KNEE IMAGING

"Source: Handout & Lectures of Prof. Mamdouh Mahfouz"

Indications:

- History of trauma
- Pain and/ or swelling
- Deformity
- Limitation of movement

Technique of examination:

- **Patient preparation:**
  - **No preparation** required unless the patient will be injected with contrast material or will receive anesthesia then the patient is instructed to fast for 4-6 hours.
  - Contrast material is Gadolinium DTPA, dose is 0.1-0.2 mmol/ Kgm body weight.
  - **Anesthesia** → to patients who cannot remain stable the time of examination [Pediatric and uncooperative patients]

- **Procedure:** Supine position of the patient
  Surface coil [single knee is examined at a time]

  When contrast material is injected axial, sagittal and coronal T_1 WIs are obtained.

SCAN PROTOCOL	
MRI	
• ***Scout***	Axial
• Axials	T2 or Gradient
• Coronal	**STIR**
• Sagital	T1 - T2 - PD
If + Contrast	Ax. – **Sag**. – Cor T1
Slice Thickness	4 mm
FOV	16
MANDATORY	***Sagital / PD***

NB Contrast is injected whenever **inflammatory** or **neoplastic** lesions are suspected.

NB Wrong angle of ACL SCAN = wrong diagnosis of Torn ACL

Steps to select the right examination plane for ACL

- Select the **axial image** which show the **intercondylar notch**
- Draw a **line tangential** to the **posterior aspect of femoral condyles** [line A].
- Draw a line perpendicular to line A [line B]
- The examination plane **should be 10° from line B** [line C]

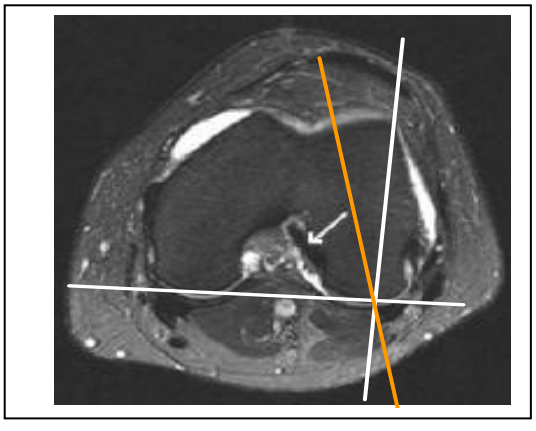
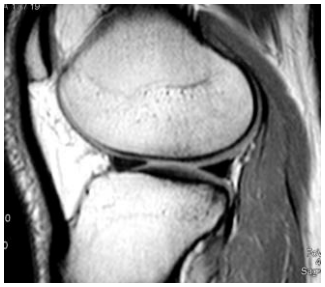
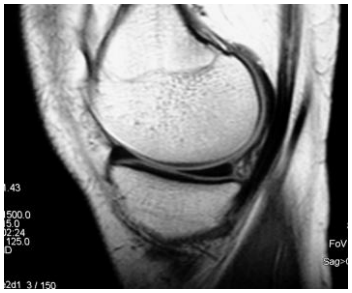


Image interpretation [Normal anatomy]

Items to assessed: Medical and lateral menisci, anterior and posterior cruciate ligaments, collateral ligaments, retinacular ligaments, bone marrow, the presence of synovial effusion or not.

▪ Menisci : → [assessed in the sagittal PD]

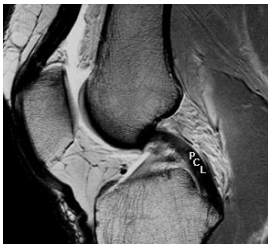




- Each meniscus has : anterior and posterior horns & body
- Homogenously black in all pulse sequences.
- Landmarks :
  - The lateral meniscus → fibula and (anterior and posterior horns is equal),
  - Medial meniscus, → posterior horn is larger than the anterior horn
- The meniscal horn is triangular with 3 surfaces,:
  - the superior surface facing the femer,
  - the inferior surface facing the tibia and
  - the menisco-capsular attachment which is the base of the triangle.

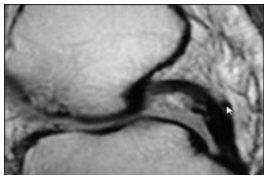
▪ Cruciate ligaments [assessed in the sagittal PD]

- **Anterior cruciate ligament [ACL] & Posterior cruciate ligament [PCL]**



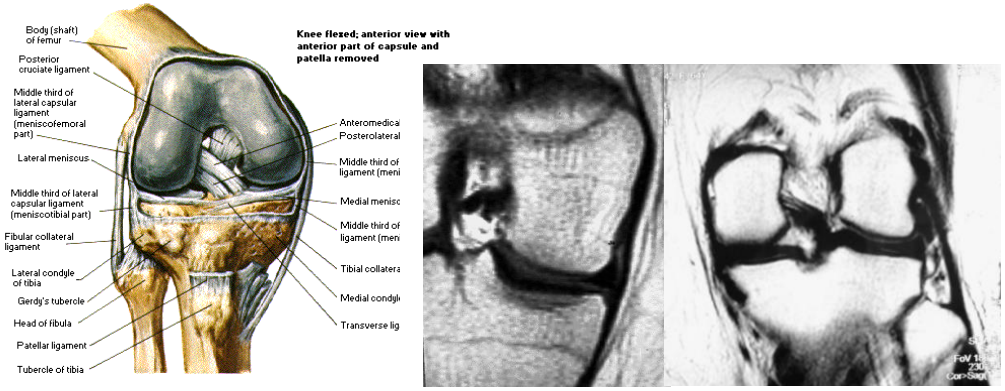
	ACL	PCL
Arise from	**posterior** aspect of the **femer**	
Insert In	**tibia / anterior** aspect of	**femer / posterior** aspect
Apperance	low signal in all pulse sequences	low signal in all pulse sequences
Exceptions	**High signal lines** within the ligament **=in T_1** (normal **intraligamentous fat**) **=in T_2** WIs (synovial recesses within the ligament, normal variant)	no exceptions
Coronal	**vertical band** in the lateral aspect of **intercondylar notch**	**Horizontal part** of the ligament is seen in the intercondylar notch attached to the medial femoral condyle.

