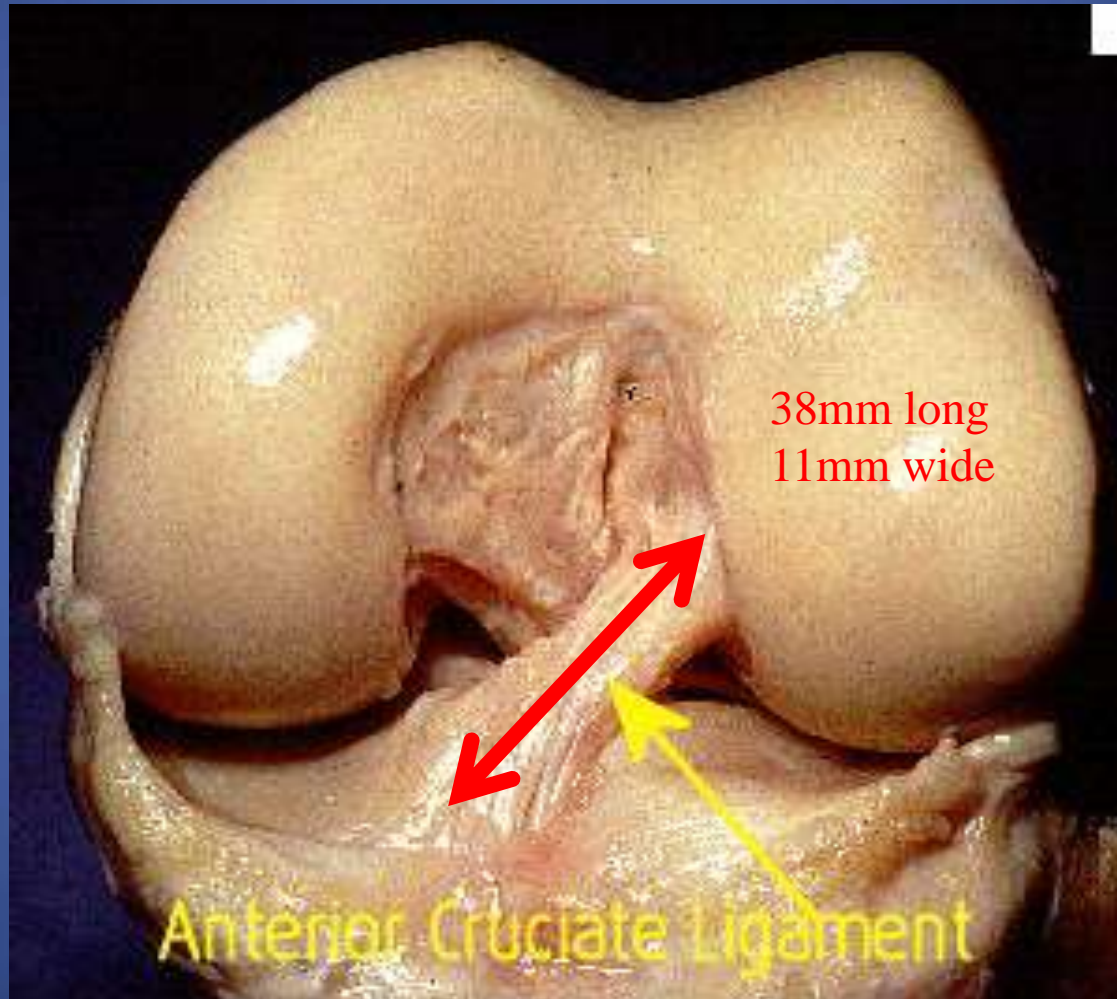


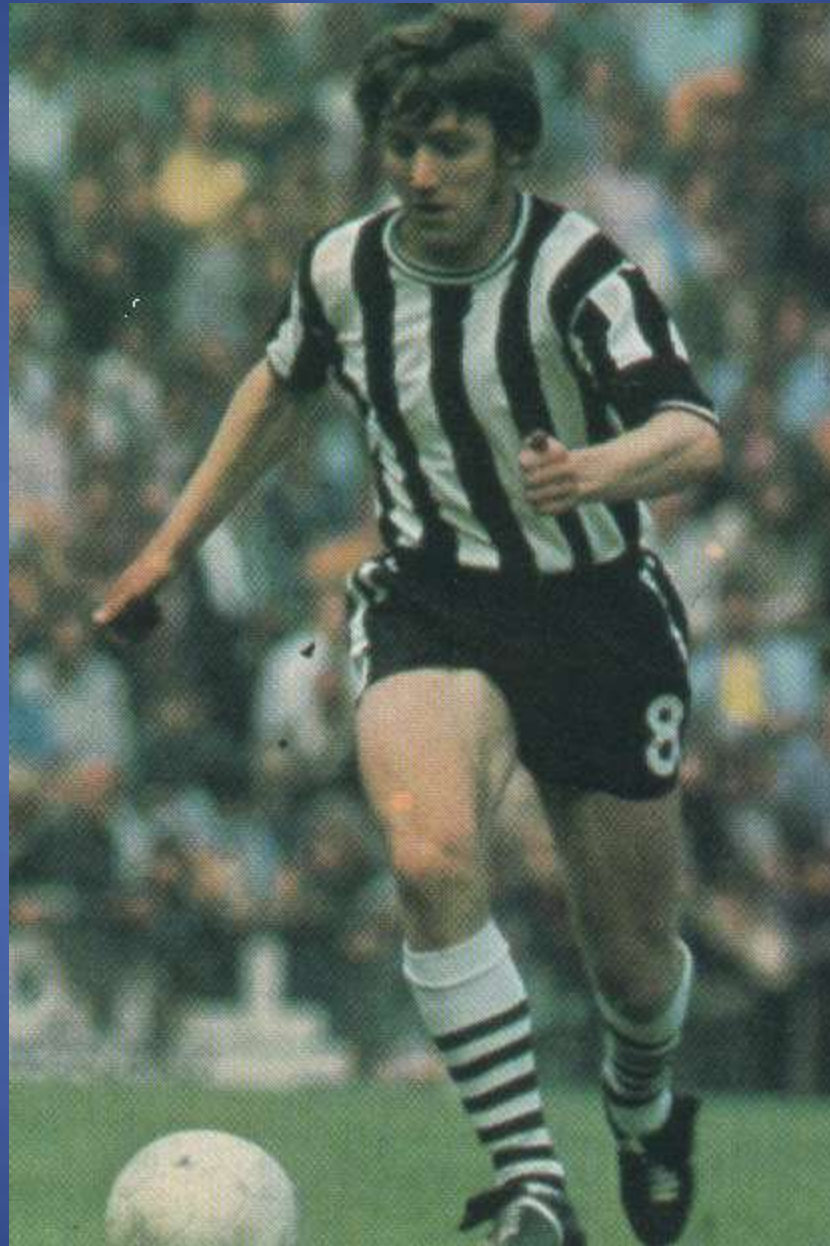
The Anterior Cruciate Ligament

Shaun O'Brien

Sunderland Royal Hospital

The most talked about 38mm in the world



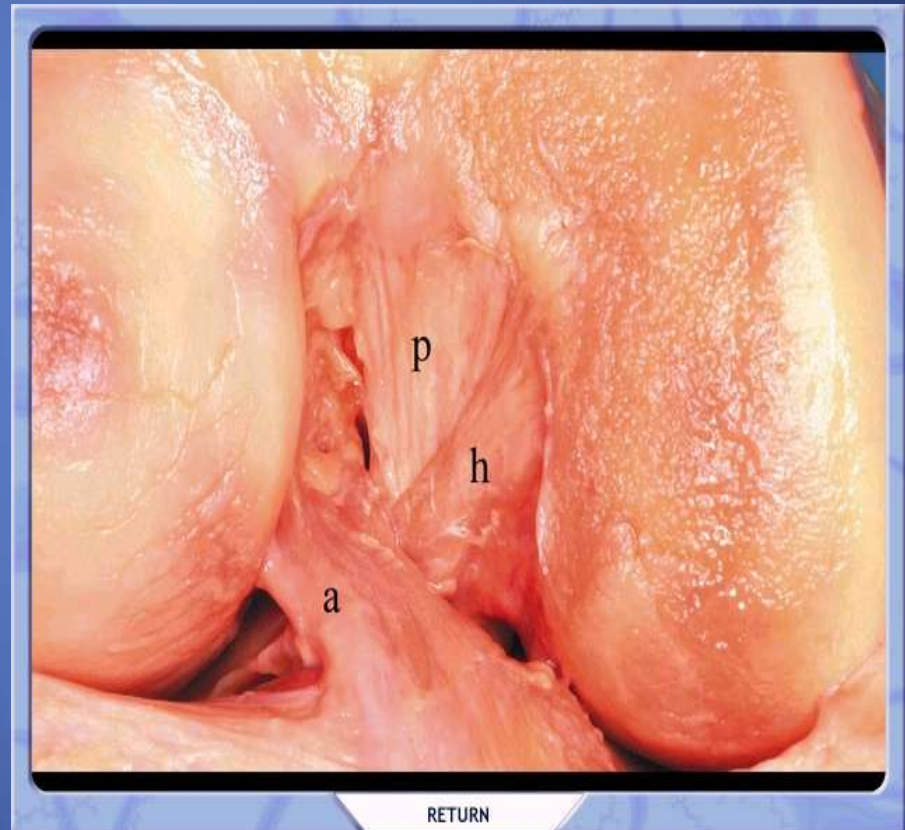






Anatomy of the ACL

- Average 38mm long
- 2160N tensile load
- 75% collagen dry wt
 - 90% type 1
 - 10% type 3
- 5% Elastin
- Middle and Inferior genicular arteries

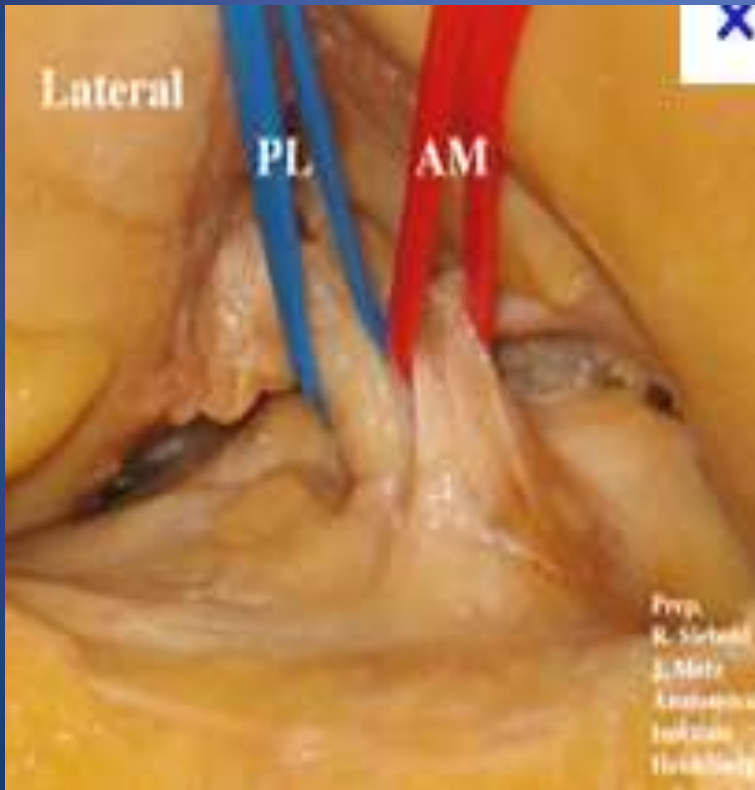


Anatomy of the ACL

- Multiple Fascicles
- Intra-articular encased in a thin synovial sheath (extra-synovial)
- Antero-medial tight in flexion
- Postero-lateral tight in extension

