Normal Anatomy and Sports Injuries of the Knee

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Normal Anatomy and Sports Injuries of the Knee

- Cruciate Ligaments
- Menisci
- Posterolateral Corner
- MCL
- Extensor Mechanism
  - Chronic Stress
  - Acute Tibial Avulsion
- Physeal Fractures
- Patella
  - Maltracking/Dislocation
  - Normal Variants
- OCD vs Normal Variant
Cruciate ligaments

Anterior Cruciate Ligament

- Prevents anterior translation of tibia on femur.
- Anteromedial bundle
  - Prevents anterior translation during knee flexion
  - Torn with high energy trauma
- Posterolateral bundle
  - Prevents anterior translation in knee extension
  - Prevents internal rotation of the tibia
  - Torn with lower-energy rotational trauma
ACL Anatomy - Coronal

- Origin – medial border of lateral femoral condyle
- Inserts anterior to tibial spines, at tibial eminence, close to anterior root of lateral meniscus
- Anteromedial bundle – more proximal origin and anteromedial insertion than Posterolateral bundle.

ACL Anatomy - Sagittal Oblique
ACL Anatomy - Sagittal Oblique

- Approximately parallel to intercondylar notch
- Appears high in signal distally as the fibers fan out.

ACL Anatomy - Axial

MOVIE

MOVIE
ACL tears

• Mechanism of injury
  – Most common – Pivot shift
    • Valgus and axial force on flexed knee
    • Varus force with internal rotation of the tibia can lead to ACL tear with Segond fracture at lateral tibia
    • Hypertension, with ACL and sometimes PCL or posterolateral corner injuries.
  – All may be associated with injury to collateral ligaments, menisci, articular cartilage

ACL tears

Pediatric Considerations

• Girls > boys
  – joint laxity
  – hormonal factors
  – limb alignment
  – configuration of intercondylar notch
  – earlier physeal fusion.

• Can see bony contusion pattern of tibial translation w/o ACL tear, due to increased ligamentous laxity (28%).
ACL tears

• Location/Type
  – Avulsion (Proximal/Distal)
  – Intrasubstance

ACL tears

• Location/Type
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ACL avulsion

• Kids - forced flexion of the knee with internal rotation of the tibia
• Adults - severe hyperextension. Associated with MCL and PCL tears.

ACL avulsion

• Meyers and McKeever classification
  – I – minimally displaced fragment
  – II – anterior elevation of fracture fragment
  – III – complete separation of fragment from tibia
  – IV – III + rotational component or comminution
6 yo male. Fall from bike with knee pain
14 yo male with skiing injury. Went off a small jump, right leg struck the ground, twisted relatively violently and his ski stayed in place
ACL tears

- Location/Type
  - Avulsion (Proximal/Distal)
  - Intrasubstance

- MRI appearance
  - Focal tear/discontinuity
  - Diffuse or focal abnormal signal
  - Mass like appearance
  - Abnormal orientation (15 degrees between roof of intercondylar notch and ACL or less than 45 degrees between distal ACL and tibia)
  - Non-visualization (chronic)
14 yo male, football injury, diagnosed with ACL tear 4 months earlier
Treated conservatively

One year later....
ACL repair – Physeal sparing

Physeal Sparing Reconstruction of the Anterior Cruciate Ligament in Skeletally Immature Prepubescent Children and Adolescents

Diagram of physeal sparing reconstruction methods for different growth stages.
ACL repair – Physeal sparing

A

B

Physeal Sparing Reconstruction of the Anterior Cruciate Ligament in Skeletally Immature Prepubescent Children and Adolescents

C

D

Physeal Sparing Reconstruction of the Anterior Cruciate Ligament in Skeletally Immature Prepubescent Children and Adolescents

Surgical Technique
13 yo male who jumped on knee and twisted it playing basketball
9 months later, landed with straight knee – not wearing brace...

**Posterior Cruciate Ligament**

- Prevents posterior tibial translation, especially in knee flexion.
- Anterolateral band
  - Has more anterior origin, from lateral margin of MFC.
  - Taut in flexion
- Posteromedial band
  - Taut in extension
- Both insert onto posterior aspect of proximal tibia, 1 cm inferior to articular surface
PCL tears

- Relatively rare
- 45% 2/2 to road traffic accidents
  - Dashboard injury - anterior blow to proximal tibia
- 40% from athletic trauma
  - Fall on flexed knee
  - Hyper flexion (may be isolated to anterolateral, with PMB intact, and sparing of posterior capsule)
  - Hyperextension (less common) – more associated with ACL and PLC or PMC injuries

11 yo male who fell on flexed knee
13 yo male with hyperflexion injury to left knee while going down stairs
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Menisci

Medial and Lateral Menisci

- Shock absorption
- Distribute axial load
- C shaped
- Root attachments to tibia in close proximity to cruciate ligaments

Coronal

Medial meniscus is attached to deep fibers of MCL

Sagittal

- Medial meniscus increases in width from anterior to posterior
- Lateral meniscus has equal size of anterior and posterior horns.
- Popliteomeniscal fascicles —
  - from periphery of posterior horn LM, forming posterolateral meniscocapsular extension, creating popliteus hiatus.
Meniscal ligaments

