Ligamentous knee injuries

Case 1

- A 24 year old male athlete, came to clinic complaining of right knee pain , swelling & and giving way after having a non-contact valgus knee injury . On examination : Anterior drawer test was positive . Xray & MRI are attached below.

What can you see in this x ray ?

- Deep sulcus (terminalis) sign :

Depression on the lateral femoral condyle at the terminal sulcus, a junction between the weight bearing tibial articular surface and the patellar articular surface of the femoral condyle.

What can you see in MRI ?

- bone bruising in > half of acute ACL tears
- middle 1/3 of LFC (sulcus terminalis)
- posterior 1/3 of the lateral and medial tibial plateau

- fluid against the lateral wall ("empty notch sign")

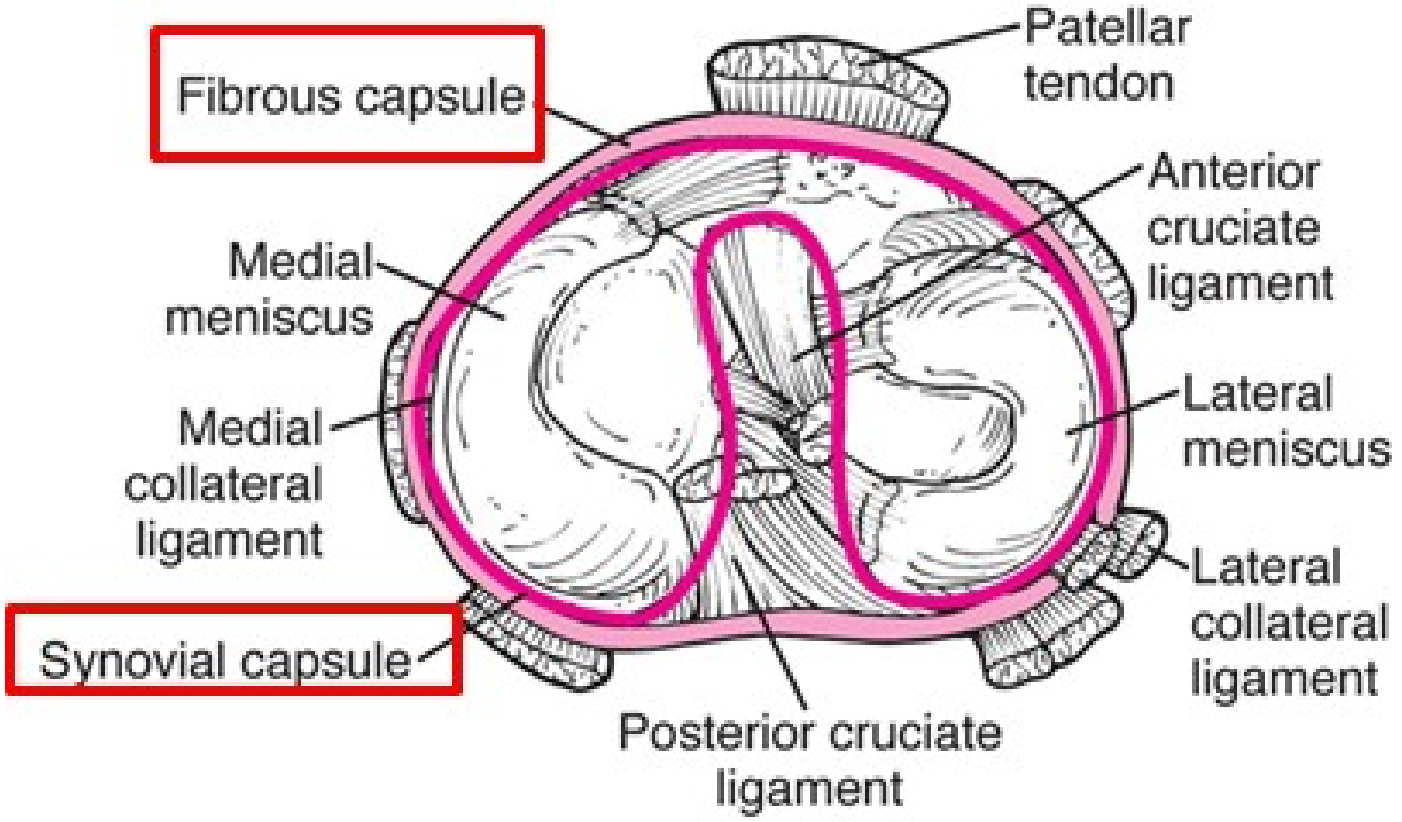
So after this discussion, what is your Diagnosis?

- This is a case of ACL tear

Describe the anatomy of ACL ?

ACL

- Anatomy
  - extrasynovial but intracapsular



Anatomy
The double bundle Concept

33mm long ,
11 mm in diameter
(Range)

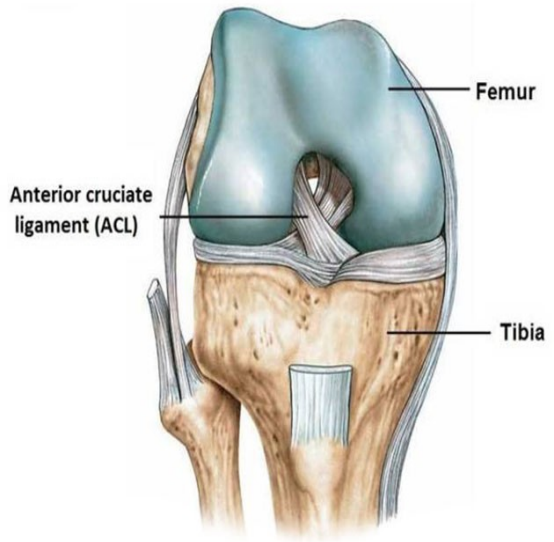
2 bundles :
Anteriomedial bundle
posteriolateral bundle
supplied by middle geniculate artery
90% type 1 and 10 % type III collagen

- **ORIGIN**

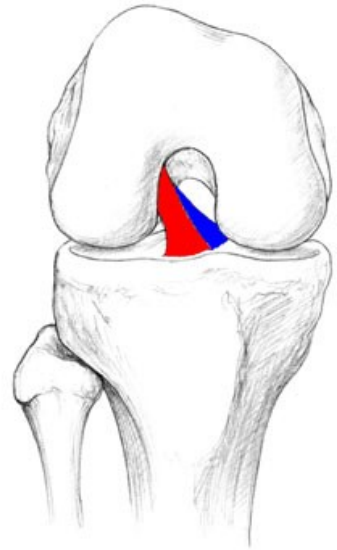
  -From the posteromedial corner of medial aspect of the LFC in the intercondylar notch

- **INSERTION**

- anterior tibia, between intercondylar eminences



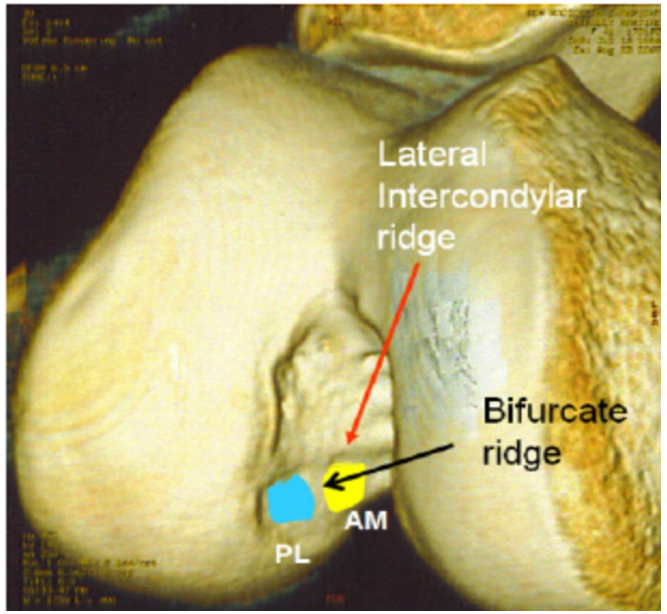
The double bundle concept



- anteromedial bundle
  - more isometric
  - tight throughout knee ROM, but tightest in flexion
  - primarily responsible for restraining anterior tibial translation (anterior drawer test)
- posterolateral bundle _
  - greater length changes
  - tightest in extension, slack in mid-flexion
  - primarily responsible for rotational stability (pivot shift test)

ACL ORIGIN

- lateral intercondylar ridge demarcates the anterior edge of the ACL
- bifurcate ridge separates the anteromedial and posterolateral bundle attachment

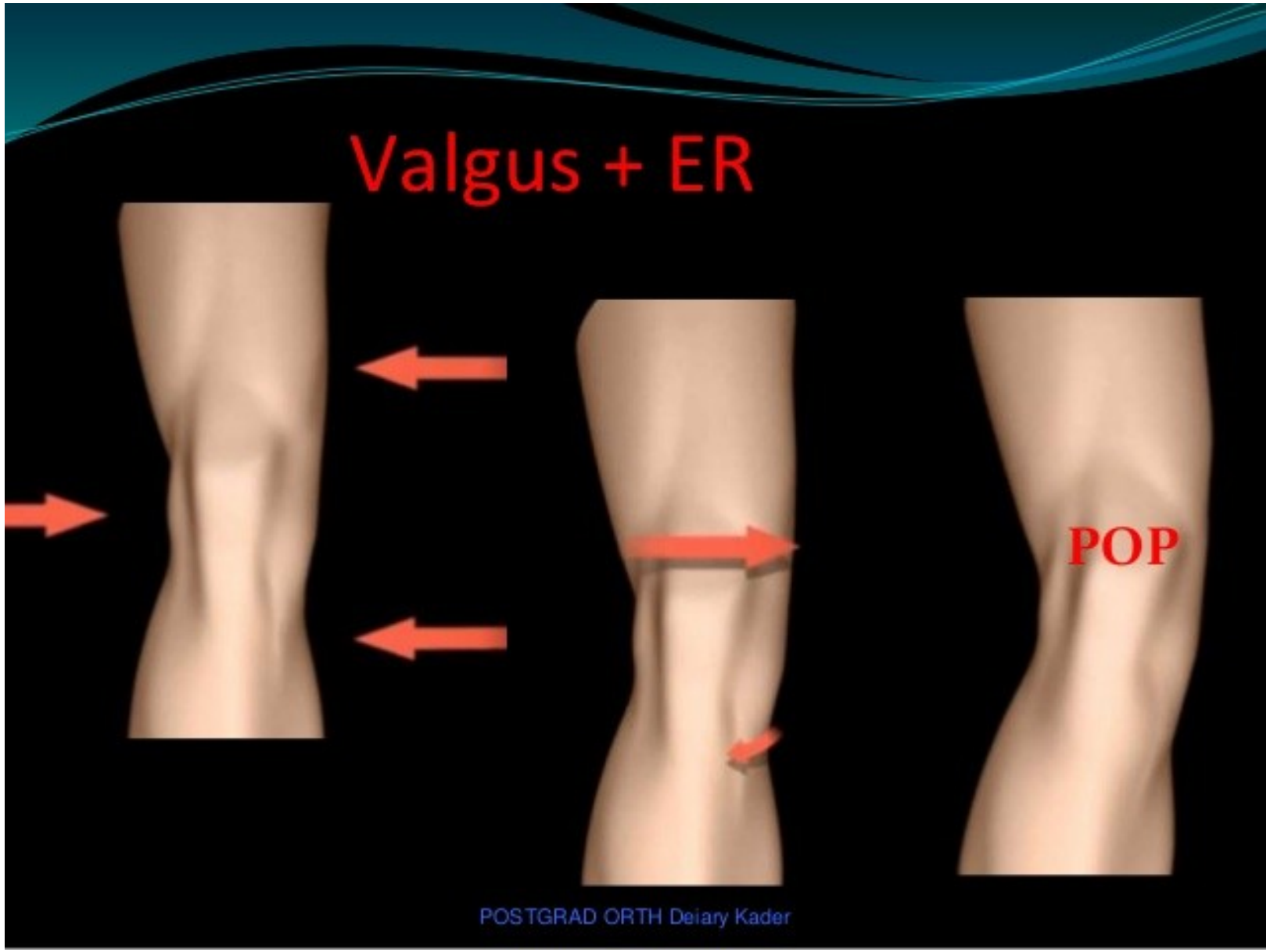


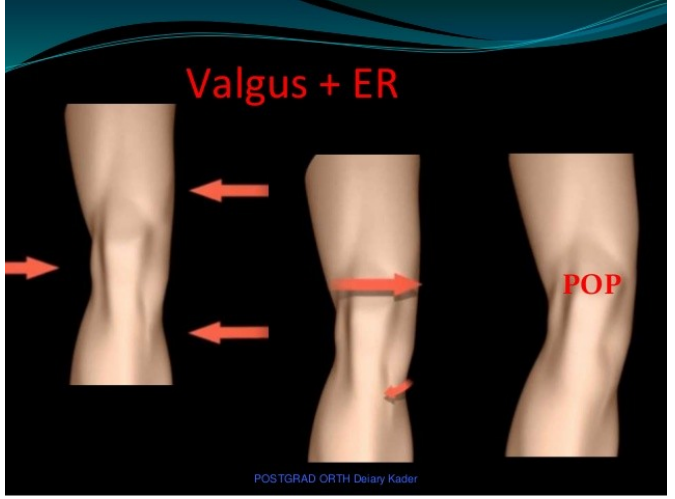
Describe the mechanism of injury ?

Contact or non-contact injury.

- **Noncontact** injuries occur with the knee in slight flexion, valgus, and internal/external rotation as a deceleration injury

- **Contact** injuries typically involve a lateral side impact producing a valgus force to the knee.


Valgus + ER
POP
POSTGRAD ORTH Deiary Kader



- the knee is internally or externally rotated
- in 10-30° of flexion
- the knee is placed in a valgus position
- the athlete takes off from the planted foot and internally rotates with the aim of suddenly changing direction.

- popping out of joint and then reducing

Why are female more likely to have ACL injury?