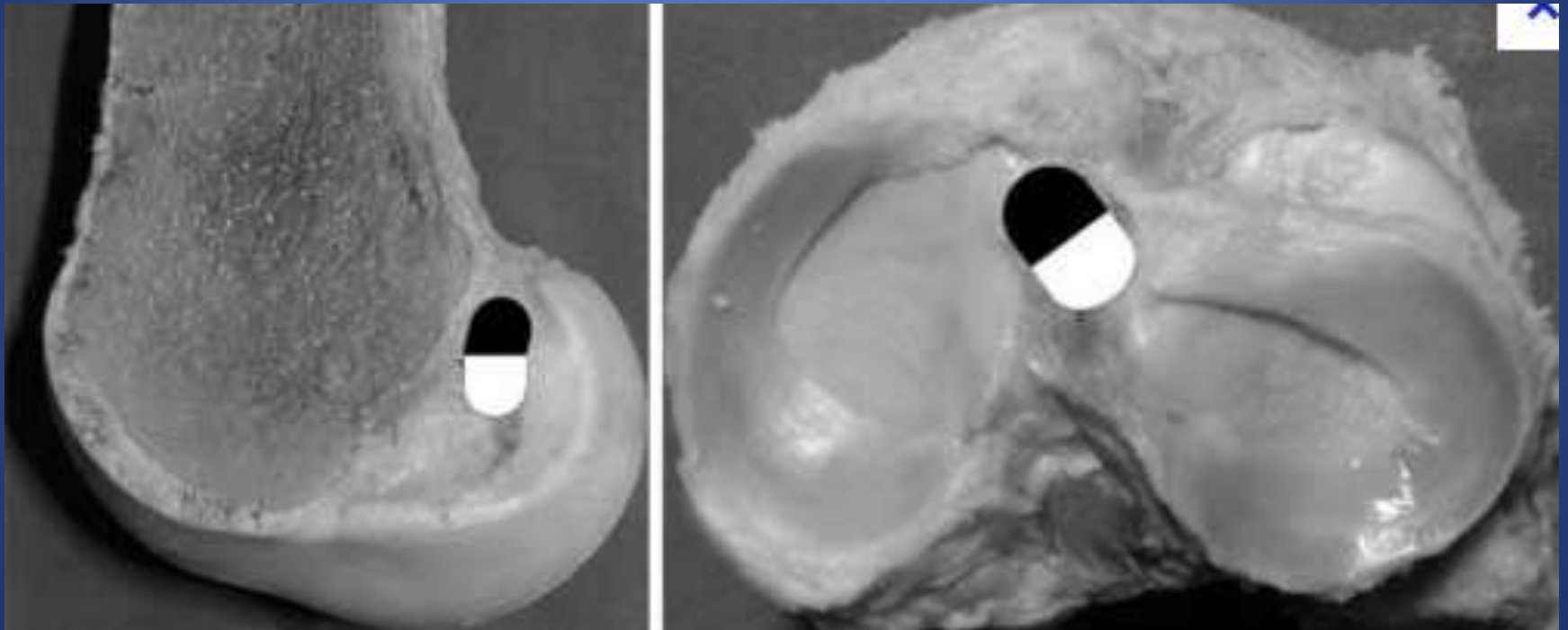


Two bundles

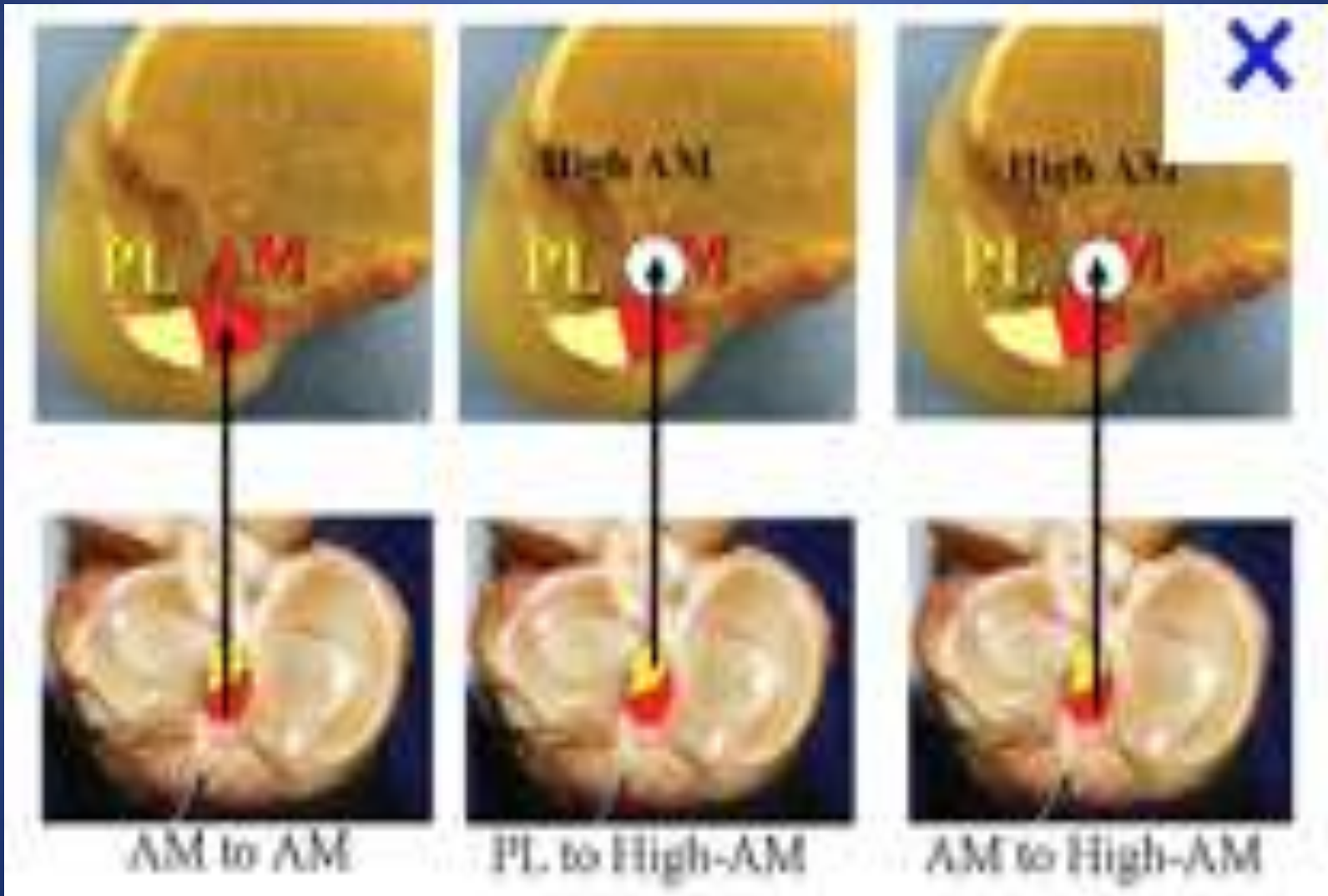


- Anteromedial is larger and tight in flexion
 - Imparts anteroposterior stability
- Posterolateral tight in flexion
 - Imparts rotational stability

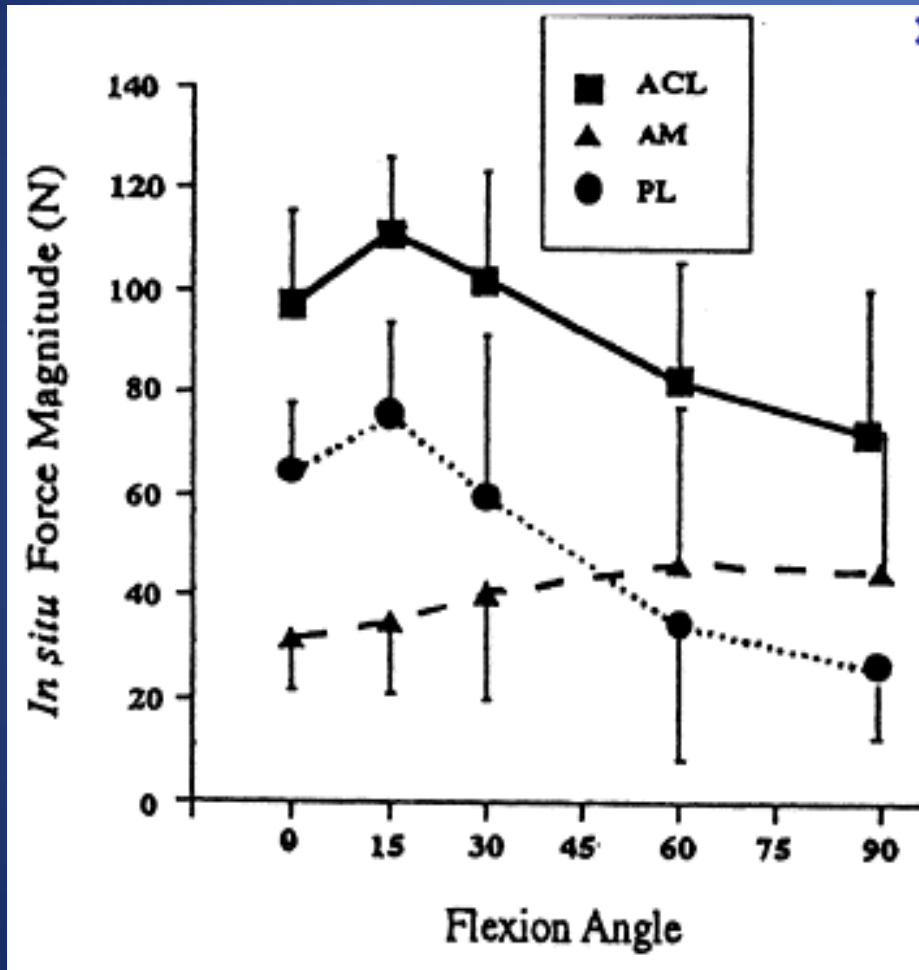
ACL Footprint



ACL footprint



Biomechanics



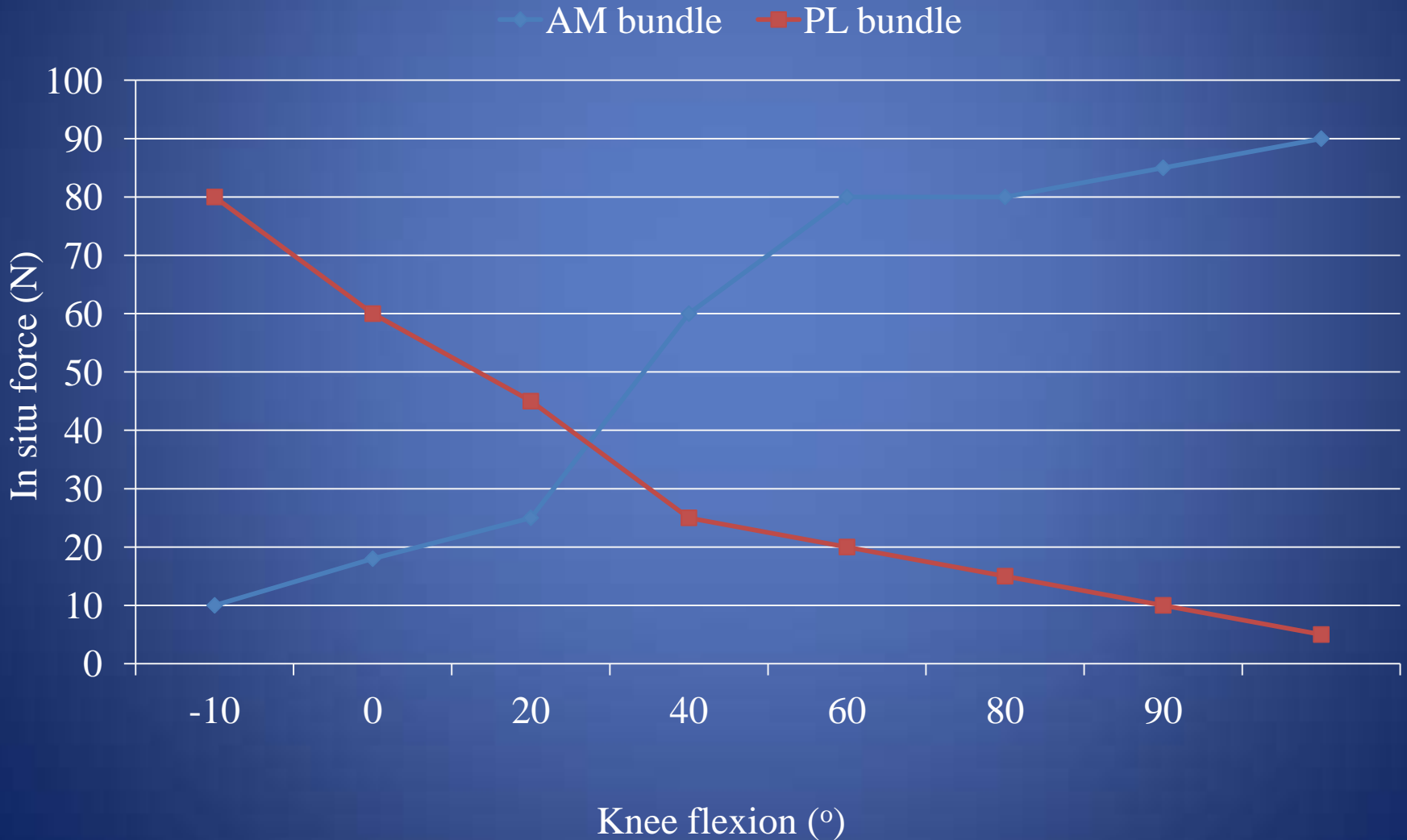
- Ultimate tensile strength
 - 1725N +/- 270N
- Stiffness
 - 242N/m – 306N/m
- Isometric
 - Greatest strain at 15 - 30 degrees
- Visco-elastic
 - Deformation is rate dependant

Two Bundles

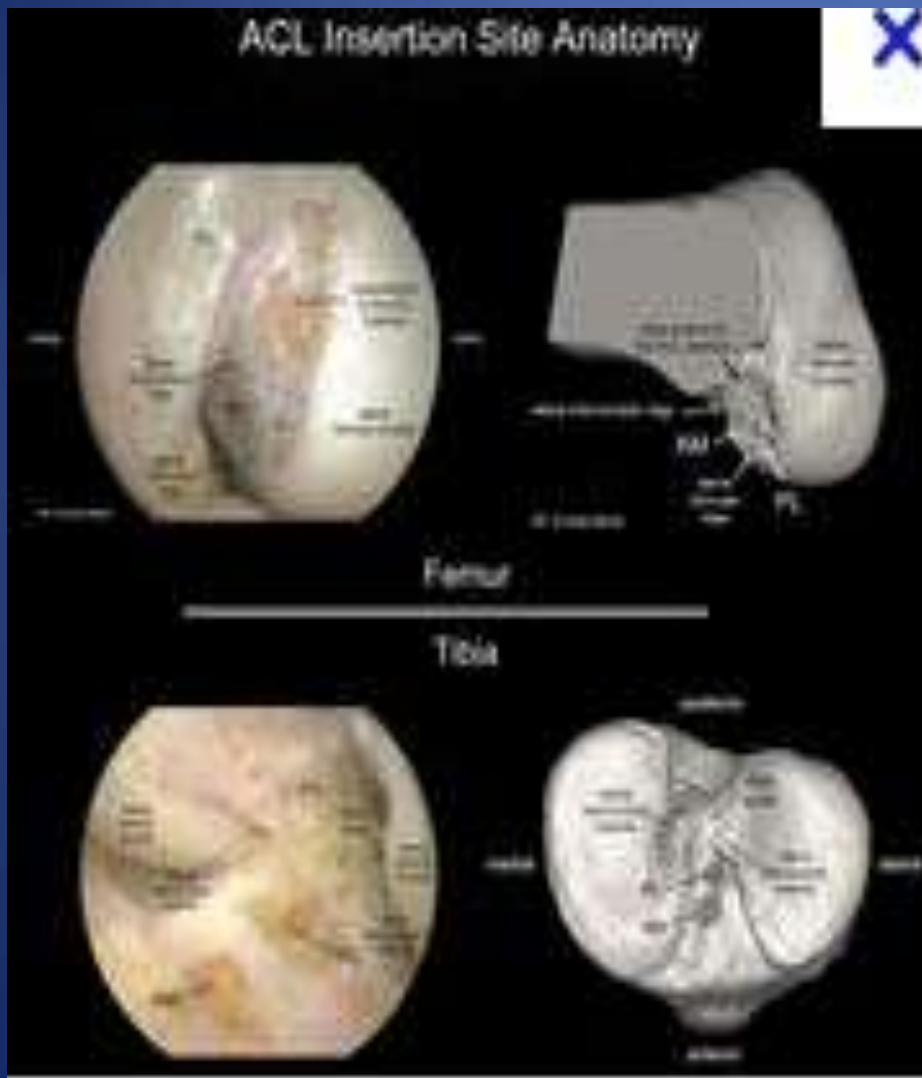
- AM and PL bundle tension is differs dependant on position of knee
- AM is taut at 90° flexion and the PL is lax
- PL taut in full extension



Tension behaviour of ACL fibers



Fiber orientation



Extension

- Fibers parallel
- Insertion is vertical

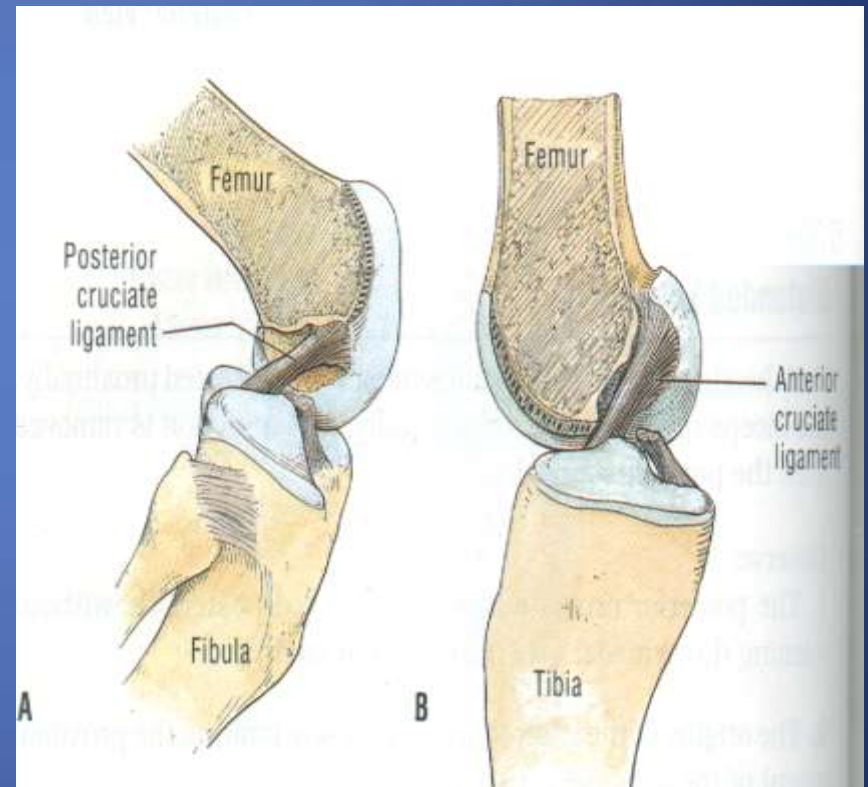
Flexion

- Fibers crossed
- Insertion horizontal

Fibers rotate 90° as they pass distal to proximal

Function of the ACL

- 1° stabiliser to ant translation
- Supported by dynamic secondary stabilisers
 - Menisci med > lat
 - Collaterals
 - Posterior Corners
- 2° stabiliser to rotation



