PCL anatomy and biomechanics

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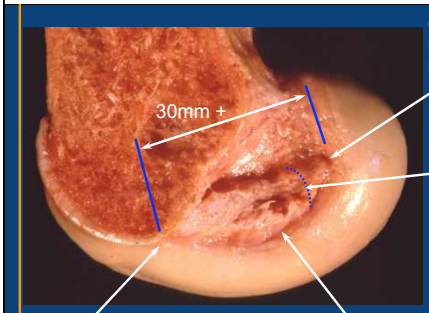
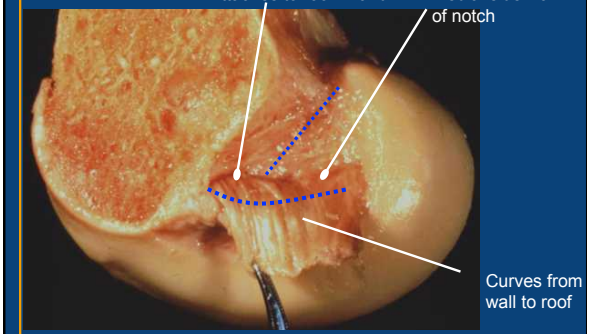
The PCL

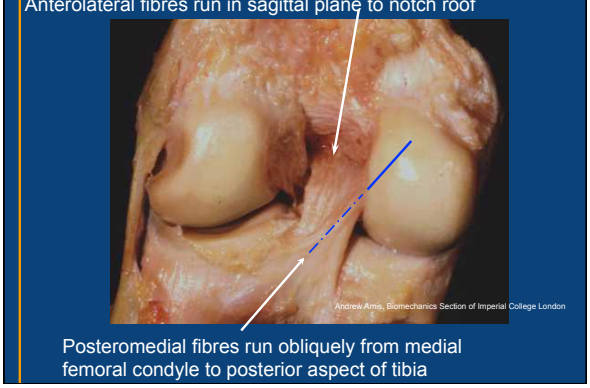
- largest intra-articular ligament
- extrasynovial structure
- 32 to 38mm long
- Cross-sectional area of 11mm²
- bony insertion sites 3-times larger than midsubstance
- longitudinally orientated collagen fibers most narrow in midsubstance fanning out at the attachments femoral more than tibial
- based on ligament function - AL and PM bundle