ACL injury more common in female athlete (4.5 :1 ratio) due to:

Neuromuscular forces and control (more quadriceps dominant)

Landing biomechanics

females land in more extension, higher valgus moment

Smaller notches

Genetic factors related to collagen production

a specific genotype within the COL5A1 gene was associated with a reduced risk of ACL tears in women compared to controls

Smaller ligaments

valgus leg alignment

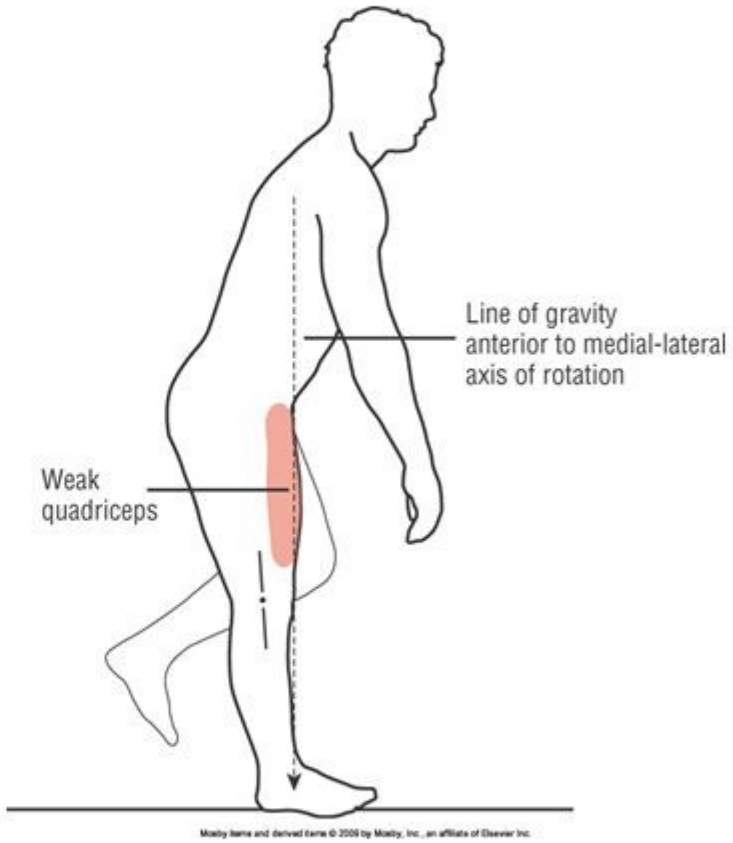
Describe *Signs* of ACL injury ?

Symptoms:

1. felt a "pop"
2. pain deep in the knee
3. immediate swelling (70%) / hemarthrosis
4. Quadriceps avoidance gait (does not actively extend knee)

Weak Quadriceps Gait

- Knee remains fully extended throughout stance, combined with excessive forward lean of trunk
- Impairment
  - Weakness or avoidance of activation of quadriceps muscle
- Reason for deviation
  - Forward lean of trunk shifts line of gravity anterior to medial-lateral axis of knee



How to Examine Knee for ACL injury ?

Special Tests

Stability Testing:

The Lachman test is the most Sensitive test in DxACL tear

History:

- *Noulis test (Georges Noulis Thesis in Paris, 1875)*
- *Ritchley test (1960)*
- *Ritchley-Lachman test (Torg et al 1976)*

Curtesy of Mr Panos Thomas

LACHMAN'S TEST

- This is a variant of the anterior drawer test
- The examination is carried out with the knee in 15 deg of flexion, and external rotation (relaxes IT band)
- For a right knee, the examiner's right hand grips the inner aspect of the calf and the left hand grasps outer aspect of the distal thigh
- Attempt to quantify the displacement in mm is done by

- End point should be graded as hard or soft
  - End point is said to be hard when the ACL
    abruptly halts the forward motion of the tibia on
    the femur
  - End point is soft when there is no ACL & restraints are more elastic secondary stabilizers;

GRADING

Grading A= firm endpoint, B= no endpoint
Grade 1: 3-5 mm translation
Grade 2 A/B: 5-10mm translation
Grade 3 A/B: > 10mm translation

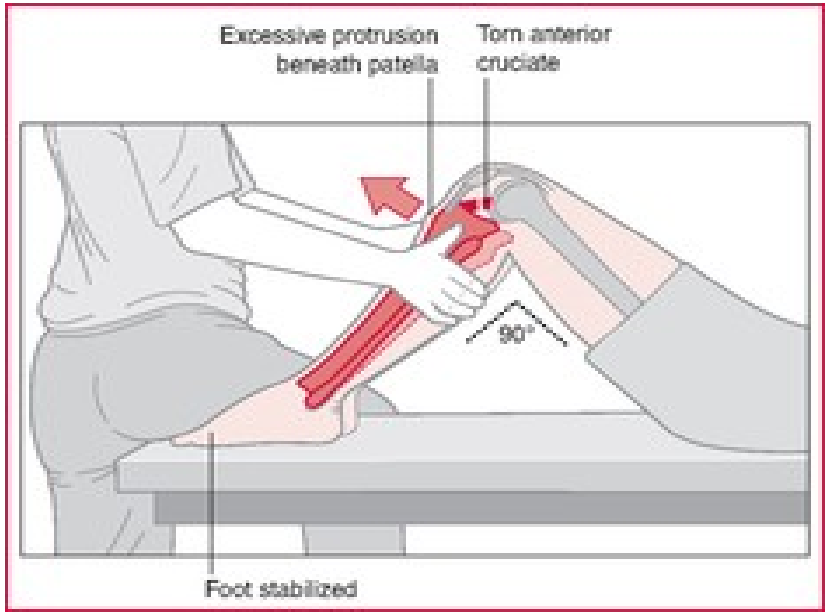
Clinical Examination

Positive Lachman test with a FIRM ENDPOINT

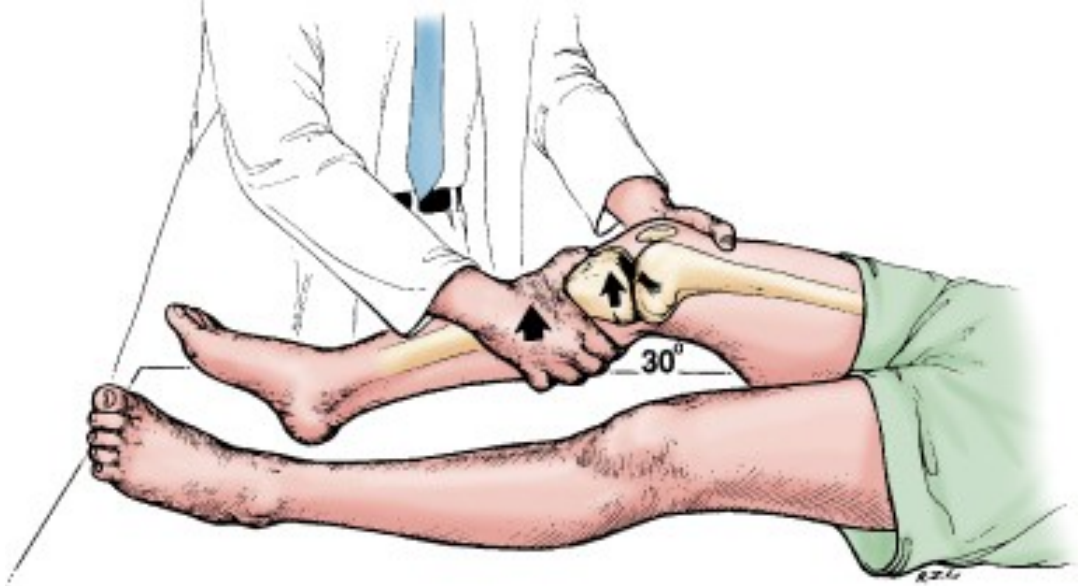
1. Partial ACL tear
2. Displaced bucket-handle meniscus tear
3. Intra-articular loose bodies
4. OA changes

ANTERIOR DRAWER TEST

- To perform anterior drawer test, examiner grasps pt's tibia & pulls it forward with hip flexed 70 degree and the knee 90 degree while noting degree of anterior tibial displacement



Lachmann Test
85% specific



Anterior Drawer Test
50% Specific

Benjaminse. *JOSPT* 2006. Results

Test	Sensitivity (95% CI)	Specificity (95% CI)	LR + (95% CI)	LR- (95% CI)	DOR (95% CI)
Anterior Drawer	55% (52-58)	92% (90-94)	7.3 (3.5-15.2)	0.5 (0.4-0.6)	21 (8-23)
Lachman Test	85% (83-87)	94% (96-99)	10.2 (4.6-22.7)	0.2 (0.1-0.3)	70 (23-206)
Pivot Shift	24% (21-27)	98% (96-99)	8.5 (4.7-15.5)	0.9 (0.8-1.0)	12 (5-31)

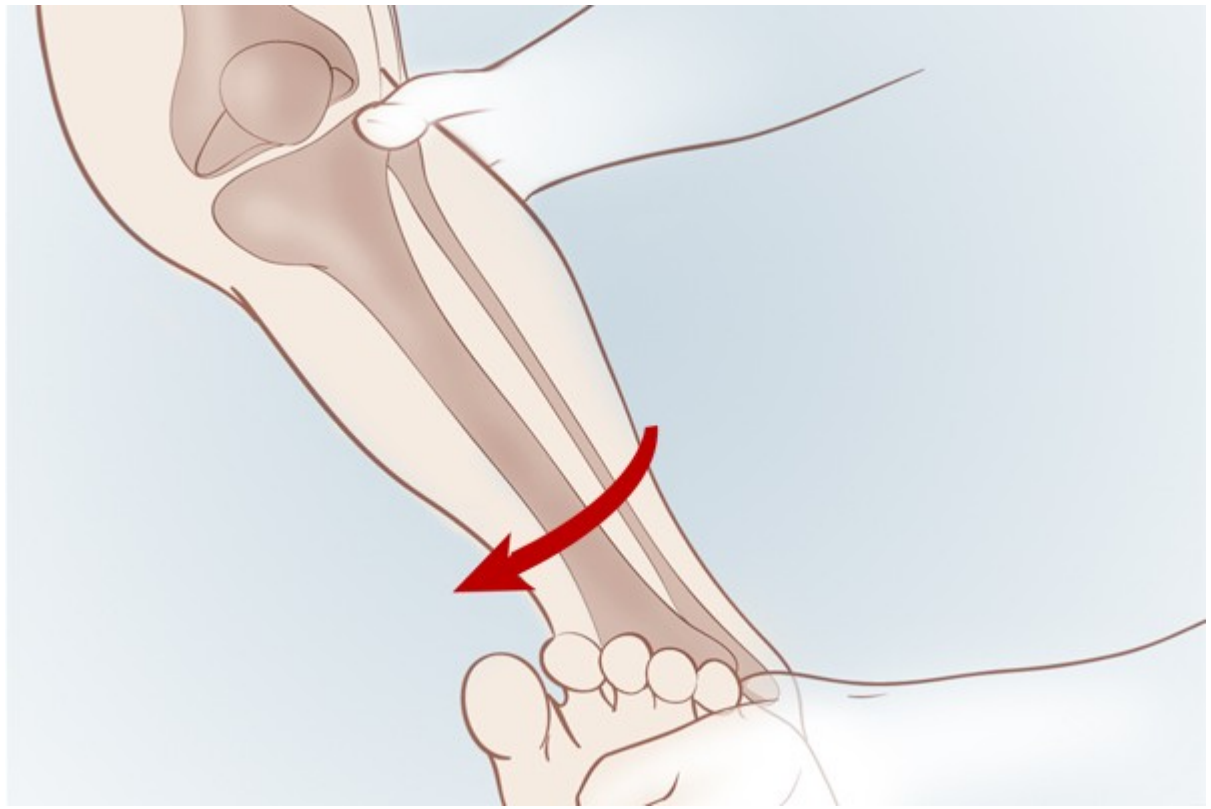
PIVOT SHIFT TEST

- During this test,

  pt is kept in supine & examiner holds pt's leg with both hands

  abduct the pt’s hip (to relax the ITB and allow the tibia to rotate)

Holding the heel in one hand and applying a valgus stress in the other hand, the knee is slowly flexed



- The tibia, as well as the valgus, subluxes easily if anterior force is applied.

- After the anterior subluxation of the tibia is noticed, the knee is slowly flexed, and the tibia will reduce with a snap at about 20° to 30°of flexion.

Discuss possible radiological findings associated with ACL injury ?

- XRAY
- MRI

X-RAY

- Segond fracture (avulsion fracture of the proximal lateral tibia) is usually pathognomonic for an ACL tear represents bony avulsion by the anterolateral ligament (ALL)
- associated with ACL tear 75-100% of the time

X-RAY

- deep sulcus (terminalis) sign _ depression on the lateral femoral condyle at the terminal sulcus, a junction between the weight bearing tibial articular surface and the patellar articular surface of the femoral condyle.

MRI

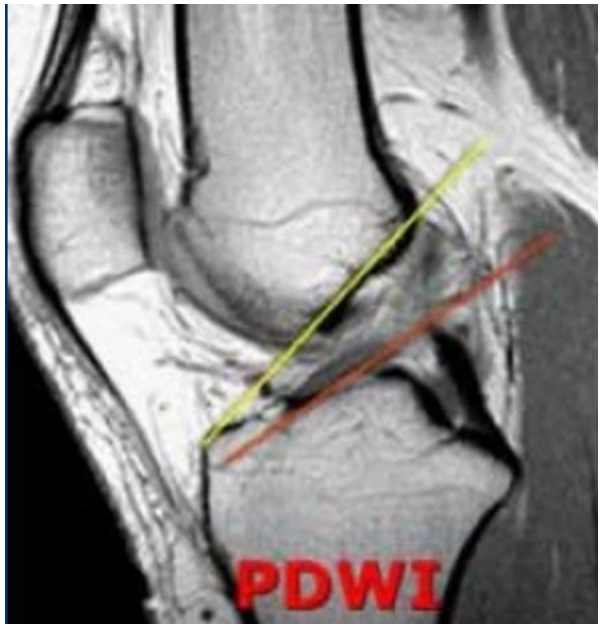
- coronal view
- discontinuity of fibers (do not reach the femur)

MRI

-
- fluid against the lateral wall ("empty notch sign")