NB. Small Ligaments , **Humphery** at Ant aspect & **Wrisperg** at Post aspect **of PCL**



NB. Small Ligaments, **Humphery** at Ant aspect & **Wrisperg** at Post aspect **of PCL**

▪ Collateral ligaments [assessed in the coronal images]



- The medial collateral ligament is intimately related to the medial femoral and tibial condyles "8 : 11 cm"
- The lateral collateral ligament attaches to the fibular head " 5 : 7 cm"
- Both ligaments are normally **of low signal** in all pulse sequences
- Both ligaments are **not usually seen** in the same image

▪ Retinacular ligaments [assessed in the axial images]

- The patella has two articular surfaces with the femoral condyles
- The **Lateral surface** is **Longe**r than the medial surface
- The medial retinacular is attached to the patella by two fasicles
- Both retinaculae are normally of low signal in all pulse sequences.

- **Bone marrow [assessed in all images]**

Normally the bone marrow is bright in T_1 and less bright in T_2 with dark signal in gradient images and very dark signal in STIR images which represent the normal signal of marrow fat.

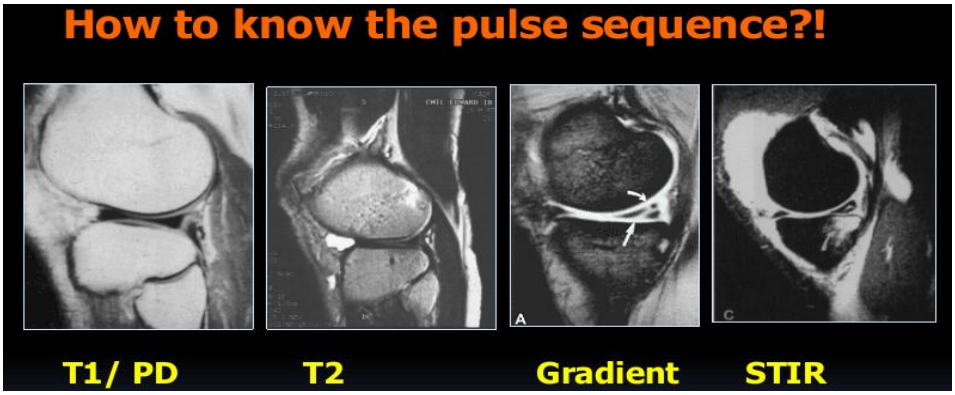
NB **STIR images** are the best for evaluation of bone marrow lesions such as edema, contusion, infection, neoplasms,…

- **Synovial effusion**

Normally the knee joint contains **minimal amount** of synovial fluid which appears black in T_1 WIs and bright in T_2 WIs

NB Assessment for synovial effusion is usually done in T_2 WIs

[Conventional T_2, T_2* , gradient and STIR images]



MRI FINDING

Items to be evaluated	Where?!
▪Menisci (medial & lateral)	Sagittal PD
▪ Ligaments	
- Cruciate (ACL, PCL)	Sagittal PD
- Collateral	Coronal
- Retinacular	Axial
▪ Tendons (Quadriceps,Pattelar)	Sagittal PD
▪ Bones	Sagittal T1& T2
▪ Synovial effusion	Sagittal T2

Meniscal Lesions

- Tear
- Degeneration
- Extrusion
- Contusion
- Cyst
- Discoid

- **Degeneration** :

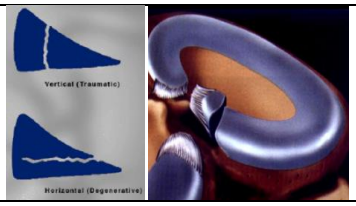
Abnormal intermediate signal NOT REACHING articular surface.

Reporting of Degeneration :
an abnormal **intermediate** signal seen at …… horn of……. Meniscus , Not reaching articular surface, not reaching menisco -capsular sueface , representing minor degenrative
 Impression : Essential Normal scan

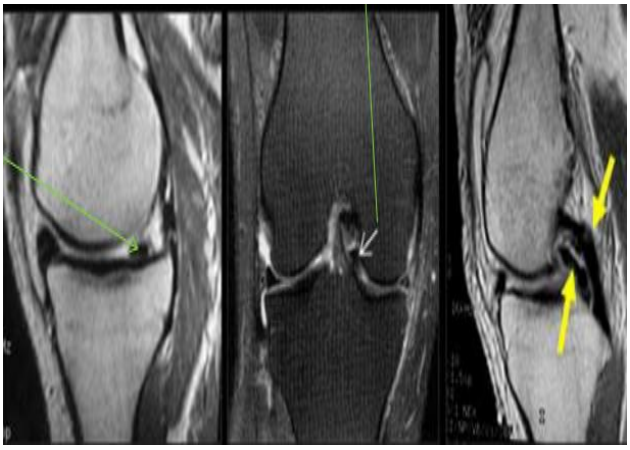
- **TEAR** :

Abnormal intermediate signal NOT REACHING articular surface.

- Types : - Simple - Complex - Special type

Meniscal Tear	Subtypes	
Simple	• Horizontal "degenerative" • Vertical "traumatic" • Radial "Root" " vertical tear of free edge of meniscus →*Ghost*	
Complex	• **F**lab "oblique" →**F**ish Mouth • Bucket Handle • Menisco-capsular separation "only medial, only traumatic"	
Special type		

Reporting : Linear band of , intermediate signal is seen traversing ….horn of ….meniscus disrupting menisco-capsular attachment as well as lower surface …… Impression : Horizontal Tear of