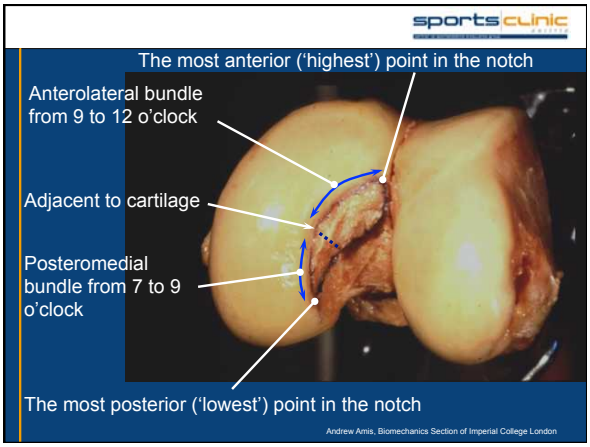
PCL

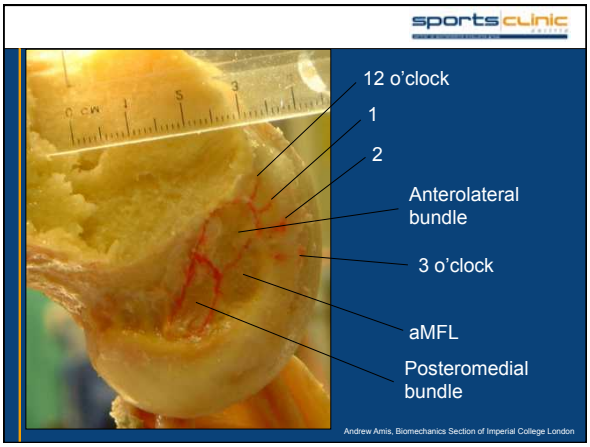
- Femoral Attachment











Arthroscopy

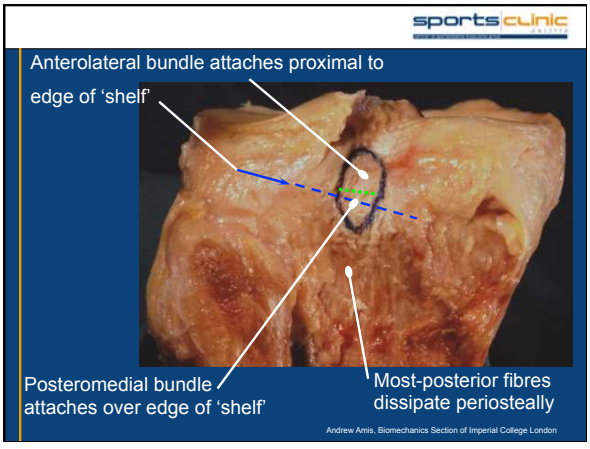
- AL bundle inserts on anterolateral aspect of intercondylar notch

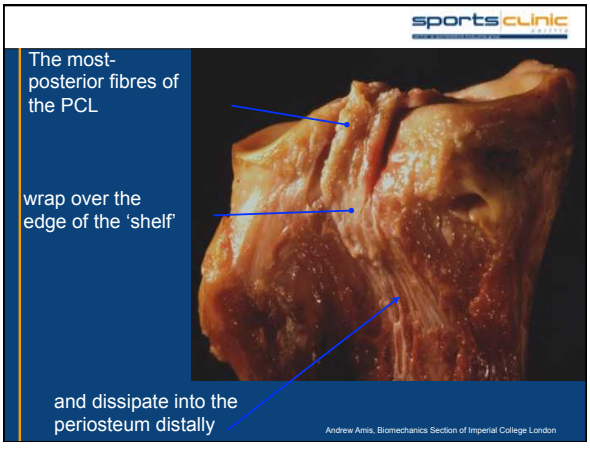
easily visualized on standard arthroscopic image

- PL bundle inserts posteriorly
  - seen inferomedially on arthroscopic view

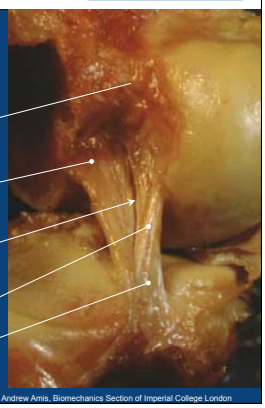
PCL

- Tibial attachment





Left knee viewed from posterolateral aspect, lateral femoral condyle removed



Posteromedial bundle attaches to side wall of notch

Anterolateral bundle attaches to roof of notch

Artificial split between bundles

Posterior-oblique fibres

Posteromedial bundle overlays anterolateral

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Biomechanics of PCL

- Posterior translational and rotational stability – tensile strength, complex orientation of fibers
- Tensile strength is highest of knee ligaments AL 1620N, PM 258N
- Underestimation for young healthy population???

95% of posterior stability between 30 and 90 degrees of flexion

The posteromedial fibres are tight in the extended knee

Rather resistance against hyperextension than posterior draw because of proximal-distal direction of fibers

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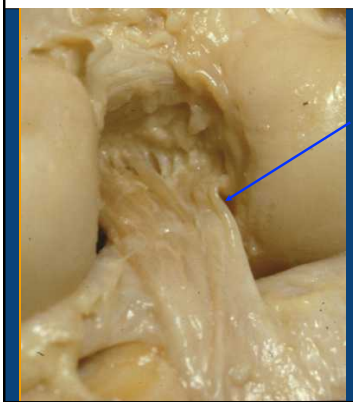

They slacken when the knee starts to flex

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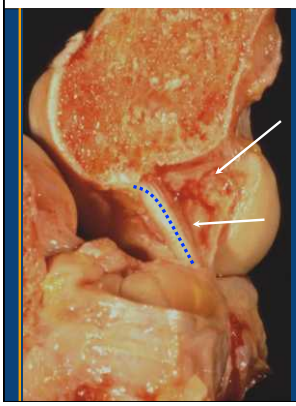

In the extended knee, the posteromedial bundle is aligned to resist hyperextension, but not posterior draw

The anterolateral bundle is slack, and takes a curved path. This is seen in MRI.