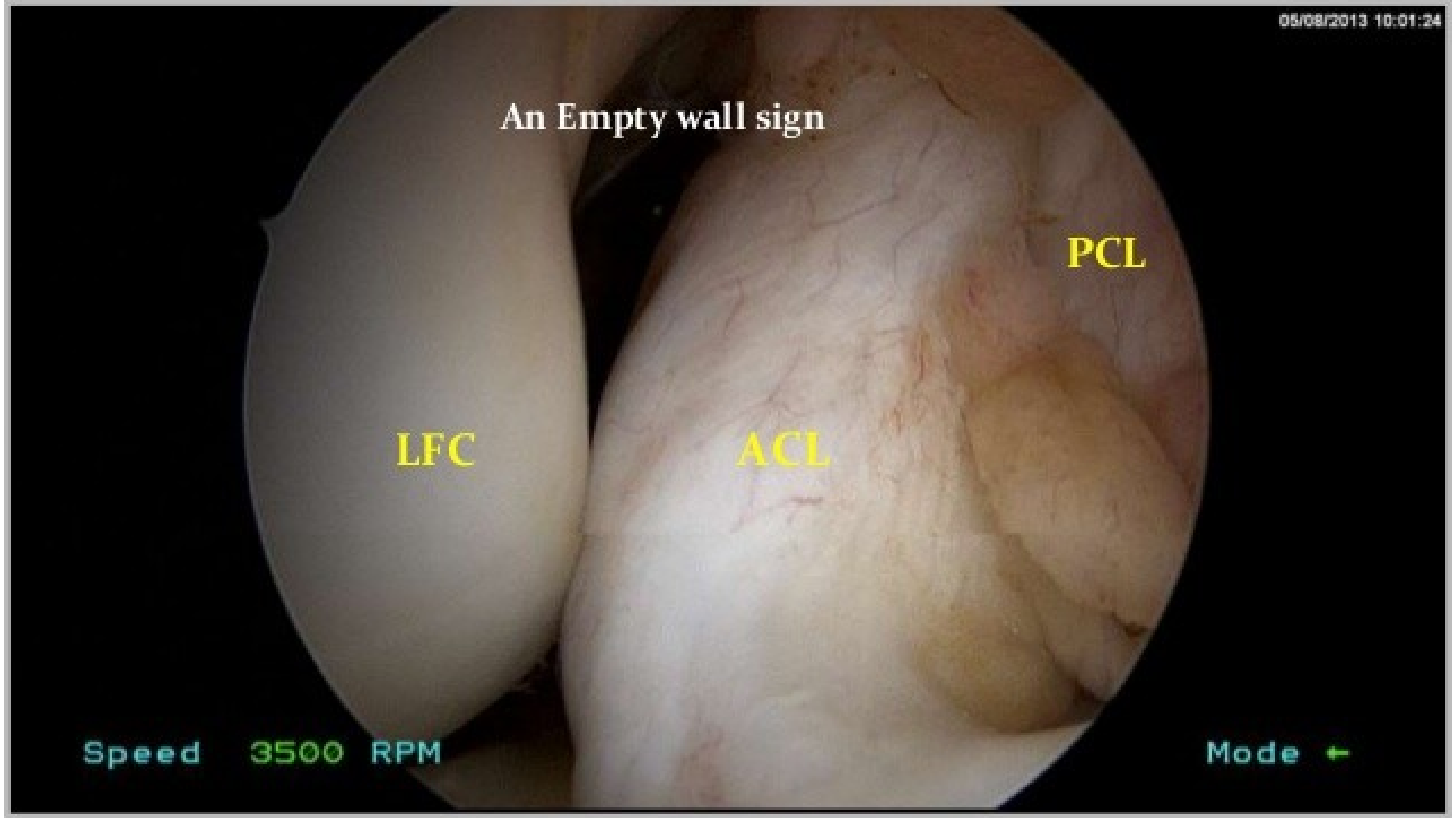
Sagittal view

- discontinuity of fibers on T2
- abnormal orientation
  - too "flat" compared with intercondylar roof / Blumensaat's line
  - this acute angle is common in chronic cases where ACL scars to the PCL



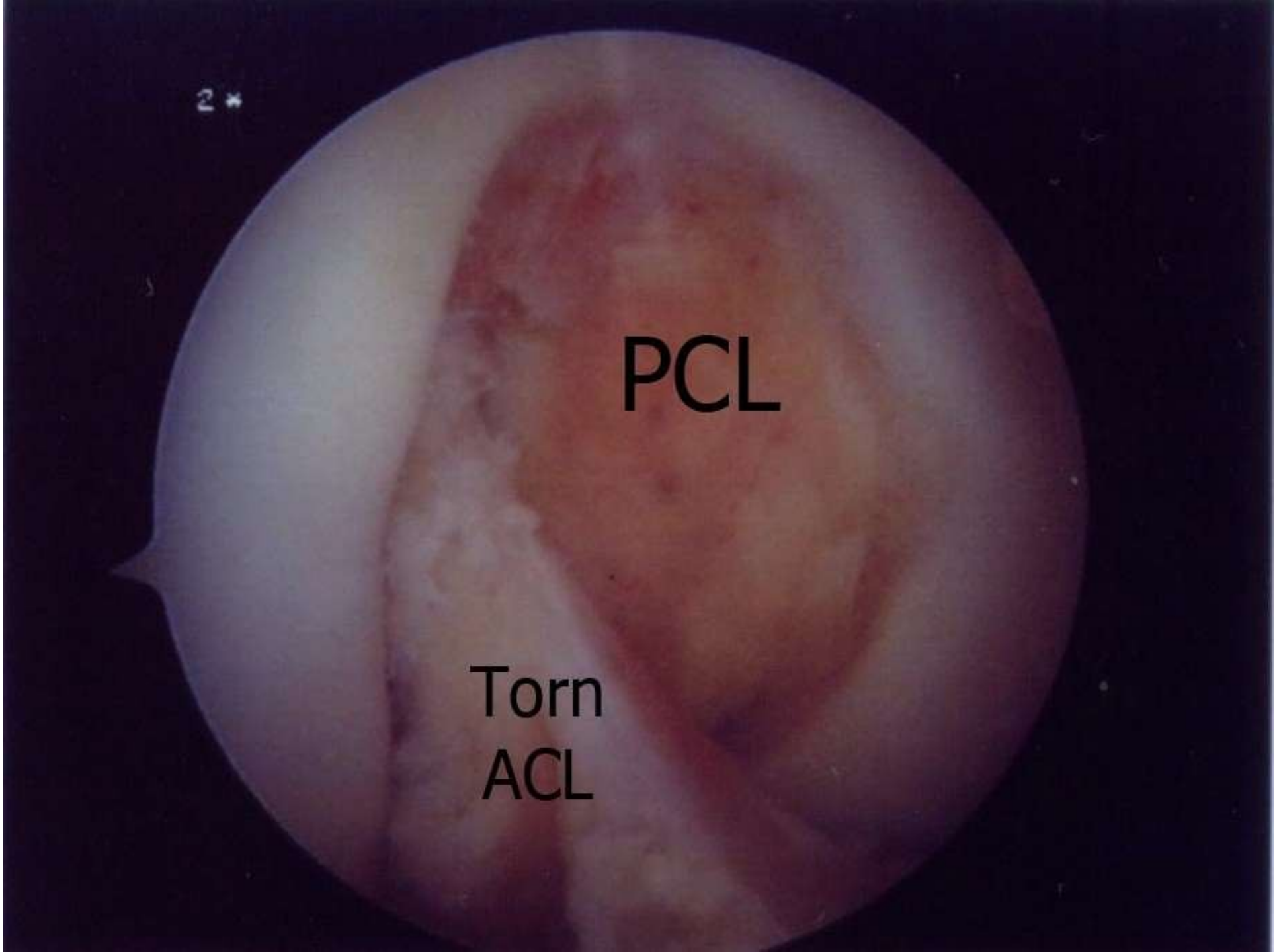
- bone bruising in > half of acute ACL tears middle 1/3 of LFC (sulcus terminalis)
- posterior 1/3 of the lateral and medial tibial plateau
- subchondral changes on MRI can persist years after injury

Describe the arthroscopic view of ACL injury ?



"Lambda healing" AM bundle heals over PCL (no subjective instability) (Zantop et al 2007)

Curtesy of Mr Panos Thomas


PCL
Torn
ACL

Talk about management of ACL injury

TREATMENT

- NON-SURGICAL METHOD
- SURGICAL METHOD

- Immediately after injury

  R.I.C.E (**R**est **I**ce **C**ompression **E**levation ()

  Exercise (after swelling decreases and weight-bearing progresses)

Nonsurgical Treatment

physical therapy & lifestyle modifications

low demand patients with decreased laxity

increased meniscal/cartilage damage linked to

- loss of meniscal integrity
- the frequency of buckling episodes
- level I and II activity (e.g. jumping, cutting, side-to-side sports, heavy manual labor

Precautions

- Modification of active lifestyle to avoid high demand activities
- Muscle strengthening exercises for life
- May require knee brace
- Despite above precautions ,secondary damage to knee cartilage & meniscus leading to premature arthritis

Surgical Treatment

- Timing of Surgery
- 1) Swelling in the knee must go down to near-normal levels
- 2) Range-of-motion (bending and straightening) of the injured knee must be nearly equal to the uninjured knee
- 3) Good Quadriceps muscle strength must be present.
- Usually it takes a couple of weeks after injury before ACL reconstruction can be performed.
- The presence of any associated injuries to the knee joint involving cartilage, meniscus, or other ligaments may change the time-frame for surgery.

Surgical Treatment

- ACL tears are not usually repaired using suture to sew it back together, because repaired ACLs have generally been shown to fail over time

- Therefore, the torn ACL is generally replaced by a substitute graft made of tendon

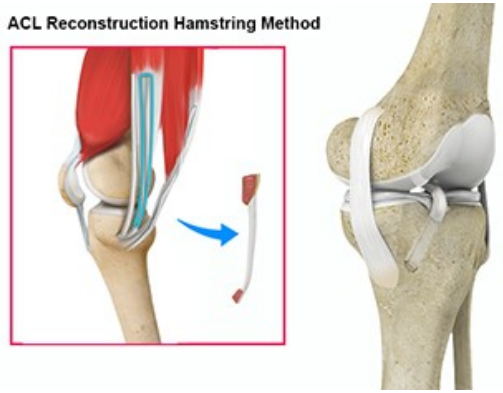
The **grafts commonly used** to replace the ACL include

autograft	Allograft
Patellar tendon	patellar tendon,
Hamstring tendon	Achilles tendon,
Quadriceps tendon	semitendinosus,
	gracilis, or posterior tibialis tendon

Ultimate tensile load of intact Human ACL and a few common replacement ACL grafts

Graft type	Ultimate tensile load
Intact ACL	2160±154
Bone-patellar tendon-bone	2376 ±151
Single-strand semitendinosus	1216±50
Quadruple hamstring	4108±200
Quadriceps tendon (10mm)	2352±495

Quadruple Hamstring autograft

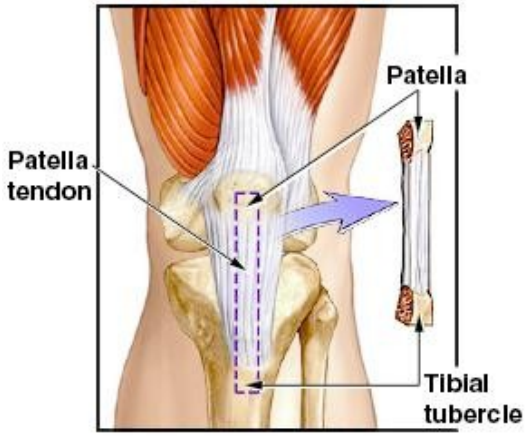


- may be taken from contralateral side in revision situation when allograft is not desirable or available

- pros and cons
  - smaller incision, less perioperative pain, less anterior knee pain
  - fixation strength may be less than Bone-PT-Bone
  - maximum load to failure is approximately 4000 Newtons
  - decreased peak flexion strength at 3 years compared to Bone-PT-Bone
  - concern about hamstring weakness in female athletes leading to increased risk of re-rupture
- complications
  - "**windshield wiper**" effect (suspensory fixation away from joint line causes tunnel abrasion and expansion with flexion/extension of knee) **, bungi jump effect** ,
  - residual hamstring weakness

BONE PATELLAR BONE AUTOGRAFT

- **Bone-patellar-bone autograft** advantages of autograft
  - using patient's own tissue
  - most common source of graft
  - faster incorporation
  - less immune reaction
  - no chance of acquiring someone else's infection
- pros and cons of bone-patella-bone
  - the longest history of use and considered previously the "gold standard"
  - bone to bone healing
  - ability to rigidly fix the joint line (screws)
  - the highest incidence of anterior knee pain (up to 10-30%)
  - maximum load to failure is 2600 Newtons (intact ACL is 1725 Newtons)
- complications
  - patella fracture (usually postop during rehab), patellar tendon rupture
  - re-rupture

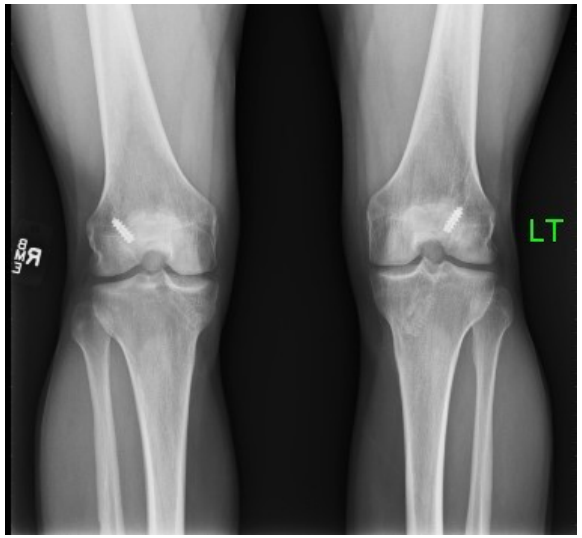


allografts

- **Allograft**pros & cons
  - useful in revisions
  - longer incorporation time
  - risk of disease transmission (HIV is < 1:1 million, hepatitis is even greater)
  - increased risk of re-rupture in young athletes
    - odds of graft re-rupture are 4.3 x higher in allograft for athletes aged 10-19

Femoral tunnel placement
The clock phase

- - -
  - sagittal plane
    - 1-2 mm rim of bone between the tunnel and posterior cortex of the femur
  - coronal plane
    - the tunnel should be placed on the lateral wall (at 2 (left knee) or 10 (right knee) o'clock position) to create a more horizontal graft - remember 2 and 10



(I.D.E.A.L) FEMORAL TUNNEL POSITION

ISOMETRIC GRAFT WILL HAVE LENGTH TENSION RELATIONSHIP SIMILAR TO NATIVE ACL

DIRECT DIRECT FIBER S INSERTION ON THE ACL FOOT PRINT

ECCENTRIC HIGHER IN THE FOOT PRINT & IN THE ANTEROMEDIAL PART OF ACL

EQUIDISTANT ½ WAY BETW.TOP & BOTTOM OF NOTCH

ANATOMIC FIBERS OF GRAFT WITHIN THE BOUNDARIES OF NATIVE ACL HIGHER IN FOOTPRINT

- LOW TENSION GRAFT SHOULD HAVE LOW TENSION FLEXION PATTERN SIMILAR TO NATIVE ACL

Tibial tunnel placement

- sagittal plane
  - the center of tunnel entrance into joint should be at the stump of the ACL (ACL REMENANT) ,or 6mm infront of the anterior border of the PCL
- coronal plane
  - tunnel trajectory of < 75° from horizontal
    - obtain by moving tibial starting point halfway between tibial tubercle and a posterior medial edge of the tibia.

Single or Double bundle technique?

