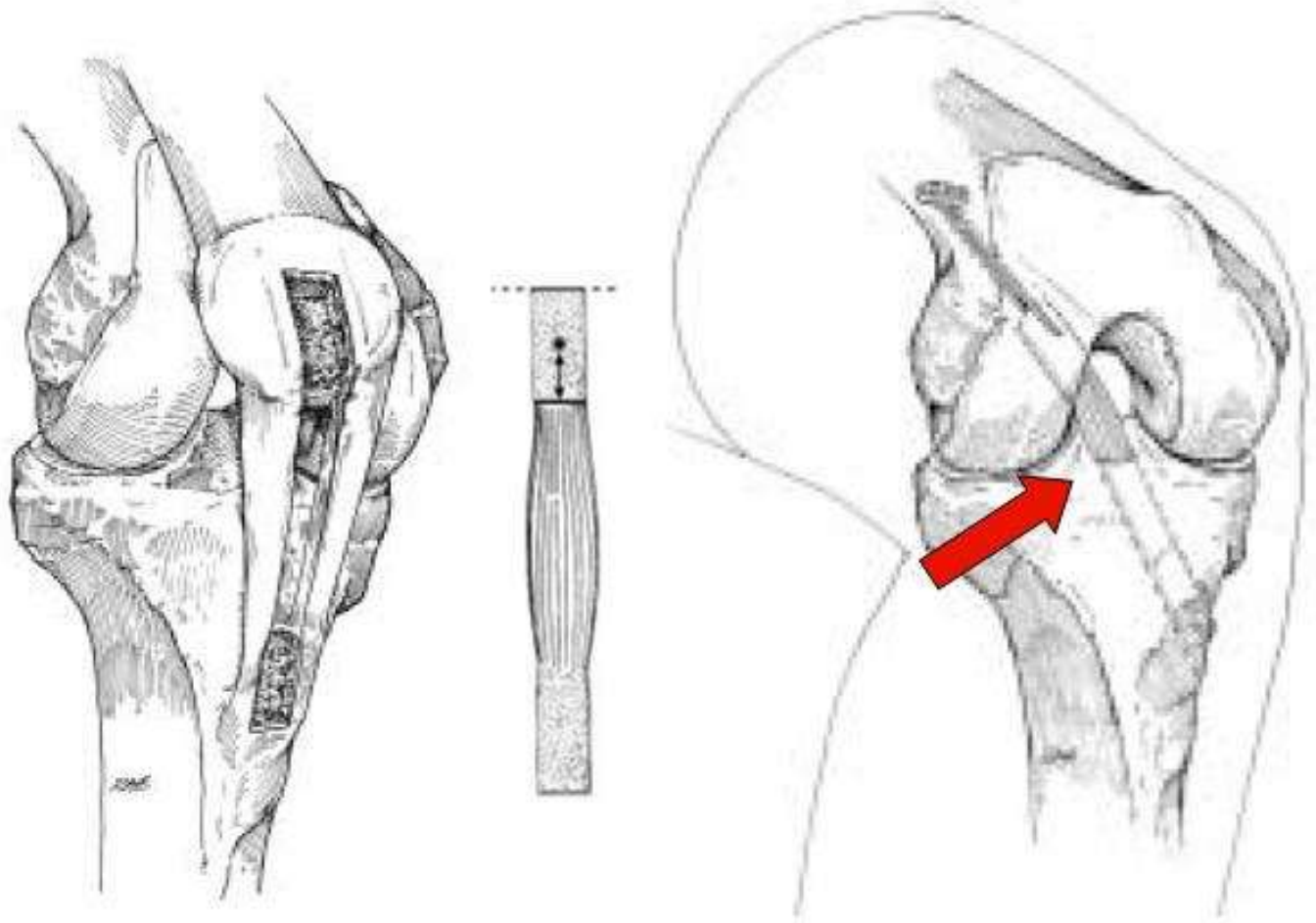
Imaging of ACL Reconstruction

- ACL tears lead to instability which can lead to meniscal tears and articular cartilage damage.
- Orthopedic surgeons recommend ACL reconstruction for most ACL tears, especially young people and those who are physically active.

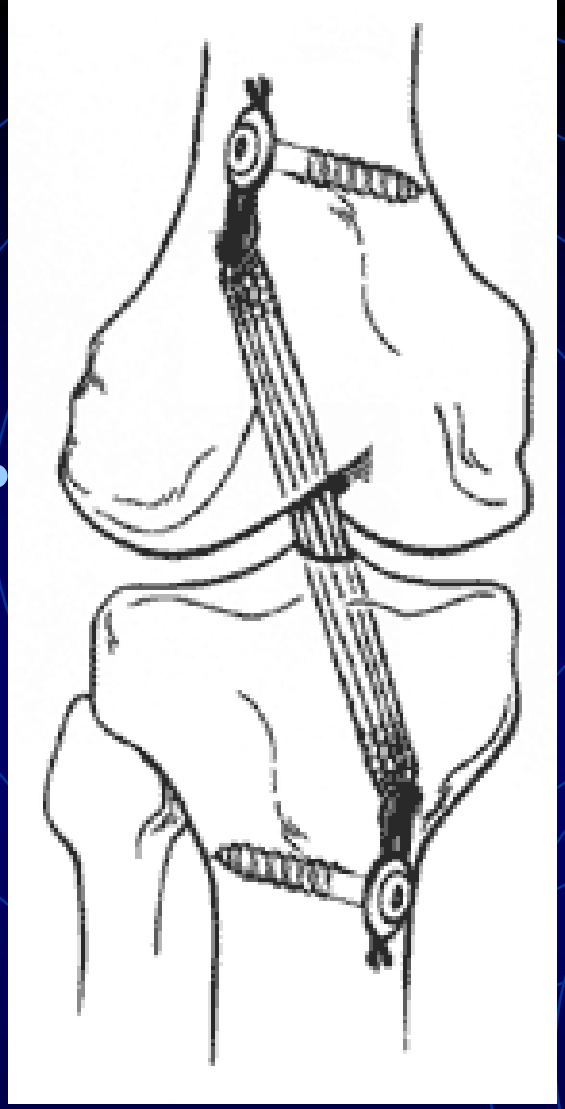
Autologous graft tissue:

- Patellar tendon
- Semitendinosus tendon
- Gracilis tendon
- Quadriceps tendon
- Iliotibial band
- Achilles tendon