Epidemiology

- 1 in 3,000 Americans
- 100,000 ACL ruptures annually
- 60-70,000 reconstructions per year
- 3 - 4 times greater in females for same sport
- Increasing due to
 - Increased awareness of the diagnosis
 - increased participation in sport
- Increased expectations for return to sport

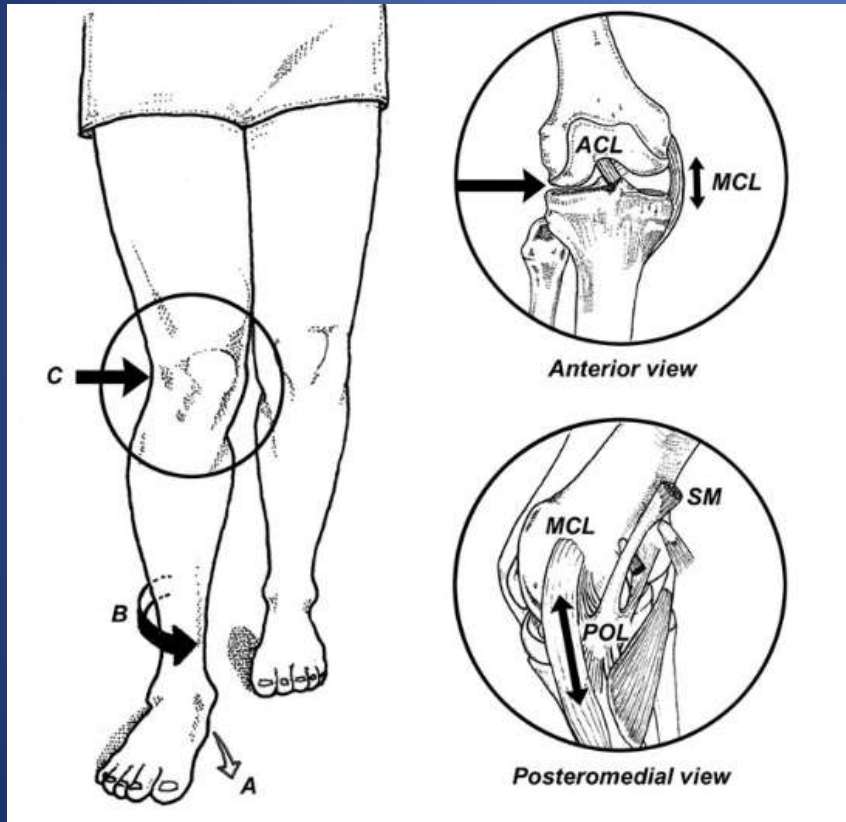
Sports involved

- Soccer
- Rugby
- Handball
- Basketball
- Sking
- Volleyball
- Netball
- Sudden pivoting
 - Plant cut manoeuvre
- Unforeseen event
 - Pre injury contact
 - Change in direction
 - Loss of balance

Mechanism of injury

- External rotation – flexion – valgus
- Internal rotation – flexion – varus
- Hyper flexion
- Hyper extension

External rotation – flexion - valgus



Why females ?

- Intrinsic/anatomical factors
 - Increased hamstring flexibility
 - Knee less stiff
 - Increased foot pronation
 - Knock knee
 - Wider pelvis
 - Hormonal
 - Oestrogen softens ligaments
 - Poorer neuromuscular control
 - Quadriceps dominant

What happens inside the knee?

- The femur externally rotates and falls off the back of the lateral tibia
 - Torn ACL
 - Lateral Meniscus Tear
 - Chondral damage to Lat Femoral Condyle
 - MCL stretched



Presentation

Chronic

- Haemarthrosis
 - Sudden onset of swelling
- Pain
- Limited motion

Acute

- Instability
- Pain
- Joint effusions
- Limited motion

Symptoms

- “ POP “ 70%
- Pain
- Swelling
- Inability to play on
- Feeling of insecurity
- Locking

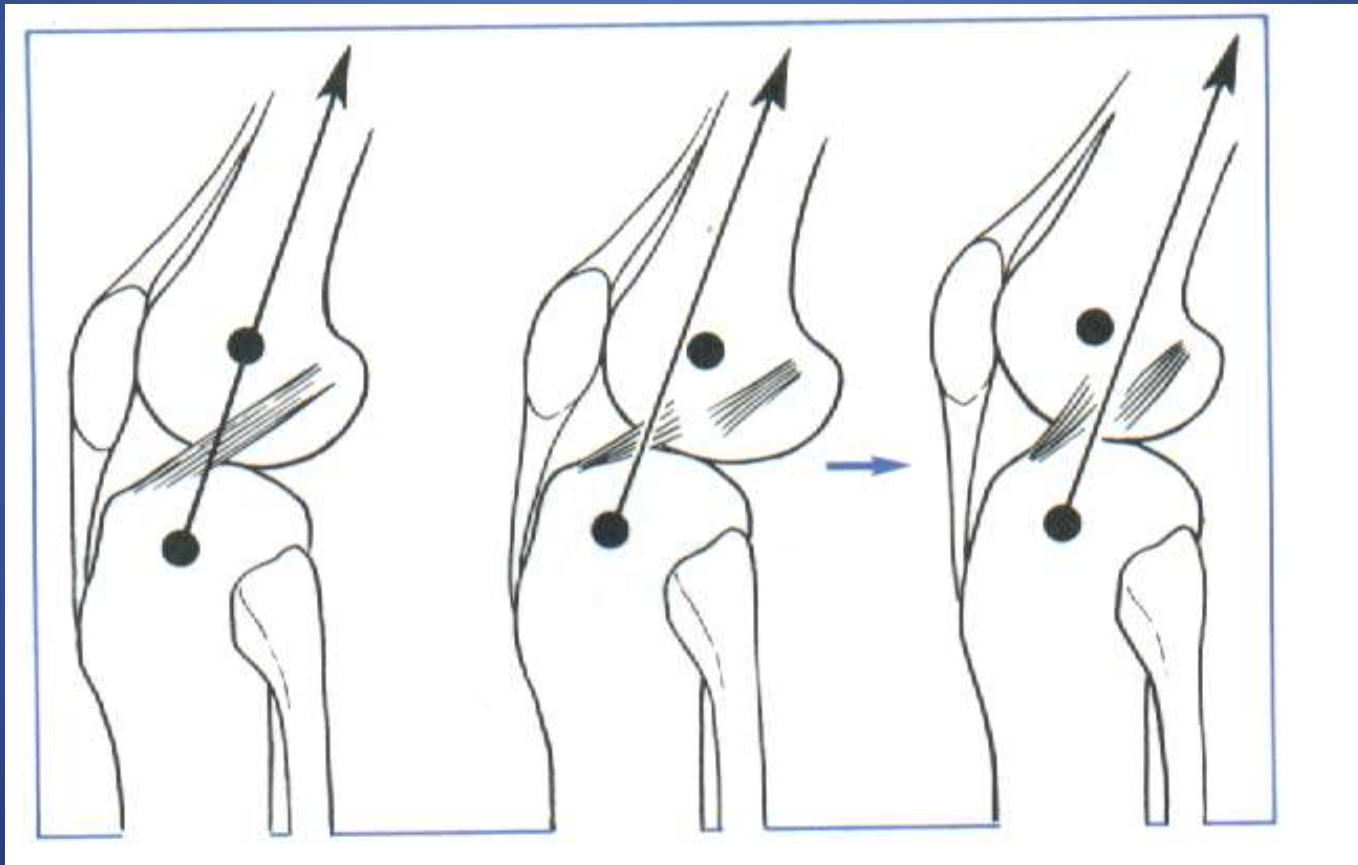
Rule of 70%

- 70% non contact
 - Landing or sharp deceleration
- 70 % hear a POP
- 70% between age of 15 and 45 years old
- Immediate swelling
 - 72% of acute haemarthrosis = ACL

Tests for ACL Insufficiency

- Lachmanns Test
 - 25° flexion
- Anterior Draw Test
 - 90° flexion
- Pivot Shift Test
 - valgus + int. rotation
 - extension into flexion

Lateral Pivot Shift Test



Investigation

- Plain X-Rays
 - Rule out OA
 - Rule out any other pathology
 - Segond lesion



MRI scan

- Not essential
- Useful for other pathology
- Multi-ligament inj
- Diagnosis in doubt



Multi ligament Injury



Do all ACL injuries need
reconstructed ?

Non Operative Treatment of the Torn ACL

- 24 patients with high levels of instability
- One year hamstrings strengthening
- 14 returned to pre-injury sport
- No OA on X-Ray

Giove TP. JBJS 65-A 184-192, 1983

Non-operative treatment of severe injuries to the Medial and Anterior Cruciate Ligament of the Knee

- 28 patients ave 3 years follow up
- 11/15 contact sports returned to sport
- 6/9 non-contact sport returned to sport
- Instability was exclusion from study

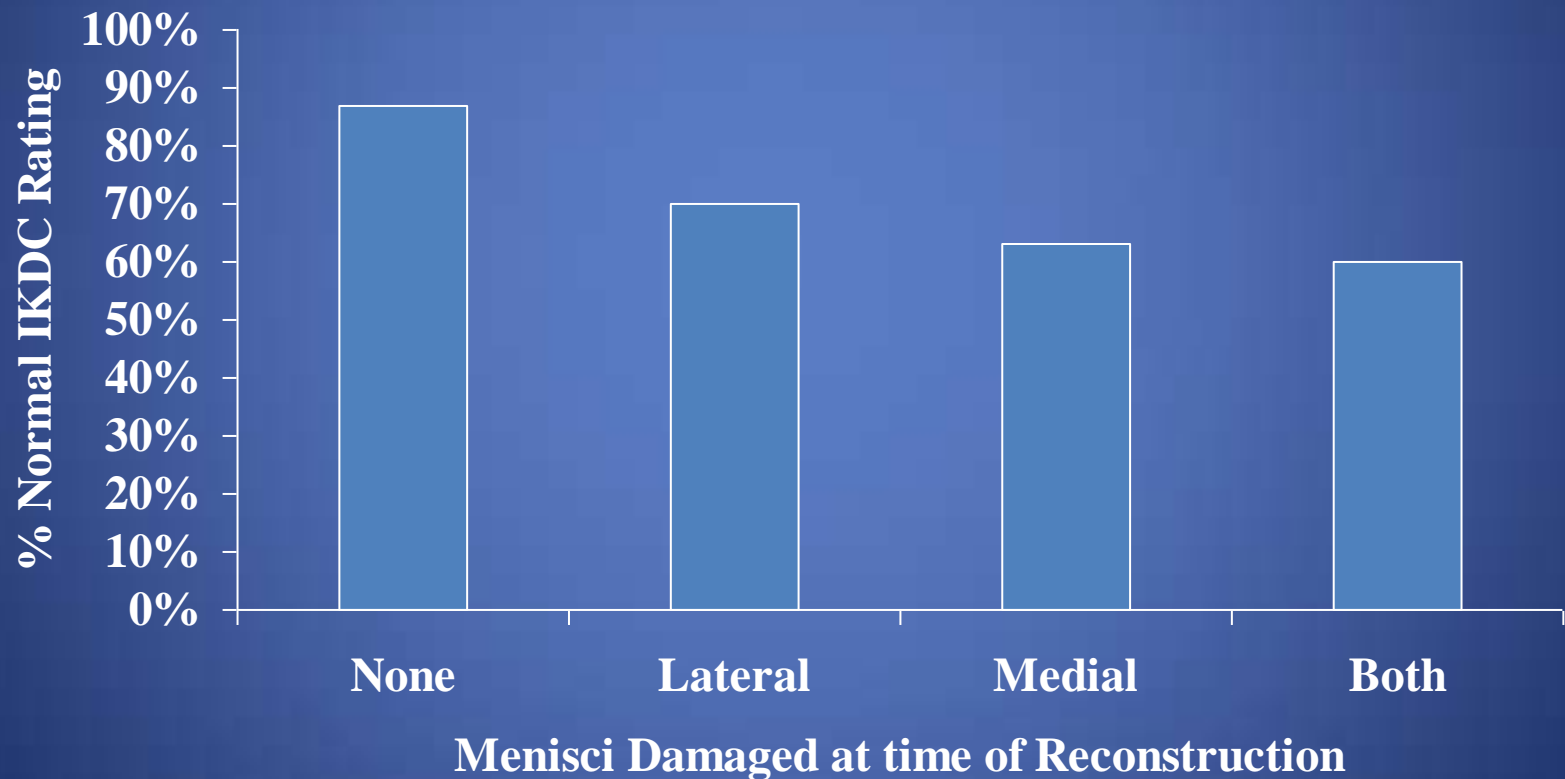
Non-operative treatment of ruptures of the ACL in Middle Aged Patients

Results after long term follow-up.

- 52 patients aged 40-60 with ave 7 yr fu
 - 97% grade 2-3 Lachmanns
 - 83% +ve pivot shift
 - 87% no X-ray changes
 - Ave 82 points on Lysholm Score
 - 83% satisfied

Ciccotti M. JBJS 76-A 1315-1321, 1994

Results of Anterior Cruciate Ligament Reconstruction Based on Meniscus and Articular Cartilage Status at the time of Surgery. Five to fifteen- year evaluations.
Shelbourne KD. AJSM. 28, 446-452, 2000



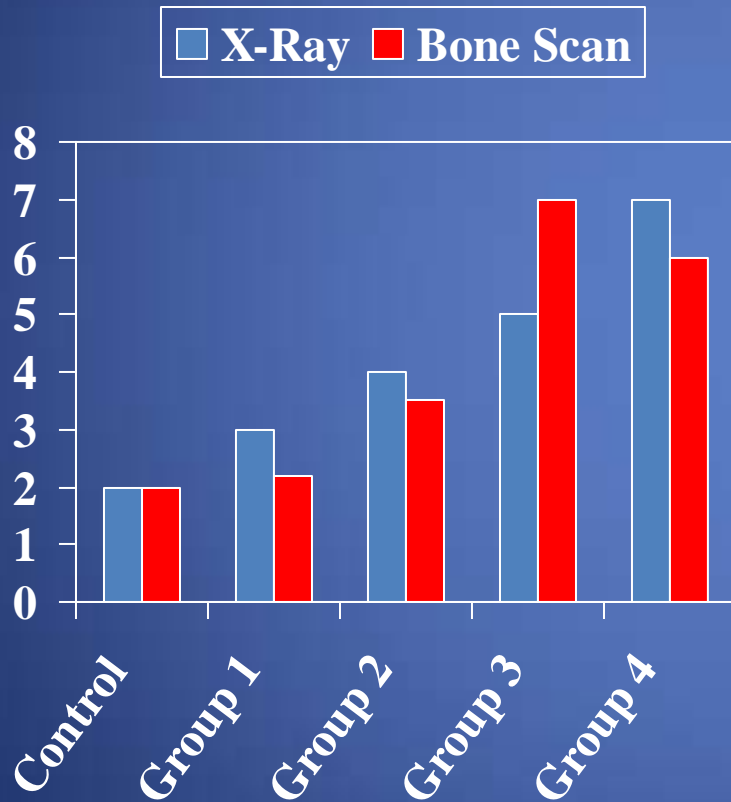
What happens inside the knee?