- **Anatomical Single-Bundle Technique**

Advantages:

1) Simplicity
2) Broad spectrum of grafts
3) Simpler graft passage
4) Lower cost

Disadvantages:

5) Inadequate rotational stability

Double-Bundle Technique

Advantages:

1) ?Better rotational stability
2) Allowance for individual variables

Disadvantages:

3) Anatomic or not? (Numerous double bundle techniques)
4) Technically demanding
5) Longer operating time
6) Limited graft selection

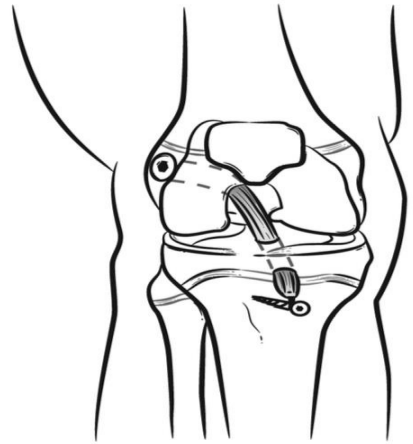
PHYSIOTHERAPY

- Early postoperativeimmediate
  - aggressive cryotherapy (ice)
  - immediate weight bearing (shown to reduce patellofemoral pain)
  - emphasize early full passive extension.
- early rehab
  - focus rehab on exercises that do not place excess stress on graft
    - appropriate rehab
      - eccentric strengthening at 3 weeks has been shown to result in increased quadriceps volume and strength
      - isometric hamstring contractions at any angle
      - isometric quadriceps, or simultaneous quadriceps and hamstrings contraction
      - active knee motion between 35 degrees and 90 degrees of flexion
      - emphasize closed chain (foot planted) exercises
    - avoid
      - isokinetic quadricep strengthening (15-30°) during early rehab
      - open chain quadriceps strengthening

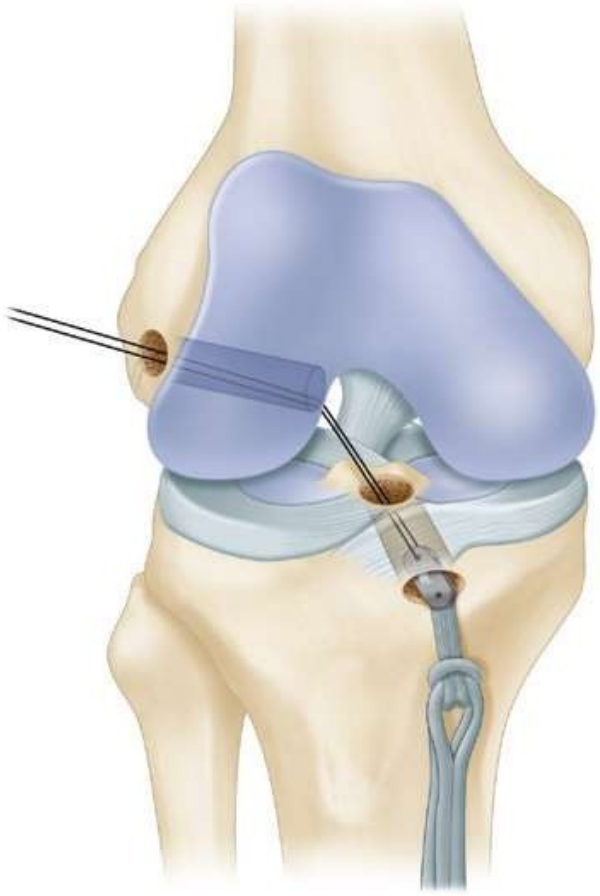
Pediatrics Consedirations

- Physis
  - < 14 yrs with open physis
  - the onset of menarche is the best determinant of skeletal maturity in females
- Treatment
  - Nonoperative
    - indications
      - compliant, low demand patient with no additional intra-articular pathologies
      - partial ACL tear (60% of adolescents have partial tears) with near normal Lachman and pivot shift
  - Surgery
    - indications
      - complete ACL tear

- Techniques
  - intra-articular
    - physis-sparing (all intra-epiphyseal)
    - transphyseal (males ≤13-16, females ≤ 12-14)
    - partial transphyseal
      - leave either distal femoral or proximal tibial physis undisturbed
    - no significant difference in growth disturbances between techniques



Anderson transepiphyseal replacement of anterior cruciate ligament using quadruple hamstring grafts



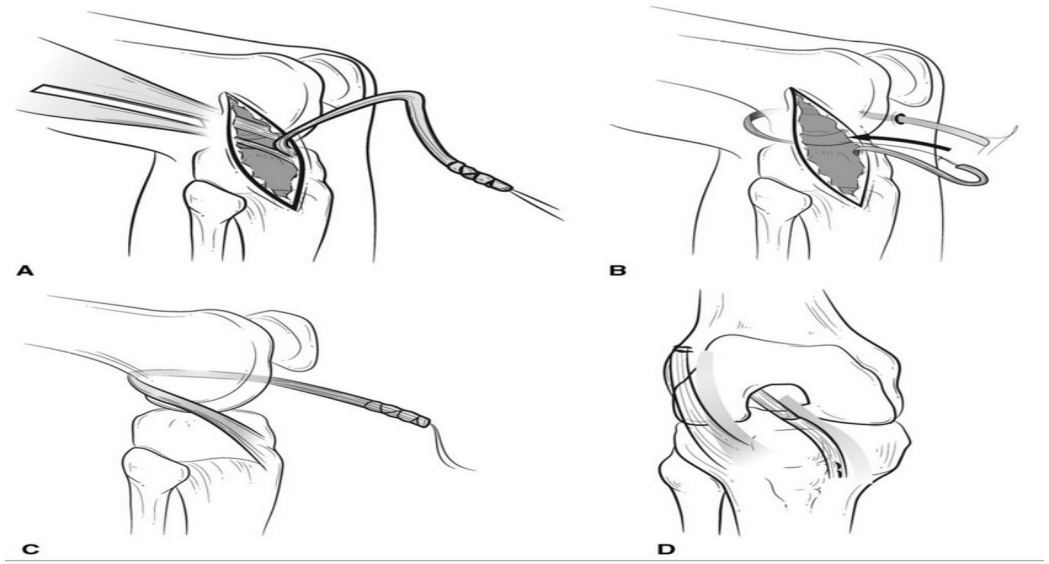


Illustration of physeal-sparing combined extra- and intra-articular anterior cruciate ligament reconstruction using autogenous iliotibial band. **A,** The iliotibial band is harvested free proximally and left attached distally to the Gerdy tubercle. **B,** The graft is brought through the knee in the over-the-top position. **C,** The graft is brought through the notch and under the intermeniscal ligament anteriorly. **D,** The final intra- and extra-articular reconstruction construct after the graft is sutured to the lateral femoral condyle and proximal tibia.

Combined intra- and extra-articular (males ≤12, females ≤ 11) _

- autogenous ITB harvested free proximally, left attached distally to Gerdy's tubercle
- looped through the knee in over the top position
- passed through the notch and under intermeniscal ligament anteriorly
- sutured to lateral femoral condyle and proximal tibia

physeal-sparing, combined intraarticular and extraarticular reconstruction of acl by Kocher, Garg, and Micheli

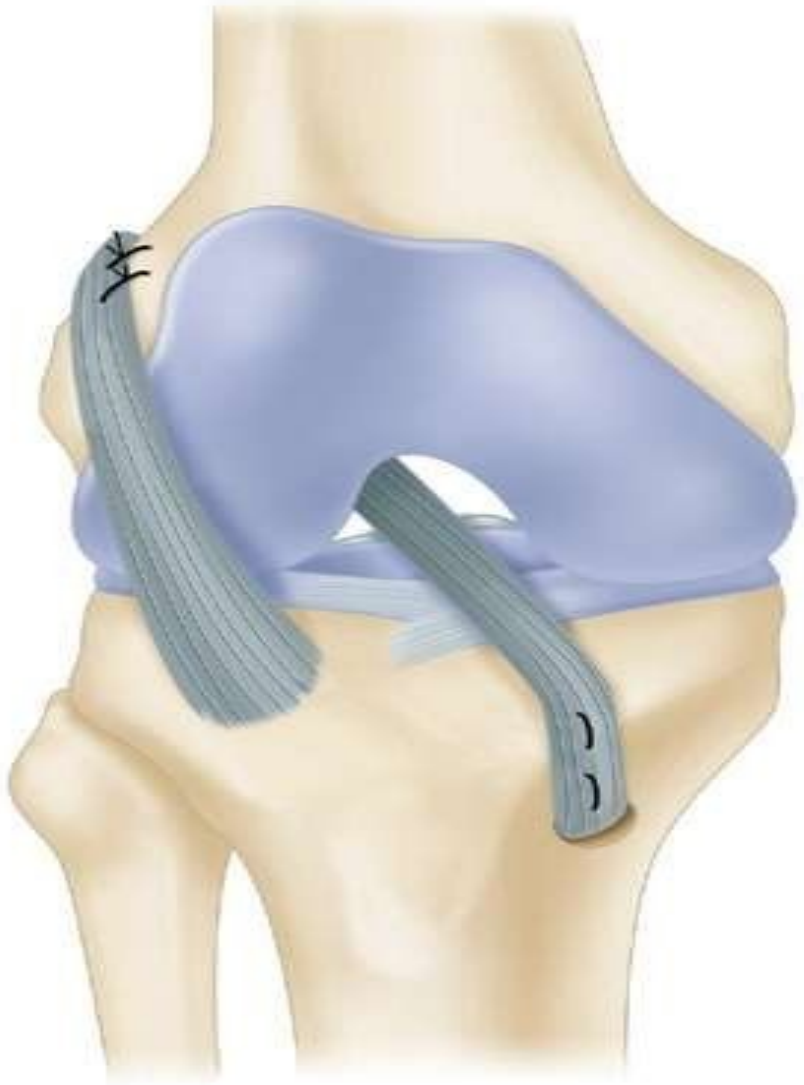


FIGURE 51-36 Causes of complications of anterior cruciate ligament reconstruction.

But….
This story is not always straight forward !!!

Case 2

A 23-year-old collegiate soccer player sustained a right knee injury 6 months ago. He has been treated with rest and rehabilitation but is unable to play at his previous level due to his knee "giving way." Physical exam reveals 10° varus alignment when standing and a varus thrust with walking. Strength is full compared to the other side. Ligamentous exam reveals a stable ACL and MCL, but opens to a varus stress and a 3+ posterior drawer and positive dial test at both 30° and 90° degrees of flexion.

PCL

Clinical Examination

- Posterior tibial shift
- Palpatory posterior tibial shift (gravity sign .posterior sag sign)
- Lachmanntest

- Quadriceps active drawer test. Flex the knee to 60← and control the foot then ask the patient to contract the quads. The test is positive when the tibia reduces.
- Posterior sag sign (step-off)
- Posterolateral rotatory instability (Dial test prone)
- External rotation recurvatum test

LCL INJURY

- Varus instability = lateral opening
  - 30° only - isolated LCL
  - 0° and 30° - combined LCL and ACL and/or PCL
- Varus opening and increased external tibial rotatory instability at 30° - combined LCL and posterolateral corner

MCL INJURY

- Valgus instability = medial opening
  - 30° only - isolated MCL
  - 0° and 30° - combined MCL and ACL and/or PCL
  - classification
    - Grade I: 0-5 mm opening
    - Grade II: 6-10 mm opening
    - Grade III: 11-15 mm opening
- Anterior Drawer with tibia in external rotation
  - grade III MCL tears often associated with ACL and posteriomedial corner tears
  - postive test will indicate associated ligamentous injury

PLC INJURY

- Gait
  - varus thrust or hyperextension thrust
- Varus stress test
  - varus laxity at 0° indicates both LCL & cruciate (ACL or PCL) injury
  - varus laxity at 30° indicates LCL injury
- Dial test
  - > 10° ER asymmetry at 30° only consistent with isolated PLC injury
  - > 10° ER asymmetry at 30° & 90° consistent with PLC and PCL injury

- Posterolateral drawer test
  - performed with the hip flexed 45°, knee flexed 80°, and foot ER 15°
  - a combined posterior drawer and ER force is applied to the knee to assess for an increase in posterolateral translation (lateral tibia externally rotates relative to lateral femoral condyle)

- Reversed pivot shift test
  - with the knee positioned at 90°, ER and valgus forces are applied to tibia
  - as the knee is extended, the tibia reduces with a palpable clunk
    - (reduction force from IT band transitioning from a flexor to an extensor of the knee)
- External rotation recurvatum test
  - positive when the leg falls into ER and recurvatum when the lower extremity is suspended by the toes in a supine patient
- Peroneal nerve assessment
  - injury present with altered sensation to foot dorsum and weak ankle dorsiflexion

PCL injury

- PCL and quadriceps dynamic partners in stabilizing the knee (sag. PL).
- Insertion 1-1.5 cm below tibialt has two parts

Anterolateral : Tight in flex

Posteromedial

′Meniscofemoral ligaments: mechanically very strong ′Anterior: Humphrey’s ligament ′Posterior: Wrisberg’s ligament

- RTA – High Velocity – Often MLI

- Sports Uncommon – Low Velocity – Usually Partial

Mechanism of injury

- 3% of all knee injuries
- Direct injury dashboard at 90 (most common
- Falling on a flexed knee with foot in plantar flexion
- Forced hyperextension (>30º) is associated with multiligament injury
- High association with fracture femur

Normal tibia step-off is 10 mm at 90 flexion

′Grade I instability is when there is a 5-mm step-off

′Grade II instability is when there is no step-off (flush)

′Grade III instability is when there is –5 mm step-off There is a high association between

Grade III PCL injury and posterolateral corner injury.