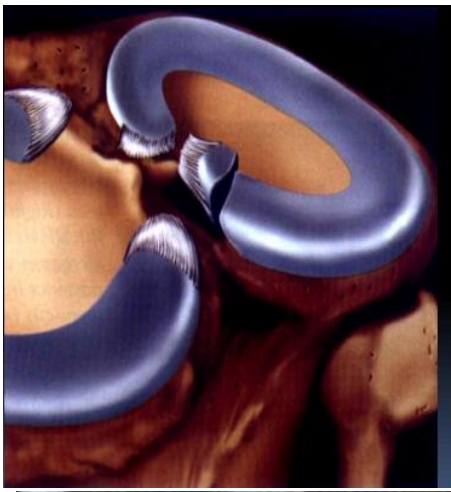
Bucket Handle Tear → 3signs

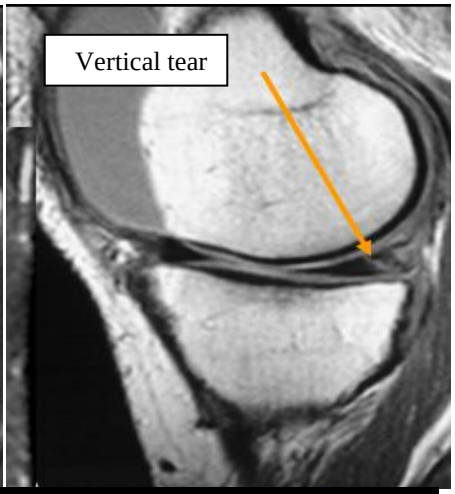
-**PHMLM** smaller than AHMM "Main sign "

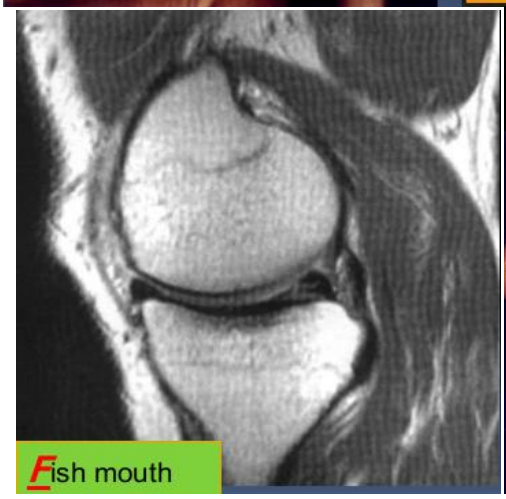
-Torn Fragment seen below PCL in coronal

"Medialy displaced "

-Double PCL sign in Sagittal



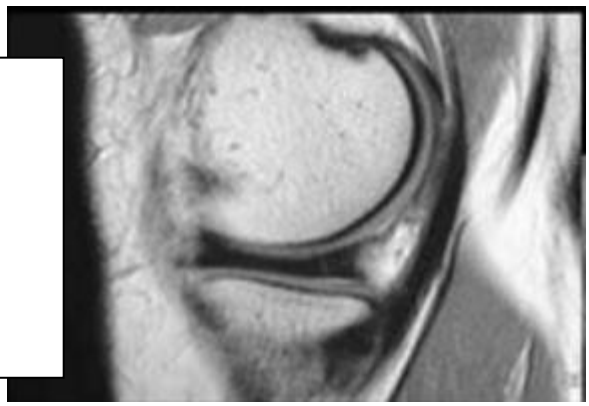




MC Separation

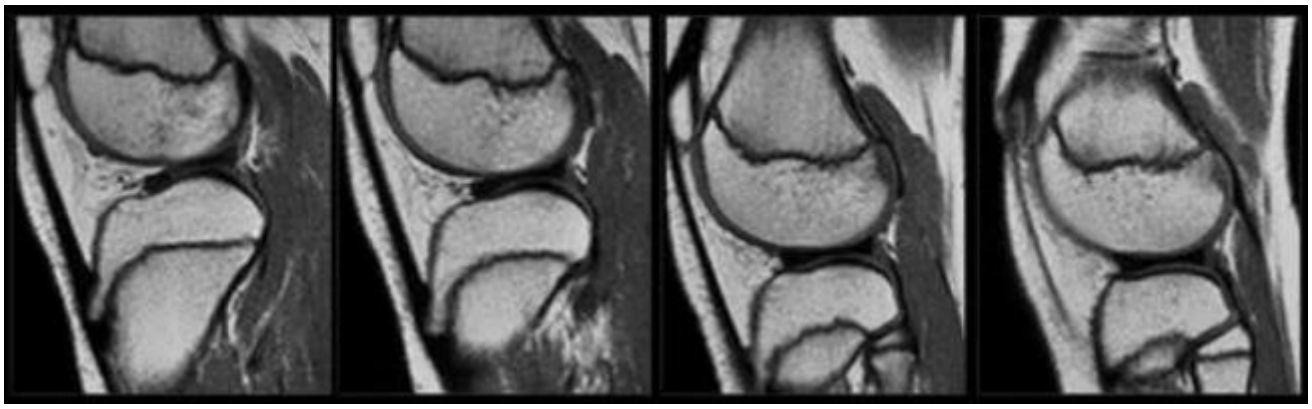
- Only **Medial**
- Only Traumatic

As Lateral meniscus is already Loss



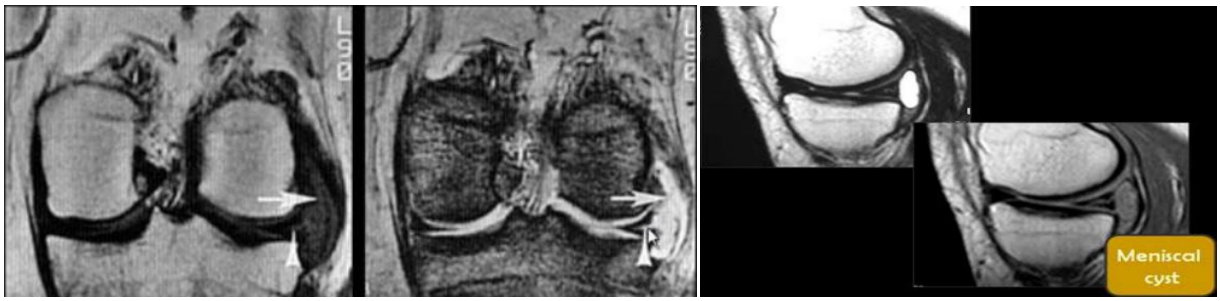
- **DISCOID** (*Meniscal body segment seen in 3 or more sagittal images*)

