Imaging of collateral ligaments and posterior corners: combined with cruciate ligament lesions

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24 yrs male, bicycle accident, your diagnosis, please

MRI is not first, but best imaging choice

Fall or twisting injuries of the knee

characteristic clinical findings:
- focal tenderness
- effusion
- inability to bear weight

Objectives
Footprint patterns of kinetic chains
Puzzling the diagnosis by grading and in the context of clinical findings

The role of twisting injuries and the main anatomic stabilizers to prevent them

The clinical entity termed the pivot shift was studied in cadaver specimens and its significance was evaluated:
It was found to be highly correlated with a tear of the anterior cruciate ligament, and it corresponded to a sudden anterior-internal rotation subluxation-dislocation of the tibia and posterior horn of the lateral meniscus beneath the lateral femoral condyle.


Anatomy: the main stabilizers of the knee
Classification basing on anatomy and biomechanical forces

Knee extensor system: osseo-musculo-tendinous unit
Lateral aspect of flexor system: lock and unlock mechanisms of tibial rotation
Medial aspect: of hamstring cuff
Posterolateral corners: capsule and tendons are strong stabilizers

Medial supporting structures
Medial retinaculum
Medial collateral ligament
- superficial portion
- deep portion with meniscofemoral extension, meniscotibial extension

Medial meniscus
Semitendinosus tendon
Medial gastrocnemius head
VALGUS-EXTERNAL ROTATION STABILIZING SYSTEM

Common overuse syndromes (ordered from superficial to profound location)
- Medial retinaculitis
- MCL insufficiency (breaststroker’s knee, due to repeated stretching during swimming)
- Pes anserinus bursitis
- Semimembranosus tendinitis or injury
- Plica syndrome

García-Valtuille R et al, Radiographics Sept 02

Medial collateral ligament (MCL)
- primary valgus stabilizer: proximal division of the superficial MCL
- primary external rotation stabilizer: distal division of the superficial MCL at 30° of knee flexion
- primary internal rotation stabilizers: PCL and the distal division of the MCL with the meniscofemoral and meniscotibial ligaments


Combined ACL and MCL lesion
-snowboarding 6 days ago: predominantly valgus injury mechanism

Medial collateral ligament
- strain/partial rupture
- rupture

Anserine bursa

The posteromedial corner: 2 components and 3 layers concepts

2 components of MCL:
- the straight part
- the fan-like posterior part

The 3 layers concept
- Layer I: the crural fascia and retinaculum
- Pes anserinus (between layers I and II)
- Layer II: superficial MCL and semimembranosus tendon
- Layer III: deep MCL and fibrous knee joint capsule

Warren LF et al. The supporting structures and layers on the medial side of the knee: an anatomical analysis JBJS (Am) 1979

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Layer II: the semimembranosus complex, i.e. its insertional tendon

Semimembranosus muscle: the strongest knee flector

Semimembranosus: abnormal findings

Meniscocapsular inflammation or separation

Baker’s cyst: Advanced degenerative rupture: rupture is a severe form of degeneration

Baker’s cyst

Menisco-capsular separation. De Maeseneer M et al., EJR, March 2002

Semimembranosus tendon

• Association with meniscal lesion: 51 %
• Association with cruciate ligament lesion: 15 %

The lateral supporting structures

Knee extensor system: osseo-musculo-tendinous unit

Lateral aspect of flexor system: kick and unlock mechanisms of tibial rotation

Medial aspect: of hamstring cuff

posterior corners: capsule and tendons strong stabilizers

Lateral collateral ligament (LCL) and popliteus tendon

VARUS-INTERNAL ROTATION STABILIZING SYSTEM

Common overuse syndromes:
- Iliobibial band friction syndrome (runner’s knee, cyclist’s knee)
- Popliteal tendinitis
- Bicipital tendinitis, peroneal nerve entrapment

Iliotibial band:
- direct contact
- in varus

Gerdy’s tubercle

Iliotibial band friction (ITBF) syndrome: Runner’s knee and cyclist’s knee

Cyclist’s knee:
- Insufficient medial muscle support leads to:
  - patellofemoral pain syndrome
  - ITBF friction during contact with 30 degrees of flexion

Farrell K et al., The Knee, 2003

Triathlete

Segond fracture

White L et al., Sem Musculoskeletal Radiol 2004

Posterolateral corner (the arcuate complex)

stabilizes against varus and external rotation

fibular collateral ligament
arcuate ligament
popliteus tendon

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Popliteus muscle

Origin: popliteal notch
popliteofibular ligament
popliteomeniscal ligament

Posterior ligamentous relationships

posterior cruciate ligament
anterior cruciate ligament
Humphrey ligament
Wrisberg ligament
Popliteus muscle

Lee BY et al. Incidence and significance of demonstrating the meniscofemoral ligament on MRI. Br J Radiol 2000; 73: 271; visible with MRI in 83 %

Posterolateral corner (= the arcuate complex)

stabilizes against varus and external rotation

Biceps muscle and tendon
Popliteus tendon
Popliteofibular ligament
Fibular collateral ligament

Posterior-lateral corner lesions

a serious problem of capsular instability

- PCL injury
- Unsharp latero-posterior capsular structures
- Popliteal muscle abnormality

40 yrs patient after skiing accident
Arcuate ligament rupture
(White L et al, 2004)

Fibular collateral ligament injury

motor cycling accident

Practice recommendation: the fibular collateral ligament – the forgotten ligament in MR reporting

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indication interpretation differential diagnosis Puzzling the diagnosis by grading and in the context of clinical findings
Diagnostic concept of kinetic chains due to indirect forces

"Ligaments at risk"
- within a narrow anatomic environment or rubbing against adjacent bones
- with exposure to strong tensile forces
- within a complicated ligament complex
- with weak bony attachments.

Resnick, Chang, Pretterklieber, 2007

The musculo-tendino-osseous chains
- The interossous ligamentous chains

"Unhappy triad":
ACL, MCL, medial meniscus

We conclude that the classic O'Donoghue triad is, in fact, an unusual clinical entity among athletes with knee injuries.


The Hayes classification system

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<th>Indication</th>
<th>Interpretation</th>
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<td>Biomechanical forces induce typical anatomic distributions of injury, mostly &quot;unhappy triad&quot; type</td>
<td>Foot prints of injury is traumatic type bone marrow edema: compression, avulsion, or stress-induced</td>
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Images and anatomic support:
- Stummvoll G, Pretterklieber M, Kainberger F (eds.) [Motion and Performance], Facultas-Publishers, Vienna
- Lena Hirtler, MD, core unit of anatomy and cell biology, Medical University of Vienna