- The femur externally rotates and falls off the back of the lateral tibia
 - Torn ACL
 - Lateral Meniscus Tear
 - Chondral damage to Lat Femoral Condyle
 - MCL stretched



Fate of the ACL-Injured Patient

A prospective outcome study



- Hours of sport, participation level and instability predictive of need for surgery.
- Meniscectomy rate
 - 4% group 3
 - 20% group 4

Daniel AJSM 22: 632, 94

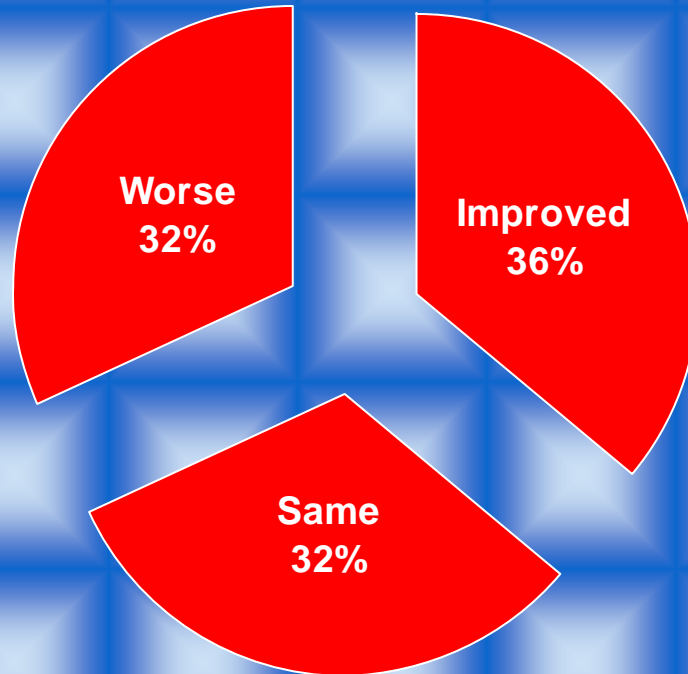
The effects of time course after ACL ligament injury in correlation with meniscal and cartilage loss.

- 130 ACL Reconstructions
- Meniscal and Articular Cartilage assessed
- Injury 2 year old lead to 6 fold increase in cartilage loss
- Injury 2 year old and meniscal damage lead to an 18 fold increase in cartilage loss

Murell G AJSM Nov 2001

The Symptomatic Anterior Cruciate-Deficient Knee

Part 2: The results of rehabilitation, activity modification and counseling



The Symptomatic Anterior Cruciate-Deficient Knee

Part1: The long term functional disability in athletically active individuals

- 103 athletes reviewed at ave 5.5ys post injury
- 82% returned to sport within 3 months
- 35% second injury by 6 months, 51% at 1yr
- 35% participating in strenuous sport at 5 yr

Noyes FR JBJS 65-A 154-162, 1983

Meniscal cartilage pathology

- 10% per year in an ACL incompetent knee
- 40% at 1 year
- 60% at 5 year
- 80% at 10 year

Levy 2003

Indications

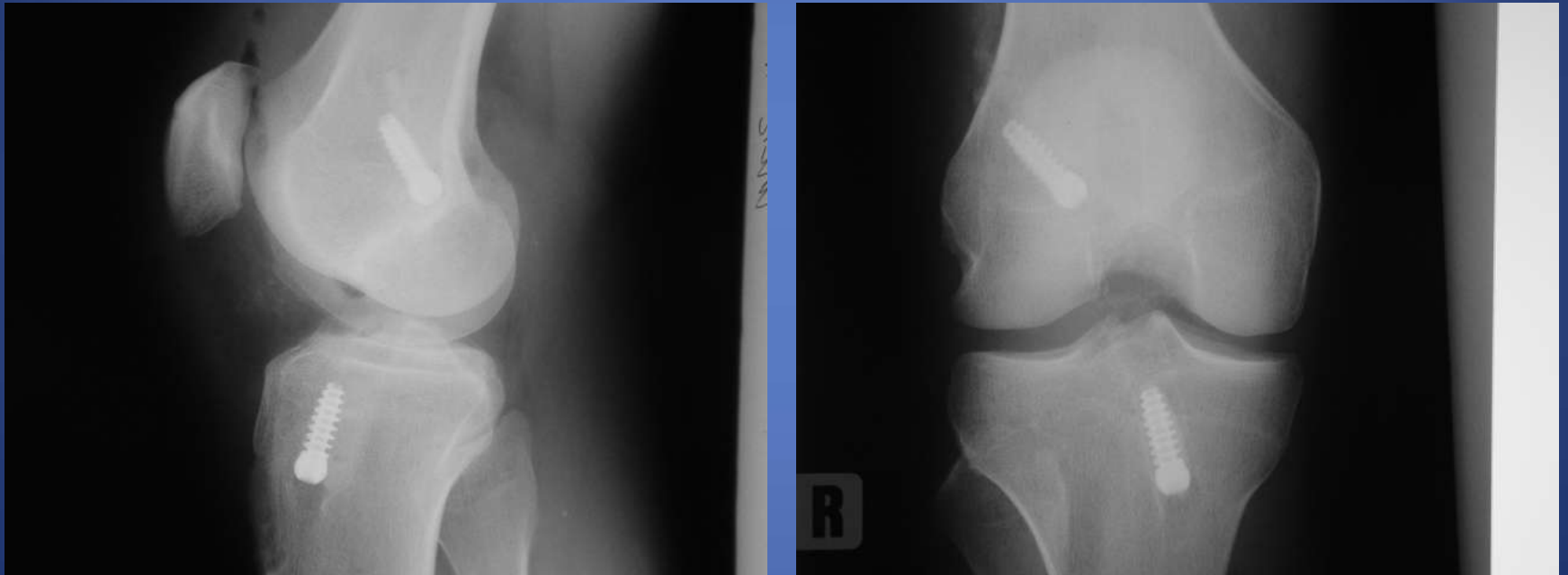
Absolute

- Multi ligament instability
- Professional athletes
- Active casual athletes
- Functional instability
- Occupation
 - Roofer
- Subjective instability
 - One leg hop test = 80%

Relative contra indications

- Underlying OA
- Advanced age
- Open growth plates
- Neuro muscular disease
- Hyperlaxity
- Marked malalignment
- Body weight

ACL Reconstruction



Timing

- Little or no effusion
- Flexion to 110°
- Little extension deficit
- Little joint line tenderness
- Cool joint
- Able to weight bear

Aims of Reconstruction?

To replace the damaged ACL with an anatomically accurate substitute of a similar or stronger biological nature.

Grafts Available

- Autografts
 - Bone Patella Tendon Bone
 - Four Strand Hamstrings
 - Quadriceps Tendon
- Allografts
 - Bone Patella Tendon Bone
 - Achilles tendon
- Synthetic Grafts

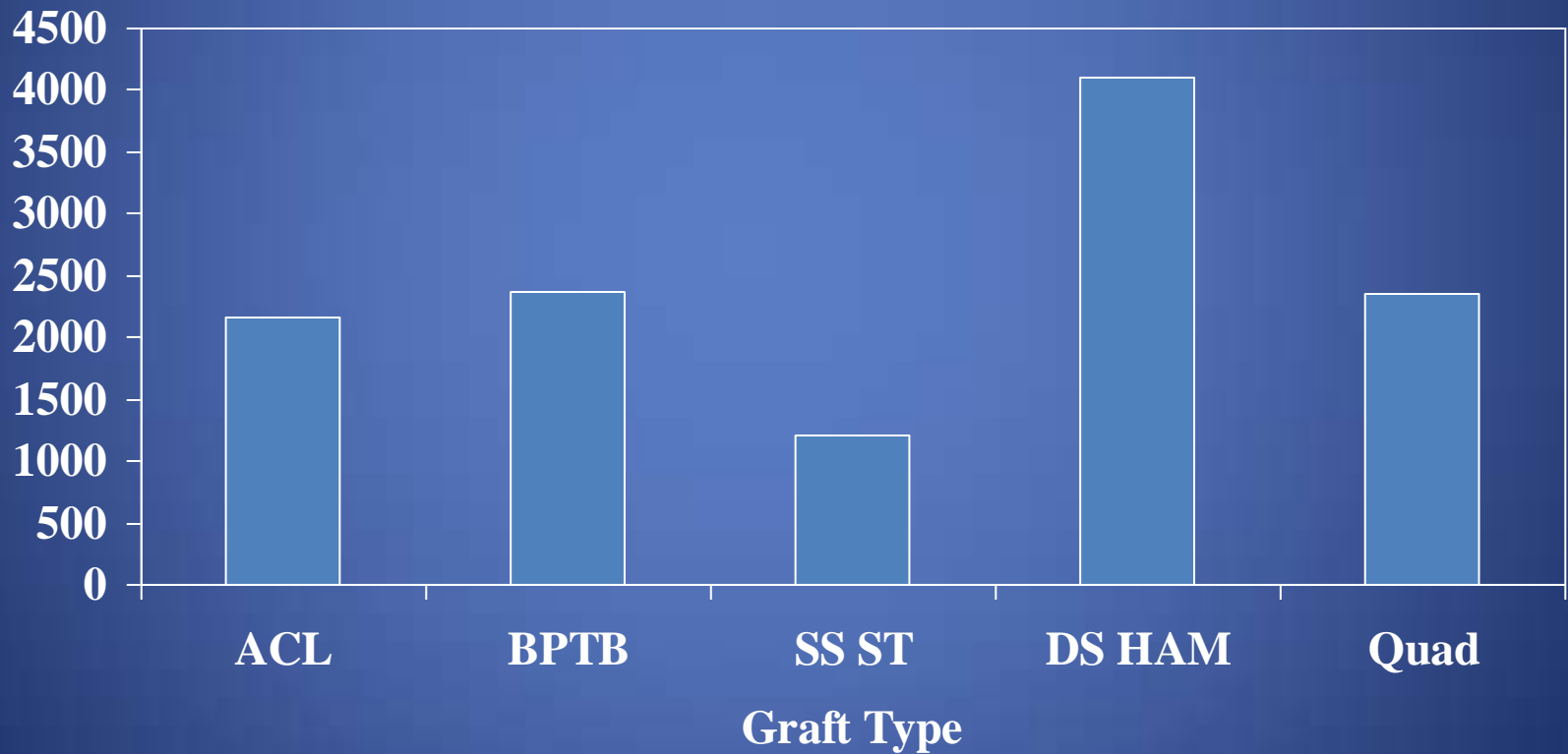


Issues with Graft Selection

- Graft strength
- Graft Fixation
- Graft Healing
- Donor site morbidity
- Rehabilitation rate

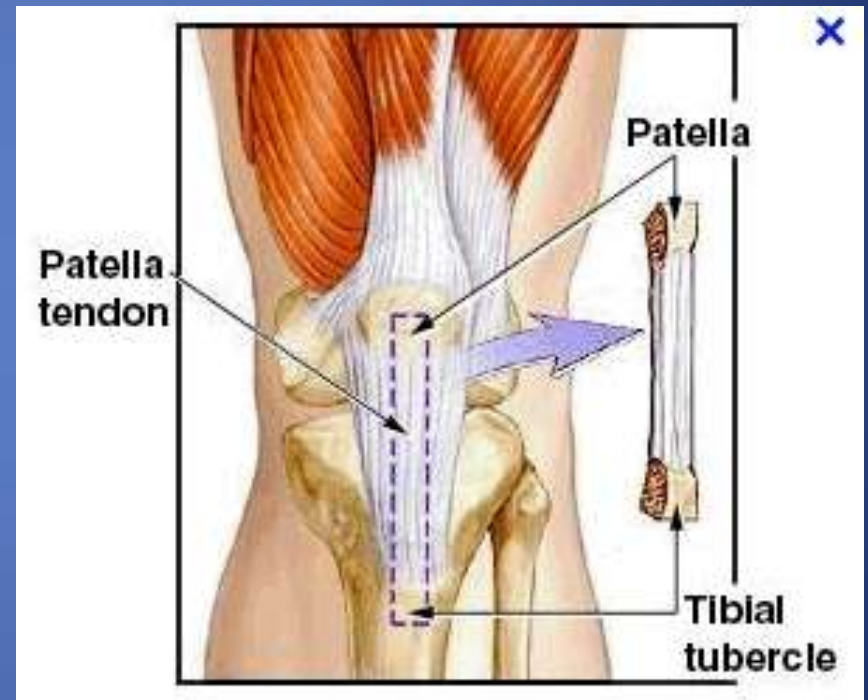


Ultimate Tensile Load (N)



Always have a fall back graft

- Hamstrings
- Bone Patella Bone
- Quadriceps
- Allograft
- Synthetic



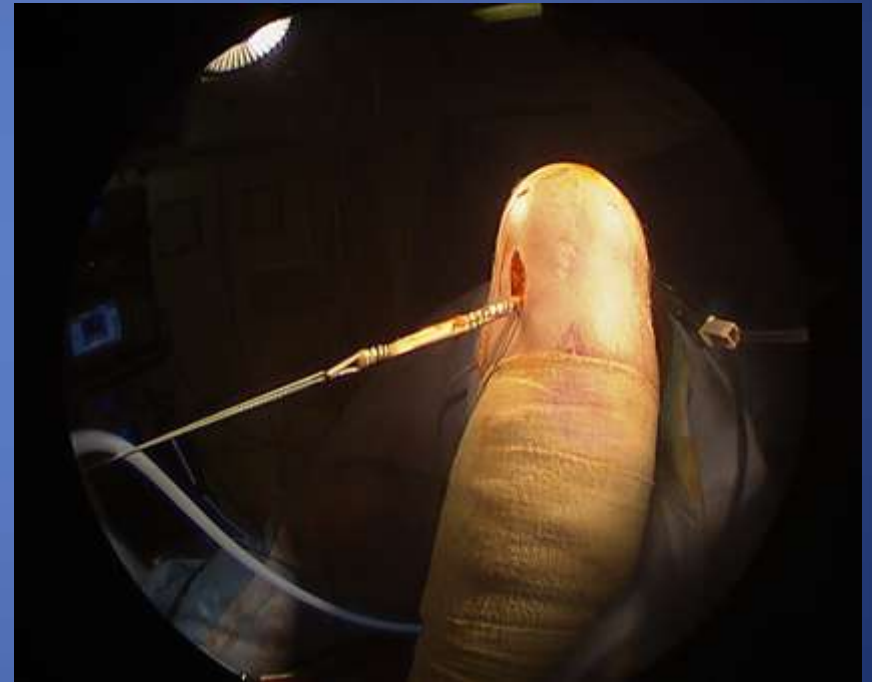
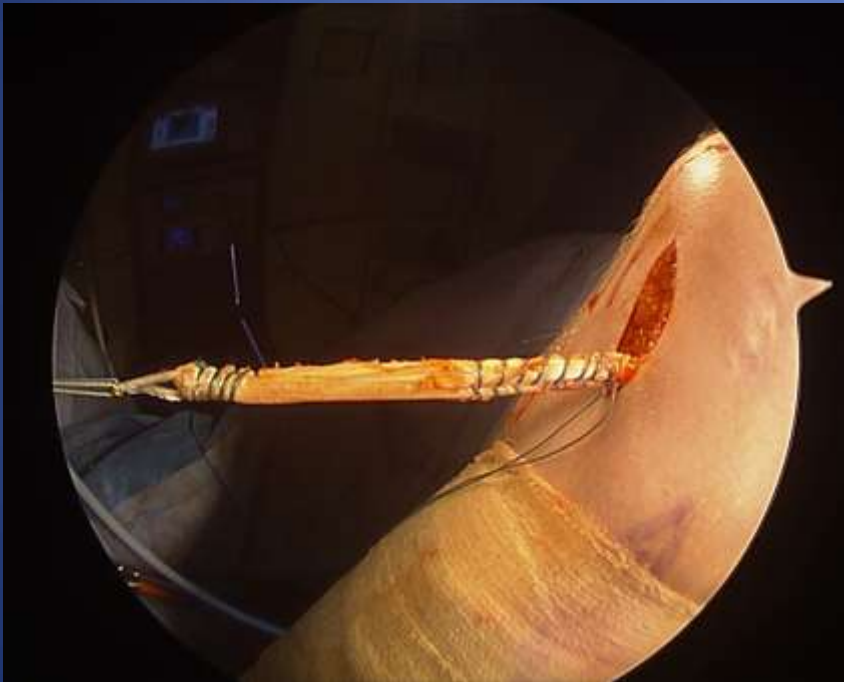
Pre-reconstruction arthroscopy