PCL

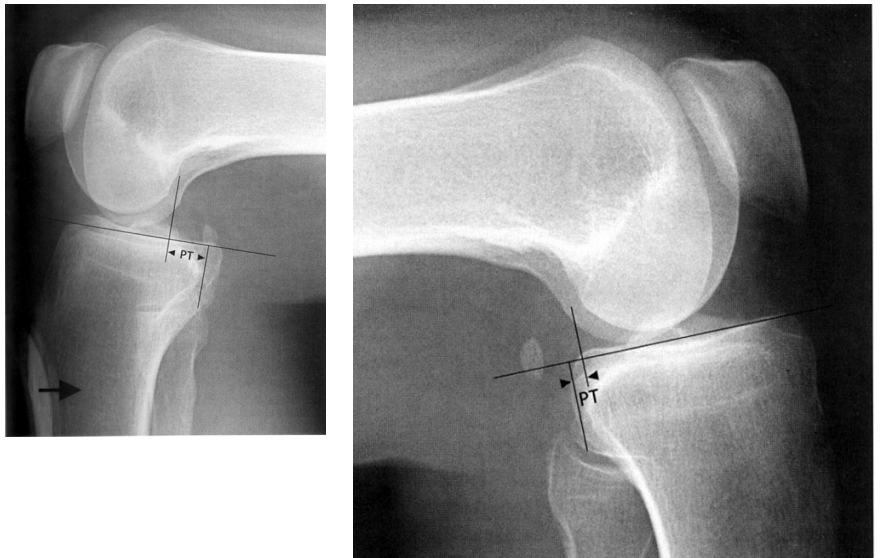
Clinical Examination

- Posterior tibial shift
- Palpatory posterior tibial shift (gravity sign .posterior sag sign)
- Lachmanntest

PCL

Diagnostic

X ray:
fractures
Chronic posterior sag



Stress x rays
Posterior sag sign:
I° 3 – 5 mm
II° 5 – 10 mm
III° more than 10mm

- Quadriceps active drawer test. Flex the knee to 60← and control the foot then ask the patient to contract the quads. The test is positive when the tibia reduces.
- Posterior sag sign (step-off)
- Posterolateral rotatory instability (Dial test prone)
- External rotation recurvatum test

PCL

Nonoperativ Treatment

- **protected weight bearing & rehab**
- Indications : isolated Grade I (partial) and II (complete isolated) injuries
- Modalities : quadriceps rehabilitation with a focus on knee extensor strengthening
- Outcomes : return to sports in 2-4 weeks

- **relative immobilization in extension for 4 weeks**
- Indications isolated Grade III injuries
- surgery may be indicated with bony avulsions or a young athlete
- Modalities extension bracing with limited daily ROM exercises
- immobilization is followed by quadriceps strengthening

Surgery

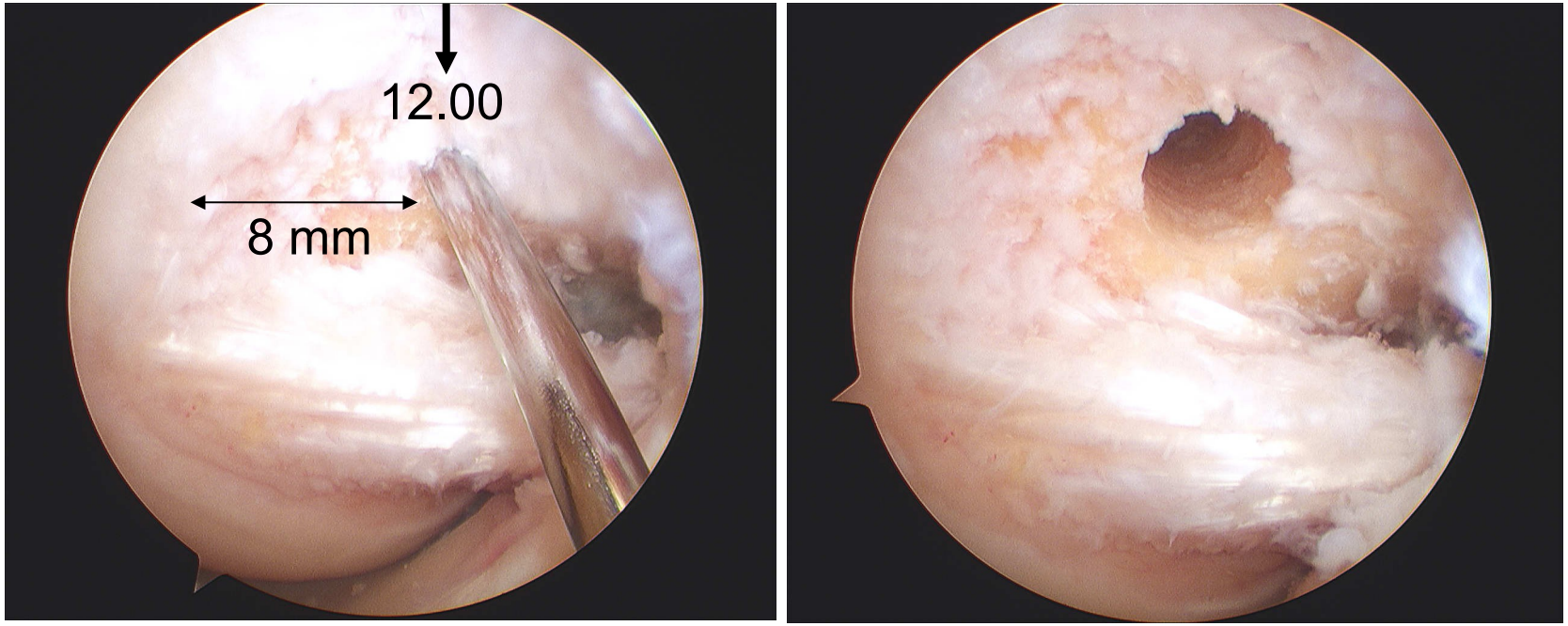
Indications

- Acute combined injuries
- Acute bony avulsion
- Symptomatic chronic PCL injuries that failed rehabilitation.

- There is no difference in clinical outcome between single and double bundle PCL reconstruction.