Patella tendon graft



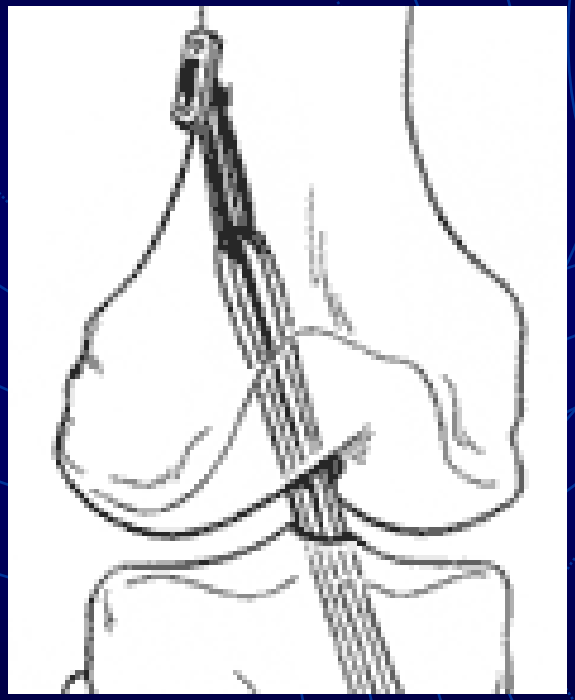
Quadrupled hamstring autograft

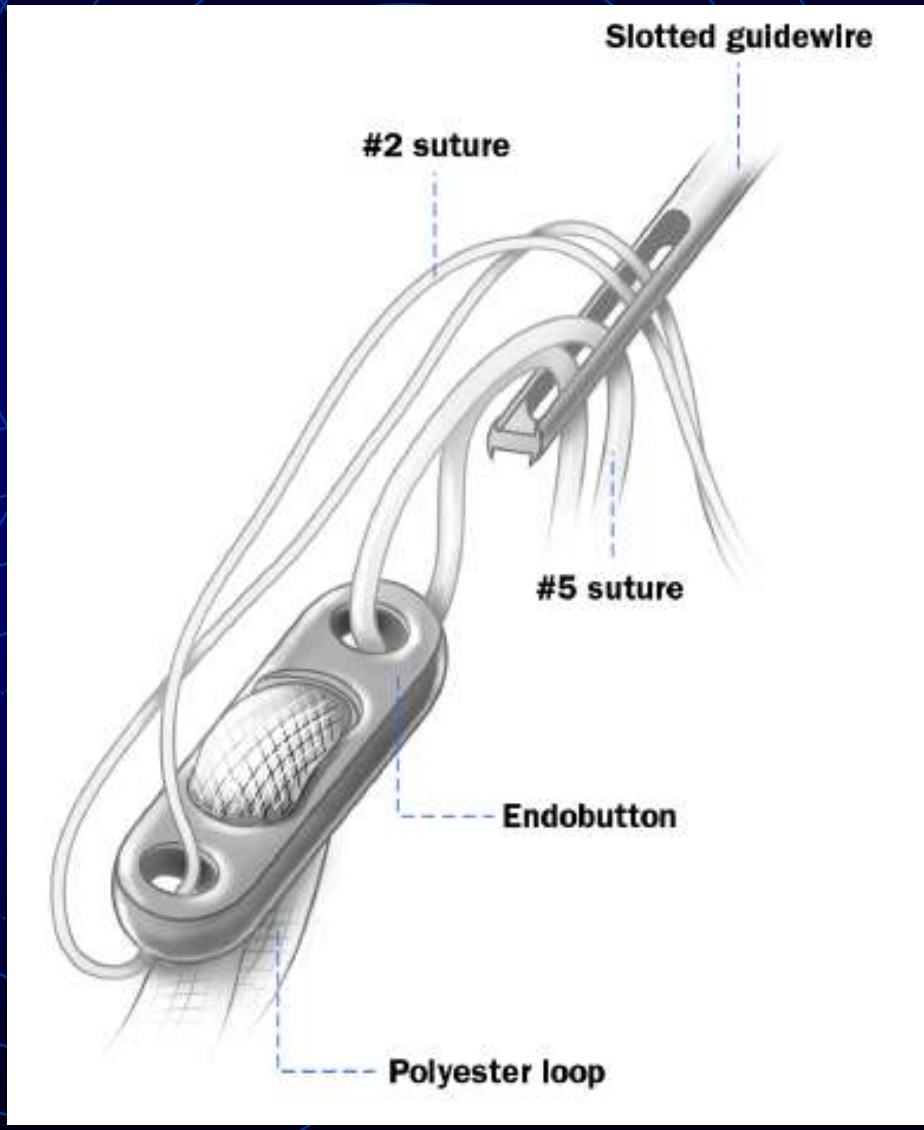


Suspensory fixation – adds length and elasticity of the whole unit thereby creating a "bungee cord" effect with a loss of graft stiffness

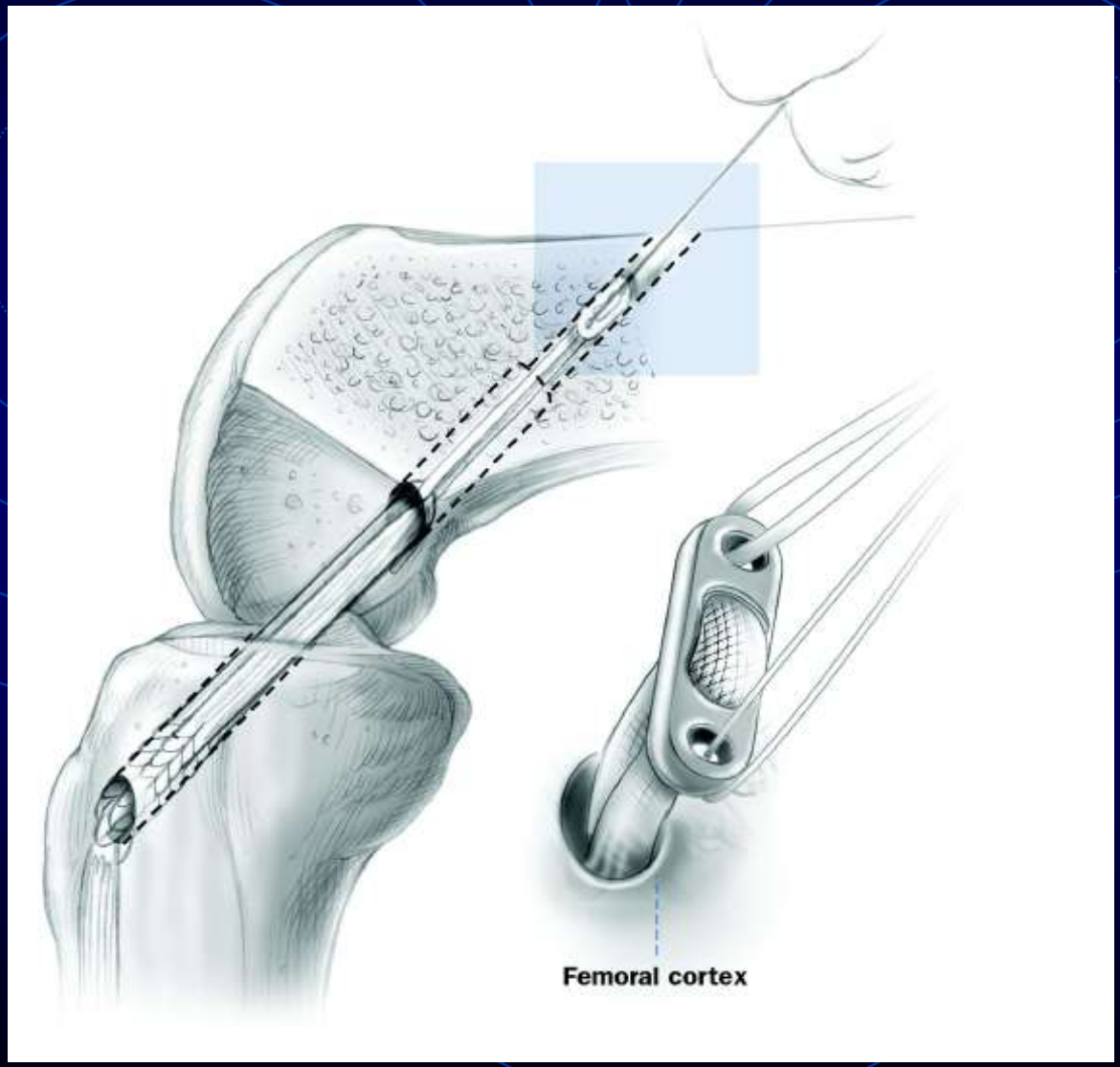
Interference screws with special blunt threads designed not to cut the hamstring tendons are now able to fix the tendon within the bone tunnel similar to the patellar tendon bone fixation

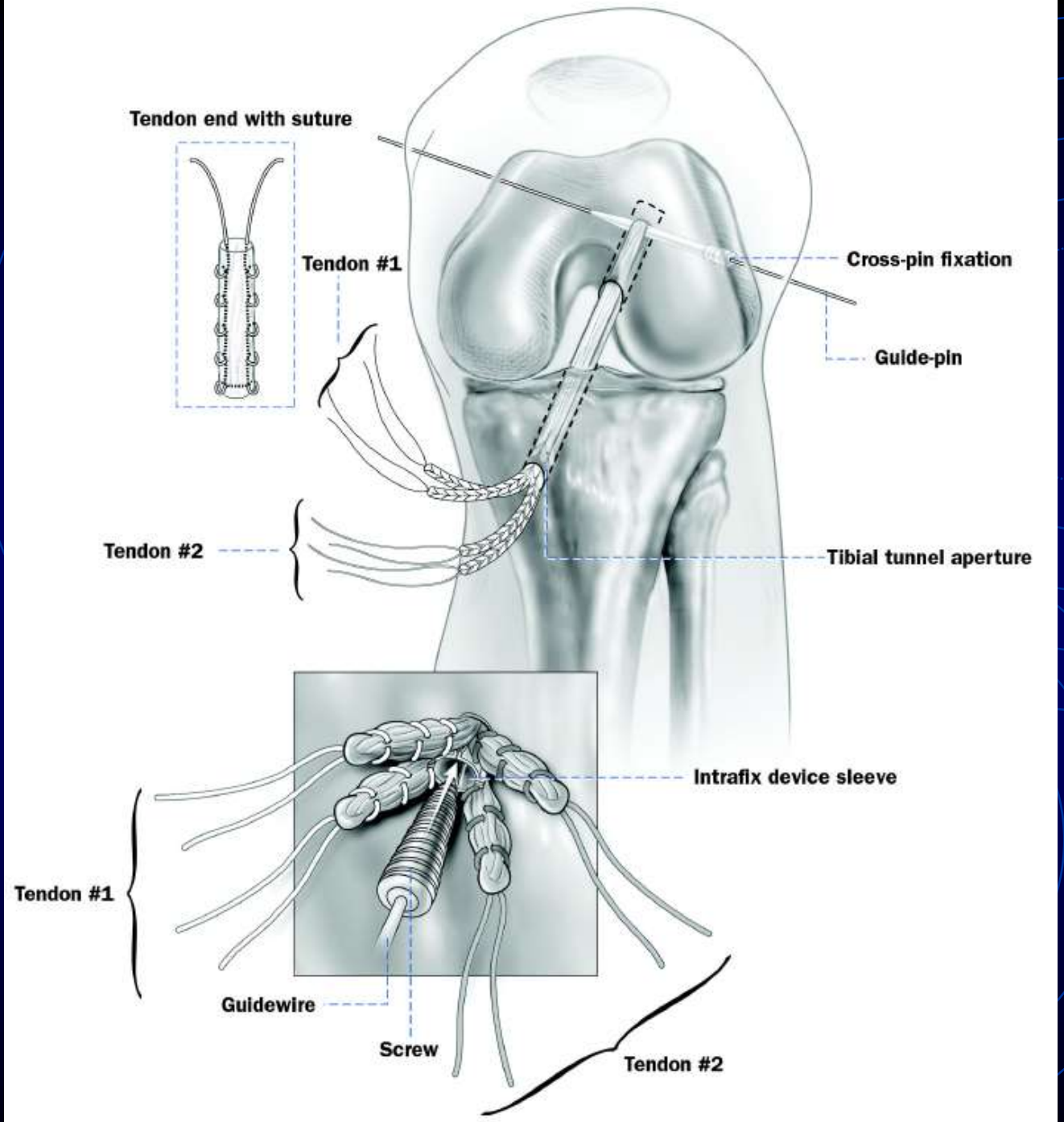
Endobutton




Slotted guidewire
#2 suture
#5 suture
Endobutton
Polyester loop

Four strand hamstring graft/endobutton pull through





Cross-pin fixation rather than endobutton.