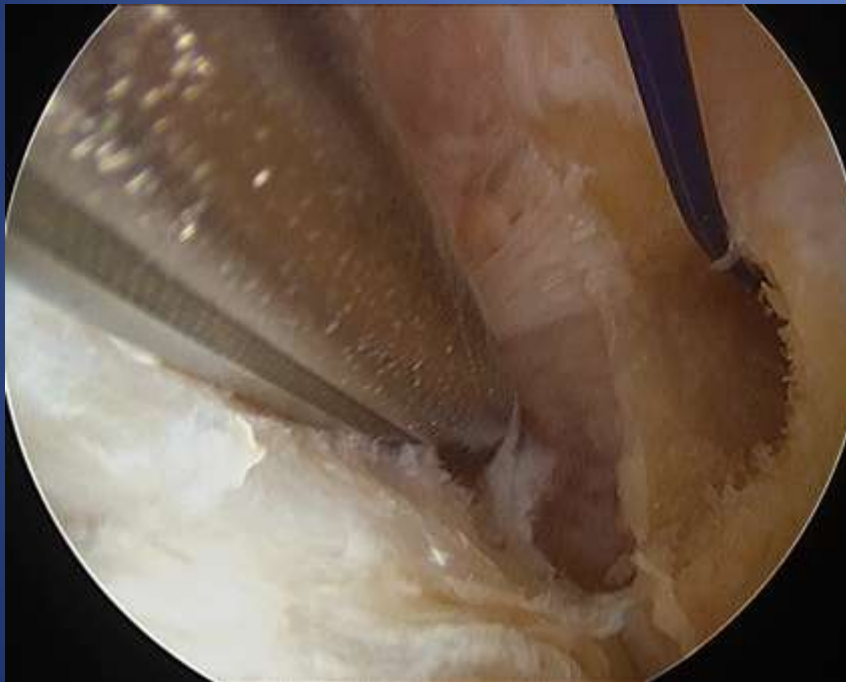
Empty lateral wall sign



Graft harvest – quadruple hamstrings



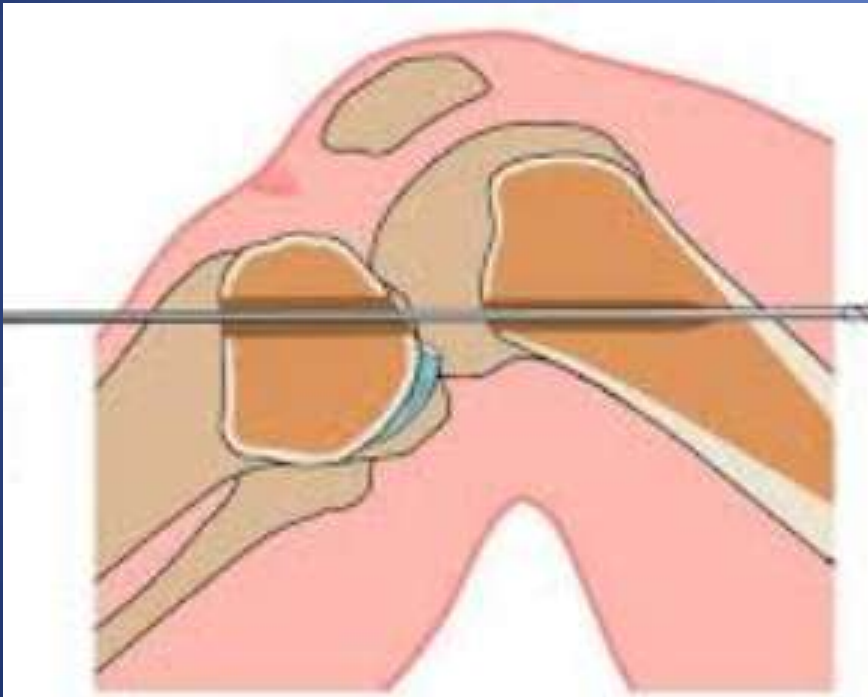
Tunnel Placement

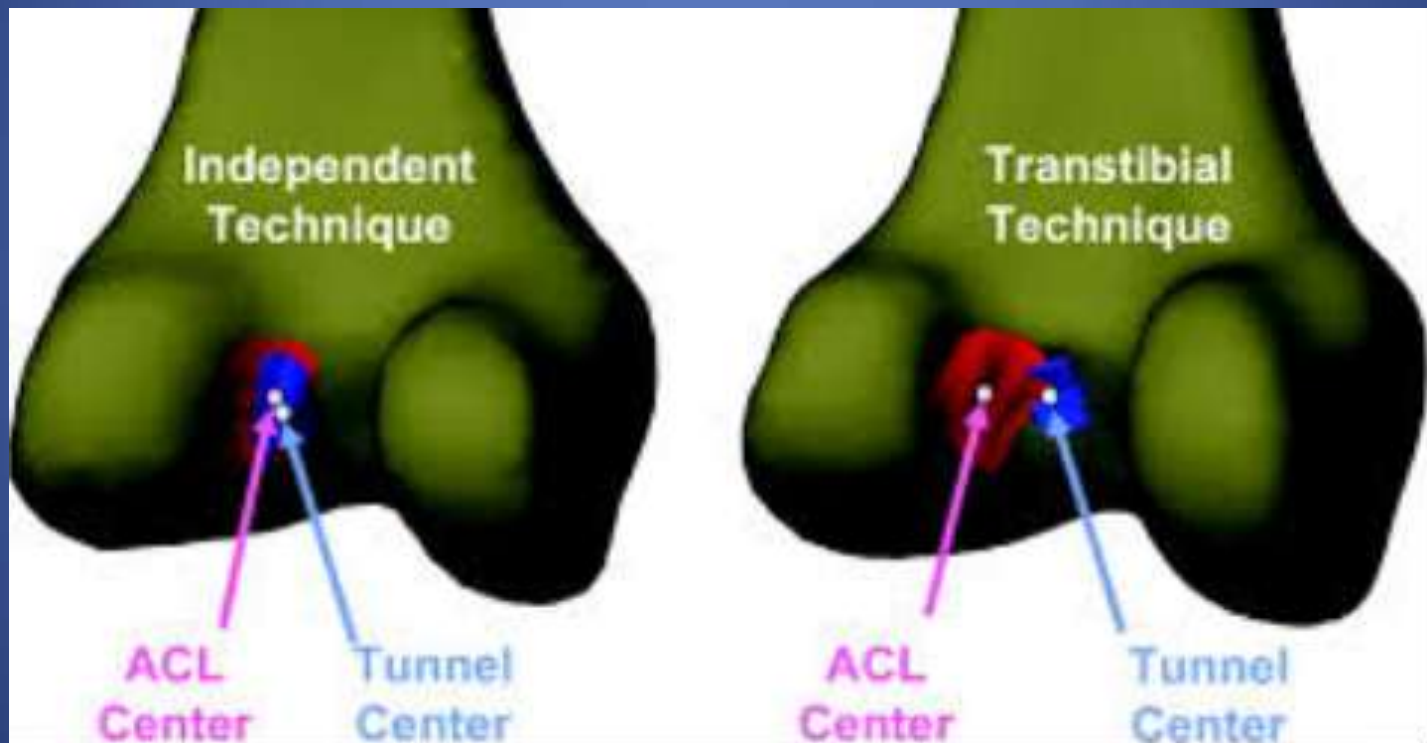


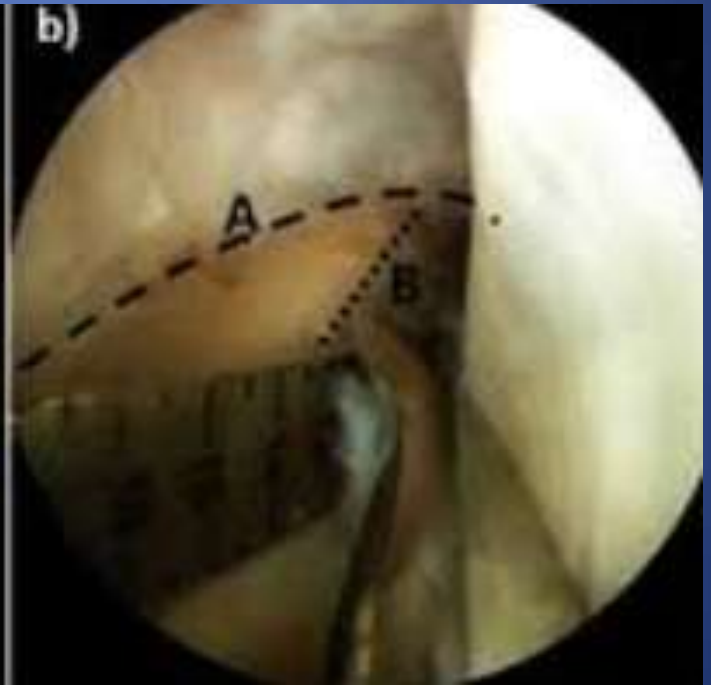
Trans tibial tunnels



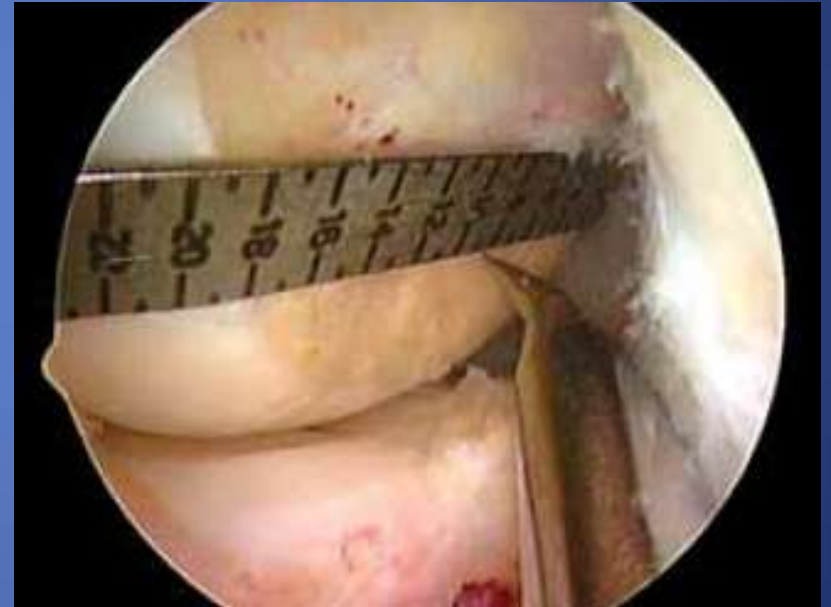
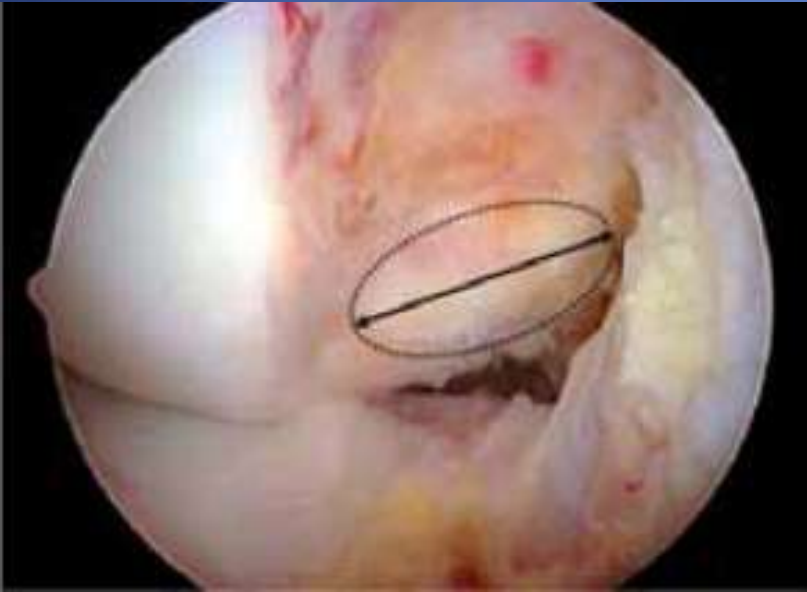
Trans tibial tunnels