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When the knee starts to flex, the posteromedial attachment moves towards the tibia, slackening the fibres

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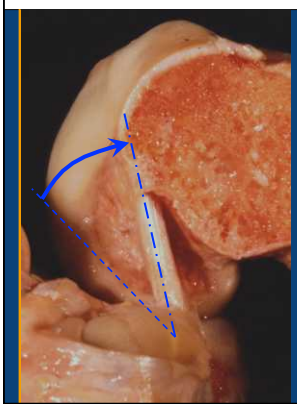

As the knee flexes, the anterolateral bundle becomes tight and swings up to a steeper orientation

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In deep knee flexion, the anterolateral bundle becomes steeper and meets the roof of the notch.

The PCL is vulnerable to impingement against the tibia in hyperflexion

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In deep flexion, the posteromedial bundle becomes tight and well-aligned to resist posterior draw

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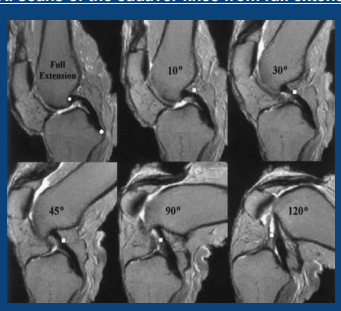
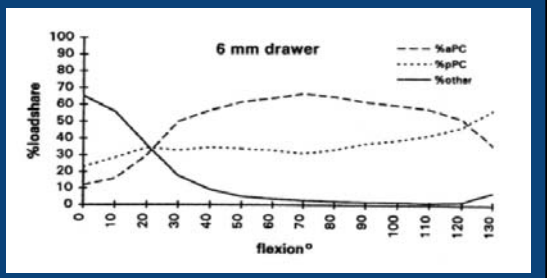
Sagital MRI scans of the cadaver knee from full extension to 120°



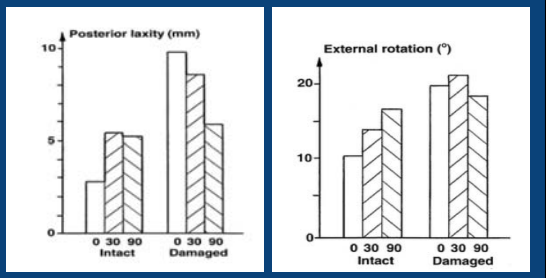
Nakagawa S; JBJS 2004: The posterior cruciate ligament during flexion of the normal knee

Percentage contributions of the two bundles (aPC and pPC) of the PCL, and of „other structures“ to resisting 6mm posterior tibial translation, across the range of knee flexion



Amis A; KSSTA 2003: Biomechanics of the PCL and related structures

Rupture of the posterolateral structures caused posterior tibial draw laxitiy at 100N to increase greatly in the extended knee, but only a little at 90 degrees knee flexion and tibial external rotation laxitiy at 5Nm torque to increase greatly in the extended knee, but only a little at 90 degrees knee flexion (I.Hijazi et al. unpublished)



Amis A; KSSTA 2003: Biomechanics of the PCL and related structures

Meniscofemoral Ligaments

Meniscal Tear???

MFLs

- 2 disdinct structures with variable incidence
- Connect posterior horn of lateral meniscus to intercondylar notch
- Anchor to lateral meniscus???
- Secondary restraint to posterior tibial translation???

MFL

(Meniscofemoral ligaments revisited CM Gupte et al.2003)

- Ligament of Humphrey aMFL 74%
- Ligament of Wrisberg pMFL 69%
- 50% with both
- serveral anatomical variations – „false pMFL“ – oblique fibers of PM bundle
- thickness varies considerably

Anterior meniscofemoral ligament of Humphrey (aMFL)

Femoral attachment between PCL and cartilage, distal to PCL attachment

Fibres of aMFL slant across vertical fibres of PCL

Distal attachment to posterior horn of lateral meniscus

(Tibia subluxed anteriorly in ACL deficient knee)