- **Congenital lesion**
- **Dysplastic meniscus** → loss of normal semi lunar shape
- Most common in **lateral meniscus**
- **More susceptible to Degen & Tear.**

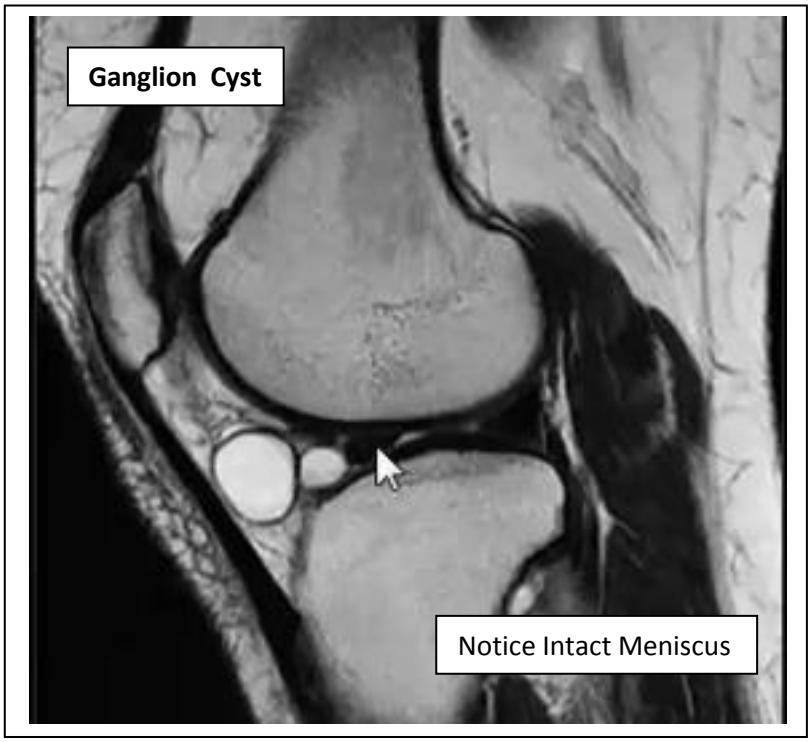


⇨ **MENISCAL CYST "Parameniscal Cyst"**

- Cyst at base of Meniscus , extending from **<u>tear</u>**
- Common in : AHLM & PHMM



➔ If Cyst Adjacent to **intact meniscus** = **Ganglion Cyst**



DONOT FORGET

- Behind **p**osterior horn of Lateral Meniscus PHLM, a tendon = "**po**pliteus tendon"- →wrongly diagnosed as Tear or Cyst

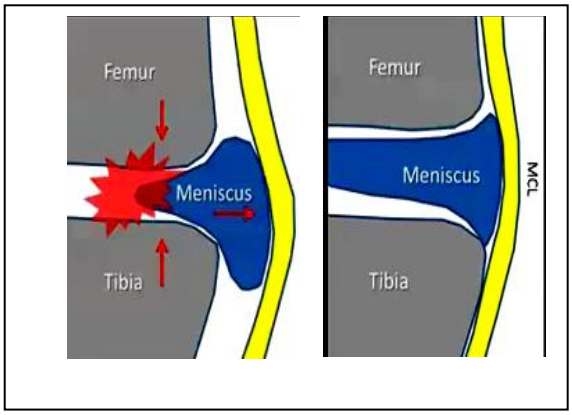
***** D.D. of Parameniscal Cyst :**

- **Ganglion cyst** "intact Meniscus"
- **Bursitis**
- **Cystic Mass** "Hematoma – Hemangioma – Rarly cystic neoplasm"
- **Tendon Popliteus** sheath filled with fluid.

MENISCAL EXTRUSION

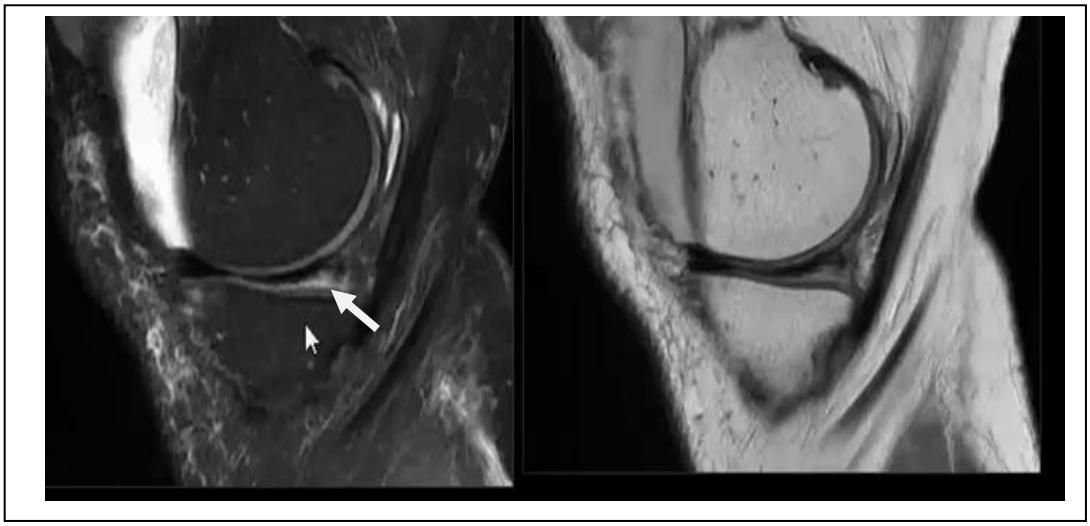
- Occurs in Medial Meniscus
- Main cause osteoarthritis →decrease joint space → Extrusion
- Measured in **Coronal** in mm , from :
  - medial Tibial aspect "without osteophytes
  - To periphery of extruded Meniscus

⇨ > 7 mm = sever extrusion



⇨ MENISCAL Contusion

- Trauma → Irregular surface * Occurs in Medial Meniscus
- Was diagnosed as an artifact



Meniscal Ossicle

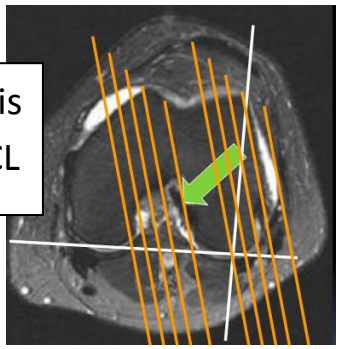
- Small bone fragment with in meniscus
- Contains Bone marrow → same signal of bone marrow in different sequences. So, best seen in T1 / Not visualized in STIR

LIGAMENTOS

Lesions

ACL

- Good Angle of scan is mandatory to see ACL



- When ACL is Not seen in Sagittal scan → Look at Coronal , if seen "at lateral aspect of intrecondylar notch" = wrong angle scan.