Both types are fixed in the tibial tunnel with screw-sleeve fixation.

Bioabsorbable interference screws

- The bioabsorbable quality of the screws alleviates some problems associated with metal implants including graft laceration, postoperative imaging, revision surgery, and cold intolerance.
- Fixation equal or better to metallic interference screws.

Fashioned from:

- poly-L-lactide (PLLA)
- tricalcium phosphate (TCP)
- Hydroxy-Apatite (HA)
- D.L-lactide
- Trimethyl Carbonate (TMC)
- Or combination

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Bioabsorbable interference screws

12 months

24 months

38 months

ACL reconstruction poor outcomes

1. ACL graft failure
2. Graft complications without failure

Contributing factors in ACL graft failure:

- Recurrent trauma
- Technical error
- Diagnostic error
- Failure of graft incorporation
- Intact graft with functional instability

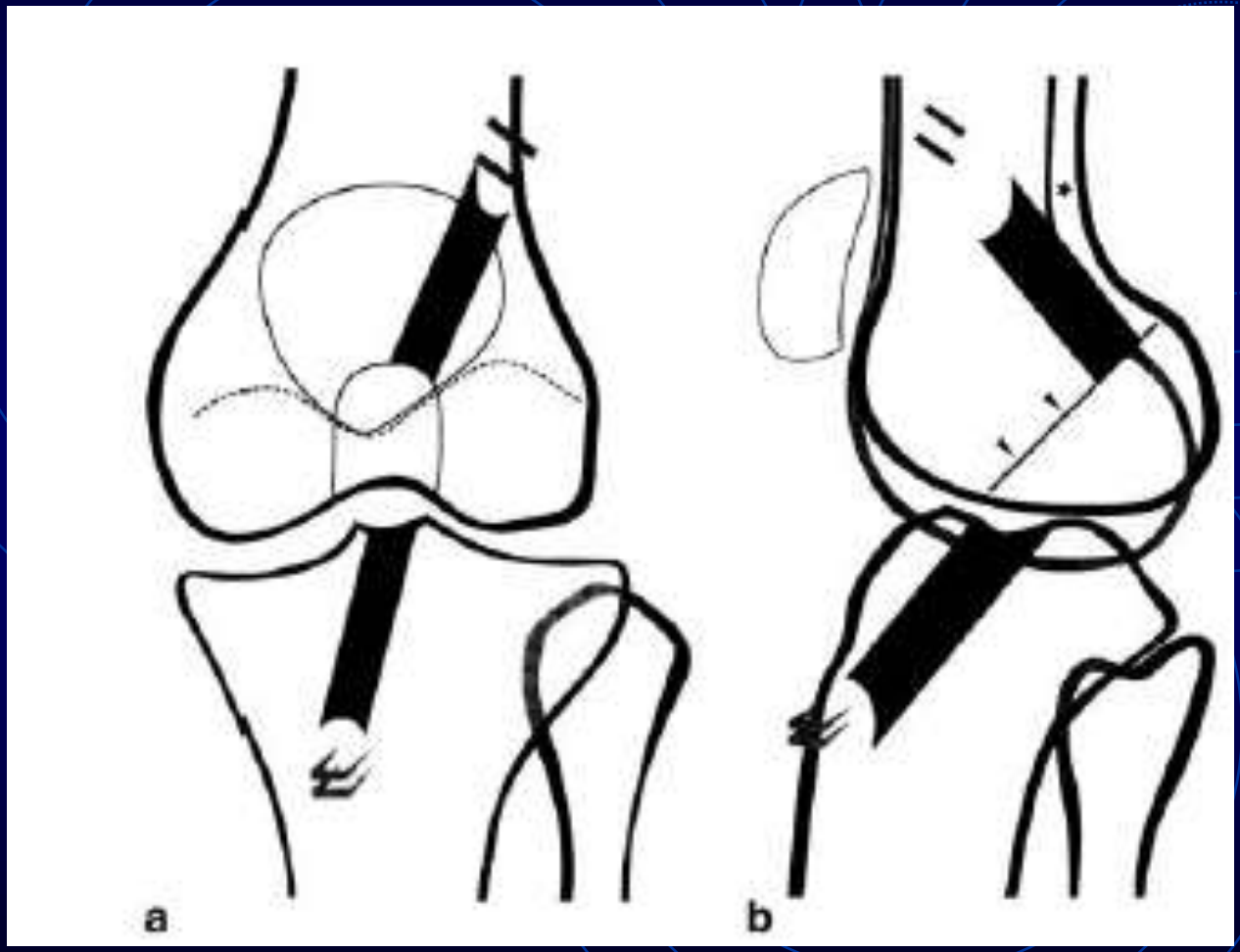
Recurrent trauma

- Premature return to high level of activity
- Deconditioning and weakness of supporting muscles of the knee
- Minor trauma in conjuntion with technical error

Technical Error

- **Error in surgical technique is the most common cause of ACL graft failure**.
- Nonanatomic graft placement, graft impingement on the intercondylar roof, improper graft tensioning and inadequate graft fixation, and failure to address concurrent ligamentous injury may result in a poor outcome.
- Anterior placement of the femoral tunnel is the most common surgical error when a one-incision endoscopic technique is used (failure to visualize the most posterior aspect of the notch).

Normal placement of ACL graft



Complications of ACL reconstruction: MR Imaging. Papakonstantinou et al Eur Rad (2003) 13:1106-1117

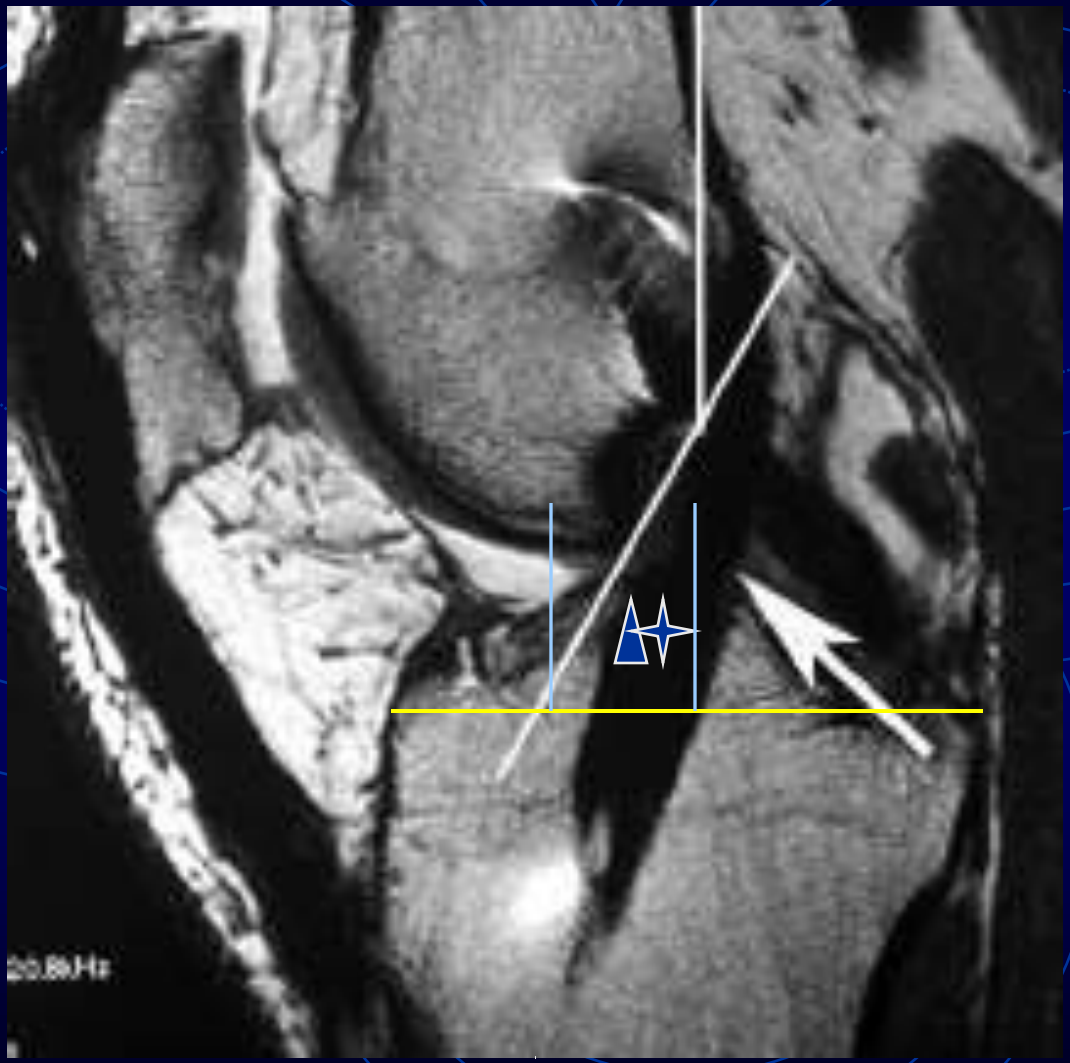
Tibial Tunnel Placement

- Evaluate on lateral view, knee in full extension.
- Anterior margin of the tibial tunnel should be behind a line drawn along the roof of the femoral notch (Blumensatt's line).
- Center of the graft tunnel should be one-quarter to one-half the distance from the anterior to the posterior tibial cortex.
- If tibial tunnel is too far forward – impingement
- If tibial tunnel is too far back – instability

Femoral Tunnel Placement

- Femoral tunnel origin should be posterior to vertical line drawn along the posterior cortex of the femur.