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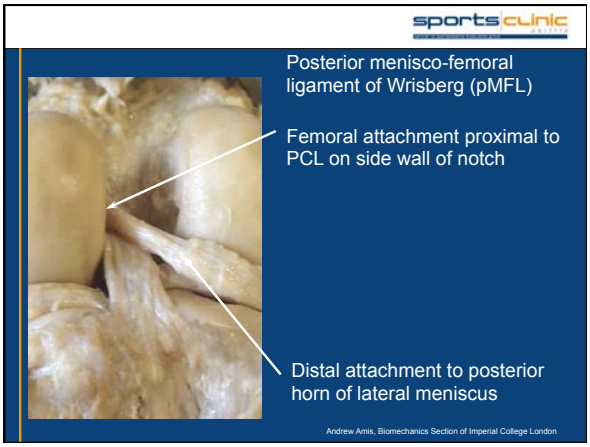
Posterior menisco-femoral ligament of Wrisberg (pMFL)
Femoral attachment proximal to PCL on side wall of notch
Distal attachment to posterior horn of lateral meniscus
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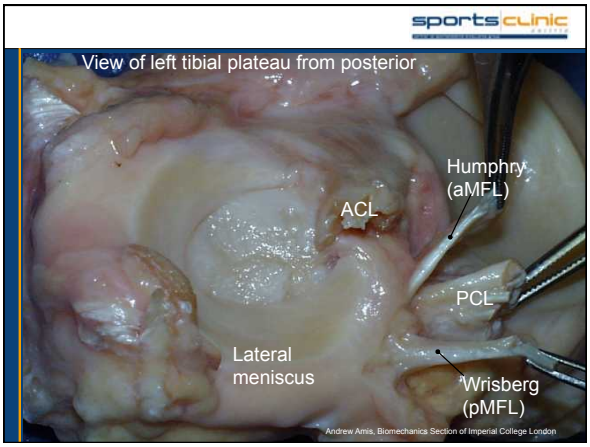
View of left tibial plateau from posterior
Humphry (aMFL)
ACL
PCL
Lateral meniscus
Wrisberg (pMFL)
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71-100% of knees have at least one MFL
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The aMFL may be large and have a wide femoral attachment…
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..or it may be thin (or absent!). The aMFL fibres always slant across the vertical PCL fibres.
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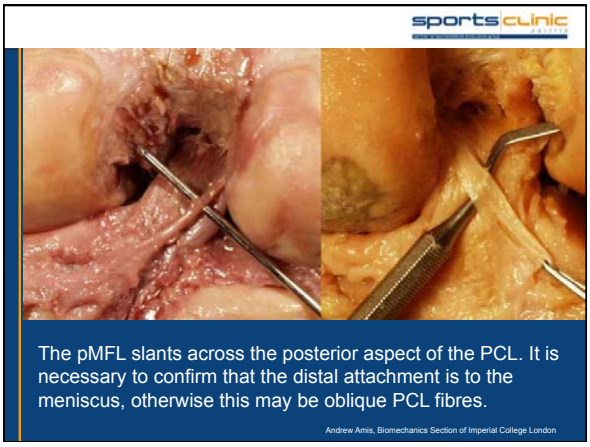
The pMFL slants across the posterior aspect of the PCL. It is necessary to confirm that the distal attachment is to the meniscus, otherwise this may be oblique PCL fibres.
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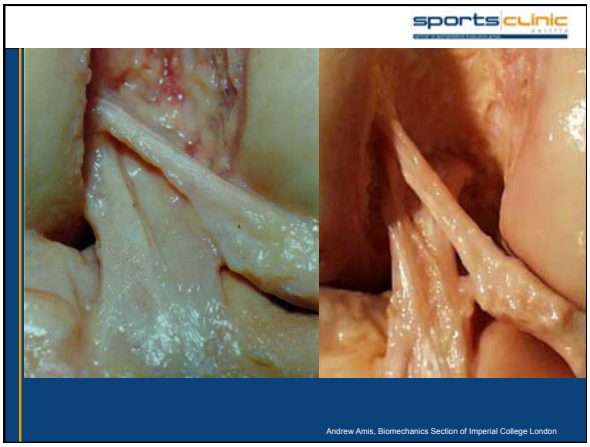
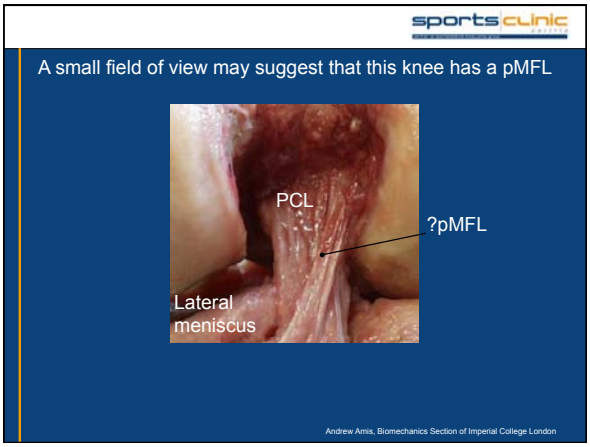
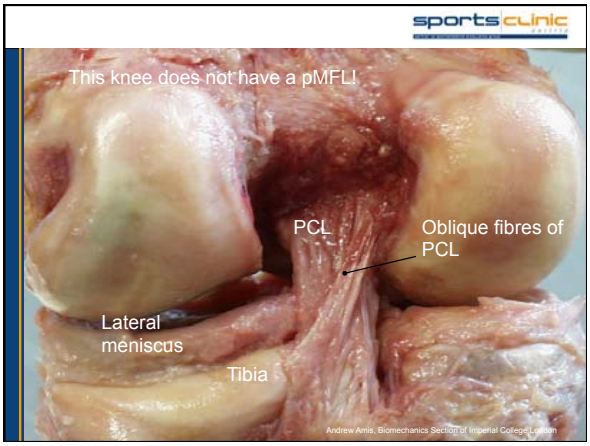
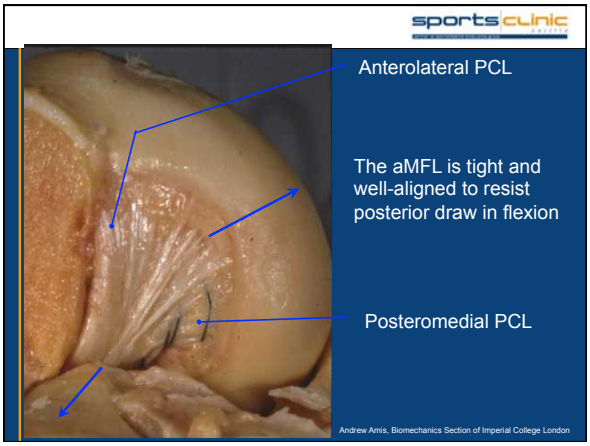