- Partial volume of lateral condyle → False appearance of ACL tear
- Notice preserved stretched fibers

Signs of Anterior cruciate ligament injury:

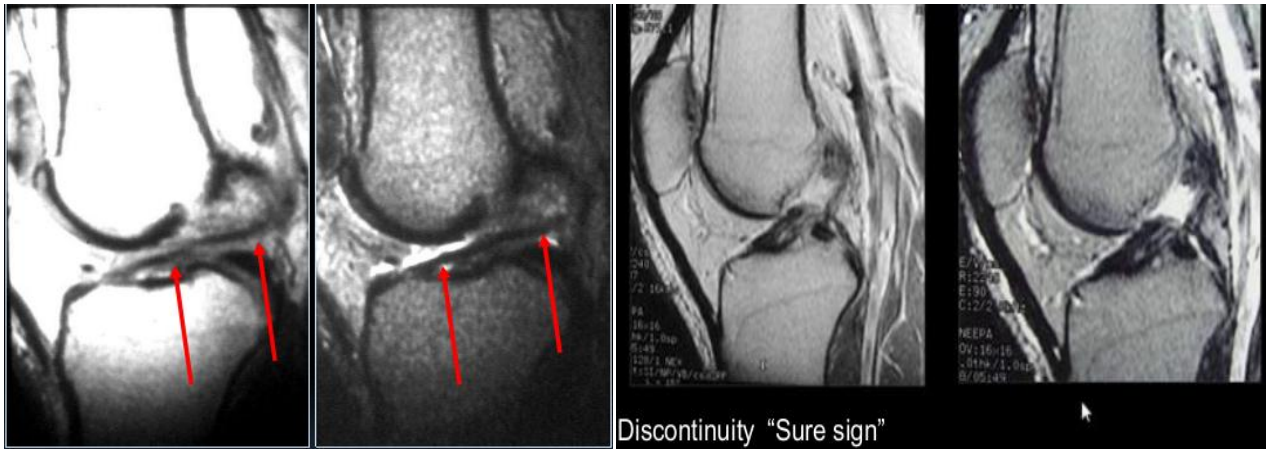
Primary signs [In the ligament]

- Total discontinuity
- Abnormal signal (not enough alone as ACL may contain fat)
- Abnormal configuration → Abrupt angulation
  → Wavy appearance
  → Abnormal axis

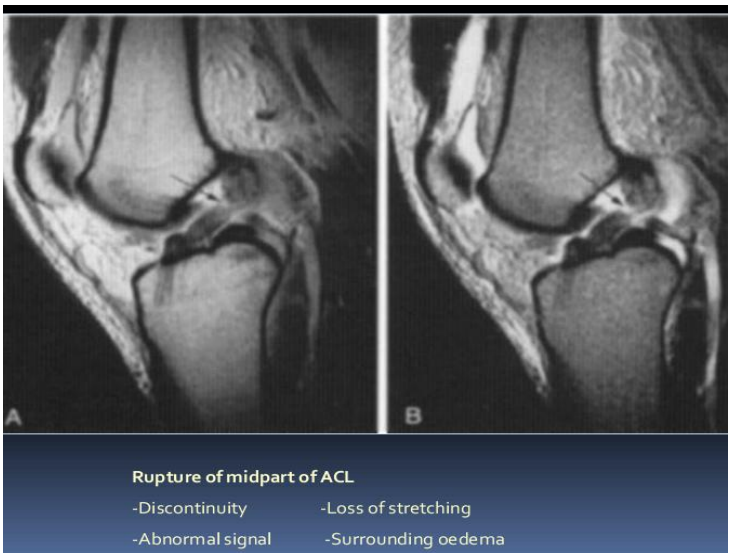
The 1st sign is enough for diagnosis alone.
The 2nd and 3rd signs must seen together for diagnosis.