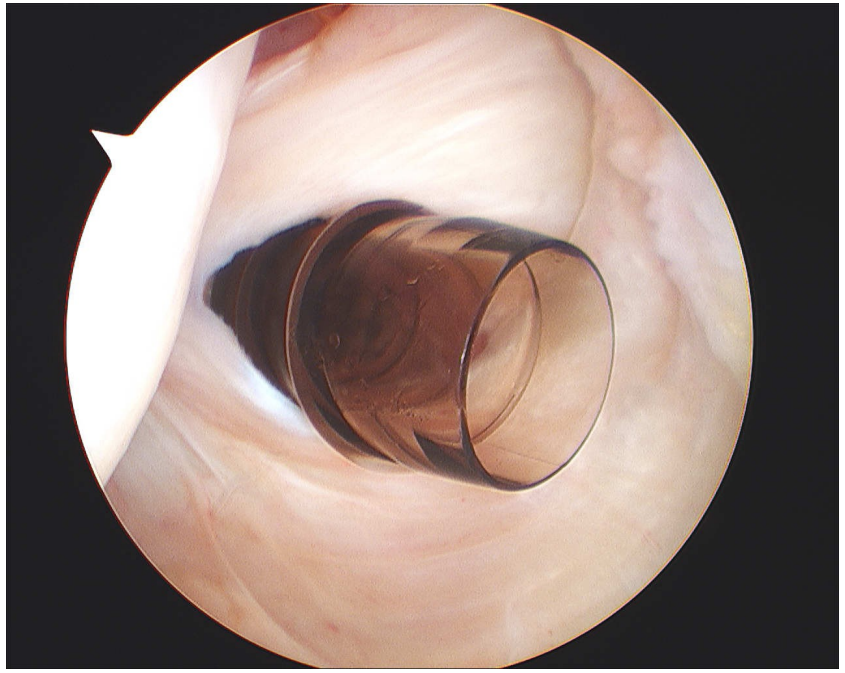
PCL

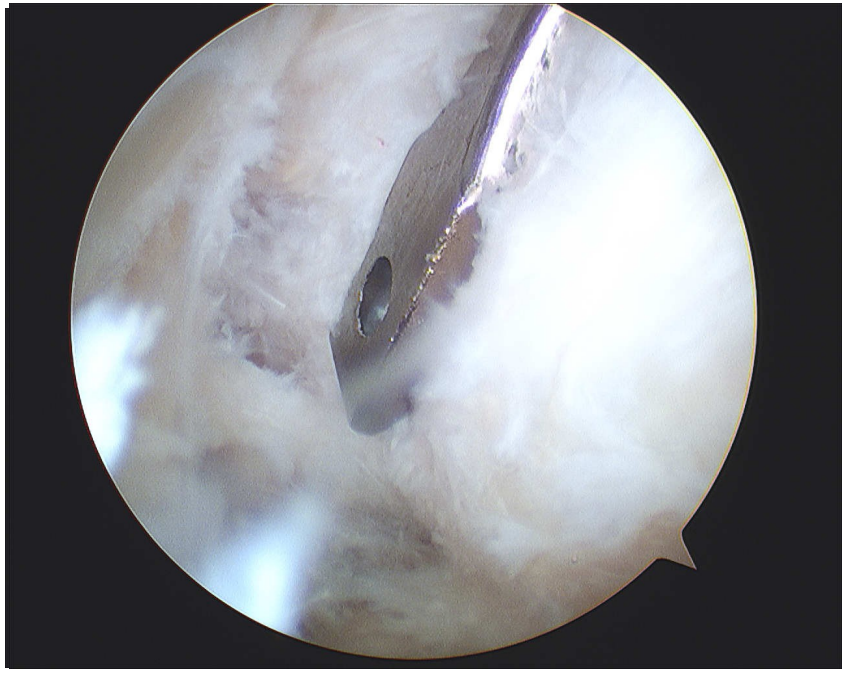
Technique



PCL

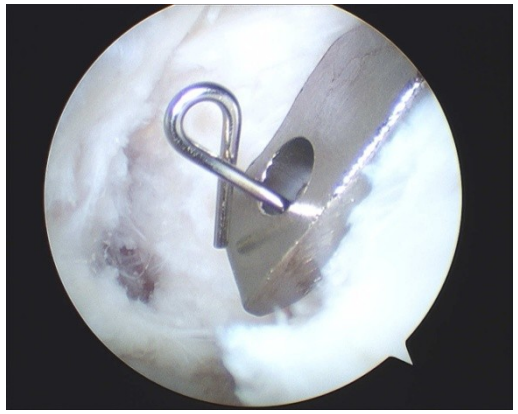
Technique

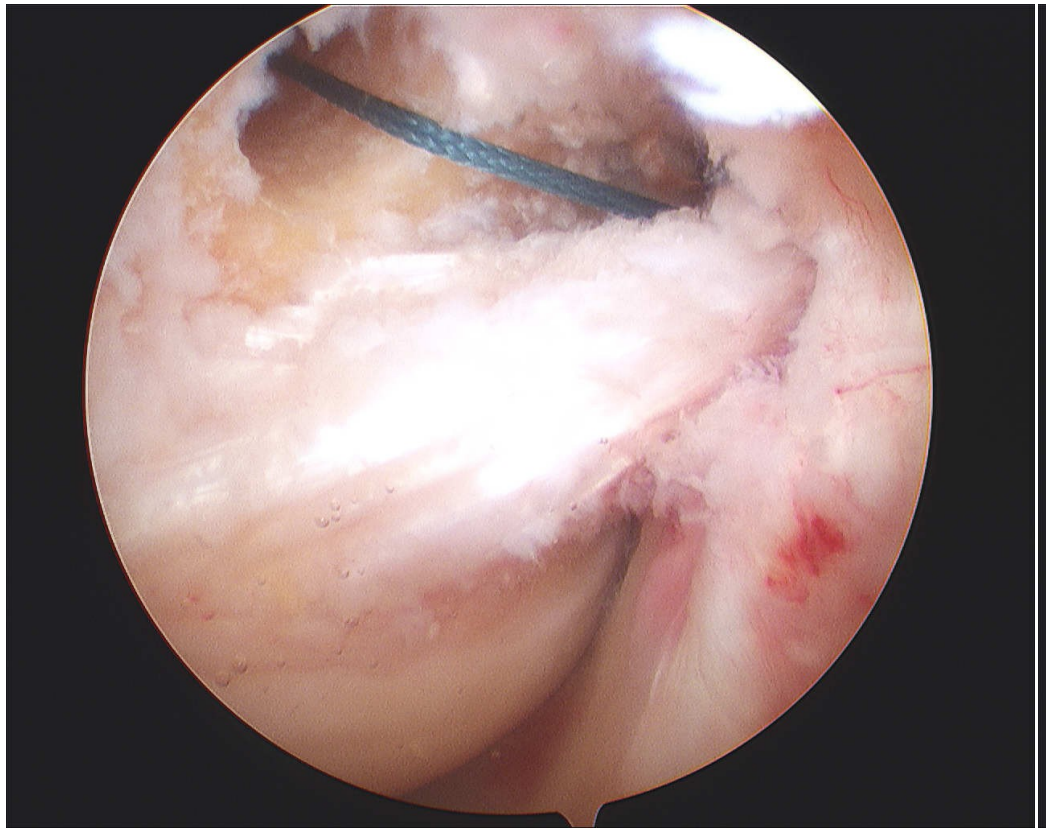


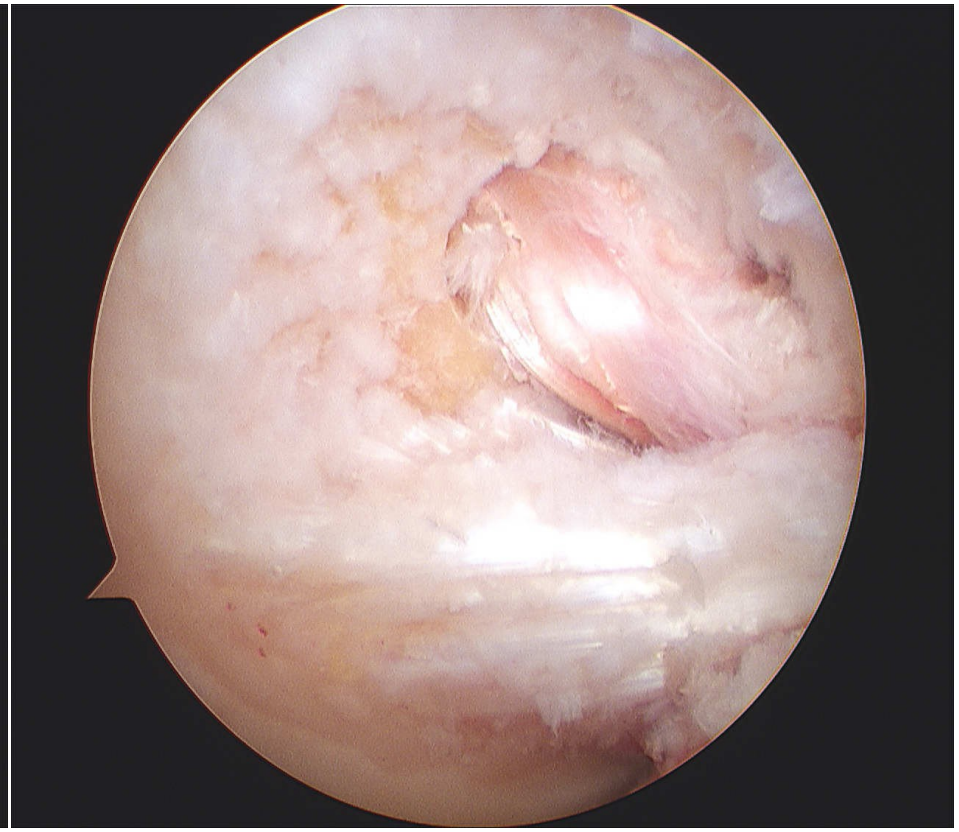


PCL

Technique



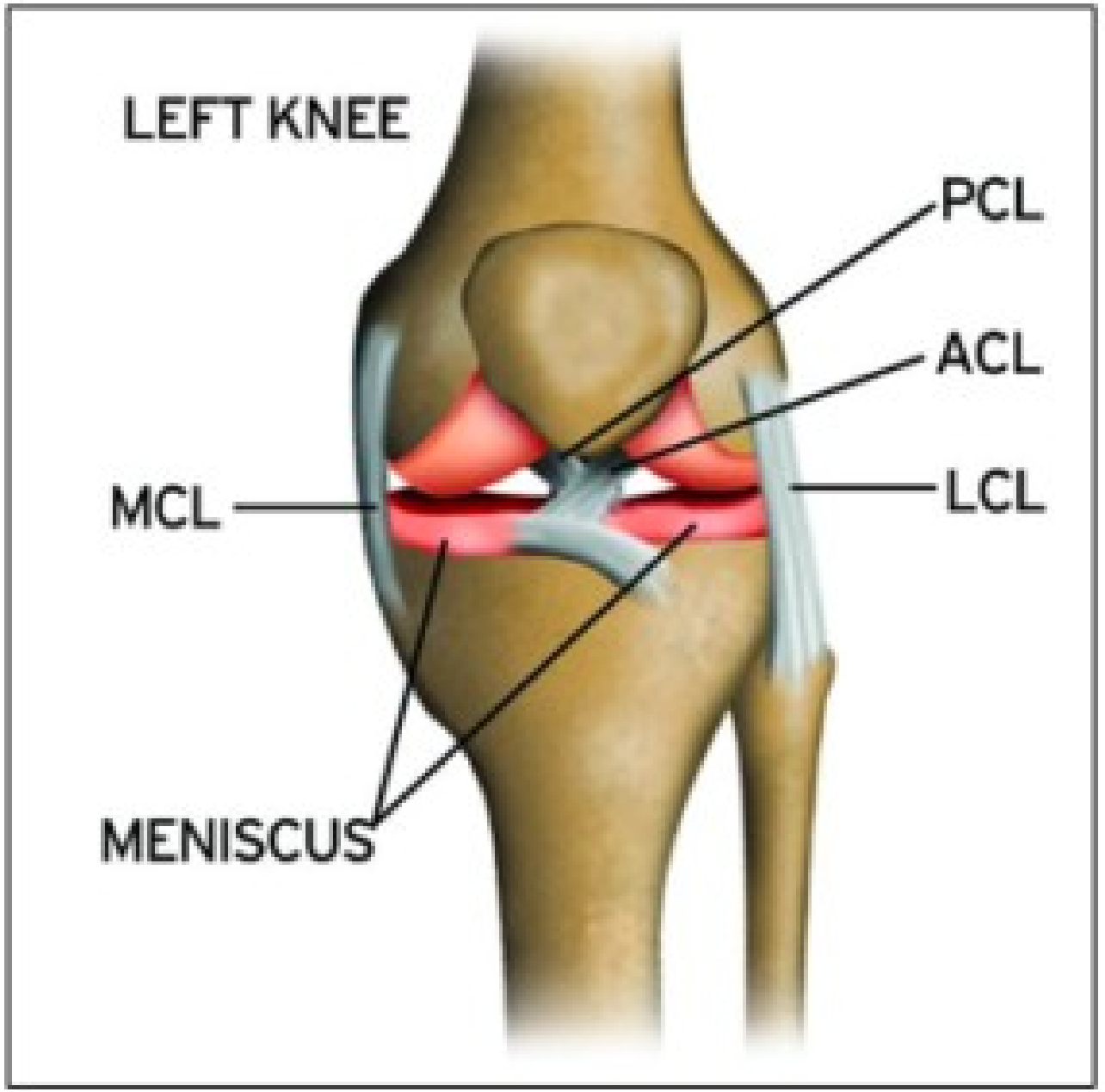




1. Insertion of shuttle suture wire with aiming device and special guide wire: The guide wire automatically locks the shuttle suture once it is inserted, than the device is removed, @ the suttle suture remains in position and shows the pathway of the graft. @
2. The last picture shows the insterted PCL-graft.

LCL

- Anatomy
  - origin
    - on ***lateral femoral condyle*** posterior and superior to insertion of *popliteus*
  - path
    - runs *superficial to popliteus*
  - insertion
    - ***on the fibula anterior to the popliteofibular*** ligament on the fibula
    - capsule's most distal extent is just posterior to the fibula
  - structure
    - cord-like
- Biomechanics
  - ***tight in extension and lax in flexion***
  - strength: 750 N (vs varus stress)

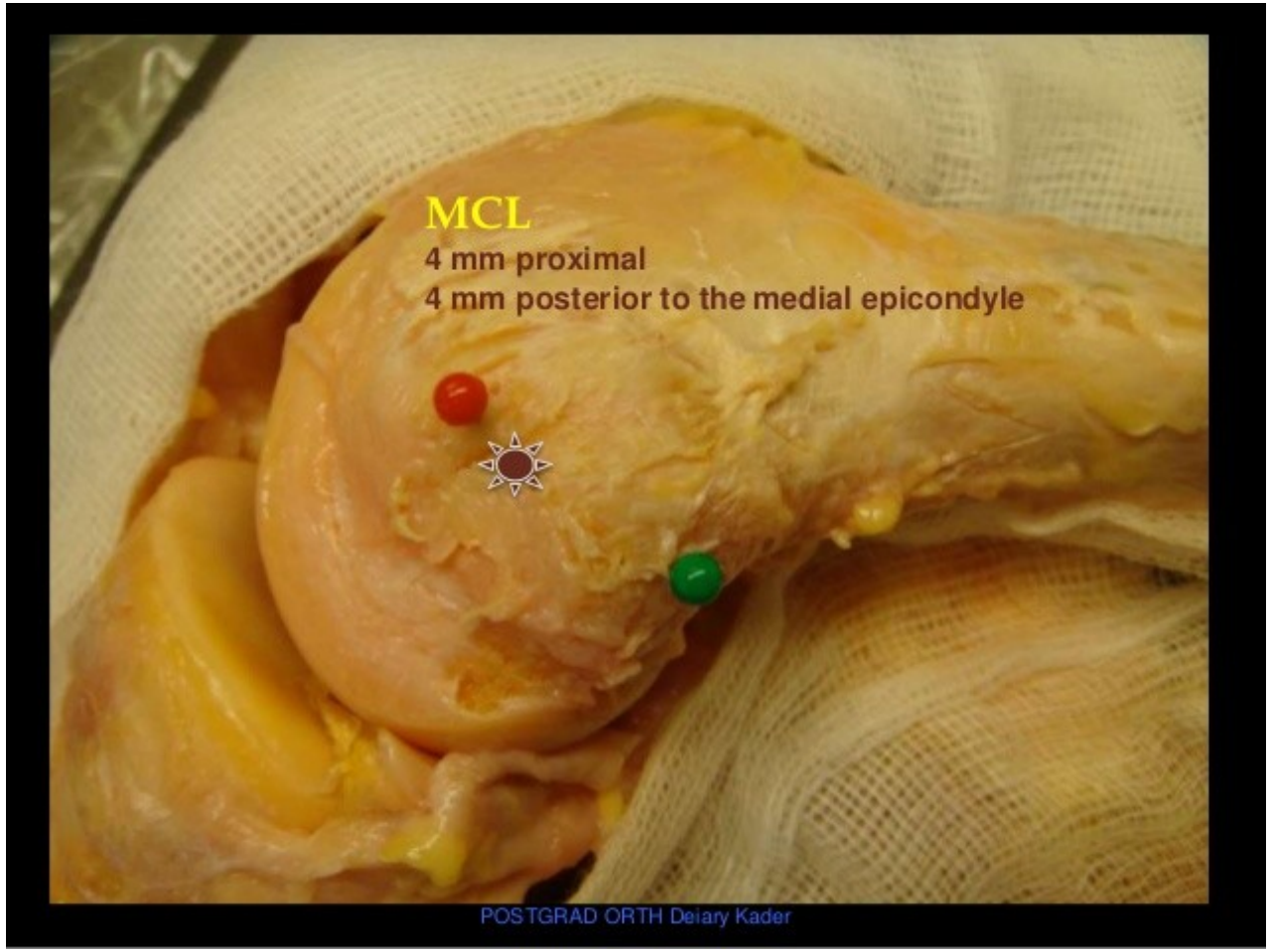

LEFT KNEE
PCL
ACL
LCL
MCL
MENISCUS

LCL INJURY

- Varus instability = lateral opening
  - 30° only - isolated LCL
  - 0° and 30° - combined LCL and ACL and/or PCL
- Varus opening and increased external tibial rotatory instability at 30° - combined LCL and posterolateral corner

MCL

- Function
  - resists ***valgus angulation***
  - works in *concert with ACL* to provide restraint to axial rotation
- Anatomy
  - origin
    - MFC to medial tibia extending down several centimeters
- Biomechanics
  - strength: 4000 N (vs valgus stress)


MCL
4 mm proximal
4 mm posterior to the medial epicondyle
POSTGRAD ORTH Deiary Kader

Structure

- two components
  - **superficial portion** (tibial collateral ligament)
    - lies just deep to gracilis and semitendinosus
    - the superficial MCL is the ***primary stabilizer to valgus stress at all angles***
  - **deep portion** (medial capsular ligament)
    - separated from superficial portion by a bursa
    - attaches to medial meniscus (coronary ligament)
    - divided into ***meniscofemoral and meniscotibial*** portions
    - posterior fibers of the deep MCL blend with posteromedial capsule and POL

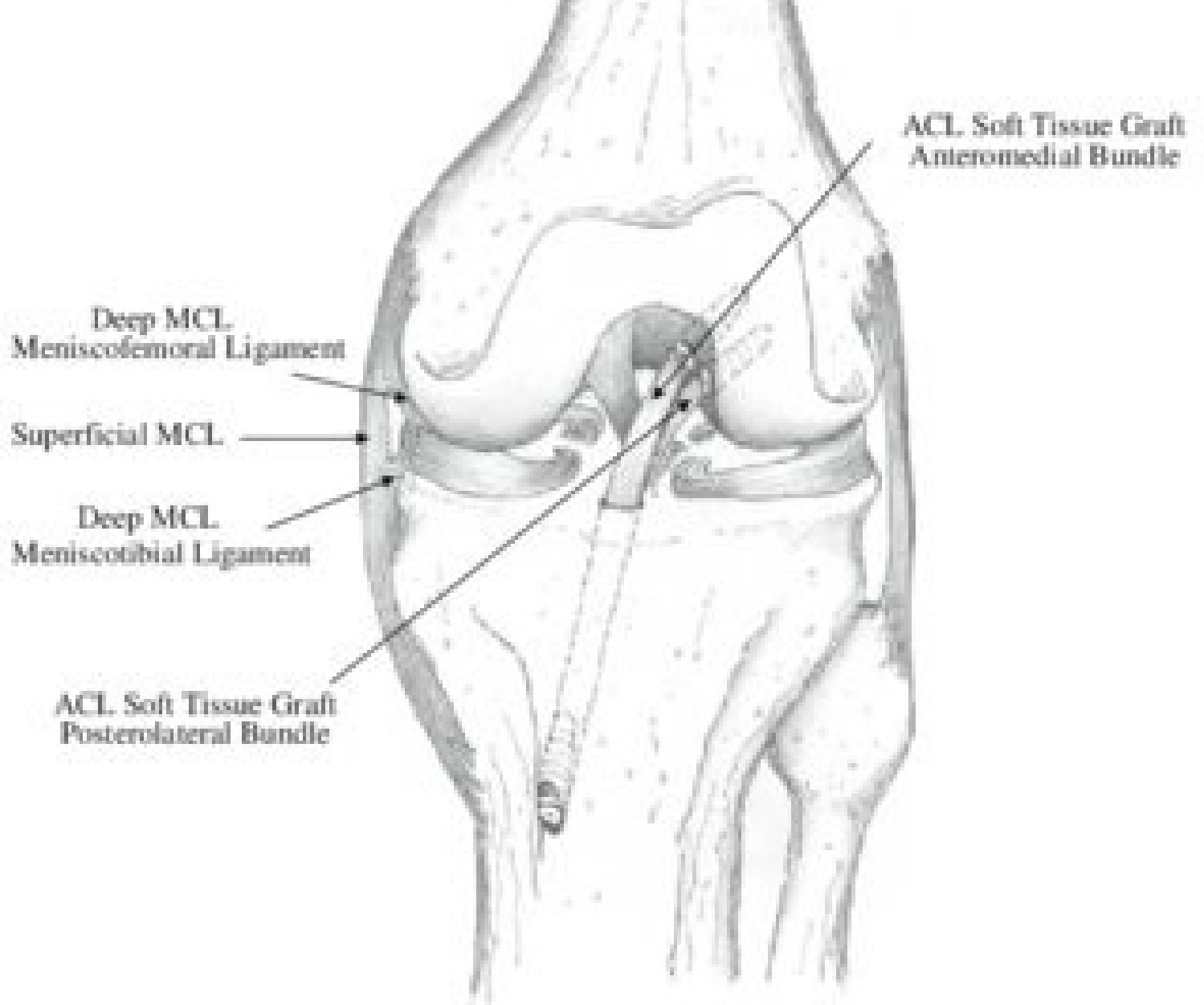
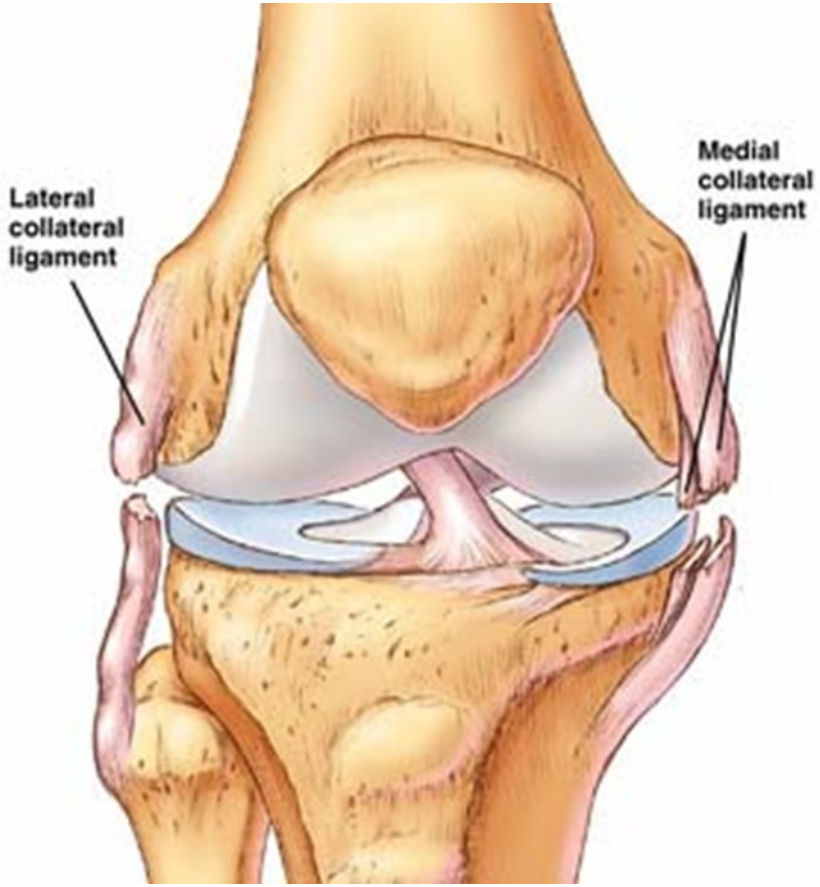