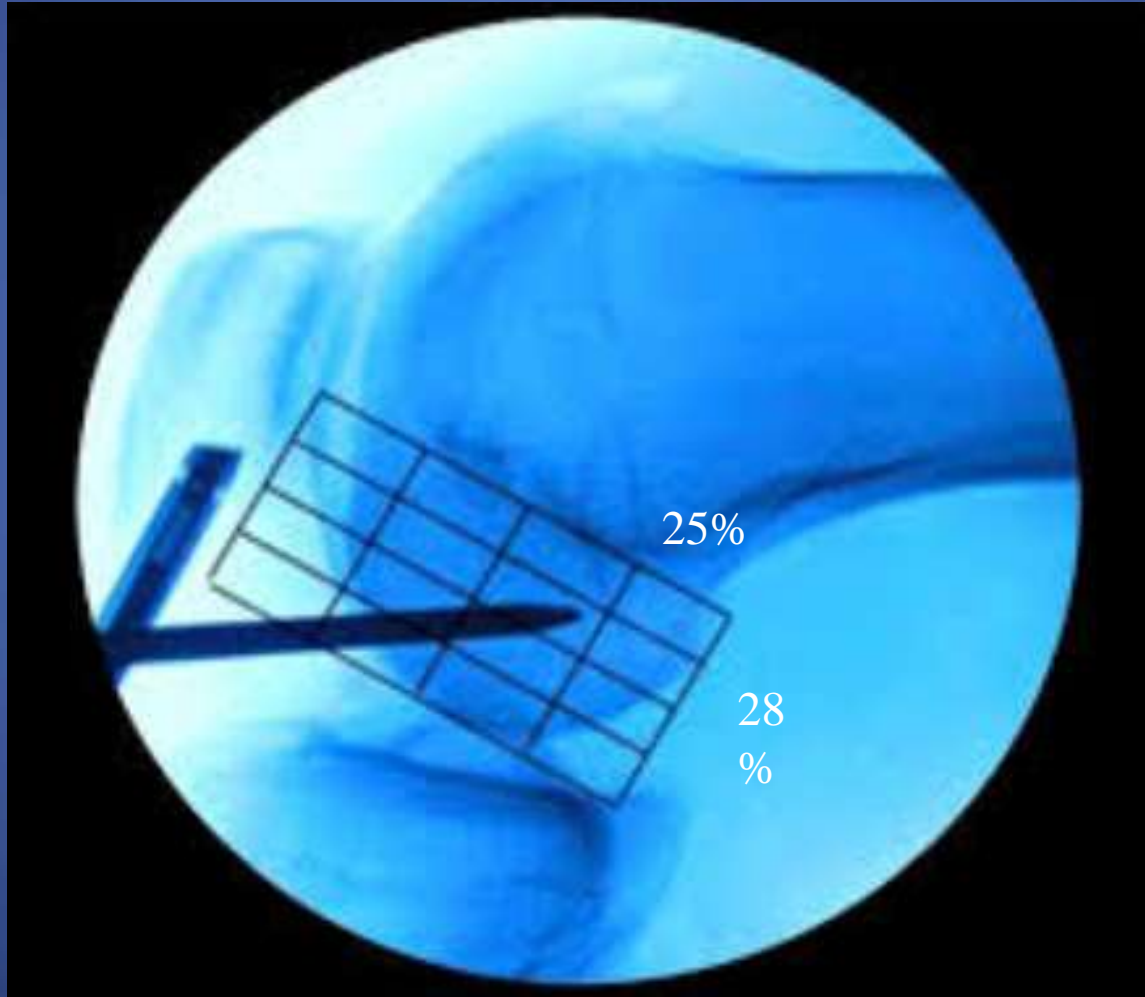




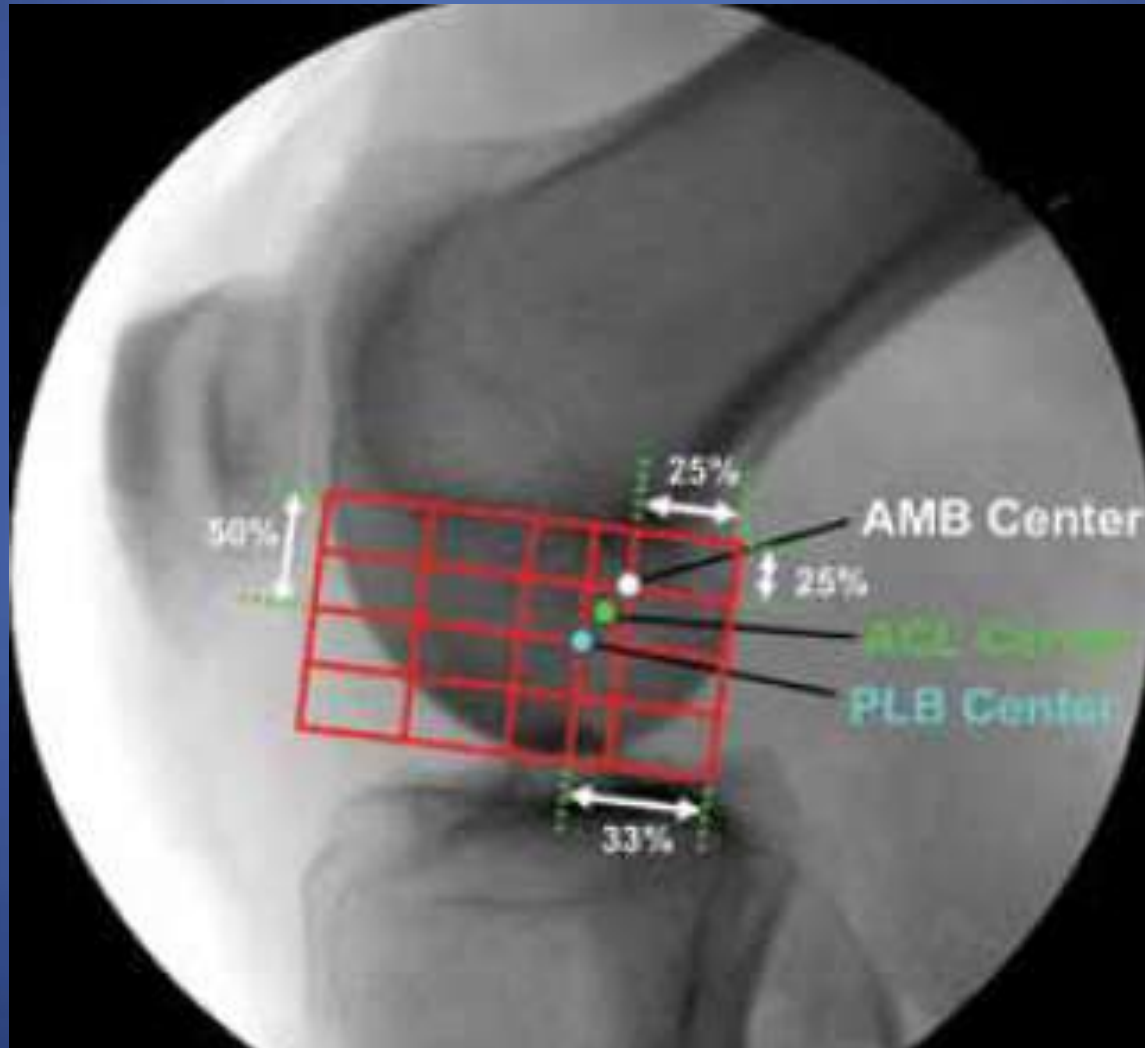
Ruler technique



Bernard and Hertel Grid -1996



Grid technique



Accessory medial Portal

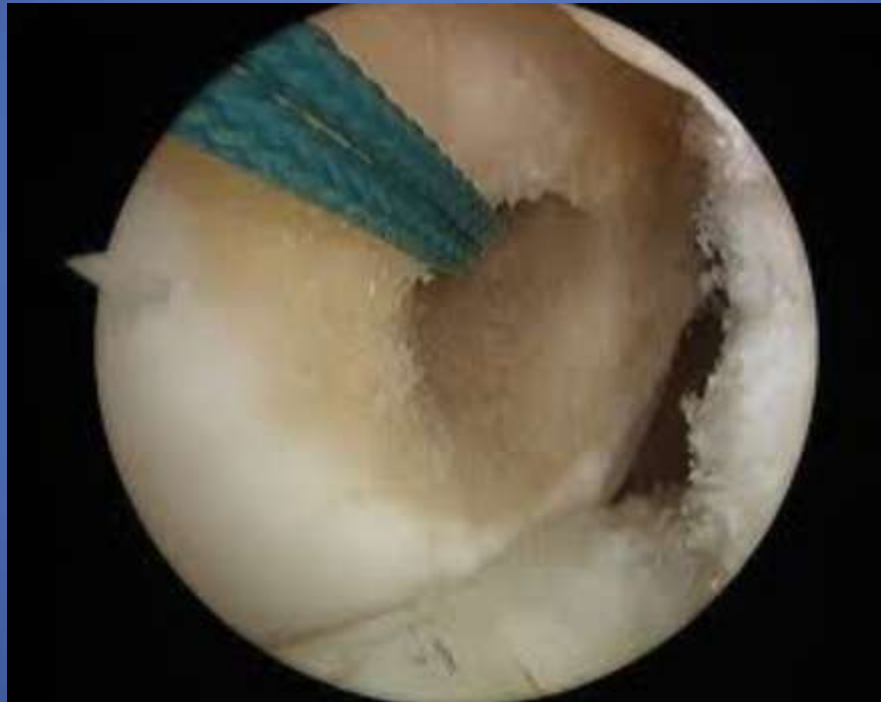




Figure 4A

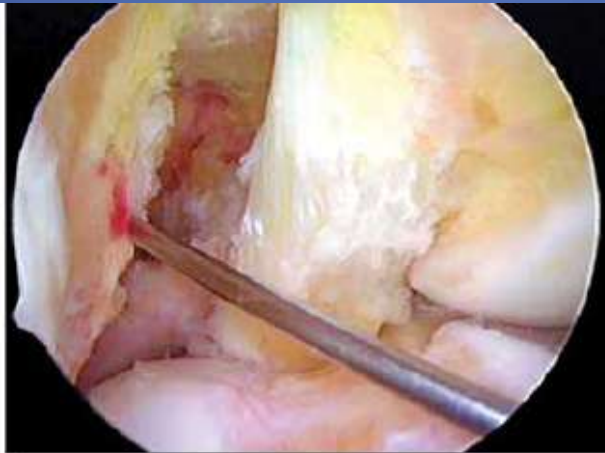
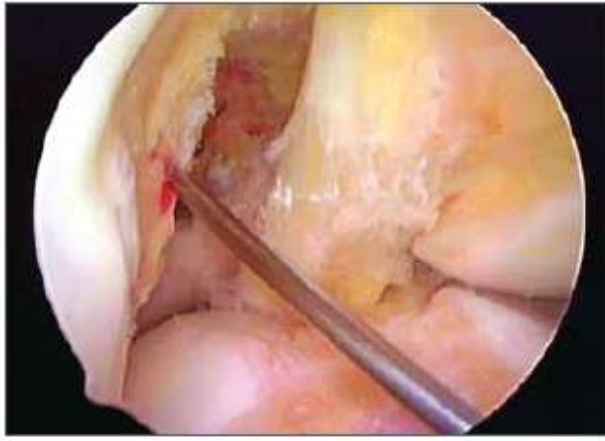


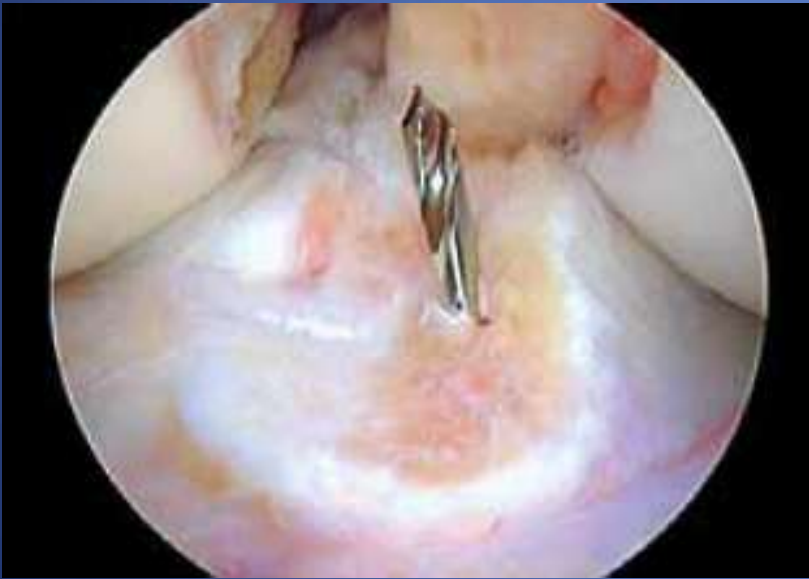
Figure 4B

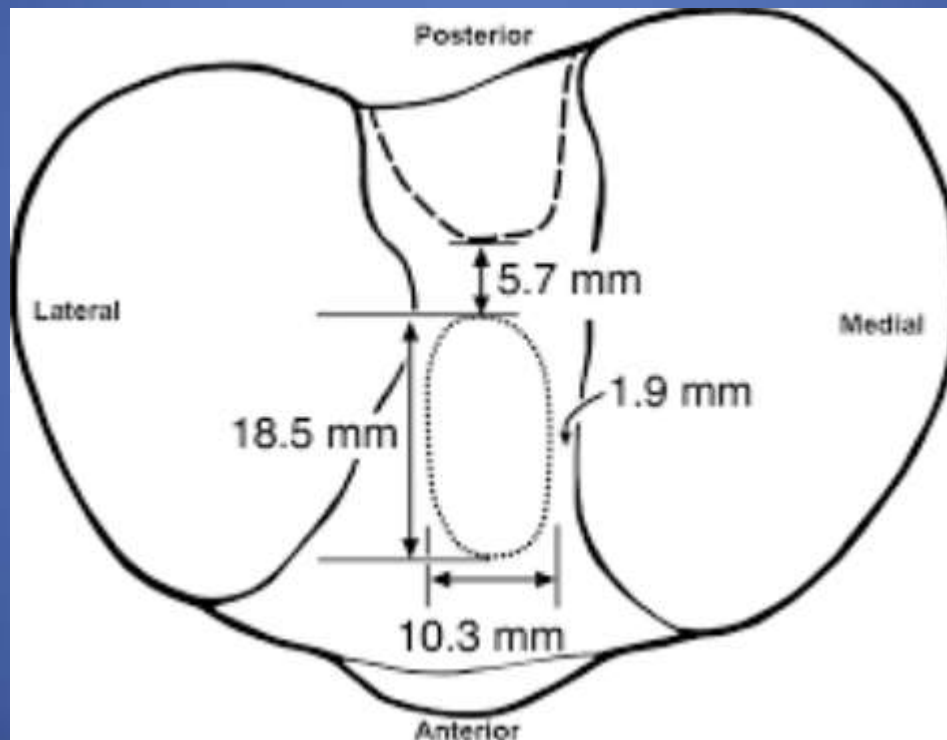


Figure 4C



Tibial Tunnel Placement

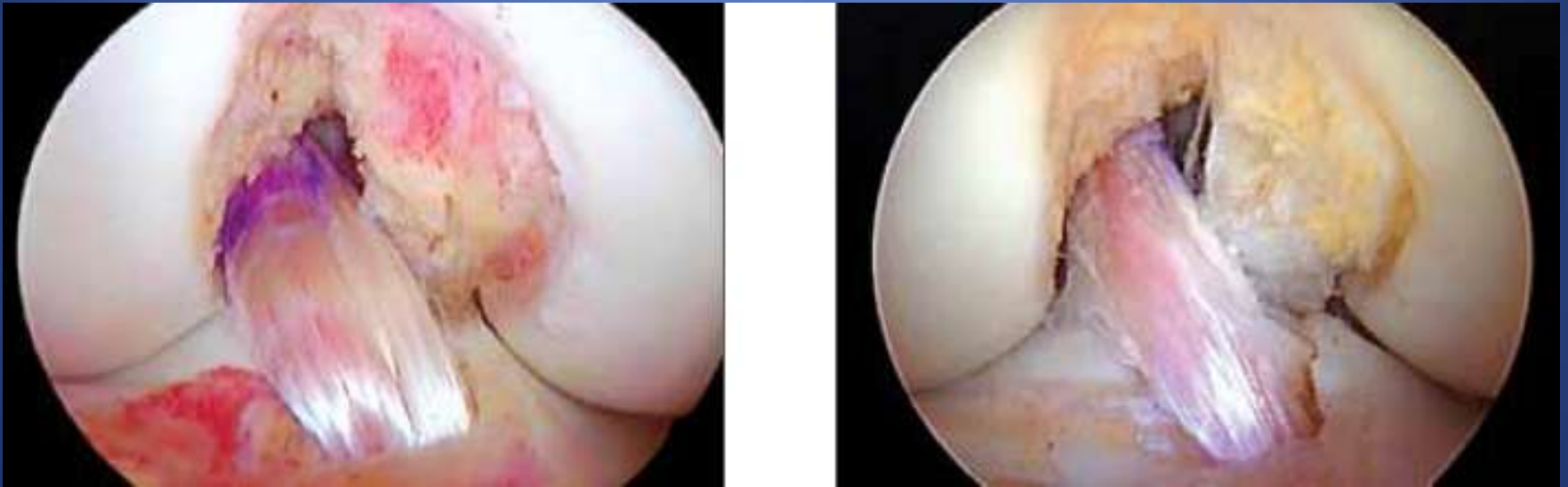




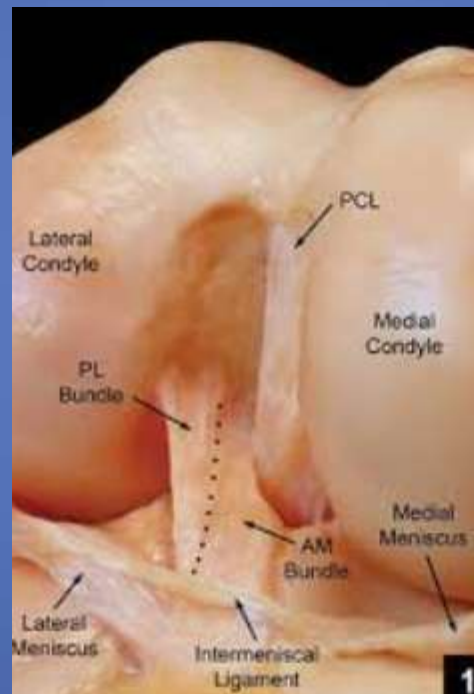
Where to tension the graft ?