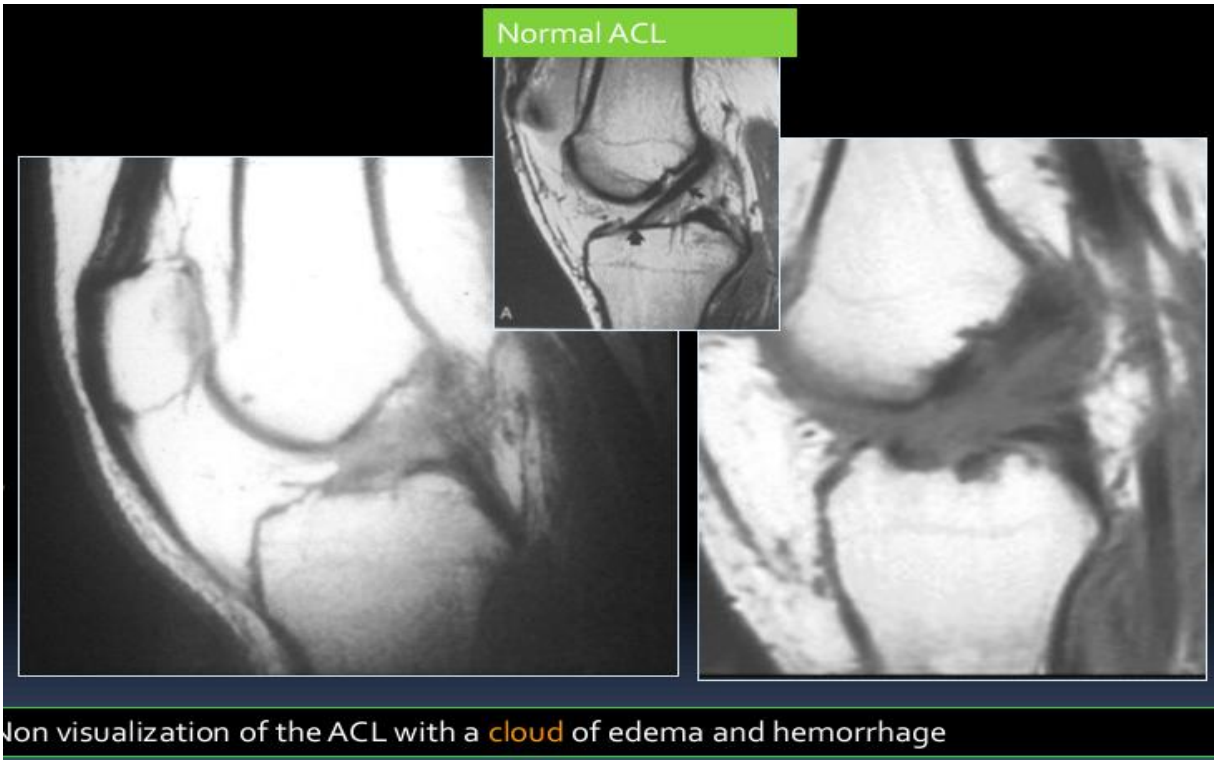
2ry signs

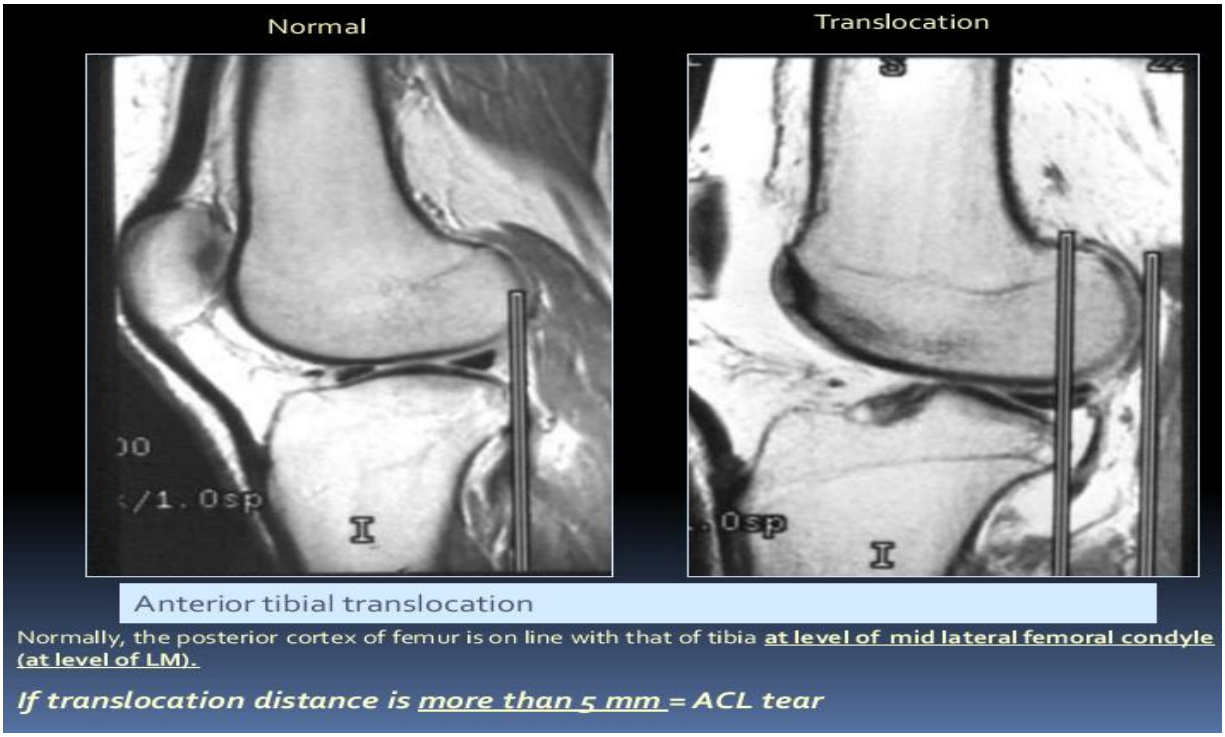
- Bone contusions [Pivot- shift bruises] (lasts for 6 weeks)
- Anterior translocation of the tibia (^ 5mm at middle of lat. femoral condyle)
- Uncovered lat. meniscus sign
- Avulsion fracture of the tibial insertion
- Segond fracture (70-100%) (vertical elliptical fragment // to lat. tibial cortex)
- PCL buckling (?mark shape) (Unreliable sign)
- PCL line sign (Unreliable sign)


Discontinuity "Sure sign"


sufficiency secondary to tibial avulsion fracture.


A
B
Rupture of midpart of ACL
-Discontinuity
-Loss of stretching
-Abnormal signal
-Surrounding oedema