Fig. 2 Anatomic double bundle ACL soft tissue graft placement lower on the lateral wall of the femoral condyle aligns it more directly

MCL INJURY

- Valgus instability = medial opening
  - 30° only - isolated MCL
  - 0° and 30° - combined MCL and ACL and/or PCL
  - classification
    - Grade I: 0-5 mm opening
    - Grade II: 6-10 mm opening
    - Grade III: 11-15 mm opening
- Anterior Drawer with tibia in external rotation
  - grade III MCL tears often associated with ACL and posteriomedial corner tears
  - postive test will indicate associated ligamentous injury


Lateral
collateral
ligament
Medial
collateral
ligament


IMPACT


Flip Angle 180
3.6 mm/FOV* 15 cm
MCL Tear

PLC

- Function
  - works synergistically with the PCL to control external rotation and posterior translation
  - PLC is primary stabilisers of ER at all knee flexion angles and the secondary restraints to anterior and posterior translation

- Anatomy
  - included structures
    - LCL (295N)
    - popliteus muscle and tendon (680N)
    - popliteofibular ligament (229N)
    - lateral capsule
  - variable
    - arcuate ligament
    - iliotibial band
    - fabellofibular ligament

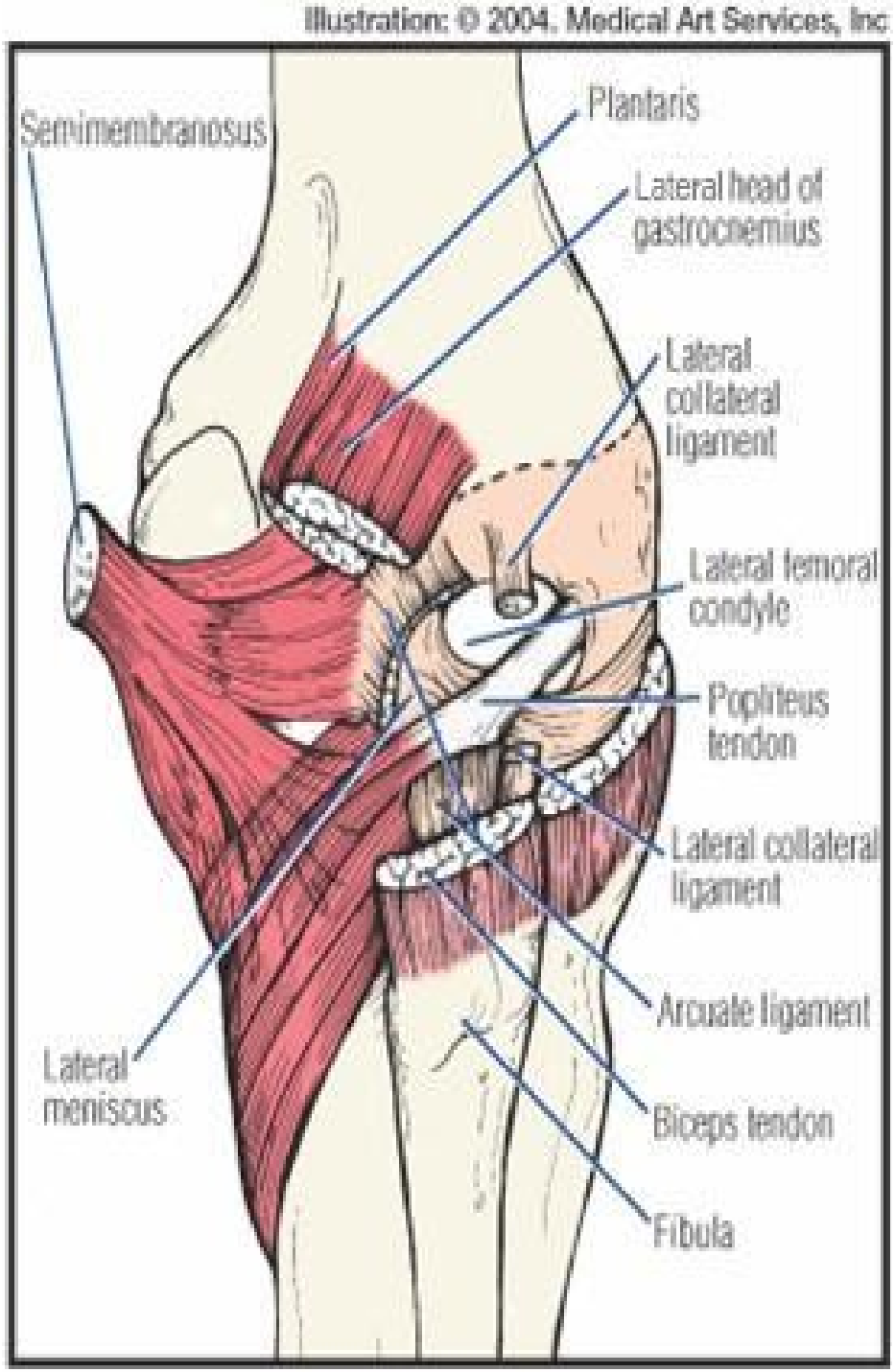
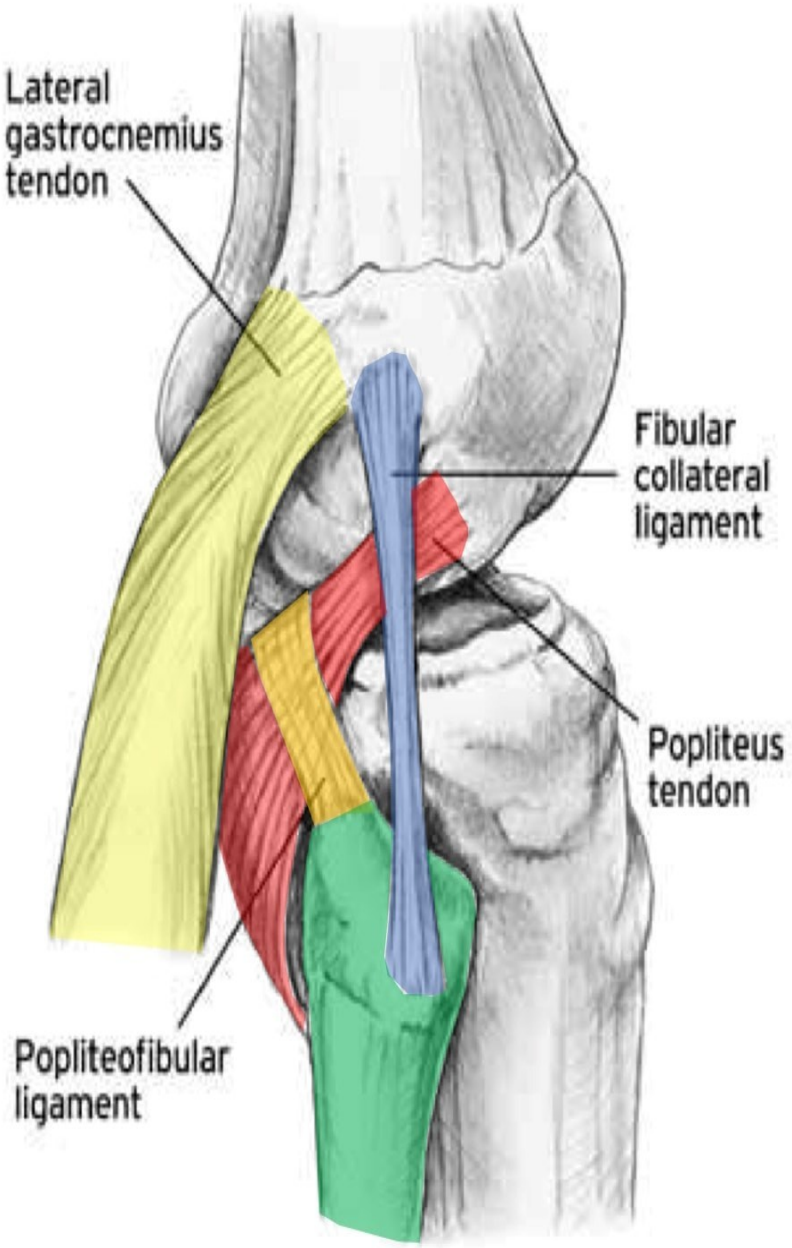


Illustration: © 2004. Medical Art Services, Inc.
Semimembranosus
Plantaris
Lateral head of gastrocnemius
Lateral collateral ligament
Lateral femoral condyle
Popliteus tendon
Lateral collateral ligament
Arcuate ligament
Lateral meniscus
Biceps tendon
Fibula


Lateral gastrocnemius tendon
Fibular collateral ligament
Popliteus tendon
Popliteofibular ligament

PLC INJURY

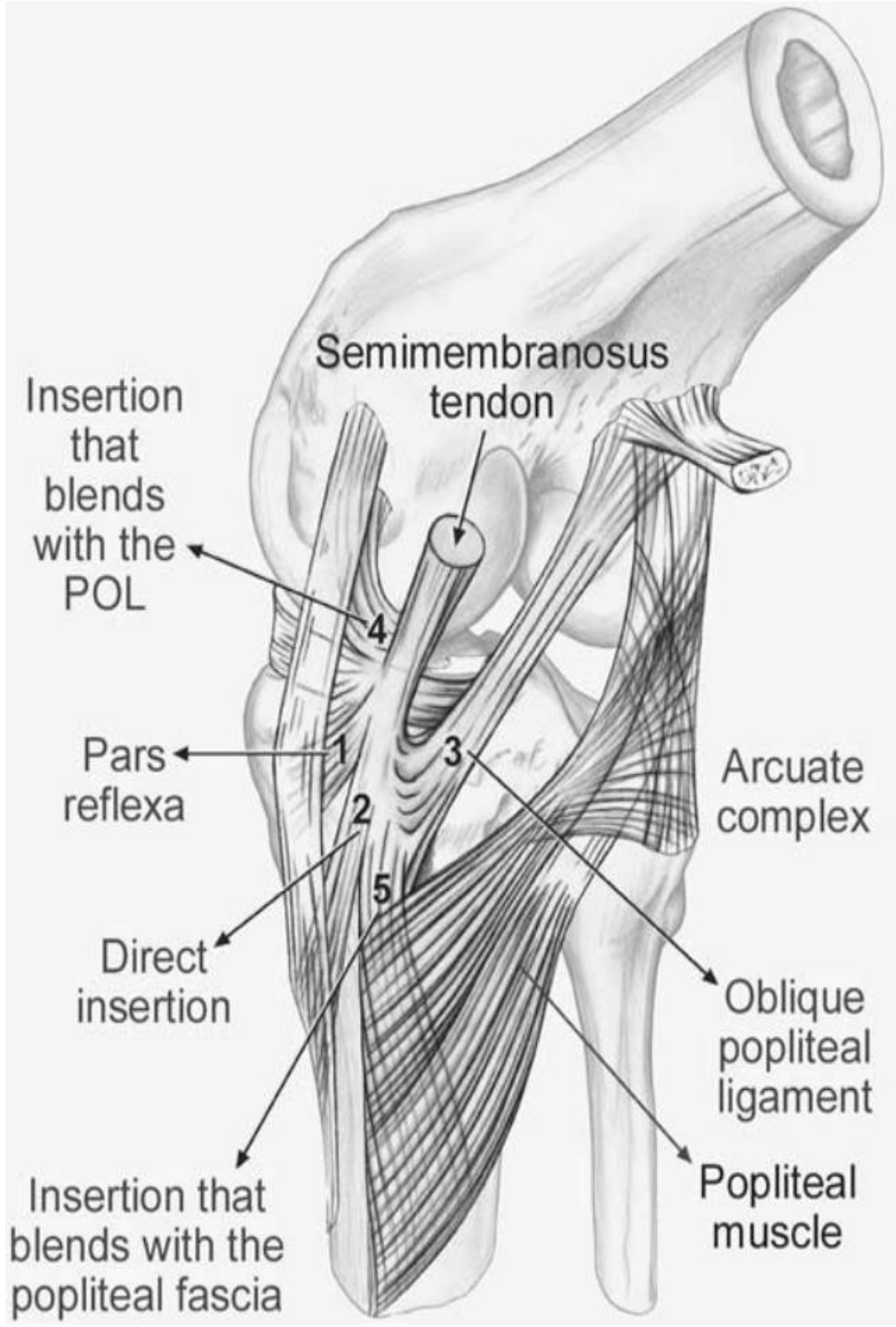
- Gait
  - varus thrust or hyperextension thrust
- Varus stress test
  - varus laxity at 0° indicates both LCL & cruciate (ACL or PCL) injury
  - varus laxity at 30° indicates LCL injury
- Dial test
  - > 10° ER asymmetry at 30° only consistent with isolated PLC injury
  - > 10° ER asymmetry at 30° & 90° consistent with PLC and PCL injury