For femoral tunnels placed:	Tension the ACL graft at:
Near the center of the AM attachment site	45°
Near the center of the ACL attachment site	20–30°
Near the center of the PL bundle	0°

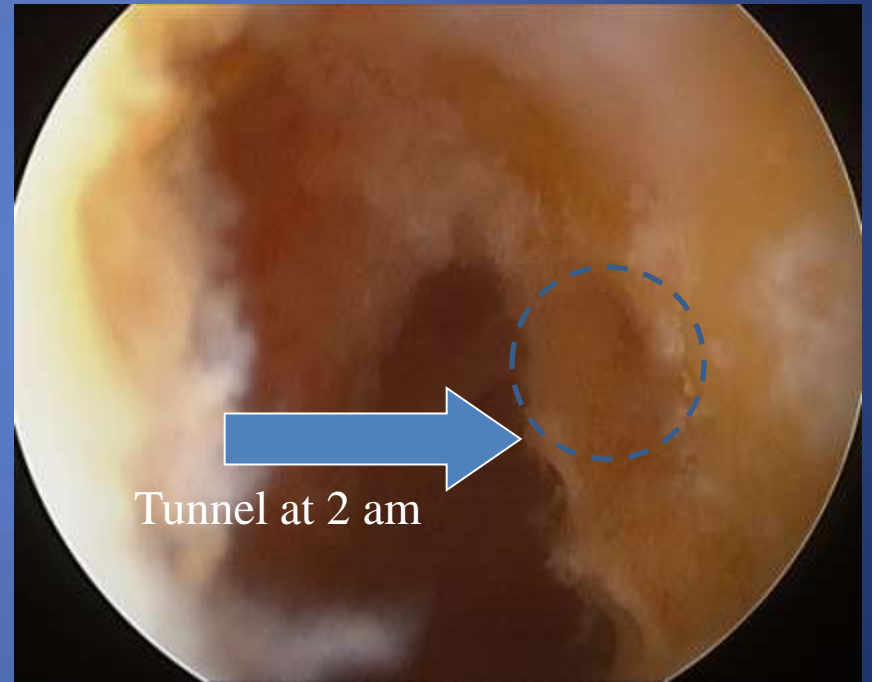
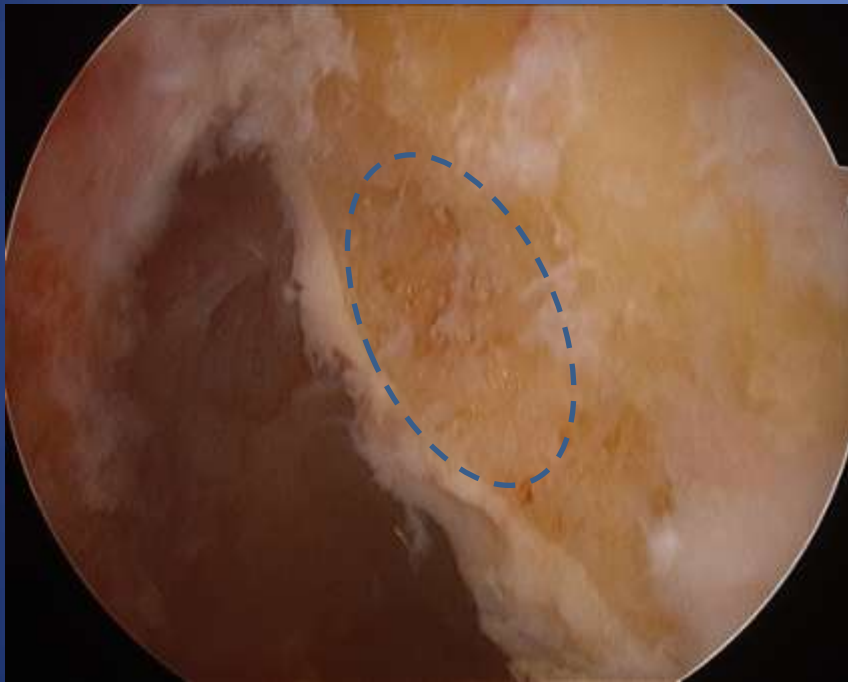
Anatomic ACL



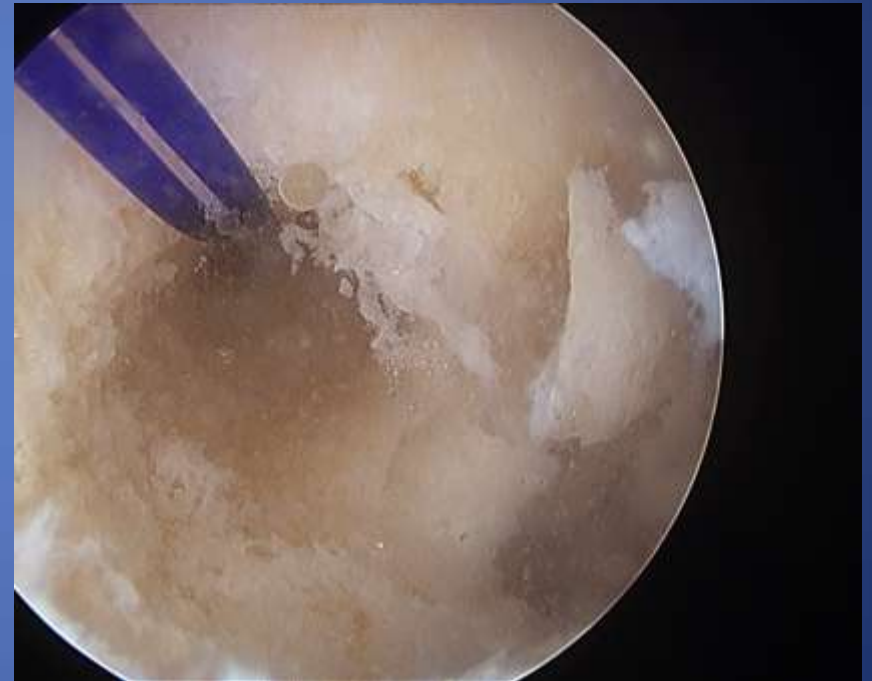
Native ACL



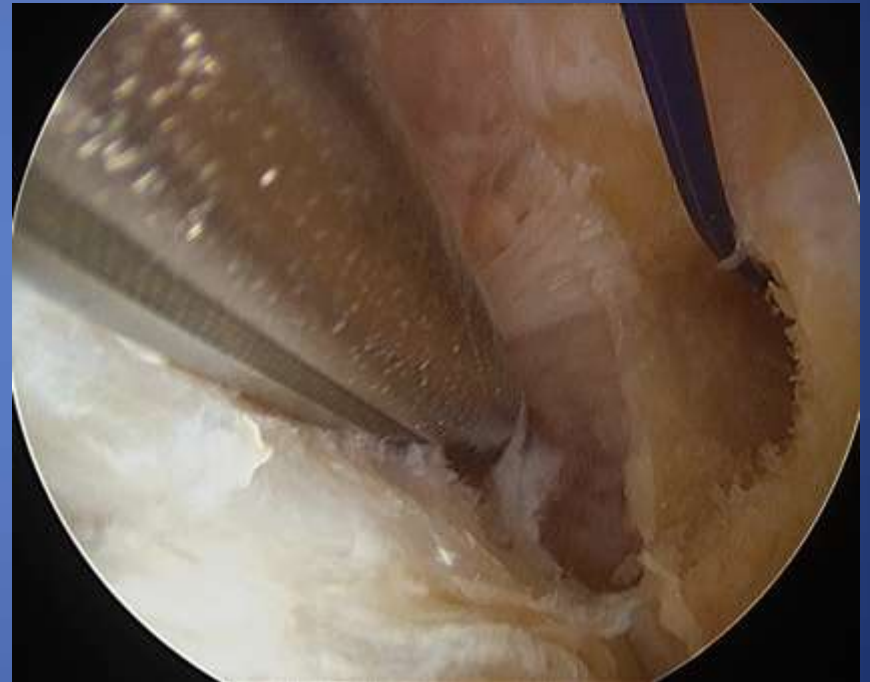
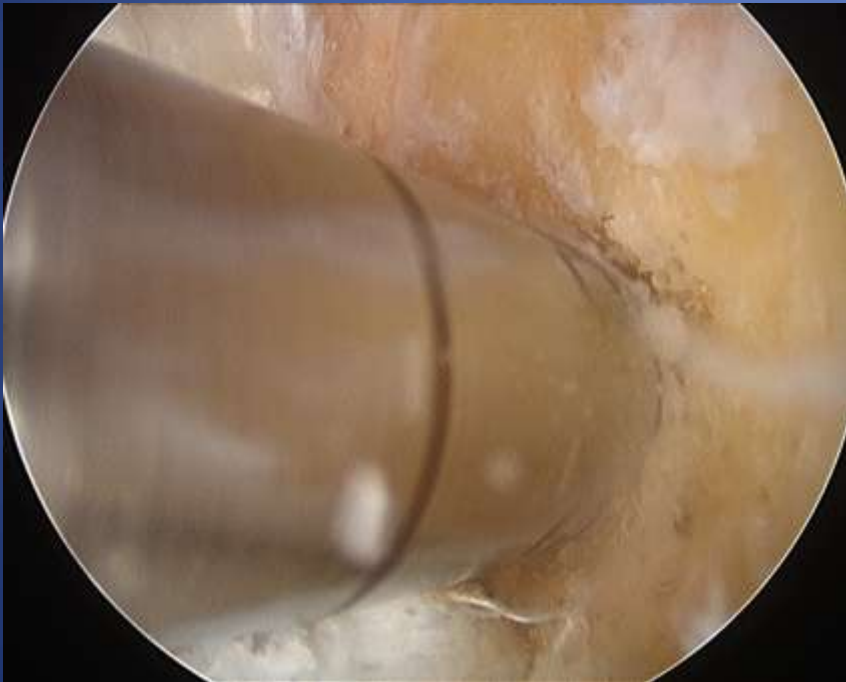
Need to see the back