Normal ACL
A
Non visualization of the ACL with a cloud of edema and hemorrhage

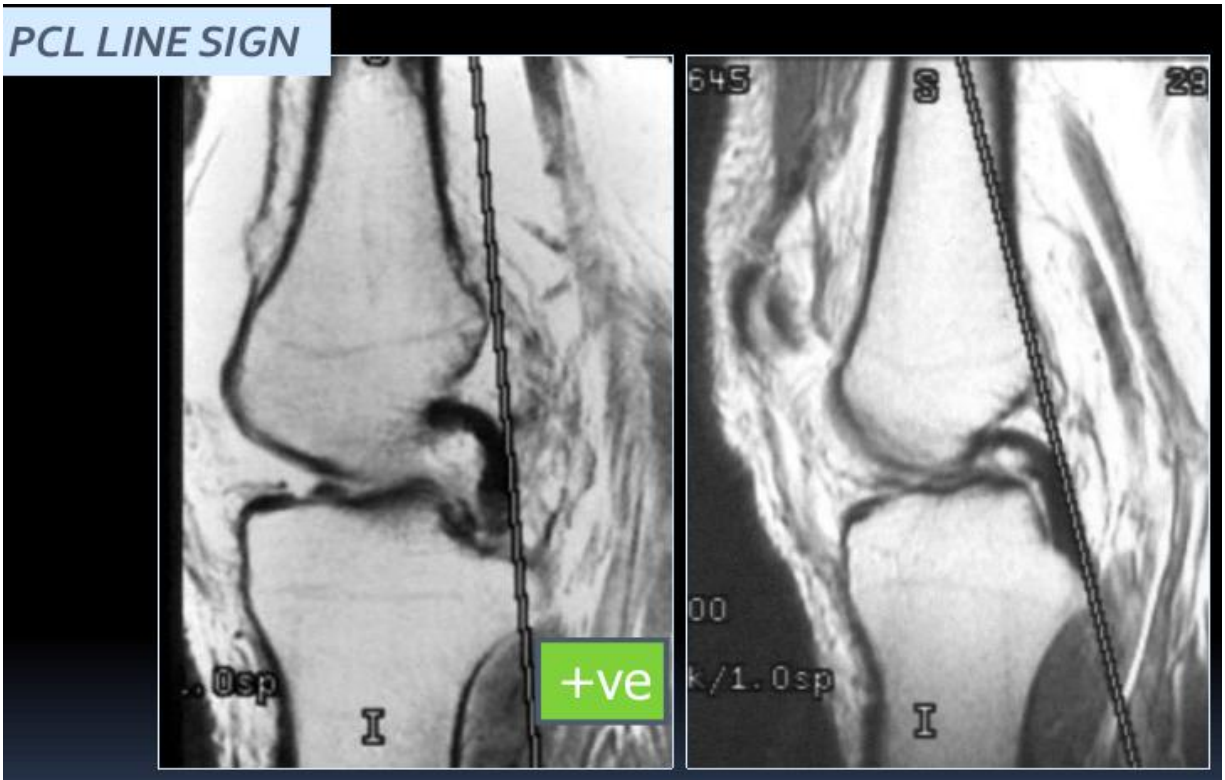


Anterior tibial translocation

Normally, the posterior cortex of femur is on line with that of tibia **at level of mid lateral femoral condyle (at level of LM).**

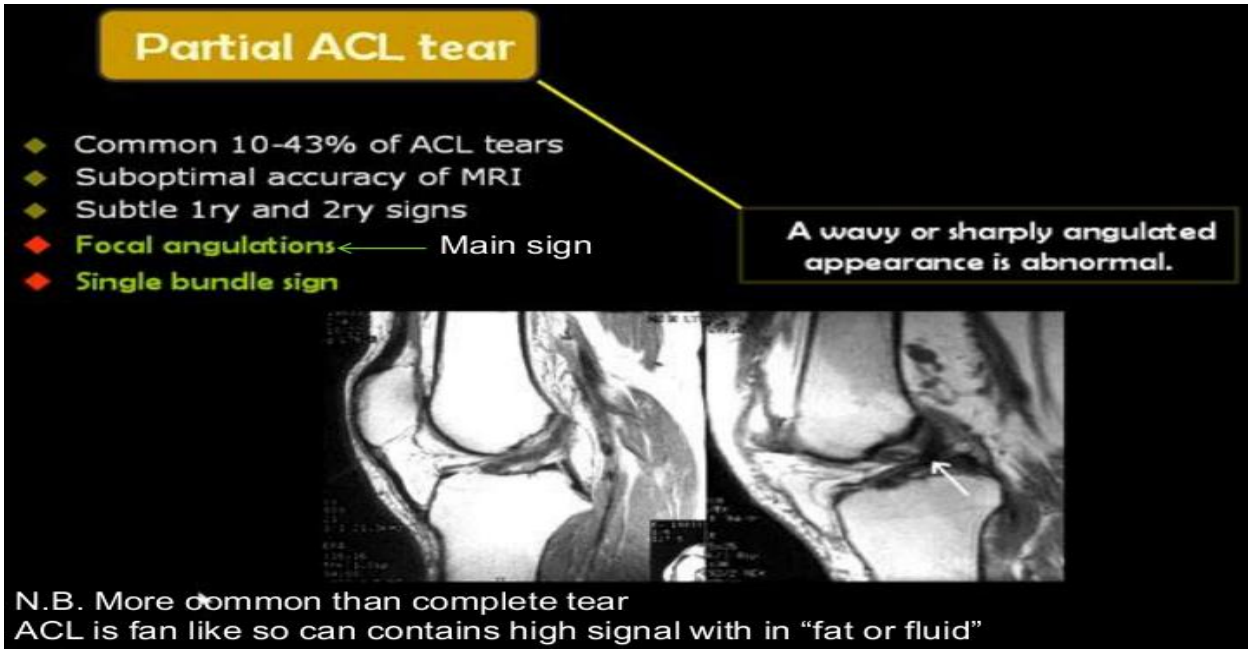
If translocation distance is more than 5 mm = ACL tear

PCL LINE SIGN



Lt normal (The line along PCL passes through the femur).

Rt +ve PCL line sign (the line do not pass through the femus). Also there is buckling of PCL

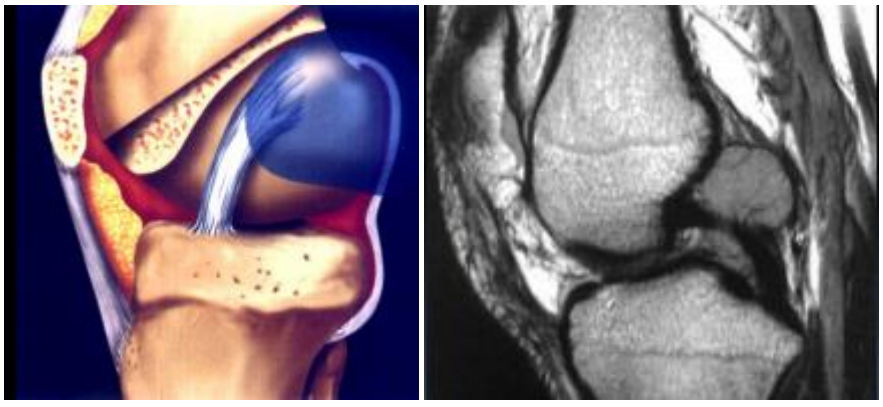


CHRONIC ACL INJURY

1- ABSENT Bone contusions
2- Fragmented ACL "***Main** sign*"
3- ACL attached to PCL
4- Empty Notch sign "in coronal scan"