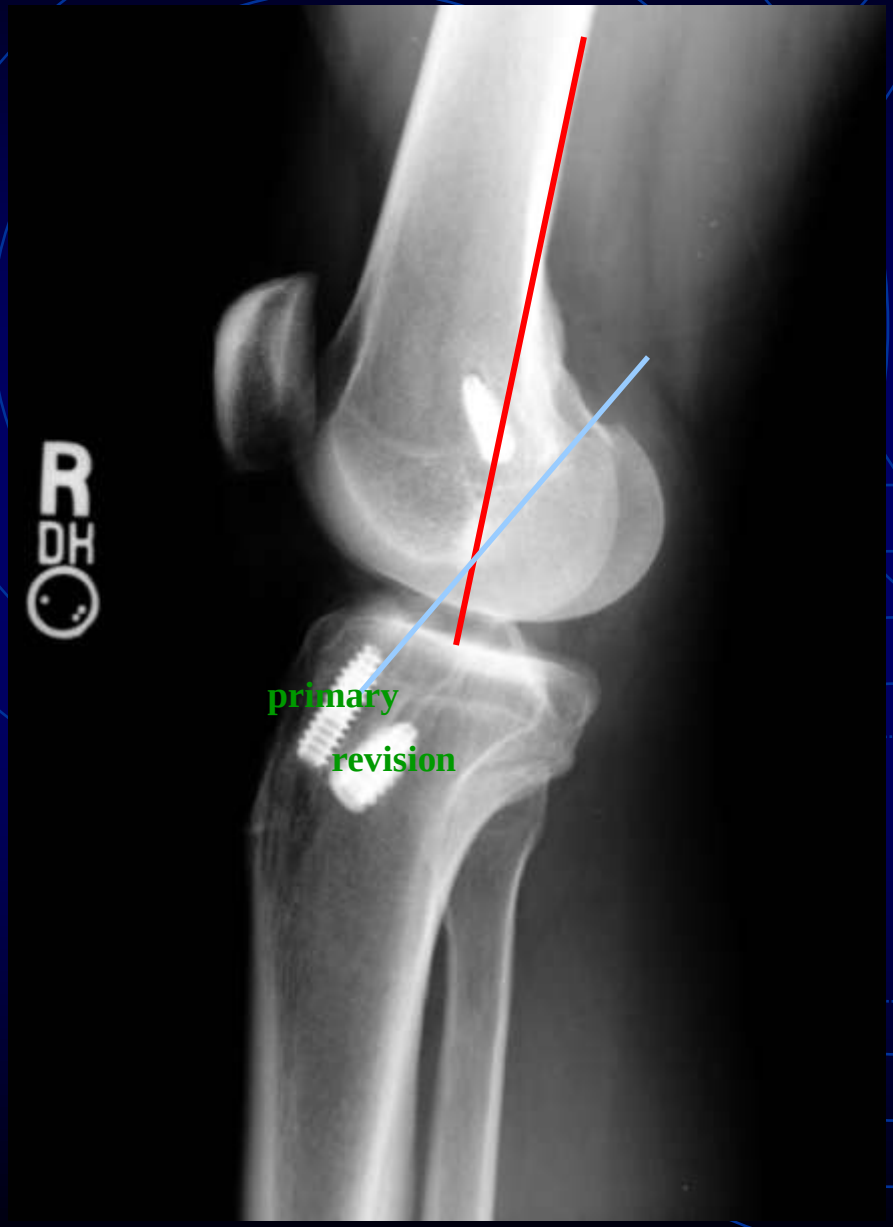
- Anterior femoral tunnel placement results in excessive tension on the graft in flexion which restricts ROM causing tension on the graft fixation site and eventual stretching of the graft.



Anterior placement of the femoral tunnel

Complication leading to graft-lengthening and subsequent failure.

Anterior placement of the tibial tunnel in primary ACL reconstruction



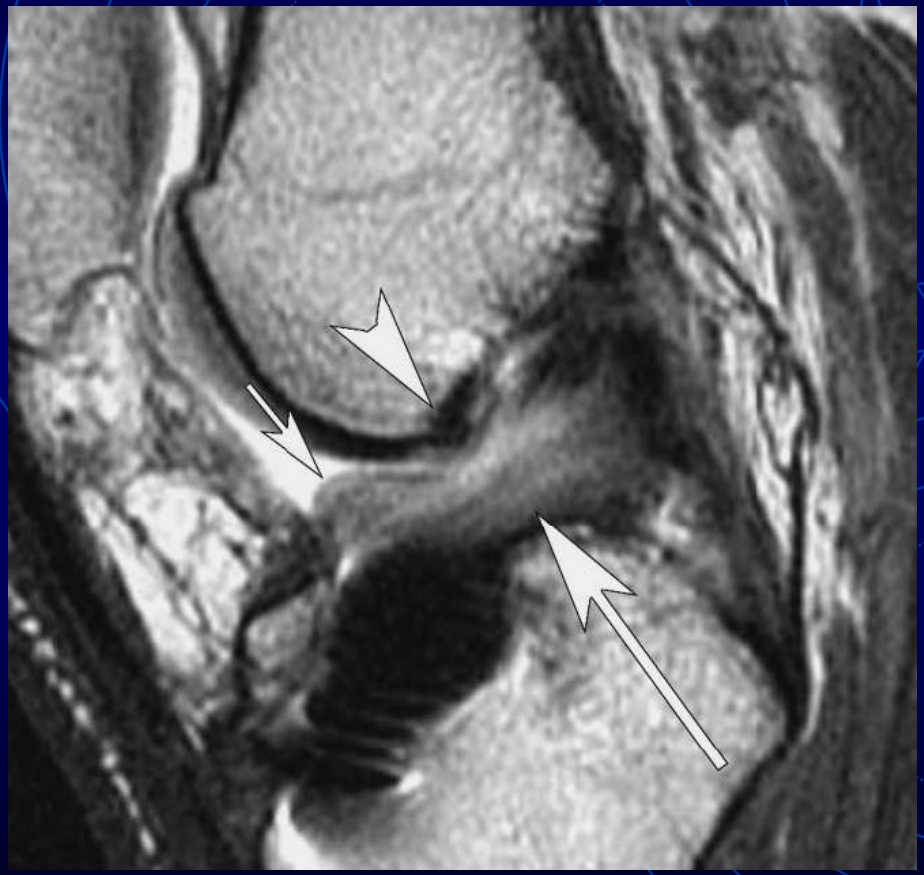
ACL reconstruction revision with better tibial tunnel location.

Tunnel placement is limited by the presence of a pre-existing tunnel from the primary ACL reconstruction.

Graft impingement

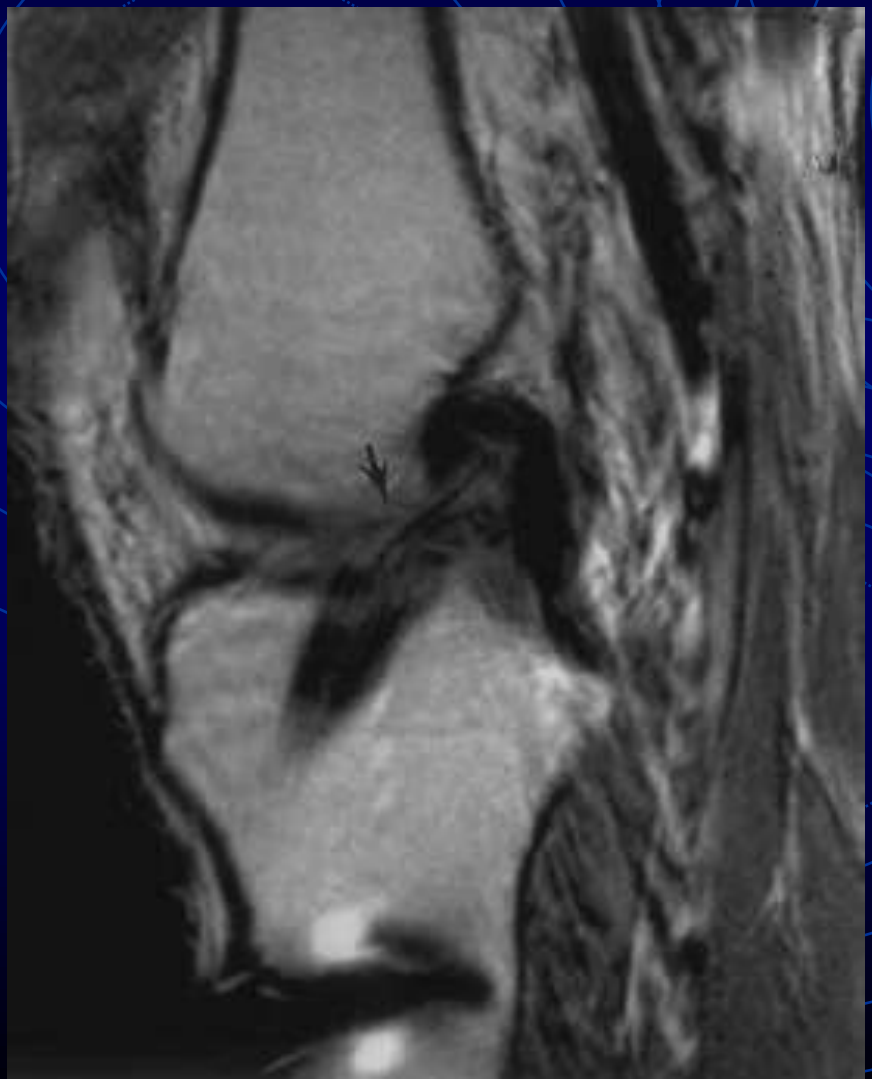
- ACL graft abuts the roof or wall of the intercondylar notch.
- Associated with anterior placement of tibial tunnel, notch osteophytes, or a small intercondylar notch
- May cause pain or loss of extension
- MR findings: increased signal, graft enlarged, tunnel placement anterior to Blumensatt's line (high interobserver variability)