- Meniscofemoral ligaments
  - Humphery, Wrisberg
- Transverse meniscal ligament.
- Oblique meniscocapsular ligament
Meniscal ligaments

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Meniscofemoral ligaments

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Pitfalls in menisci

• Anterior root attachment of lateral meniscus with striated appearance
• Anterior attachment of the med meniscus, looking like extrusion
• Meniscal flounce

Mensical tears

• Criteria
  – Signal contacts articular surface
    • Especially important in peds (vs vascularity)
    • Change in shape or size of meniscus
Mensical tears

- Grade 1 – Uniform hypointense signal
- Grade 2 – Hyperintense signal does not extend to meniscal surface
- Grade 3 – Hyperintense signal extends to meniscal surface

Mensical tears

- Longitudinal Vertical
  - (Bucket handle)
- Horizontal
- Radial
- Flap
- Root
- Complex
Meniscal tears

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Longitudinal Tear

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Radial Tear

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Flap Tear

Meniscal tears

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Meniscal tears

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Discoid Meniscus

• Lateral
• Greater than 15 mm TR dimension
• Asymptomatic → to pain and locking
• Increased degeneration and tearing

Discoid Meniscus
Discoid Meniscus

Discoid Meniscus
Discoid Meniscus

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Posterolateral Corner

- Frequently associated with PCL tears
- Secondary to:
  - blow to the anteromedial prox tibia, directed posterolaterally w/knee in extension
  - noncontact external rotation with hyperextension
- Failure to dx → chronic instability and cruciate graft failure.

Posterolateral Corner

- Superficial layer
  - Iliotibial band
  - Biceps femoris
- Middle Layer
  - Quadriceps retinaculum, patellofemoral ligaments, patellomeniscal ligament
- Deep Layer
  - Lateral joint capsule/meniscal attachments
  - Popliteus/popliteofibular ligament.
  - Mid third lateral capsular ligament (Segond)
  - Coronary, fabellolateral, fibular collateral, and arcuate ligaments
Posterolateral Corner

- **Superficial layer**
  - Iliotibial band
  - Biceps femoris tendon
- **Middle Layer**
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Biceps Femoris/FCL tear

15 yo male with right knee hyperextension injury while playing football
Biceps Femoris/FCL tear

15 yo male with right knee hyperextension injury while playing football

Proximal avulsion
Proximal avulsion

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Popliteus tear

10 yo male s/p twist and fall

Posterolateral Corner

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Arcuate ligament
Arcuate ligament tear

Arcuate ligament tear...& ACL
Posterolateral Corner

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  - Mid third lateral capsular ligament (Segond)
  - Coronary, fabellofibular, fibular collateral, and arcuate ligaments
Segond Fracture

- Mechanism is internal rotation of the knee and varus stress
- Middle third of the lateral capsular ligament
  - (? ITB and anterior oblique band of FCL)
- Associated with ACL and meniscal tear (also with avulsion of fibular attachment of long head of biceps femoris and fibular collateral ligament)
17 yo male football player with knee dislocation

MOVIE

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Medial Collateral Ligament

• MCL anatomy

MOVIE
MCL tear
MCL (ACL and PCL) tear

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Chronic Stress Injuries of Extensor Mechanism

- Osgood Schlatter
- Sinding Larsen Johansson (vs patellar sleeve fracture)

Osgood Schlatter
SLJ vs patellar sleeve fracture

Tibial Tubercle Avulsion

- Powerful contraction of knee extensors
- Active adolescent males
- Occurs as the growth fuses...
Tibial Tubercle Avulsion

- Powerful contraction of knee extensors (take off from jump)
- Rapid passive flexion of knee with contracted quad (land from jump, or fall from height)
- Active adolescent males
- Occurs as the growth fuses...

Tibial Tuberosity Development

Cartilaginous - 11 yo male
Tibial Tuberosity Development

Apophyseal – 13 yo male

Tibial Tuberosity Development

Epiphyseal - 11 yo female
Tibial Tuberosity Development

Bony - 19 yo female

Tibial Tubercle Avulsion

13 yo male skier

Type 3B Tibial Tubercle Fracture

LEFT

RIGHT
Type 4 Tibial Tubercle Fracture

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Physeal Injuries

- Physeal fractures can be complicated by entrapment of tendons, ligaments or periosteum
- Persistent widening of physis >3 mm on radiographs
- Periosteum ➔ bone formation and increased risk of physeal bar.

13 yo male with basketball injury - jump
Periosteal Entrapment
Periosteal Entrapment

Periosteal Entrapment
Periosteal Entrapment

3 yo male

Periosteal Entrapment
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Patellar alignment

- Anatomy
  - Patellofemoral ligaments
  - Trochlear morphology
  - TT-TG
Trochlear morphology
TT-TG interval

TT-TG – 2.9 cm

Patellar dislocation

Women > men
2nd decade of life
Risk factors
- trochlear dysplasia
- Patella alta
- Increased TT-TG

• Dislocates laterally
• Flexed knee, internal rotation, with valgus force
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Dorsal defect of patella
Dorsal defect of patella

Bipartite patella
Right knee pain

Right knee pain
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- **OCD vs Normal Variant**
OCD vs normal variant

OCD vs normal variant
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