INTER CONDYLAR NOTCH CYST

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



N.B. In X ray Film , Fracture in Tibial spine
"site of tibial attachment of ACL"
= ACL Avulsion Tear

IN ACL reconstruction, Assess Graft & Its complications:

- **Site of Graft** = Attachment behind these Lines
  "Tibial Attach behind Red line –Intercondylar"
  "Femoral " " behind Green Line- F. Shaft paral
- **Graft Shape** → Stretched "if Curved = Impengment"
- **Graft Nature** →Become total signal loss **after**
  1 Year , before 1 Y any signal accepted
- **Cyclops Lesion** *"commonest complication"*

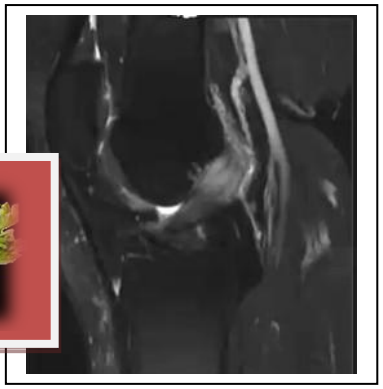
Rounded Fibrotic lesion , formed Ant to the graft → prevent knee extension

- Best seen in Saggital

- **Tunnel Cyst** > in Tibial tunnel of the screw
- Screw Displacement

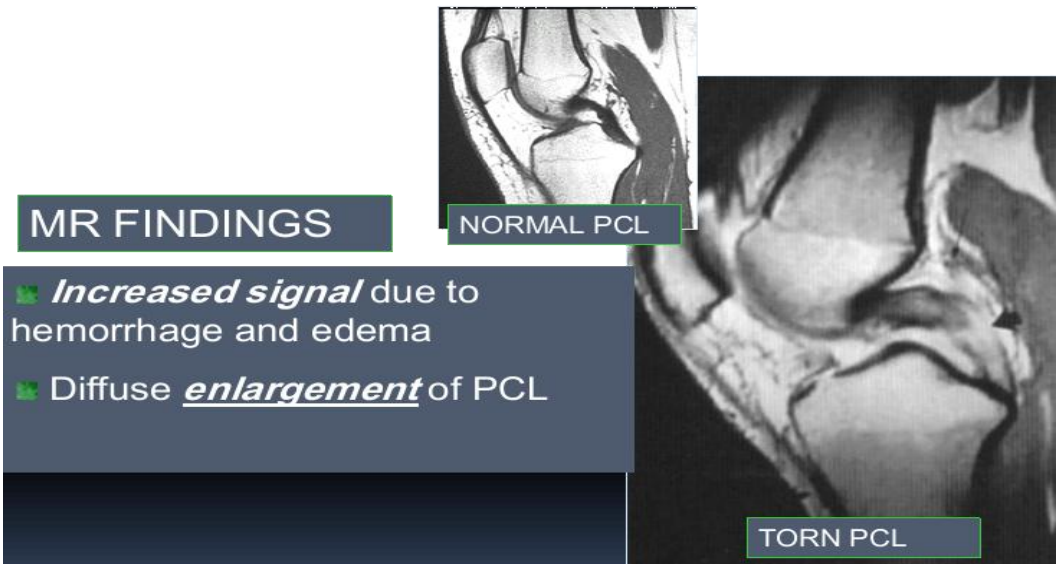
NEW

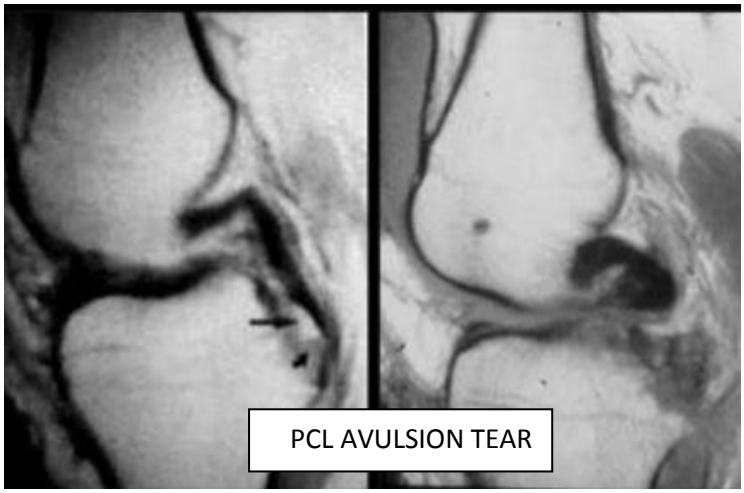
- Mucoid Degeneration → Swollen ACL *'Pain + No Trauma'*
- **In T2** alternative black normal fibers & white degn. Fibers
  - ➔ ***Celery stalk*** عيدان الكرفس
  - ➔ **ttt:** Mucoid clean by arthrography
  - ➔ Usually Recurrent in few years



PCL

- Major stabilizer of the knee
- Uniform low signal , no striations
- Twice strong as the ACL
- **PCL injuries** represent about **12%** of knee injuries
- Combined PCL injuries represent 97%
  - With ACL 65%
  - With MCL 50%
  - With MM 30%





AVULSION TEAR

- Involves the tibial insertion
- Retracted bone fragment
- Bone marrow edema at avulsion site
- The actual PCL may be normal

COLLATERAL LIGAMENTS

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

GRADING SYSTEM

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

CL INJURY GRADES	FINDUNG
I	Just Focal Edema
II	Edema + Thickening "MCL elevation from cortical surface"
III	Complete tear "Disrupted Ligament"

Grade I,II and isolated grade III are treated ***conservatively***, while grade ***III*** tears associated ***with ACL*** tears are treated by repairing ACL only