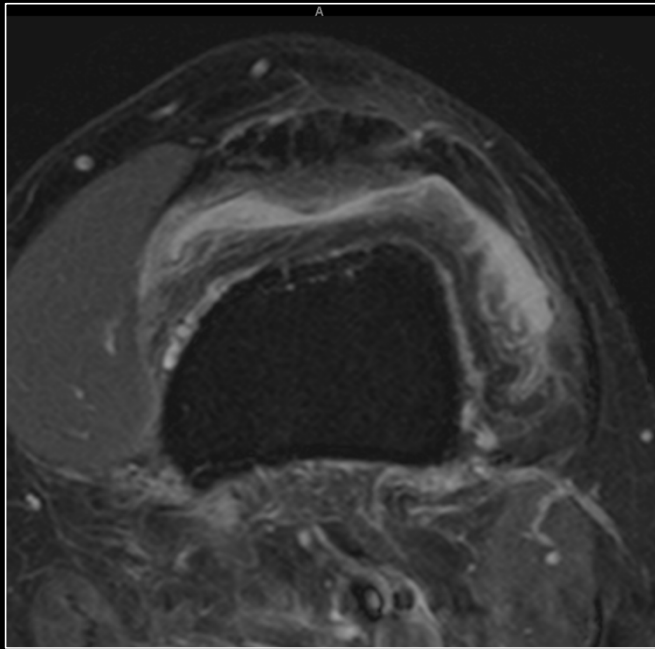


A different patient with typical findings of transient patellar dislocation

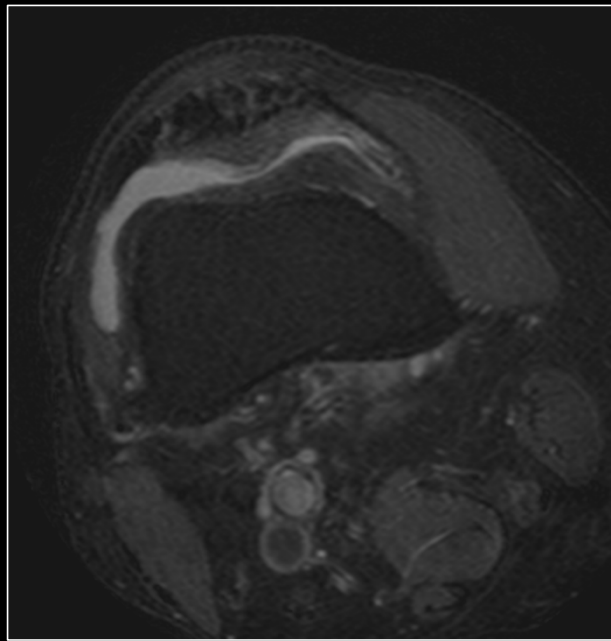
- Tear of the anterior aspect of the medial patellar retinaculum/MPFL → , another common finding
- Note also the shallow appearing trochlear groove, which can be seen with lateral patellofemoral maltracking ↷



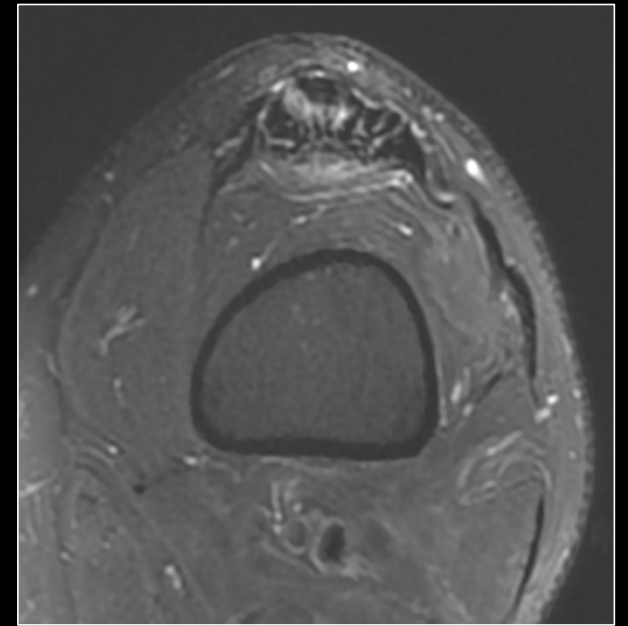
Quadriceps tendinosis



Mild



Moderate



Severe

'Jumper's Knee'

'Jumper's knee' = Proximal patellar tendinosis

- Partial tear/edema with expansion of the tendon →
- Often seen in basketball and volleyball players