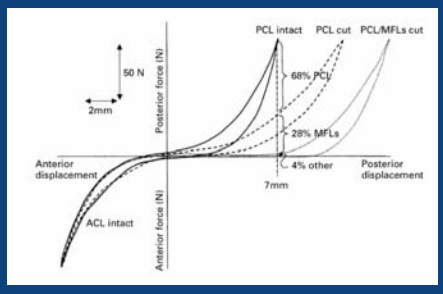


Biomechanics of MFLs

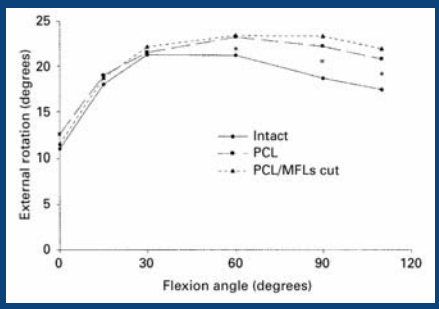
- Control the movement of the posterior horn of the lateral meniscus
- Last suggested protection against meniscal tears
- Lee et al. could not confirm assosiation between presence or absence of MFLs and lateral meniscal tears (MRI scans of arthroscopically proven meniscal tears)

Biomechanics of MFLs

- Substantial contribution to resisting posterior tibial drawer in intact and PCL-deficient knees
- Division of MFLs in PCL-deficient knee increases posterior translation between 15° and 90° of flexion
- No effect of rotational laxity

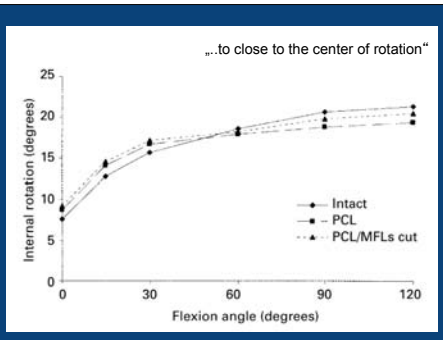


Gupte C; JBJS 2003: The meniscofemoral ligaments: secondary restraints to the posterior drawer



Gupte C; JBJS 2003: The meniscofemoral ligaments: secondary restraints to the posterior drawer

„..to close to the center of rotation“



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THANK YOU!