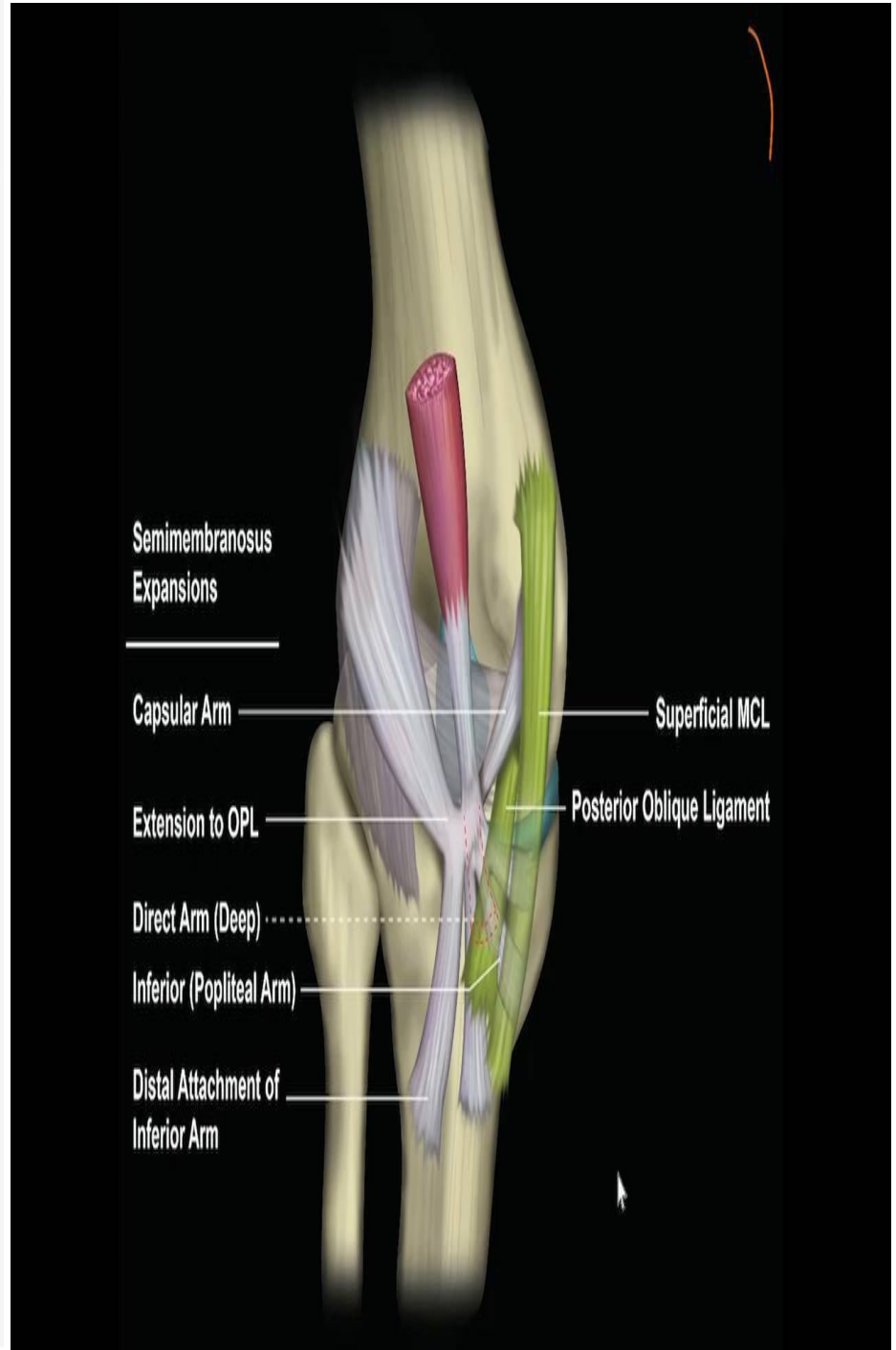
- Posterolateral drawer test
  - performed with the hip flexed 45°, knee flexed 80°, and foot ER 15°
  - a combined posterior drawer and ER force is applied to the knee to assess for an increase in posterolateral translation (lateral tibia externally rotates relative to lateral femoral condyle)

- Reversed pivot shift test
  - with the knee positioned at 90°, ER and valgus forces are applied to tibia
  - as the knee is extended, the tibia reduces with a palpable clunk
    - (reduction force from IT band transitioning from a flexor to an extensor of the knee)
- External rotation recurvatum test
  - positive when the leg falls into ER and recurvatum when the lower extremity is suspended by the toes in a supine patient
- Peroneal nerve assessment
  - injury present with altered sensation to foot dorsum and weak ankle dorsiflexion

POSTEROMEDIAL CORNER

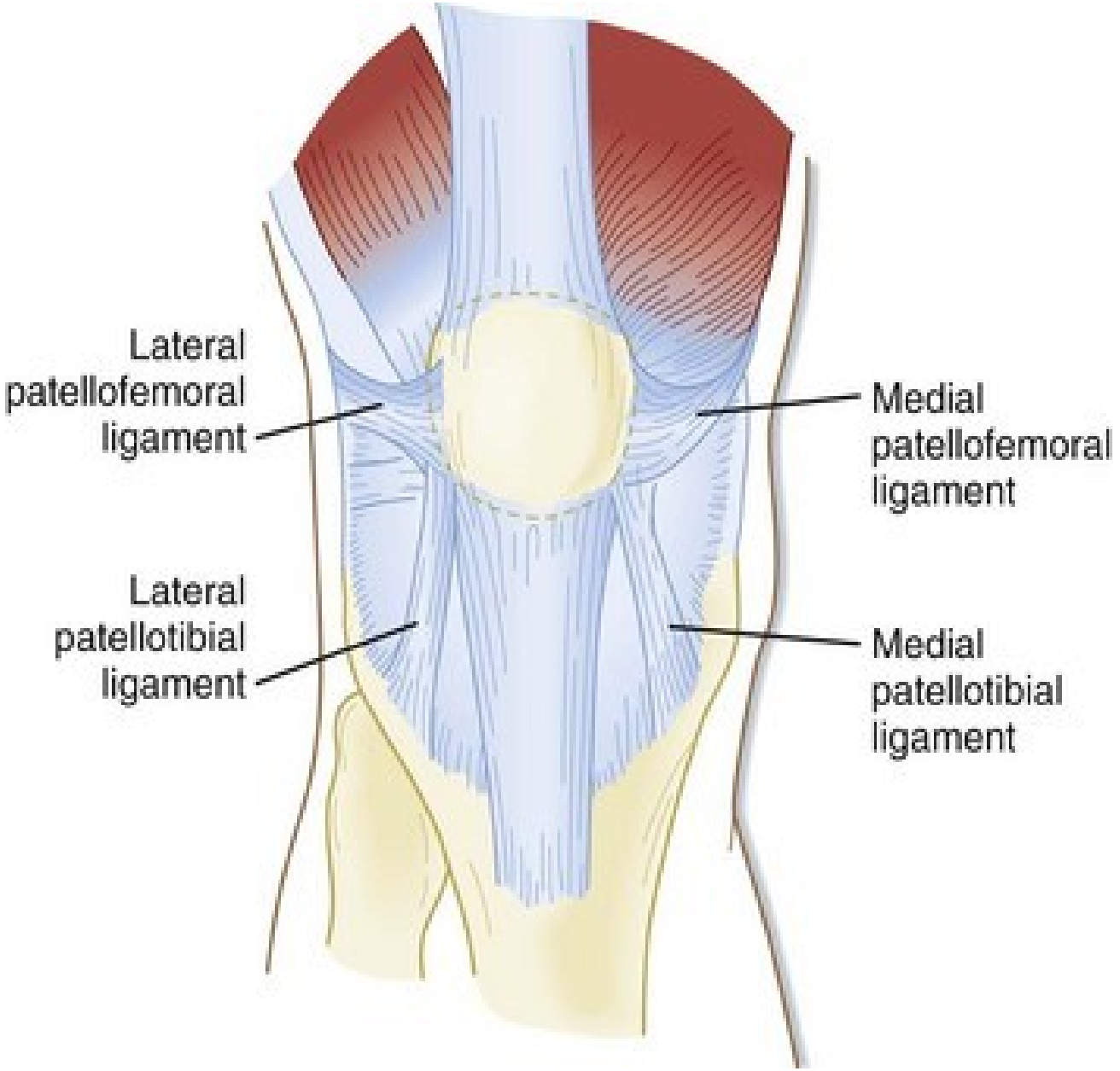
- Function
  - important for rotatory stability
- Anatomy
  - lies deep to MCL
  - formed by
    - insertion of semimembranosus
    - posterior oblique ligament
      - ***resists tibial internal rotation in full extension***
    - oblique popliteal ligament
    - posterior capsule


Semimembranosus tendon
Insertion that blends with the POL
Pars reflexa
Direct insertion
Insertion that blends with the popliteal fascia
Arcuate complex
Oblique popliteal ligament
Popliteal muscle
1
2
3
4
5


Semimembranosus Expansions
Capsular Arm
Extension to OPL
Direct Arm (Deep)
Inferior (Popliteal Arm)
Distal Attachment of Inferior Arm
Superficial MCL
Posterior Oblique Ligament

MPFL

- Function
  - provide restraint against lateral translation of the patella from 0° to 30° of knee flexion
- Characteristics
  - low tension throughout flexion-extension (2-10N of force)
  - isometric between 0° and 90°, then becomes slack beyond 90°
  - can withstand 200N before tearing
    - much lower load to failure than ACL (1725N)


Lateral patellofemoral ligament
Medial patellofemoral ligament
Lateral patellotibial ligament
Medial patellotibial ligament

MPFL

- Anatomy
  - lies in 2nd layer of medial soft tissue complex
  - 2 bundles
    - short oblique bundle, inserts on superior patellar pole
    - inferior straight bundle
  - femoral insertion
    - medial femoral condyle, distal to adductor tubercle and proximal to MCL attachment
    - Schottle's point
      - 1.3mm anterior to posterior femoral diaphyseal cortex
      - 2.5mm distal to posterior origin of medial femoral condyle
      - proximal to the level of the posterior point of Blumensaat's line

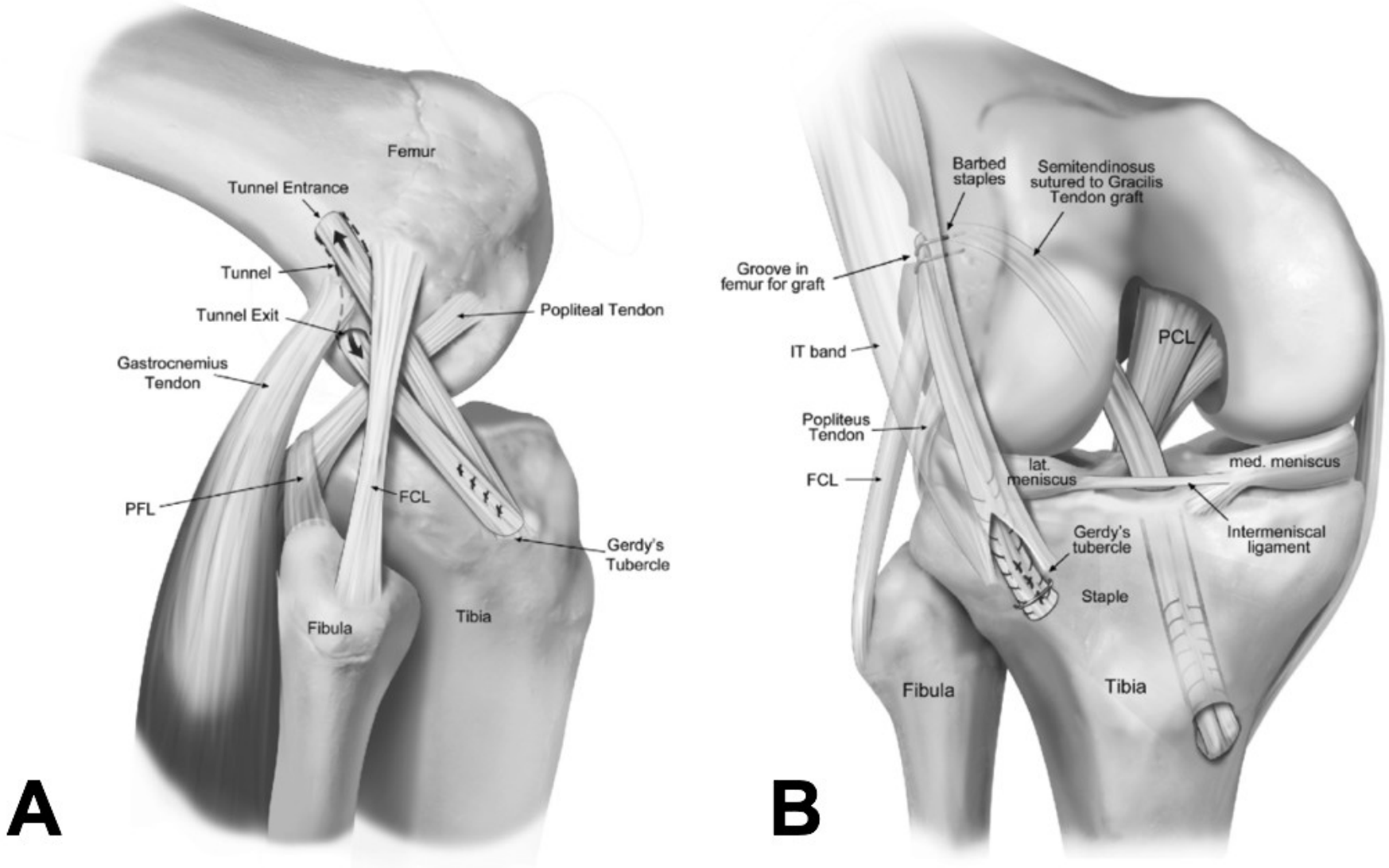
- patellar attachment
  - fan-like structure inserting at junction between proximal-middle thirds of superomedial border of patella
- Pathoanatomy
  - tears off femoral attachment > patellar attachment
    - some studies show otherwise
  - risk of 2nd dislocation is 13%
    - risk of 3rd dislocation (after 2nd dislocation) is 50%

ANTEROLATERAL LIGMMENT

- Function
  - rotational stability
- Anatomy _
  - lies in Layer 3 with LCL
  - attachments
    - femoral
      - lateral femoral epicondyle
    - tibial
      - midway between Gerdy's tubercle and head of fibula

- attachments to middle third of lateral meniscus body
- lateral inferior genicular artery and vein contained between lateral meniscus and ALL at level of joint line

- Pathoanatomy
  - Segond's fracture (associated with ACL rupture) is avulsion fracture of ALL


Femur
Tunnel Entrance
Tunnel
Tunnel Exit
Gastrocnemius Tendon
Popliteal Tendon
PFL
FCL
Gerdy's Tubercle
Fibula
Tibia
A
Barbed staples
Semitendinosus sutured to Gracilis Tendon graft
Groove in femur for graft
IT band
PCL
Popliteus Tendon
FCL
lat. meniscus
med. meniscus
Gerdy's tubercle
Intermeniscal ligament
Staple
Fibula
Tibia
B

Thank you