Graft impingement



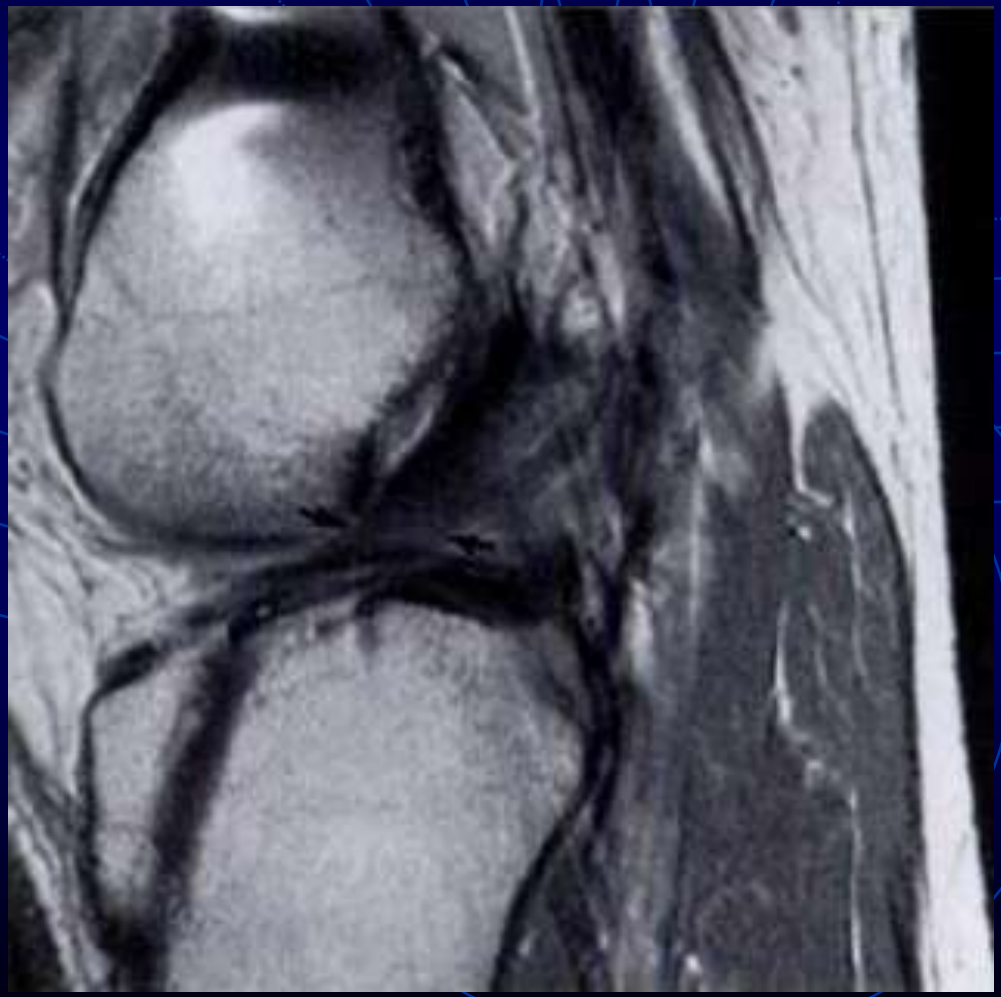
MR arthrogram shows increased signal intensity in graft (long arrow). Spur (arrowhead) at anterior margin of intercondylar notch deforms the superior surface of the graft, which bulges (short arrow) anterior to the spur.

Graft impingement



Graft fibers draped under the intercondylar roof.

Graft impingement



Diagnostic Error

- Don’t fall victim to “satisfaction of search”.
- Failure to recognize and treat injuries to secondary and tertiary restraints can cause increased loads on the ACL reconstruction.
- **Posterolateral instability** is the most commonly unrecognized concurrent deficiency and is seen in 10% to 15% of chronically ACL-deficient knees.
- The medial collateral ligament, posterior horn of the medial meniscus, and posterior capsule provide secondary stability in the ACL-deficient knee and must also be carefully assessed for injury.

Failure of graft incorporation

- Causes include inadequate vascularity, immunological reaction, and stress-shielding associated with use of augmentation device.
- Suspected in patients presenting with recurrent instability without a history of trauma or an identifiable technical error.
- The rate of incorporation has been shown to depend on the type of graft material, method of fixation, healing response and design of early rehabilitation program.

Failure of graft incorporation

Expansion of bone tunnels has been well described and may be seen with autograft or allograft.

Laxity with intact ACL graft

- Anterior displacement of the tibial with respect to the femur may be seen with an intact ACL graft.
- The Orthopedic surgeon should be notified of possible graft insufficiency.
- Instability on physical exam will determine the need for graft revision.

Laxity with intact ACL graft

Evidence of Graft Failure on MR

- Discontinuity of graft fibers
- Anterior translation of tibia with respect to the femur
- Buckling of the posterior cruciate ligament
- Posterior displacement of the posterior horn of the lateral meniscus relative to the tibial plateau

Discontinuity

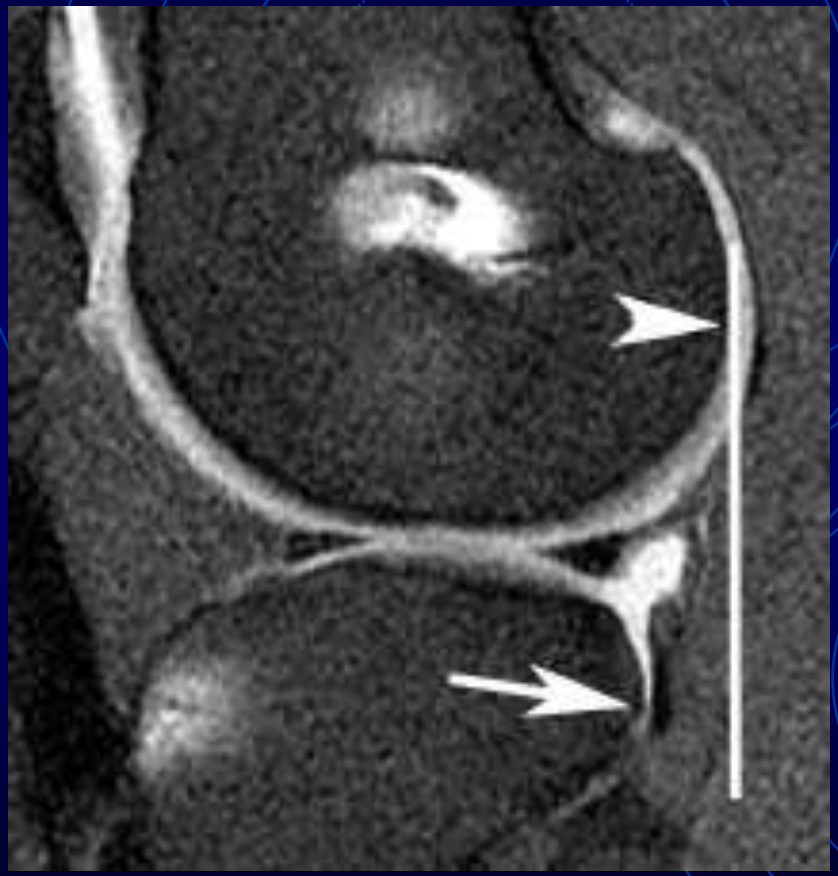
- MR arthrogram with tear of ACL graft.
- Discontinuity of fibers (arrow) traversed by intraarticular gadolinium

Discontinuity

Sagittal T2:

increased signal intensity along the expected course of the ACL graft

Anterior displacement of the tibia



- Vertical line from posterior cortex of lateral femoral condyle
- < 5mm - normal
- 5-7mm - equivocal
- > 7mm - abnormal

Complications of ACL reconstruction

- Arthrofibrosis
- Cyclops lesion
- Extensor mechanism abnormalities
- Hardware complications
- Graft weakening/stretching
- Infection