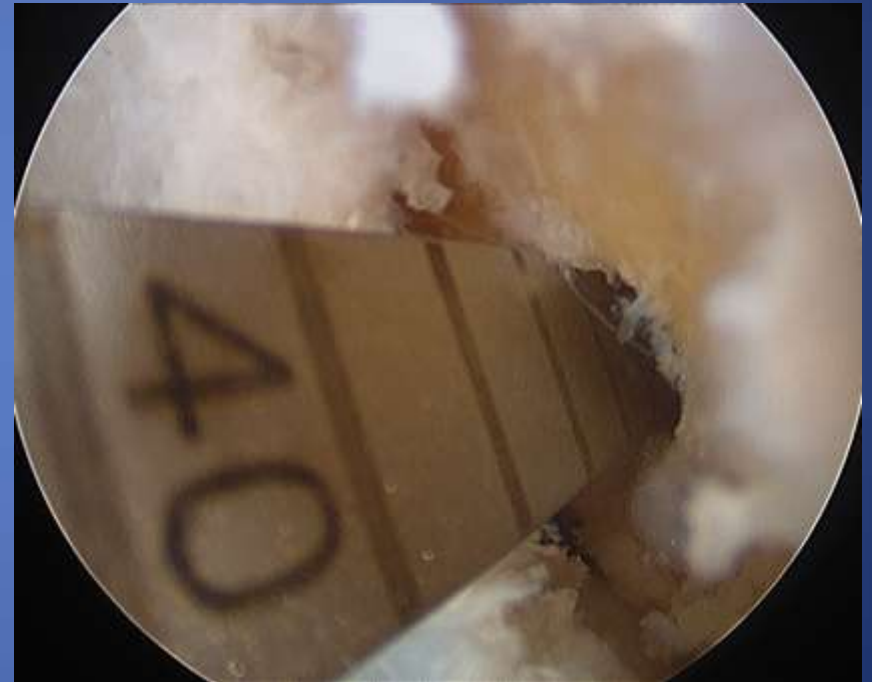
Flip the portals



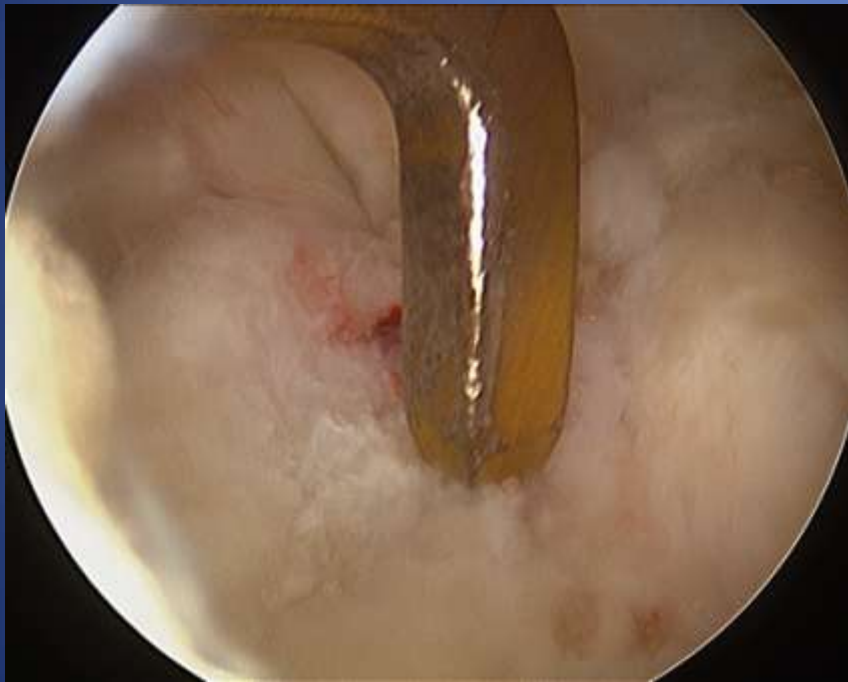
Drill from AM portal



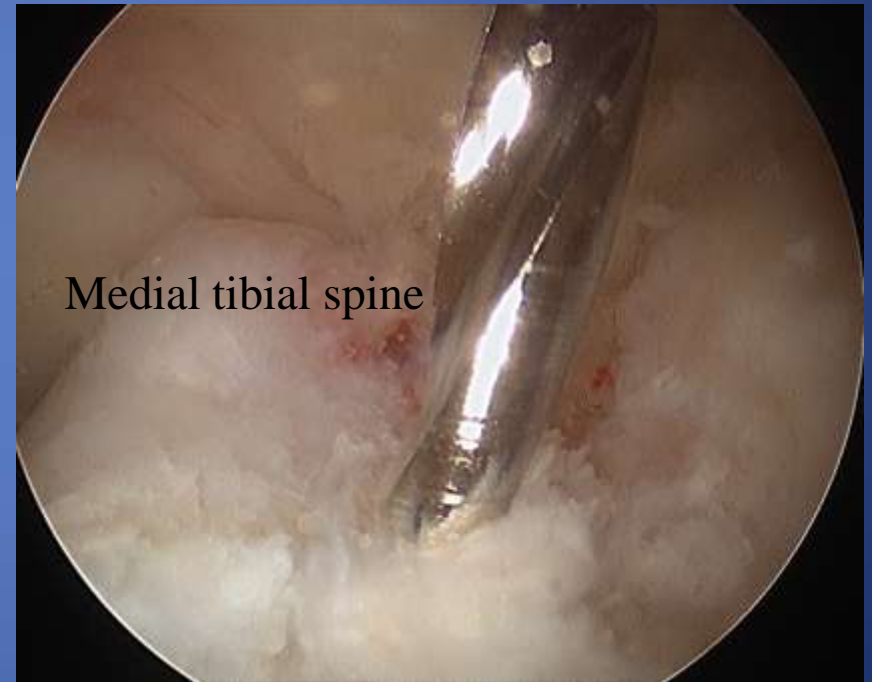
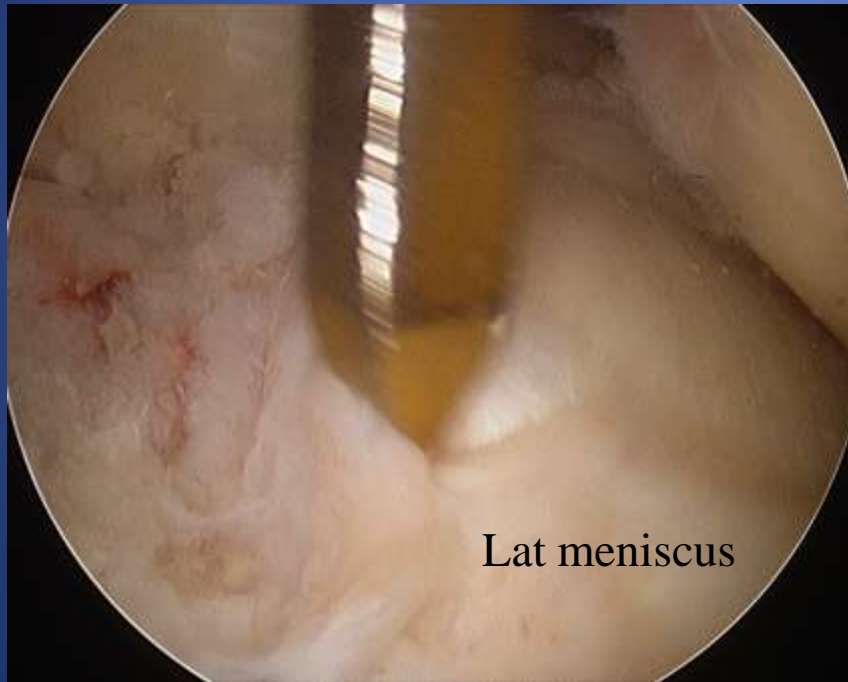
Measure tunnel length



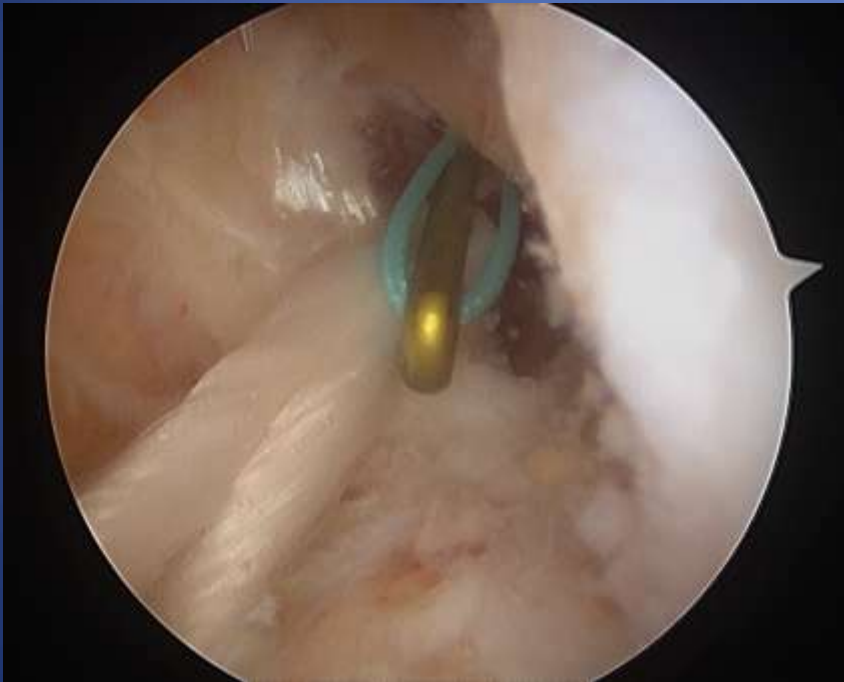
Tibial Tunnel Placement

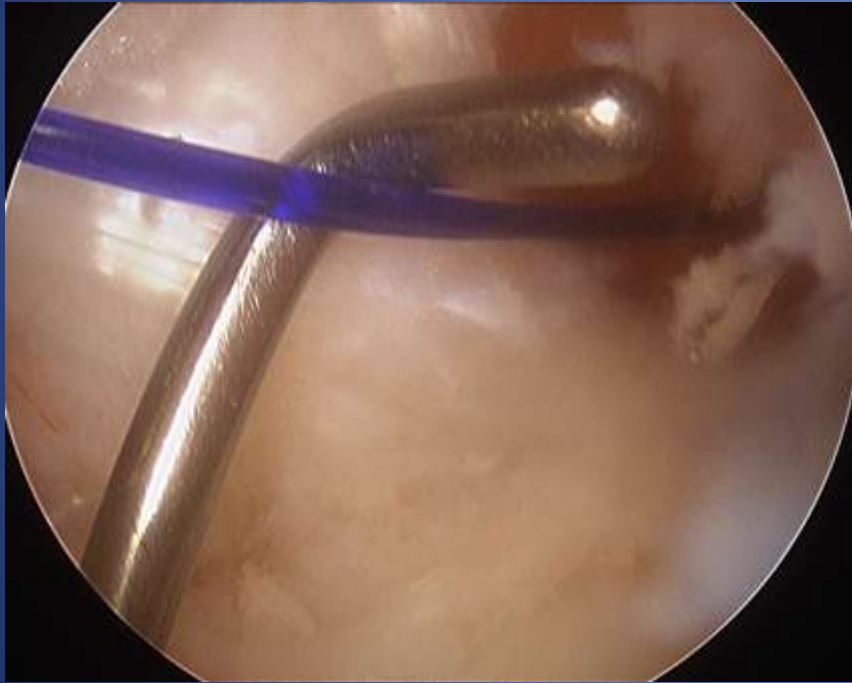


Locate tibial foot print



Pass the graft

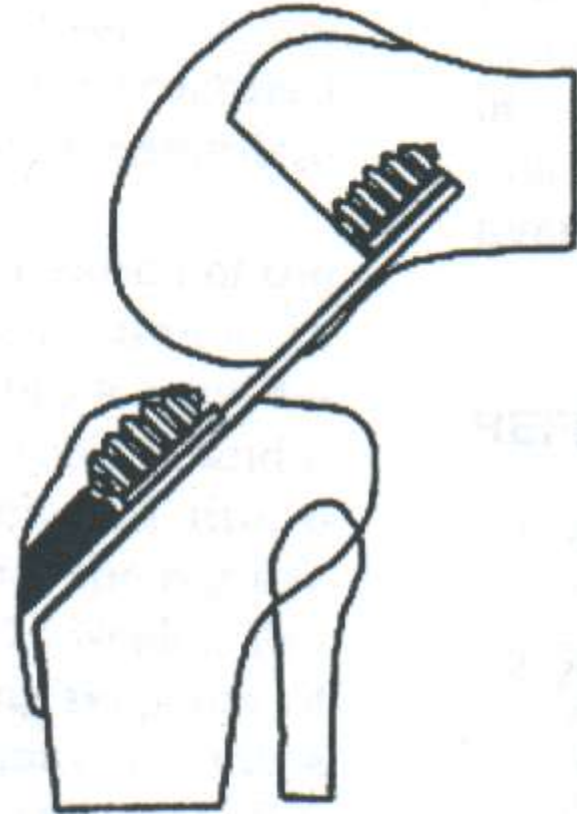




Secure the graft



Distal Fixation



Proximal Fixation

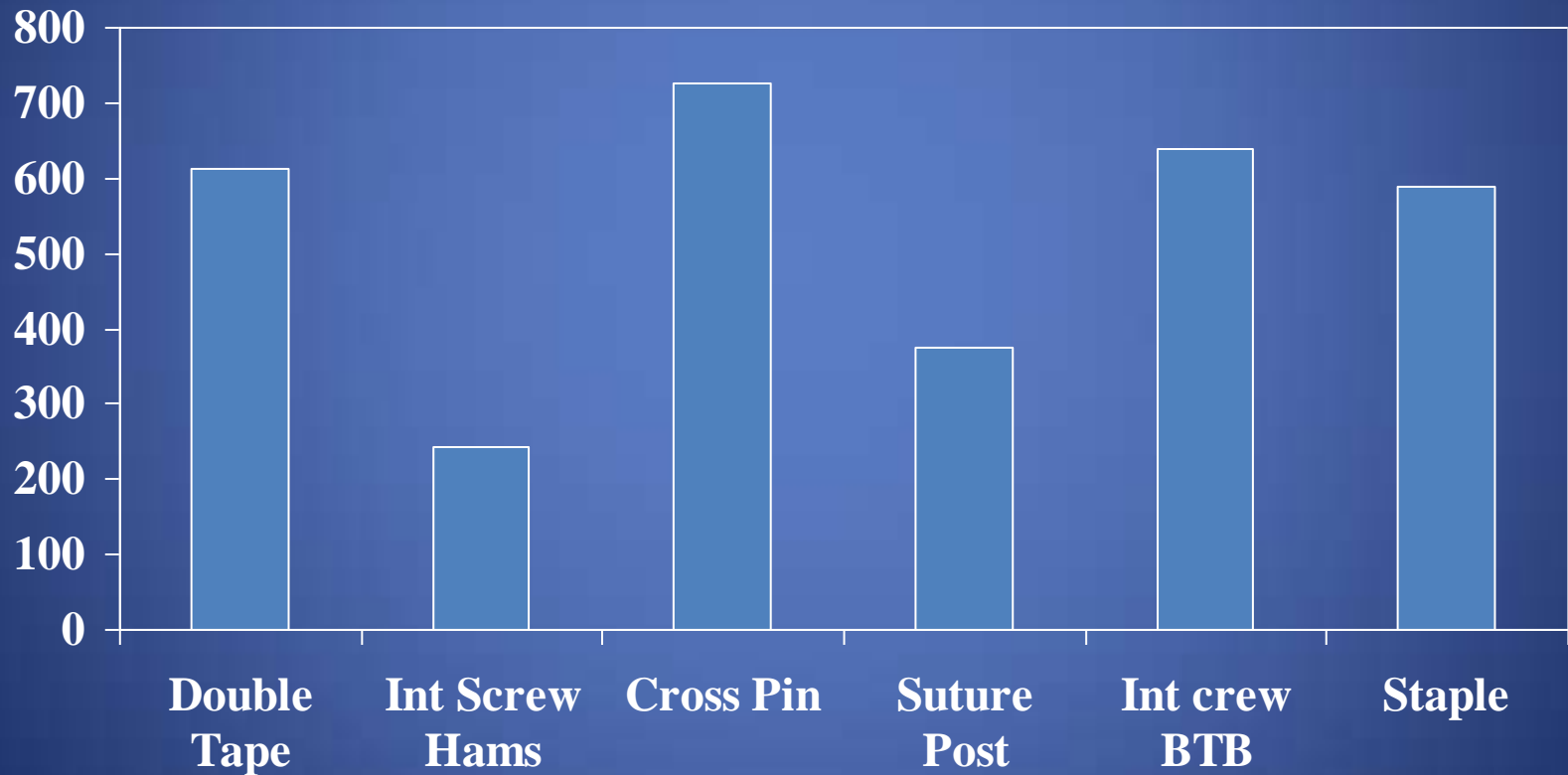
Graft Fixation



- Inside Joint
 - Interference Fixation
- Outside the joint
 - Cross Bolt
 - Endobutton
 - Screws and Washers
 - Staples



Ultimate Tensile Load of Fixation (N)



Modes of fixation failure

- Inadequate size of screw
- Blow out of posterior wall
- Soft osteoporotic bone
- Failure to toggle endo button
 - Inadequate tunnel length
- Missed tunnels
- Intra operative graft rupture
 - Especially BTB allografts

Be able to cope with disaster



Post operative rehabilitation



Early

Phase 1 (weeks 1 -2)

- Pain relief
- Reduction of swelling
- Patella mobilisation
- Static quads
- Co-contractions
- Protected weight bearing
- No brace

Phase 2 (weeks 2 – 6)

- Restore normal ROM
- Full weight bearing
- Restore coordination
- Exercise bike

Medium

Phase 3 (6 weeks – 3 month)

- No heavy employment
- No weights
- Improve motor function
- Start proprioception training
- Straight line tread mill

Phase 4 (3 – 6 month)

- Allow back to work
- Add in shuttle runs
- Figure of 8's
- Pylometrics
- Proprioception

Long

Phase 5 (6 month +)

- Sports specific training
- Non contact

Phase 6 (9month +)

- Return to sports activity

Five-Year Results of Single -Incision Arthroscopic ACL Reconstruction with PT Autograft

- 98% Grade 0 or 1 Lachmanns or Pivot
- 77% strenuous to moderate activity (IKDC)
- 52% normal or nearly normal knee (IKDC)
- 24% evidence of degenerative change

Otto D, Pinczewski L AJSM 26: 181, 1998

The outcome at 15 years of endoscopic ACL reconstruction using hamstring tendon autograft for isolated ACL rupture

- Graft survival 83%
- Moderate to severe OA 8%
- Strenuous activity 52%
- Patients < 18 or > 2 mm of laxity at 1 year had a 3 fold risk of graft failure

15 year outcome of endoscopic ACL reconstruction with patellar tendon autograft for isolated ACL tear

- 51% evidence of OA
- 70% had kneeling pain
- 8% graft failure
- 24% risk of contralateral ACL rupture

- Good results but concerns regarding complications

Arthroscopically assisted hamstrings graft in the reconstruction of the ACL in Athletes

- 69 reconstructions , 60 month follow-up
 - Over the top technique
- 10% graft failure
- 7% giving way
- 80% returned to pivoting sport

Aglietti P, AJSM 22:211, 1994

Arthroscopically assisted ACL reconstruction using PT Autograft

- 97 patients followed up 5 -9 years
- 100% Grade 0 or 1 Lachmanns or Pivot
- 89% good to excellent HSS score
- 87 average Lysholm Score
- 97% would undergo the procedure again

Bach BR, AJSM 26: 202,1998

Arthroscopic-assisted outpatient ACL Reconstruction using the Semitendinosus and Gracilis Tendons

- 93% Complete graft function
- 98% full knee movement
- 83% returned to sport
- 92% rated their knee as good or normal

Siegel M, Arthroscopy 14: 268, 2998