Arthrofibrosis

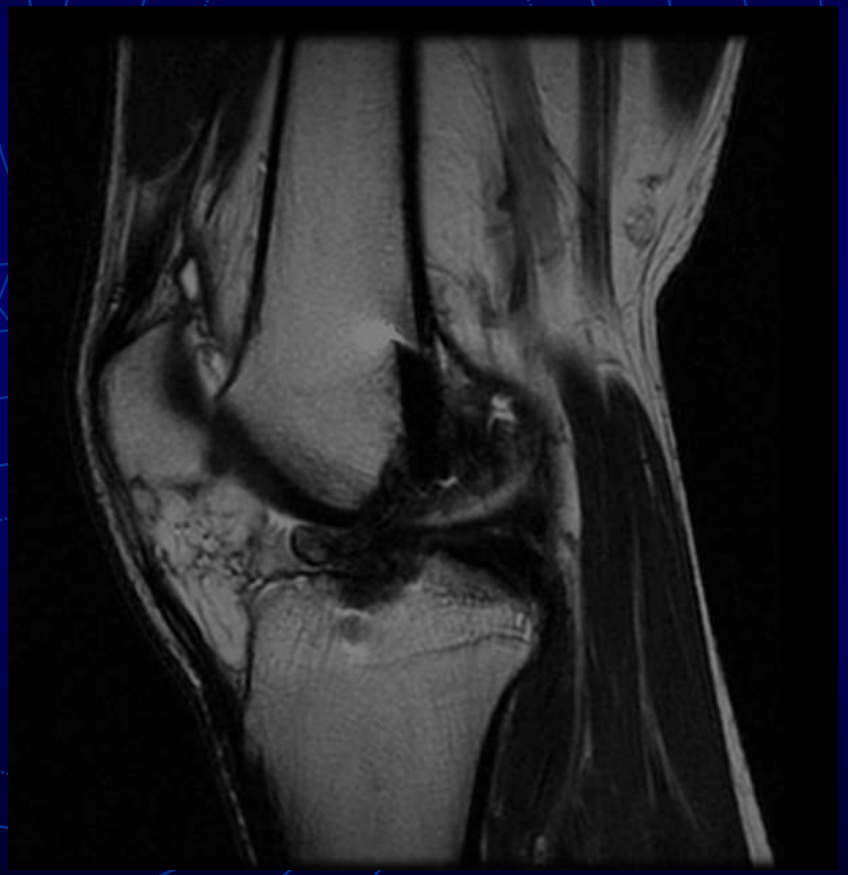
- Synovial hyperplasia with excessive production of fibrous tissue and inflammatory cell infiltration around the ACL graft

Arthrofibrosis

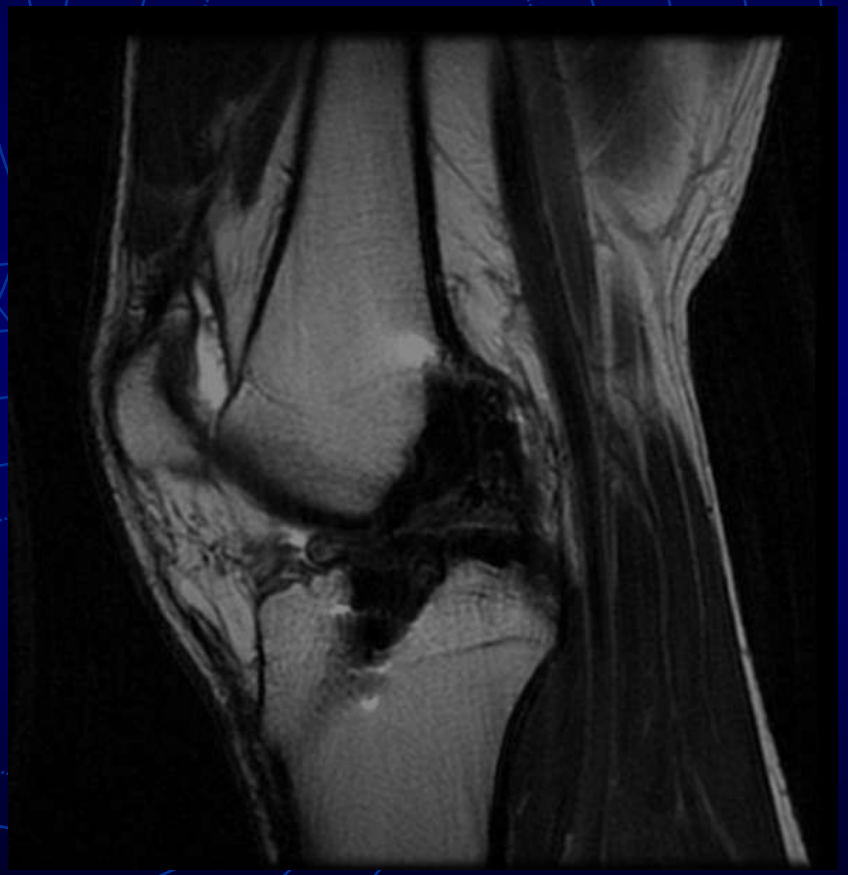
Cyclops lesion

- Focal arthrofibrosis
- Nodular fibrosis forms anterior to the ACL above the tibial plateau.
- Resembles an eyeball at arthroscopy.
- Can restrict motion and prevent extension.
- MR findings – low to intermediate signal on all sequences (intermediate due to irritation).
- Symptoms relieved with surgical resection.

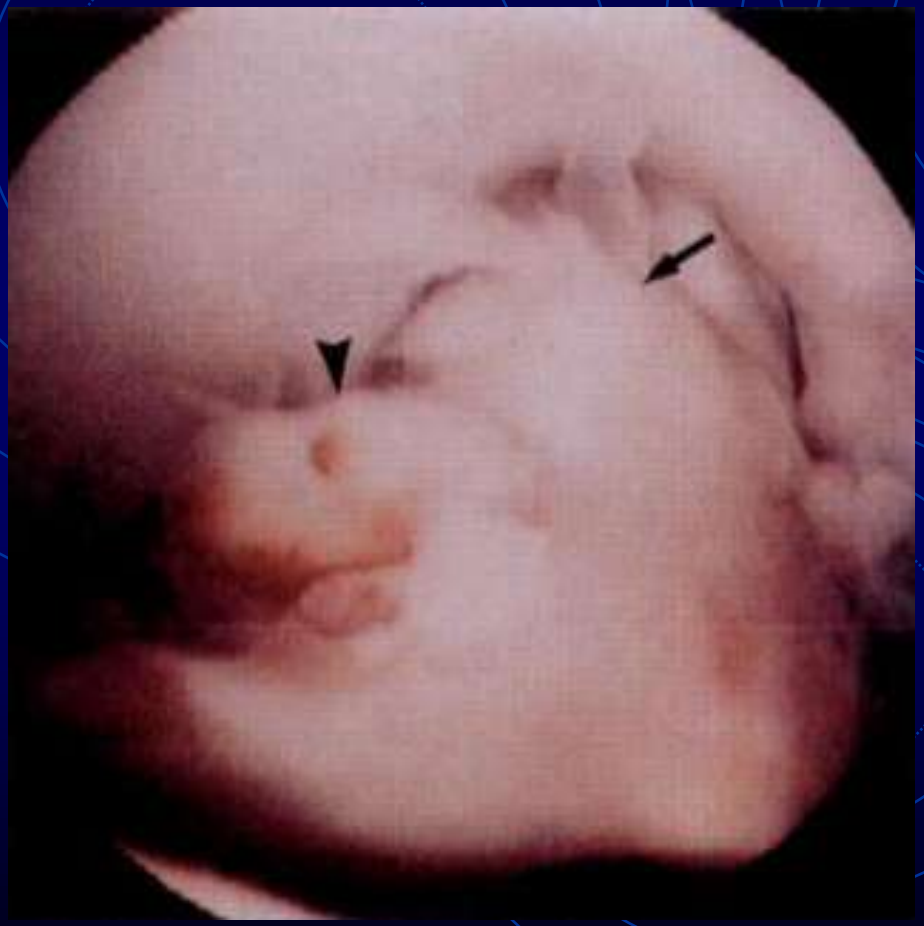
Cyclops lesion



Cyclops lesion



Cyclops lesion



Arthroscopic image of cyclops lesion sitting anterior to ACL graft *(arrow)*

Note focal areas of discoloration resembling cyclops' eye *(arrowhead)*

Patella tendon abnormalities

- Tendinosis
- Quadriceps weakness
- Patella fracture

Patella tendinosis

- Signal intensity usually normalizes within 18 months.
- Thickened tendon may persist.

Patella tendinosis

4 months post-op ACL

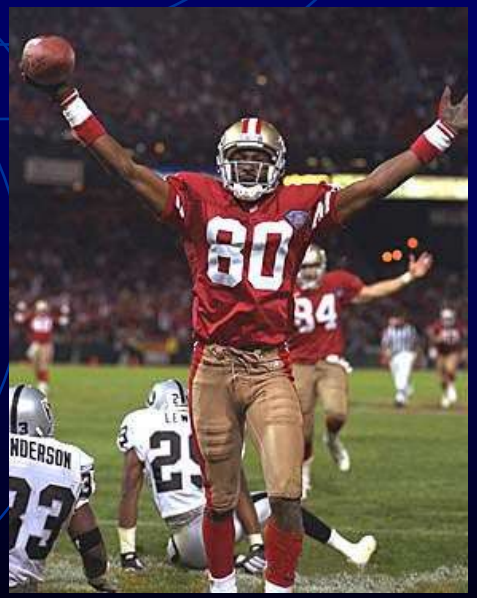
2 years post-op ACL

Quadriceps weakness

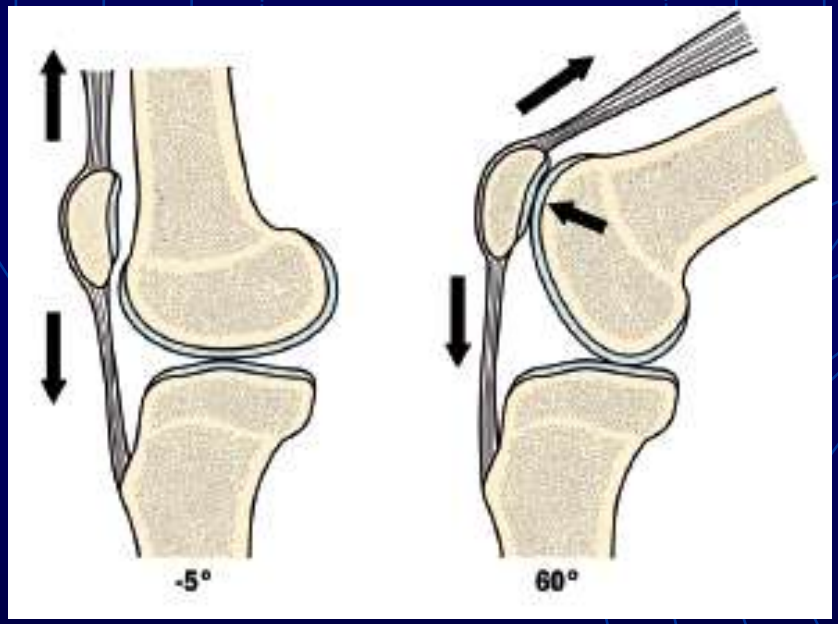
- Quadriceps weakness can be severe and persistent
- Cybex machine – used to determine the amount of force that one can generate during a maximal muscular contraction.

Patella fracture

- The osteotomy acts as a stress riser and can lead to patella fractures.
- Reported with and without trauma.
- Uncommon



Patella fracture



Contributing factors:

- Knee flexion
- Altered forces on the patella following graft harvest
- Decrease patella thickness
- Decreased vascularization of patella

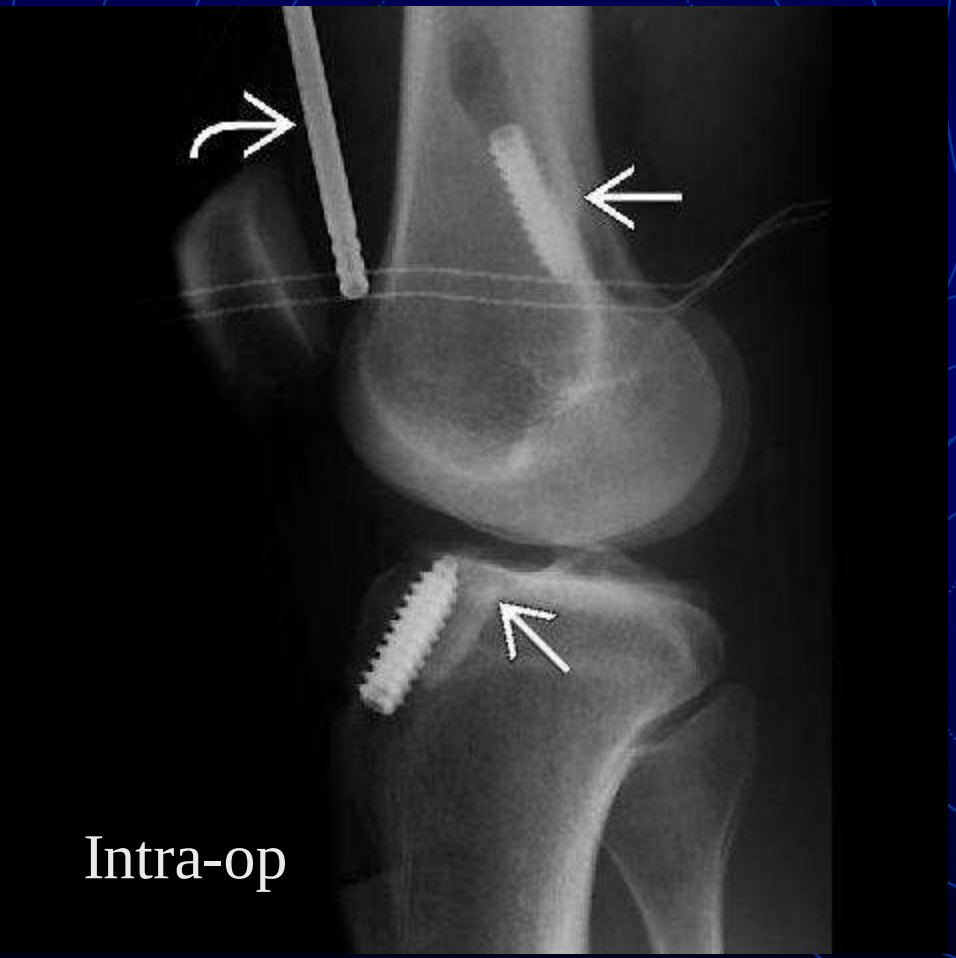
Hardware complications

- Dislodged screws
- Bone graft slippage
- Screw fracture
- Screw impingement on graft

Dislodged screw

The femoral interference screw is dislodged with an intraarticular location.

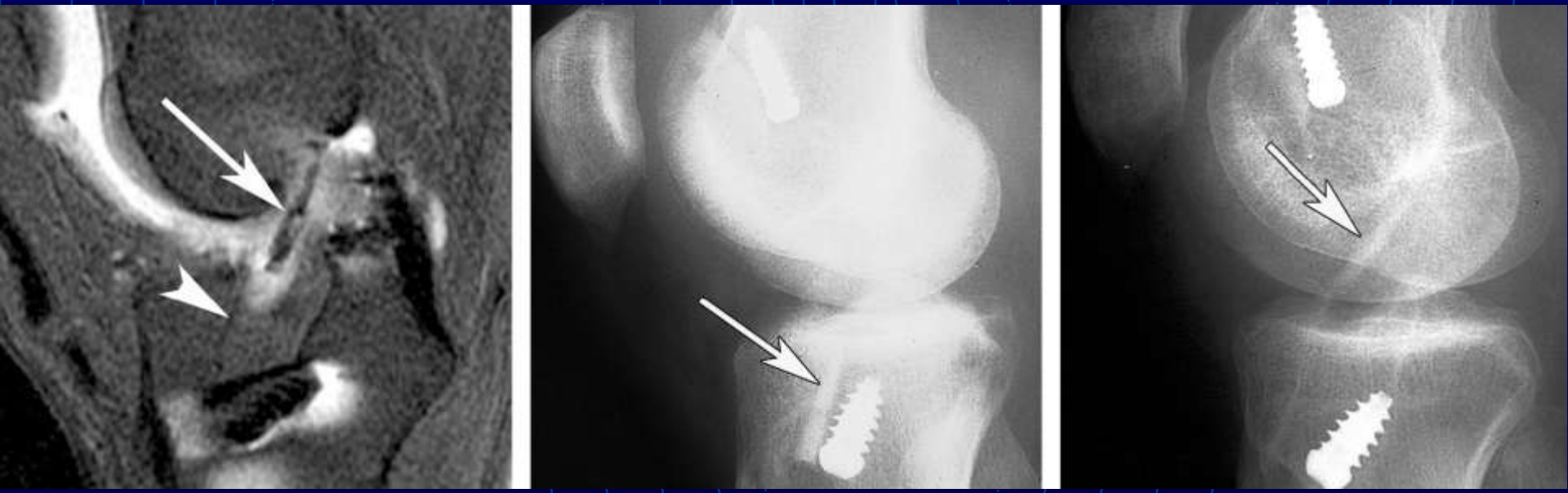
Bone graft slippage



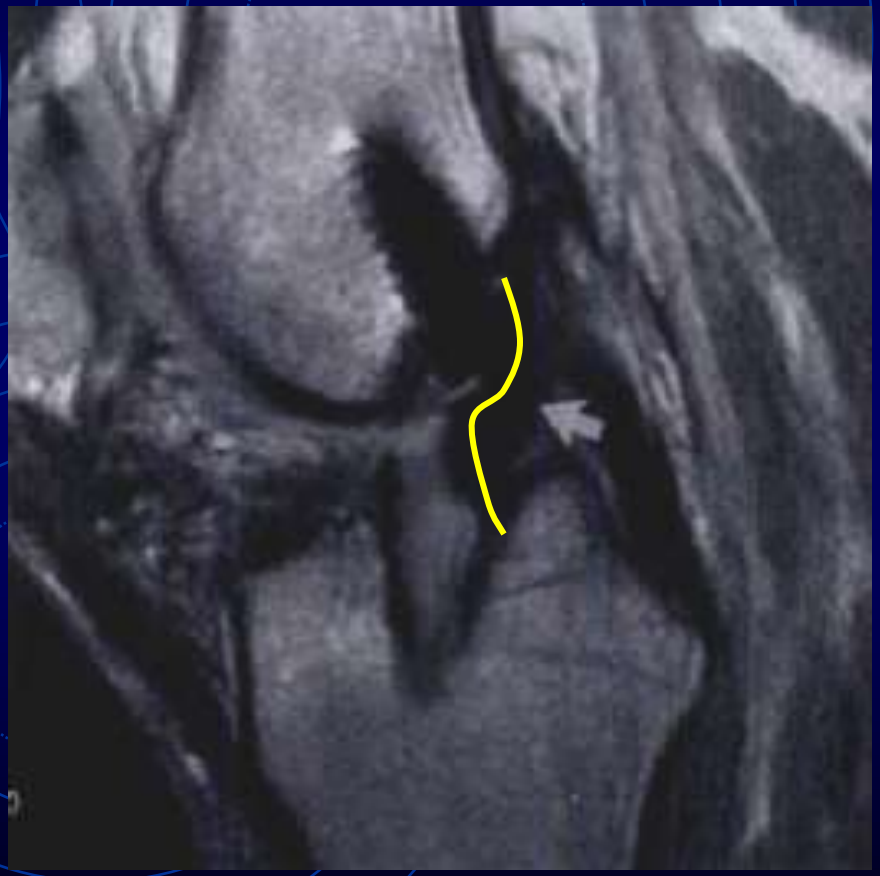
Intra-op

Post-op

Bone graft slippage



Graft impingement by screw

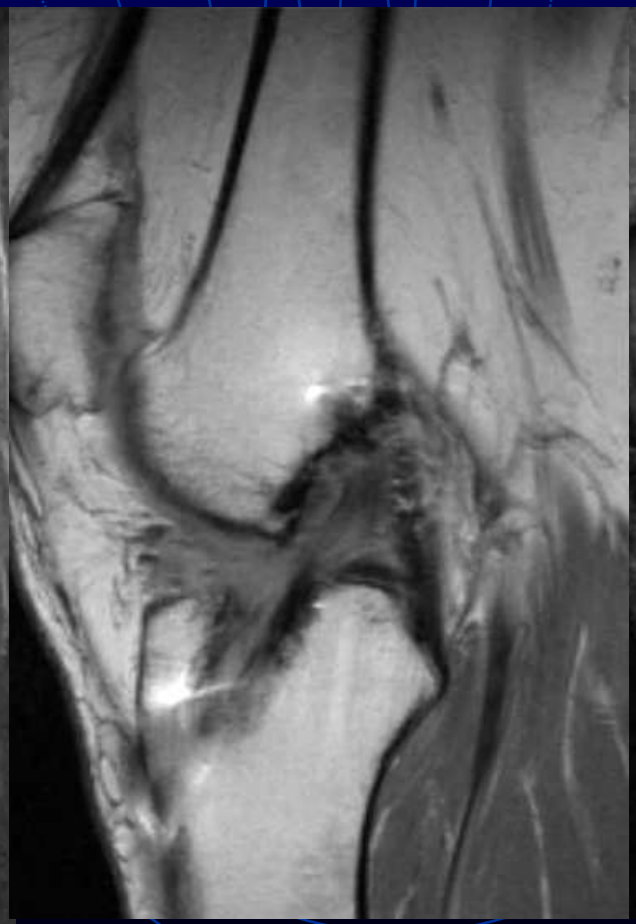


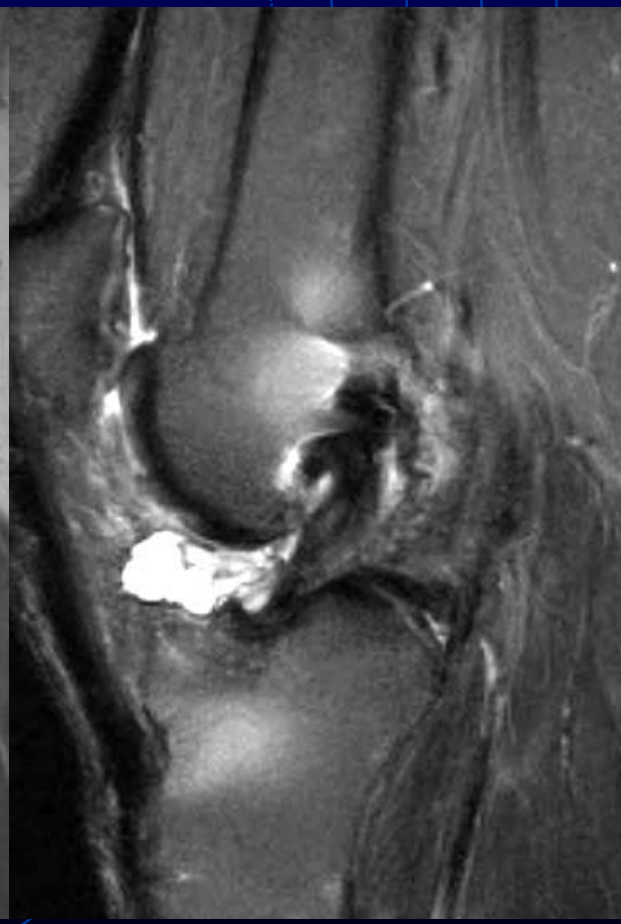
Screw fracture

- More commonly seen with bioabsorbable screws at the time of graft placement.
- Decreased incidence when a tap is used.

Cystic Degeneration

Cystic Degeneration

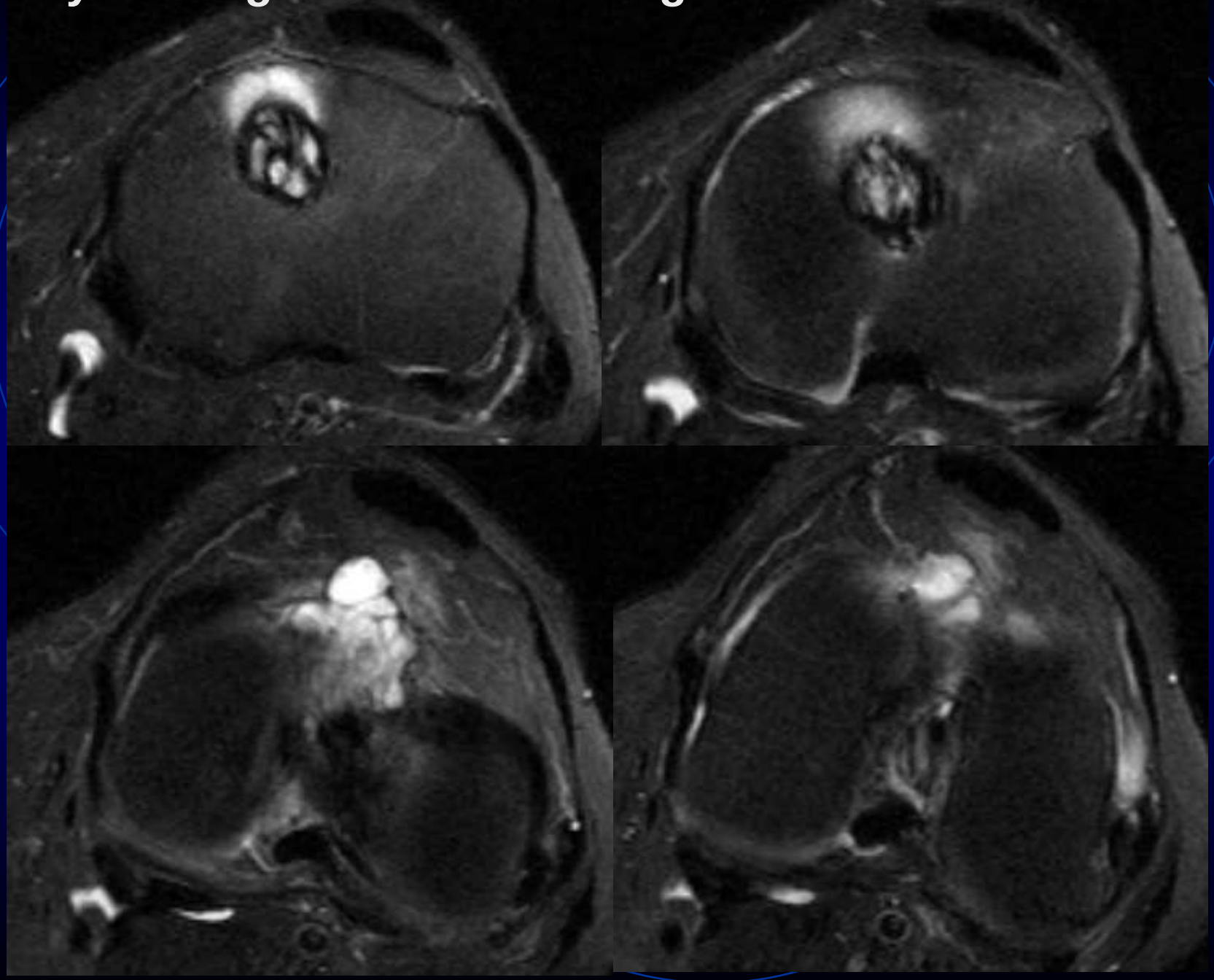


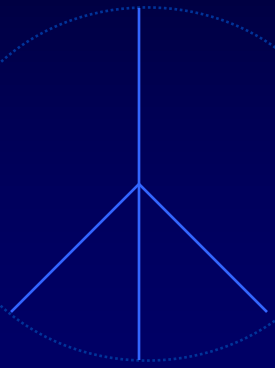


Cystic Degeneration



Cystic Degeneration of ACL graft and fluid collection





PEACE

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